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Results of the Cooperative 1990 U.S. - Japan Squid Jigging Survey off the Oregon and Washington Coast

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RESULTS OF THE COOPERATIVE 1990 U.S.-JAPAN SQUID JIGGING SURVEY OFF THE OREGON AND WASHINGTON COAST

by

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ABSTRACT

A cooperative squid jigging research survey was conducted by U.S. and Japanese participants in the U.S. Exclusive Economic Zone off the coast of Oregon and Washington during August and September, 1990 to determine the distribution and abundance of neon flying squid (Ommastrephes bartrami) and examine the feasibility of harvesting this species with jig gear. Four Japanese vessels, three with one U.S. scientist aboard and one with both a Japanese and U.S. scientist, completed 142 night fishing stations between 1 August and 4 September, 1990, using overhead attraction lights, automatic jigging machines, and handlines. Information on catch, effort, and biological characteristics were collected from target and bycatch species. Product recovery rates were calculated for different products produced from neon flying squid.

Automatic jigging machines were less effective at catching squid than handlines, which were able to be fished deeper, had a longer fishing time at depth, and utilized more rosettes of barbless hooks. Because the automatic machines were ineffective, the catch rates determined from them are not considered to be an appropriate measure of relative abundance.

The fishing vessels were not able to attract sizeable concentrations of neon flying squid. Squid caught were generally located at 100 m or greater depths and were associated with water mass fronts of colder water beneath warmer surface water. These ocean fronts concentrate plankton and nail squid (Onychoteuthis borealijaponicus) which were also caught in some abundance and were observed be an important prey item for the larger neon flying squid. Neon flying squid were caught at higher rates at greater bottom depths (>1,000 m) and during nights with less than a 60 percent full moon. Neon flying squid caught averaged 2.2 kg, 40 cm mantle length, and were predominantly immature females. Product recovery rates of neon flying squid averaged 49 percent for mantles and 62 percent for mantles and tentacles.

In addition to the target species, neon flying squid, five additional species of cephalopods and seven species of fish were caught during the survey. Bycatch rates averaged 86.8 kg/mt of target species and were dominated by nail squid (51.7 kg/mt), Pacific pomfret (Brama japonica) (9.7

kg/mt), and blue shark (Prionace glauca).(7.1 kg/mt). No marine mammals or birds were observed to be directly affected by the fishing gear or operations during the survey.

Although catch rates were generally less than sufficient to sustain a economically viable commercial operation, further exploration in and outside the survey area and during other months of the year might locate spawning concentrations or other aggregations which could sustain profitable operations for vessels smaller than the survey vessels used.

CONTENTS

INTRODUCTION

For many years the neon flying squid (Ommastrephes bartrami) resource in the northeast Pacific Ocean has been exploited by Asian fleets fishing with drift gill nets. U.S. scientists have long expressed an interest in investigating whether similar concentrations of neon flying squid occur within the U.S. Exclusive Economic Zone (EEZ), of what importance these concentrations might be to other marine resources, particularly marine mammals, and whether these concentrations offer a commercially viable resource harvestable by U.S. fishermen.

Recent public attention has focused on the non-selective nature of the squid drift gill nets and the resulting bycatch of other commercially important species, marine mammals, and birds. Increasing international interest has been directed at examining alternative harvest methods which would reduce bycatch and continue to effectively utilize the oceanic squid resource. As part of this effort, a cooperative research project was conducted by U.S. and Japanese participants during August and September of 1990 to examine the feasibility of harvesting neon flying squid with jig gear within the U.S. EEZ off the coast of Oregon and Washington.

U.S. and Canadian research has been conducted on neon flying squid in the eastern North Pacific since 1979. Jigging experiments for neon flying squid were carried out in conjunction with drift net fishing off Canada in 1979 (Bernard 1980), and were repeated in 1983 (Sloan 1984, Robinson and Jamieson 1984) and 1987 (Jamieson and Heritage 1988). Another squid jigging experiment was conducted in 1981 off Washington aboard a salmon troller in cooperation with the U.S. National Marine Fisheries Service (NMFS) (Mercer and Bucy 1983).

In the spring of 1990, Anchor Trading International, Inc. requested the participation and permission of the National Marine Fisheries Service to conduct a joint squid research survey with a Japanese company, Sanko Gyogyo Company, using state-of-the-art squid jigging vessels. The NMFS reviewed the proposed research plan, suggested changes, and approved the revised plan in July of 1990. Sanko Gyogyo Company Ltd. provided four Japanese squid jigging vessels, STI Company conducted project coordination in Japan, Anchor Trading International, Inc. conducted project coordination in the U.S., Natural Resources Consultants, Inc. was responsible for scientific data collection and analysis, and NMFS monitored the survey performance. A NMFS approved, U.S. scientist was placed on board each of the four Japanese vessels and a Japanese scientist, Dr. Yoshihiko Nakmura, was assigned to one of the vessels. The survey began on 1 August and was terminated on 6 September, 1990.

The specific objectives of the investigation were to 1) survey the U.S. EEZ off Oregon and Washington by jigging for cephalopods, specifically targeting neon flying squid, to determine their distribution and relative density by area, depth, moon phase, water temperature and other environmental factors based on comparison of catch-per-unit-effort (CPUE); 2) determine the associated bycatch of non-target species; 3) record any interactions between marine mammals, birds, or turtles and the target squid species or with the fishing operations; 4) collect biological information on cephalopods including size composition, sex ratio, length-weight relationships and sexual maturity; 5) determine the effectiveness of jig fishing gear in regard to catching cephalopods in the survey area; and 6) to acquaint the U.S. fishing industry with modern Japanese squid jigging equipment and techniques.

METHODS

Survey Area and Sampling Strategy

The 1990 U.S.-Japan cooperative squid research project covered the waters of the U.S. EEZ between 12 and 200 miles off Washington and Oregon (42°00 N lat. north to the U.S. Canada border). The area was stratified into six sub-areas to ensure data was collected evenly from as wide an area as possible. Each of the four vessels were scheduled to occupy 88 unique stations during the survey. Japanese fishing masters were allowed to select the location of each nightly sampling station, subject to the limits on the number of stations in each sub-area and the prohibition of not sampling the same station on more than one night. The number of stations assigned per area was established by dividing the total of 88 stations by the proportion of total survey area surface area represented by each sub-area. Each of the four vessels had an equal number of stations assigned in each of the survey sub-areas. The extent of the survey area and the number of stations completed in each sub-area are shown in Figure 1.

Fishing operations were scheduled from 1 August through 30 October, but were terminated on 5 September when it was concluded that the automatic jigging machines employed were ineffective, as rigged, in catching neon flying squid in the survey area.

Vessels and Gear

Four Japanese squid jigging catcher/processor vessels were furnished by Sanko Gyogyo Company, Ltd. The vessels ranged in length from 55 to 70 m, had 1,450 to 1,800 hp, crews of 11 to 17 men, and were capable of catching and processing between 22.5 and 57.1 mt of squid per day (Table 1).

The vessels were equipped with single and dual-drum automatic jigging machines, along the full length of each side and at the stern of each vessel. The drums on each machine were oval shaped to impart an uneven, jigging motion to lines during recovery. Lines ran from the machines over pulleys suspended on the ends of metal platforms outboard of each machine. Short (1.5 m) and long (3 m) platform lengths were alternated along the length of the vessel to reduce tangling of lines from different machines. The bottoms and sides of each platform were covered with stiff plastic mesh to form a basket-like arrangement. While running, the platforms were usually secured in a vertical position. When fishing, the platforms were inclined to collect squid that were caught and allow them to slide down the platforms and fall into a collection flume running along the gunwale. The flume contained running water which washed the collected squid from each machine down the side of the vessel and to the factory, below deck. On the Fuki Maru No. 63 separate controls for each machine were located on the bridge or on the machines, allowing the fishing master to control the depth and speed of recovery. On the other three vessels, the machines were controlled by switches on the machines themselves. The number of jigging machines aboard each vessel ranged from 64 to 118.

The lure arrangement on the jigging machine lines consisted of a main wire or nylon monofilament (80 to 130 lb test) fishing line attached to a series of 12 to 15 squid jigs spaced approximately 1 m apart by nylon monofilament leaders (30 to 90 lb test). The standard machine line squid jigs are 10 to 12 cm long, 1.5 cm in diameter, with one, two, or three rosettes of 16 barbless hooks 10 to 12 mm long. On each end of the jig is a metal ring attached to swivels and a wire running through the body of the jig allowed the jigs to be rigged one below the other with the 1 m nylon monofilament leader. The body of the jig was constructed of hard or soft plastic in a variety of colors and finishes. The most common colors were clear, dark or light green, and dark or light blue. At the terminal end of each line was a 2.5 kg lead weight to vertically orient the line and sink it to the desired depth.

Lines were lowered to a pre-set depth by the machines and then immediately retrieved with the jigging motion imparted by the oval drums. Squid were attracted to the jigs and the barbless hooks set into the mantles or tentacles of the squid. The squid remained hooked on the barbless hooks due to the constant upward pressure of the line during the retrieve. The main line and jigs were retrieved over the top of the pulley on the end of the outboard platform until only the terminal weight remained hanging vertically over the side of the vessel below the platform. The squid fell off the barbless hooks when the jigs passed over the pulley on the end of the platform and the upward pressure was removed. The squid then rolled down the basket-like bottom of the platform into the collection flume and were washed into the processing factory below deck. When the terminal weight reached the pulley on the end of the platform the machine immediately began re-setting the line to the pre-set depth and the process was repeated. The fishing rate of each machine depended upon the depth and speed of retrieval.

Handlines were also used to test fish at particular depths or to employ different types of jigs than those used on the automatic jigging machines. Handlines were constructed of wood frame reels with 100 to 250 m of 90 lb test nylon monofilament with one or more jigs rigged vertically. Special jigs were used on the handline. These jigs were constructed of long (5 to 30 cm), 1 cm thick chrome metal, weighted with 0.5 to 1.0 kg of lead, and contained two to ten rosettes of hooks on the terminal end. These jigs could not be safely fished on the jigging machines since their size and weight damaged the terminal pulley on the platforms. Most handlines were fished with a single jig. The jig was lowered to the desired depth and the line moved up and down approximately 1 m in a slow jigging motion until a squid was hooked. Then the line was retrieved to the surface with constant upward pressure.

Attraction lights were suspended approximately 2.5 m inboard and 4.5 meters above each machine. Bulbs were 1 or 2 kw and were spaced 70-80 cm apart down the length of each side of the vessel. This arrangement created a shadow angle of approximately 31° off the vertical. The color of the lights could be varied between white and green by controlling their intensity from the fishing master's station on the bridge. The number of lights used on any particular night varied but generally 100 to 160 lights were illuminated at any one station. The Japanese scientist estimated that the lights were able to attract squid from between 70 and 100 m deep.

The fishing masters, lacking specific knowledge of the fishing area and resource distribution in the region, resorted to experimentation to determine the most effective gear and fishing strategy. During the day, hydroacoustic detection patterns and surface water temperature were used to locate areas were favorable fishing conditions existed. Although squid concentrations were not sufficient to be directly detected by hydroacoustic equipment, plankton layers upon which squid might feed were identified. One of the vessels (Fuki Maru No. 63) was equipped with an expendable bathymetric thermometer (XBT) which was used to measure water temperature at depth and examine the relationship between squid distribution and water temperature depth profile. Surface temperature (measured at hull depth) was recorded by each vessel at all stations fished.

When potential fishing stations were identified, the vessel would slow to a stop and deploy a bow mounted sea anchor. The lights were illuminated at dusk and fishing operations began just after dark. Early in the evening only a few jigging machines would be operated and later additional machines would be employed, depending upon initial harvest success. Handlines were used periodically throughout the night to sample a variety of depths and alternative jig styles and colors.

Neon flying squid caught were processed into a variety of products including whole, tubes (head, tentacles and organs removed), and mantles (head, tentacles and organs removed, tube split and cleaned). In most cases tentacles, organs, and heads were discarded. Approximately 10 to 12 kg of processed squid were placed in individual metal holding pans and frozen in a blast freezer. Frozen squid blocks were removed from the metal pans after freezing, glazed with sea water, and stored unpackaged in a frozen hold at -35°C.

Data Collection

Navigation, weather, catch, and effort data were collected at each station. Target and incidental species caught were counted and, if not all weighed, a subsample was weighed and counted to extrapolate the total catch weight at each station. Effort was recorded in line hours, which were calculated by multiplying the number of lines actively fishing by the length of time fished. Jig hours were calculated by multiplying the number of jigs actively fished by the length of time fished. In addition to the overall catch and effort recorded at each station, scientists selected one or more machines or handlines, recorded precise information on the type of jigs used, and observed the number of squid caught and the number of squid lost due to drop-off for a given period of time. Drop-off loss was recorded as the number of squid becoming unhooked between the surface and the deck of the ship and lost over the side. This allowed comparisons of CPUE by line type (short machine, long machine or handline) and jig type.

Biological information was collected from specimens of both target and incidental species. Length frequencies (mantle length for squid, fork length for bony fish, and total length for sharks) were recorded by 1 cm length categories, and by sex, when it could be determined, for all species caught. Individual specimen length in millimeters and weight in grams were recorded for all species of squid caught and for several incidental species. Length and weight data were transformed with a log transformation and length-weight relationships calculated for four species of cephalopods using a least squares regression method (Ricker 1975) where:

$$\log w = \log A * (\log l)^b$$

and

w = weight in grams,

l = length in millimeters.

Maturity (nidamental gland length and egg diameter in millimeters) was determined for female neon flying squid. Average nidamental gland length was compared by 0.5 cm mantle length categories. Specimens of all species of cephalopods were collected and frozen for laboratory analyses of age, food habits, maturity, morphometrics, and other studies.

Product recovery rates were determined for each neon flying squid product. A subsample of squid was collected from the catch, counted, and weighed to the nearest gram. The scientists allowed the processing crew to conduct normal processing procedures on the subsample and then counted and weighed the resulting products. Product recovery rates were calculated as a percent of the fresh, whole weight of the animal.

Scientists were also requested to conduct daylight observations for marine mammals in the survey area and to observe and record any interactions between marine mammals and the squid jigging operation.

RESULTS

Effort

Fishing was conducted at 142 stations between 1 August and 4 September, 1990. The project was terminated approximately two months early on 5 September after the fishing masters, scientists, support organizations, and the NMFS determined the jigging machines were ineffective as rigged to adequately assess the neon flying squid distribution and commercial potential under the prevailing cephalopod distribution in the survey area. All stations sampled were in the U.S. EEZ off Washington and Oregon (Fig. 1).

Of the 352 stations originally scheduled to be sampled during the survey, 142 or 40 percent were actually sampled (Table 2). Coverage ranged from a low of 19 percent of the scheduled stations in area 5 to 75 percent of the scheduled stations in area 3. There was a total of 1,206 hours of active fishing operations conducted during the survey by the four vessels. Total gear fishing effort totalled 50,904 line hours and 612,181 jig hours. Observations of individual gear and jig type performance totalled 7,961 line hours. Handline performance was observed for 267 line hours, short platform jigging machines were observed for 705 line hours, long platform jigging machines were observed for 6,989 line hours, and combined long and short jigging machines were observed for 2,374 line hours.

Catch

Six species of squid and seven species of fish weighing 20,200 kg were caught during the survey by the four vessels (Table 3). The target species, neon flying squid, dominated the catch with 8,395 squid weighing 18,587 kg. Daily single-vessel catches ranged from 0 to 1,137 kg. Nail squid (Onychoteuthis borealijaponicus) was the second most abundant species with a catch of 1,450 squid weighing 961 kg. These two species represented over 96 percent by weight of the total harvest during the survey. Other occasionally caught cephalopods included eight armed squid (Gonatopsis borealis), robust clubhook squid (Moroteuthis robusta), opal squid (formerly market squid) (Loligo opalescense), and schoolmaster gonate squid (Berryteuthis magister). Pacific pomfret (Brama japonica) was the most abundant incidentally caught fish species, followed by blue sharks (Prionace glauca), jack mackerel (Trachurus symmetricus), and chub mackerel (Scomber japonicus). King-of-the-salmon (Trachipterus altivelis), Pacific hake (Merluccius productus), and unidentified rockfish (Sebates spp.) were taken infrequently. Navigational, effort, and catch data are presented in Appendix 1.

Area 3 had the highest total catch, 8,371 kg, 41 percent of the total harvest, and received approximately 28 percent of the total effort (based on line hours) (Table 4). Neon flying squid dominated the catch in each of the six areas surveyed.

Due to the ineffectiveness of the automatic jigging machines in harvesting neon flying squid and the sporadic use of the more effective handlines, analyses of CPUE trends to determine relative abundance, distribution, and potential commercial harvest rates were difficult. However, estimates of total effort in line hours were recorded at each station and CPUE may offer the best comparison of relative harvest by area, gear type, and environmental factor. The reader is cautioned that different, more effective gear may have produced quite different CPUE results.

Over the entire survey area, CPUE of neon flying squid averaged 0.34 kg/line hour or 91 percent of the total CPUE of all species (Table 3). Neon flying squid dominated the total CPUE in all areas. Area 3 had the highest CPUE of neon flying squid (0.56 kg/line hour), followed closely by area 2 (0.45 kg/line hour) (Table 5). Other incidentally caught species had an overall CPUE of 0.03 kg/line hour.

The incidental catch rate of species other than neon flying squid totalled 86.8 kg per metric ton of neon flying squid (Table 6). The dominant incidentally caught species was nail squid at 51.7 kg/mt of neon flying squid, followed by Pacific pomfret at 9.7 kg/mt, and blue shark at 7.1 kg/mt. Other species were only occasionally caught during the fishing operation.

Observations of catch by individual gear and jig type indicated that handlines caught 2.55 squid/line hour compared with the short and long platform jigging machine catches of 0.15 and 0.17 squid/ line hour, respectively (Table 7). Squid loss or drop off rate was highest for the handlines at 0.4 squid/line hour indicating that handlines lost approximately 13.6 percent of the squid hooked, due to drop-off. Drop-off rates for the short and long jigging machines were nearly identical with one another at 0.04 and 0.05 squid/line hour or about a 22 percent loss rate.

Handlines observed were equipped with only long, chrome jigs of variable sizes and weights. The jigging machines were equipped with a variety of jigs The most effective jig pattern on the machines was a combination of clear and green hard plastic jigs. This configuration had an overall catch rate of 0.38 squid/line hour (Table 7). Dark green jigs lighted with chemical or battery powered lights produced catch rates of 0.25 squid/line hour, similar to green jigs fished without the lights. Drop-off rates for jigs fished on the jigging machines ranged from 0 to 0.08 squid/line hour.

Environmental Factors

Area

Neon flying squid mean CPUE was highest in area 3 (0.56 kg/line hour) and area 2 (0.45 kg/line hour) off the mid-Oregon coast (Table 8, Fig. 2). The highest catches in area 2 were concentrated somewhat inshore (<75 nm offshore) while in area 3 the highest catches occurred offshore (>125 nm offshore) (Fig. 3). Mean CPUE declined in the more northerly areas.

Bottom Depth

Mean CPUE of neon flying squid increased with increasing bottom depth (Table 9, Fig. 4). Mean CPUE ranged from 0.01 kg/line hour at depths less than 200 m to a high of 0.68 kg/line hour at depths of 3,000 to 4,000 m. All opal squid were caught from water less than 200 m in depth and all robust clubhook squid were caught from water 1,800 m or deeper. Although other cephalopods were taken at stations with a wide range of bottom depths, generally higher catches occurred at stations with bottom depths greater than 2,000 m.

Gear Depth

Gear depth was defined as the maximum depth fished below the surface at each station and was categorized into 25 m increments. Mean CPUE of neon flying squid increased with peaking at 100-125 m and decreasing in the deepest gear depth category of 126 m and greater. Mean CPUE decreased at gear depths deeper than 126 m (Table 10, Fig. 5). Gear depths deeper than 100 m were predominantly fished with the more effective handline gear, while gear depths less than 100 m were fished mainly with the jigging machines. The CPUE of flying squid in the 101-125 m depth category (1.16 kg/line hour) was more than three-fold higher than any other gear depth category.

Surface Water Temperature

There was no distinct relationship between surface temperature and mean CPUE of neon flying squid. Neon flying squid were not caught at stations fished with surface temperatures of 12°C or less (Table 11, Fig. 6). The highest mean CPUE occurred at stations with surface temperatures of 18.1 to 20.0°C (0.65 kg/line hour) and 14.1 to 16.0°C (0.42 kg/line hour).

Water Temperature At Gear Depth

Water temperature at gear depth was measured at the 35 stations fished by the Fuki Maru No. 63. There was no discernable relationship between water temperature at gear depth and mean CPUE of neon flying squid. The highest mean CPUE occurred at temperature ranges of 6.6 to 7.0°C (0.74 kg/line hour) and at 8.6 to 9.0°C (0.67 kg/line hour) (Table 12, Fig. 7). Appendix 2 contains tabular and graphical data of water temperature at depth profiles recorded by the Fuki Maru No. 63.

Lunar Cycle

Mean CPUE of neon flying squid was highest between 0 and 60 percent of full moon, 0.59 to 0.89 kg/line hour. Mean CPUE declined when the lunar cycle was between 61 and 100 percent of full moon, 0.22 to 0.03 kg/line hour (Table 13, Fig.8).

Cloud Cover

There was no definite relationship between cloud cover and mean CPUE of neon flying squid detected during the survey. During about 80 percent of the survey period skies were clear to partly cloudy. Mean CPUE was highest during periods of cloudy, rainy weather (0.55 kg/line hour) and lowest during foggy periods (0.0 kg/line hour) (Table 13, Fig. 9).

Beaufort Sea-State

Beaufort sea-state ranged from one to seven during the survey period. There was no detectable relationship between mean CPUE of neon flying squid and Beaufort sea-state category. The highest mean CPUE occurred at Beaufort sea-state six (1.15 kg/line hour) (Table 14, Fig. 10). Although fishing operations were not halted during the survey period due to weather, fewer jigging machines were fished under rougher conditions to prevent line tangles from increased wind, swell, wave action, and drift.

Biological Parameters

Neon Flying Squid (*Ommastrephes bartrami*)

Neon flying squid had a mean overall mantle length of 40.4 cm and an average weight of 2.21 kg. A total of 2,539 squid were measured and mantle length ranged from 13 to 59 cm (Table 15). Females dominated the catch, accounting for 2,339 squid or 93 percent out of the 2,503 squid sexed. Males were virtually absent from the survey catch during the first 15 days of the survey period. Males were generally smaller than females. The length frequency distribution for males was bimodal with peaks at 270 and 350 mm (Fig. 11). Females also had two peaks at 380 and 460 mm mantle length. Length-weight relationship coefficients for male, female, and sexes combined neon flying squid are presented in Appendix 3. None of the female neon flying squid examined during the survey were mature or near spawning. Preliminary results of laboratory examination of male and female squid indicate of 83 female squid examined, all were immature. Of the 45 male neon flying squid examined in the laboratory, 9 were approaching maturity, 12 were mature (presence of developed spermatophores in sperm packet), and 24 male squid were immature (pers. comm. Dr. Hiroshi Kajimura, NMFS, January 28, 1991). Nidamental gland length generally increased with increasing size (mantle length) of squid (Table 16, Fig. 12). Average gland length ranged from 13.8 mm for squid with 240 mm mantle length, to 110 mm for squid with 590 mm mantle length. Egg size was visually estimated to be less than 1 mm diameter in all female neon flying squid examined.

Nail Squid (Onychoteuthis borealijaponicus)

Nail squid were the second most abundant cephalopod species caught during the survey. Nail squid had a mean weight of 0.66 kg, and mean mantle length of 24.9 cm, ranging from 9 to 47 cm. Of the 574 animals sexed, 18 percent were male and 82 percent female. Males were generally smaller than females with a peak in the length frequency distribution at 210 mm. Female length frequency peaked at 260 mm (Fig. 13). Nail squid length-weight relationships by sex and for sexes combined are presented in Appendix 3. Preliminary examination of laboratory specimens indicate that of 13 female squid examined 11 were immature, one was approaching maturity, and three were mature. Of the 51 male nail squid examined, all were immature.

Other Cephalopods

Four other species of cephalopods were harvested during the survey. Eight armed squid (Gonatopsis borealis) had an average weight of 0.71 kg, and average length of 26.4 cm, and ranged in length from 19 to 34 cm. Of the 57 specimens sexed, males represented 53 percent and females 47 percent. There was an insufficient number of this species measured to determine distinct characteristic of the length frequency distribution (Fig. 14). Length-weight relationships for male, female, and both sexes of eight armed squid are presented in Appendix 3. Preliminary laboratory examinations found three out of ten, male, eight armed squid mature and all four female examined were immature.

Twelve specimens of robust clubhook squid (Moroteuthis robusta) were caught during the survey with an average weight of 3.76 kg. They ranged in size from 40 to 115 cm mantle length and averaged 55.6 cm. None of the individuals were sexed and an insufficient number were available to characterize the length frequency distribution (Fig. 15). A length-weight relationship for eleven robust clubhook squid was calculated and is presented in Appendix 3.

Five specimens of opal squid (Loligo opalescense) were caught during the survey. They had an average weight of 0.08 kg, average length of 10.8 cm, and ranged in mantle length from 10 to 12 cm. Too few specimens were caught to calculate a length-weight relationship or generate a length-frequency distribution.

A single specimen of schoolmaster gonate squid (Berryteuthis magister) was caught during the survey. The squid weighed 0.03 kg and had a mantle length of 14 cm.

Incidentally Caught Fish Species

Pacific pomfret (Brama japonica) was the most common incidentally caught species of fish during the survey. Pacific pomfret caught averaged 1.85 kg, ranged in length from 29 to 50 cm and had an average fork length of 42 cm. The length frequency distribution for Pacific pomfret caught during the survey is presented in Figure 16.

Blue shark (Prionace glauca) was also a commonly taken bycatch species during the survey. Blue shark caught ranged in total length from 77 to 150 cm and averaged 101.5 cm and 6.58 kg.

Jack mackerel (Trachurus symmetricus) caught ranged in fork length from 35 to 50 cm and averaged 41.9 cm and 0.84 kg. Figure 17 shows the length frequency distribution for incidentally caught jack mackerel.

Chub mackerel (Scomber japonicus) caught during the survey ranged in fork length from 19 to 47 cm and averaged 33.8 cm and 0.44 kg. Figure 18 presents the length frequency distribution of chub mackerel taken as bycatch.

Three Pacific hake (Merluccius productus), one king-of-the-salmon (Trachipterus altivelis), and an unidentified rockfish (Sebates spp.) were also caught during the survey. The Pacific hake caught had an average weight of 0.6 kg. The king-of-the-salmon weighed 10.4 kg and the unidentified rockfish weighed 0.3 kg and was 28 cm in fork length.

Product Recovery

Product recovery rates were calculated for eight different products produced from neon flying squid during the survey (Table 17). "Tubes" are the mantles of the squid with the head, tentacles, and organs removed, but the mantle left uncut in a tube shape. Tubes are a common product produced on board Japanese squid jigging vessels when catch rates are high and there is not enough time to process the squid further. During this survey there was adequate time to further process all squid and only a demonstration sample of squid were processed into tubes. The average recovery rate of tubes produced from whole squid was 51.9 percent. Mantles were processed similar to tubes, but the mantle was cut length-wise and the internal surface was thoroughly cleaned. Nearly all of the neon squid processed during the survey were processed into mantles. The recovery rate from whole squid to mantles ranged from 39.8 to 62.5 percent and averaged 49 percent. Tentacles were also retained from many of the squid. After removal from the whole squid, the head and organs were removed from the tentacles which were left attached together at the base. The recovery rate for neon flying squid tentacles averaged 18.8 percent of whole body weight. "Middles" is a term used to describe the area between the attachment of the organs and the base of the tentacles including the head. Middles yielded an average recovery rate of 6.6 percent and ranged from 3.2 to 8.3 percent of whole body weight. The average recovery rate for tubes and tentacles was 68.5 percent of whole body weight; mantles and tentacles ranged from 56.2 to 71.5 percent and averaged 62.4 percent; and mantles, tentacles, and middles had an average recovery rate of 69.1 percent.

DISCUSSION

Fishing effort was difficult to measure accurately due to the extensive use of handlines during the latter half of the survey period. Inconsistent fishing patterns caused by the crews experimenting with different gear configurations also made effort measurement difficult. Additionally, during any one night, spatial and temporal catch patterns of neon flying squid were irregular. Clusters of 10 to 12 squid were taken at a time on adjacent lines, with long periods of no catch in between. Japanese fishing masters noted that this pattern is common when squid are not concentrated in spawning groups but are traveling in small feeding groups. Fishing success may have been better if the survey had been conducted in areas and times of peak spawning, which are unknown for this stock.

The greatest abundance of neon flying squid was caught between 101 and 125 m gear depth. Hydroacoustic traces commonly showed a layer of plankton 100 m and more below the surface. Nail squid were also commonly caught at this depth. The smaller nail squid were also observed in the stomachs of the larger neon flying squid taken during the survey. Neon flying squid may have been attracted to small fish and nail squid feeding in the plankton layers at depths greater than 100 m. A subjective analysis of the water temperature profile data indicated these plankton layers were most common in colder water (6.6 to 7.0°C) located under warmer surface waters (18 to 20°C). These areas may represent fronts between different bodies of water or currents that aggregate species upon which neon flying squid feed.

The presence of abundant prey at deeper depths was likely a factor in the inability of the vessels to successfully attract neon flying squid to shallower depths with the attraction lights limiting the effectiveness of the jigging machines. These machines are designed to harvest squid from dense schools less than 70 m below the vessel when nearly every retrieval of the line is likely to catch one or more squid. The jigging machines are not designed to fish the jigs at depth until squid are encountered. On the contrary, they keep the lines moving almost constantly either setting or retrieving the gear. When the target squid are at depths of 100 m or greater, the jigging machines only fish the jigs at that depth for a few moments and then return the lures to the vessels, minimizing effective fishing time and the resulting catch. Although the Japanese fishing masters indicated the jigging machines were capable of fishing at depths up to 150 m with the addition of longer main lines, the reduction in the effective fishing time at these depths and their belief that squid were not concentrated by the attraction lights at these depths, made effective use of the jigging machines highly unlikely. Fishing masters also commented that, at increased fishing depths, lines from the jigging machines are more likely to get tangled. It should be noted that during the survey individual jigging machines were set to fish up to 150 m and still proved ineffective at catching neon flying squid.

Handlines were notably more effective in catching squid than the jigging machines during the survey. The handlines allowed fishermen to maximize fishing time within the depth range where squid were most abundant. The multiple hook rosettes on the larger handline jigs appeared to reduce the squid drop-off rate observed with the single or double hook rosettes on the standard machine jigs. The jigs fished on the handlines had a 14 percent squid drop-off rate compared with a 25 to 50 percent drop-off rate for the standard jigs.

Bycatch rates of non-target species were low during the survey. Many of the fish and cephalopods taken incidentally were returned to the sea with only minor damage. Larger specimens usually fell off the hooks during the retrieval. No salmon or tuna were caught during the fishing operations. Blue sharks created some problems such as damaging or consuming target squid during retrieval or becoming hooked by the jigs and entangling other jigging lines. Blue sharks accounted for most of the minor gear loss which was limited to several jigs with attached terminal line weights. The Japanese fishing masters and the scientists indicated that blue sharks were not a significant problem during the survey, nor did they significantly impact the squid harvest.

Marine mammals were observed in the vicinity of the squid fishing operations during daylight. Although several Dall's porpoise (Phocoenoides dalli), Pacific white-sided dolphins (Lagenorhynchus obliquidens), unidentified seals (Phocidae), and Sei whales (Balaenoptera borealis) were observed in the vicinity of the ships during night fishing operations, none were observed interacting directly with the fishing gear.

The Japanese fishing masters indicated that marine mammals are rarely, if ever, encountered during active fishing operations.

The potential for squid jigging as an alternative fishery off the West Coast of the U.S. remains unknown. The survey indicated the target species, neon flying squid, was present in the area during the time period and within the area surveyed. Neon flying squid catch increased with increasing bottom depth, indicating jigging may offer an alternative fishing method to drift gill netting in deeper, oceanic waters outside the U.S. EEZ. The reduced effort expended during the project and the inability of the jigging machines to effectively catch squid at the depths and concentrations encountered did not allow an analysis of relative abundance or distribution of neon flying squid. The vessels used in this survey require minimum average target species catches of five metric tons per night to maintain break-even operations.

Smaller U.S. vessels may be able to conduct profitable operations at significantly lower harvest rates. The cost of converting existing U.S. vessels to squid jigging could be high. Electrical supply capacity of most vessels would need to be upgraded to power the attraction lights and machines. Vessels would either have to fish close to ports of delivery, making one to three day trips, or install blast freezing and storage freezing capable of maintaining frozen product at -35°C.

Jig fishing for squid offers the attractive advantage of producing little or no bycatch and no direct interactions with marine mammals or birds. Gear loss in the squid jigging operational is minimal which reduces marine debris effects of other traditional gear types.

Further research into the abundance, distribution, spawning, and migration characteristics of cephalopods off the West Coast of the U.S. is warranted. Modifications of existing jigging machines to allow greater fishing time at deeper depths should be tested. Further work on the effects of environmental conditions on the distribution and abundance of cephalopods should be initiated. Any future research on these resources should fully cover the U.S. EEZ off California, Oregon, and Washington and operate during periods likely to cover the spawning season of neon flying squid.

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Table 1.--Characteristics of the Japanese squid jigging catcher/processor vessels used during the 1990 U.S.-Japan Cooperative Squid Research Project.

	Fuki Maru No. 58	Fuki Maru No. 63	Wakashio Maru No. 68	Narita Maru No. 37
Length (m)	55	70	56	55
H/P Main Engine	1,600	1,800	1,600	1,450
Cruising Speed (knots)	11.5	12.5	10	11
Crew	13	17	14	11
Processing Capacity (mt/day)	23.8	57.1	25	22.5
Jigging Machine Lines	64	118	80	70
Overhead Lights	140	160	110	100

Table 2.--Average fishing effort expended during the 1990 U.S.-Japan Cooperative Squid Research Project.

Area	Scheduled Stations	Completed Stations	Percent Completed Stations	Fishing Hours	Line Hours	Jig Hours
1	64	23	36%	182	9,725	116,769
2	64	26	41%	231	10,550	122,572
3	64	49	77%	417	14,638	178,242
4	64	20	31%	175	7,335	88,301
5	84	16	19%	135	6,028	74,965
6	12	8	67%	66	2,628	31,333
Total	352	142	40%	1,206	50,904	612,181

Table 3.--Round weight (kilograms), numbers, mean weight (kilograms, and mean catch-per-unit-effort for species caught during the 1990 U.S.-Japan Cooperative Squid Research Project.

Common Name	Catch (kg)	Catch (numbers)	Mean Weight (kg)	Mean CPUE (kg/line hour)	Percent of Total CPUE	Cumulative Percent of CPUE
Neon Flying Squid	18,587.0	8,395	2.21	0.3442	91.14%	91.14%
Nail Squid	961.1	1,450	0.66	0.0203	5.37%	96.51%
Pacific Pomfret	179.5	97	1.85	0.0040	1.07%	97.58%
Blue Shark	131.5	20	6.58	0.0022	0.59%	98.16%
Jack Mackerel	106.4	126	0.84	0.0019	0.51%	98.67%
Chub Mackerel	71.6	162	0.44	0.0018	0.48%	99.15%
Eight Armed Squid	82.8	117	0.71	0.0016	0.43%	99.58%
Robust Clubhook Squid	67.6	18	3.76	0.0013	0.35%	99.93%
King-of-the-Salmon	10.4	1	10.40	0.0002	0.06%	99.98%
Pacific Hake	1.8	3	0.60	<0.0001	0.01%	99.99%
Rockfish Unid.	0.3	1	0.30	<0.0001	0.00%	100.00%
Opal Squid (Market Squid)	0.5	6	0.08	<0.0001	0.00%	100.00%
Schoolmaster Gonate Squid	<0.1	1	0.03	<0.0001	0.00%	100.00%
Total	20,200.5	10,397		0.3777	100.00%	

Table 4.--Round weight (kilograms) and numbers caught by species and stratum during the 1990 U.S.-Japan Cooperative Squid Research Project.

Common Name	Catch by Area (kg)						
	1	2	3	4	5	6	Total
Neon Flying Squid	1,848.3	4,640.5	7,969.5	2,035.8	1,684.1	408.8	18,587.0
Nail Squid	247.0	115.6	241.2	331.2	19.7	6.4	961.1
Pacific Pomfret	0.0	30.7	97.0	18.1	24.4	9.3	179.5
Blue Shark	40.7	70.8	14.6	2.5	2.9	0.0	131.5
Jack Mackerel	31.1	72.5	2.8	0.0	0.0	0.0	106.4
Eight Armed Squid	51.9	20.7	8.6	1.6	0.0	0.0	82.8
Chub Mackerel	52.0	10.9	8.7	0.0	0.0	0.0	71.6
Robust Clubhook Squid	3.5	2.1	27.8	2.3	31.9	0.0	67.6
King-of-the-Salmon	0.0	0.0	0.0	10.4	0.0	0.0	10.4
Pacific Hake	1.8	0.0	0.0	0.0	0.0	0.0	1.8
Opal Squid (Market Squid)	0.0	0.0	0.5	0.0	0.0	0.0	0.5
Rockfish Unid.	0.0	0.0	0.3	0.0	0.0	0.0	0.3
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	2,276.3	4,963.8	8,370.9	2,401.9	1,763.0	424.5	20,200.5

Common Name	Catch by Area (numbers)						
	1	2	3	4	5	6	Total
Neon Flying Squid	855	1,896	3,927	832	719	166	8,395
Nail Squid	413	273	501	149	103	11	1,450
Pacific Pomfret	0	14	53	12	12	6	97
Blue Shark	7	8	3	1	1	0	20
Jack Mackerel	36	88	2	0	0	0	126
Eight Armed Squid	72	32	12	1	0	0	117
Chub Mackerel	128	19	15	0	0	0	162
Robust Clubhook Squid	2	1	9	1	5	0	18
King-of-the-Salmon	0	0	0	1	0	0	1
Pacific Hake	3	0	0	0	0	0	3
Opal Squid (Market Squid)	0	0	5	1	0	0	6
Rockfish Unid.	0	0	1	0	0	0	1
Schoolmaster Gonate Squid	0	0	0	0	1	0	1
Total	1,516	2,331	4,528	998	841	183	10,397

Table 5.--Average catch-per-unit-effort (kilograms per line hour) by species and stratum during the 1990 U.S.-Japan Cooperative Squid Research Project.

	Catch Per Unit Effort by Area (kg/line hour)						
Common Name	1	2	3	4	5	6	Total
Neon Flying Squid	0.2356	0.4482	0.5552	0.3815	0.2678	0.1770	0.3442
Nail Squid	0.0328	0.0120	0.0349	0.0357	0.0036	0.0027	0.0203
Pacific Pomfret	0.0000	0.0031	0.0072	0.0042	0.0036	0.0061	0.0040
Blue Shark	0.0043	0.0067	0.0011	0.0008	0.0004	0.0000	0.0022
Jack Mackerel	0.0050	0.0064	0.0002	0.0000	0.0000	0.0000	0.0019
Chub Mackerel	0.0088	0.0010	0.0010	0.0000	0.0000	0.0000	0.0018
Eight Armed Squid	0.0069	0.0019	0.0007	0.0002	0.0000	0.0000	0.0016
Robust Clubhook Squid	0.0003	0.0002	0.0018	0.0006	0.0051	0.0000	0.0013
King-of-the-Salmon	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000	0.0002
Pacific Hake	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	<0.0001
Rockfish Unid.	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	<0.0001
Opal Squid (Market Squid)	0.0000	0.0000	<0.0001	<0.0001	0.0000	0.0000	<0.0001
Schoolmaster Gonate Squid	0.0000	0.0000	0.0000	0.0000	<0.0001	0.0000	<0.0001
Total	0.2939	0.4795	0.6022	0.4242	0.2805	0.1857	0.3777

Table 6.--Average bycatch rates (kilograms per metric ton) based on the catch of flying squid (Ommastrephes bartrami) during the 1990 U.S.-Japan Cooperative Squid Research Project.

Common Name	Bycatch Rate (kg/mt target)	Percent of Total Bycatch	Cumulative Percent of Bycatch
Nail Squid	51.7	59.56%	59.56%
Pacific Pomfret	9.7	11.12%	70.69%
Blue Shark	7.1	8.15%	78.84%
Jack Mackerel	5.7	6.59%	85.43%
Chub Mackerel	3.9	4.44%	89.87%
Eight Armed Squid	4.5	5.13%	95.00%
Robust Clubhook Squid	3.6	4.19%	99.19%
King-of-the-Salmon	0.6	0.64%	99.84%
Pacific Hake	0.1	0.11%	99.95%
Rockfish Unid.	<0.1	0.02%	99.97%
Opal Squid (Market Squid)	<0.1	0.03%	100.00%
Schoolmaster Gonate Squid	<0.1	<0.00%	100.00%
Total	86.8	100.00%	

Table 7.--Effort (line hours), average catch-per-unit-effort (number per line hour), and loss rate (number per line hour) for all species of squid by jig and line type during the 1990 U.S.-Japan Cooperative Squid Research Project.

Jig Type	Total Effort (line hours observed)				
	hand	short	long	long & short	Total
long silver	267	2	4	0	273
mixed	0	402	1	0	403
clear	0	261	6,714	2,374	6,975
soft green	0	15	258	0	272
soft green, hard green	0	0	229	0	229
hard green	0	26	8	0	34
clear, soft green	0	4	0	0	4
clear, hard green	0	0	30	0	30
lighted dark green	0	0	4	0	4
mixed opaque	0	15	0	0	15
Total	267	705	6,989	2,374	7,961

Catch of Squid Per Line Hour

Jig Type	Line Type (CPUE #/line hr)				
	hand	short	long	long & short	Total
long silver	2.55	0.50	0.00	- - -	2.48
mixed	- - -	0.19	0.00	- - -	0.18
clear	- - -	0.00	0.08	0.08	0.06
soft green	- - -	0.22	0.24	- - -	0.23
soft green, hard green	- - -	- - -	0.18	- - -	0.18
hard green	- - -	0.03	0.50	- - -	0.15
clear, soft green	- - -	0.00	- - -	- - -	0.00
clear, hard green	- - -	- - -	0.38	- - -	0.38
lighted dark green	- - -	- - -	0.25	- - -	0.25
mixed opaque	- - -	0.28	- - -	- - -	0.28
Total	2.55	0.15	0.17	0.08	0.91

Squid Loss Per Line Hour

Jig Type	Line Type (CPUE #/line hr)				
	hand	short	long	long & short	Total
long silver	0.40	0.00	0.00	- - -	0.39
mixed	- - -	0.09	0.00	- - -	0.08
clear	- - -	0.00	0.00	0.00	0.00
soft green	- - -	0.00	0.09	- - -	0.07
soft green, hard green	- - -	- - -	0.07	- - -	0.07
hard green	- - -	0.00	0.00	- - -	0.00
clear, soft green	- - -	0.00	- - -	- - -	0.00
clear, hard green	- - -	- - -	0.00	- - -	0.00
lighted dark green	- - -	- - -	0.00	- - -	0.00
mixed opaque	- - -	0.00	- - -	- - -	0.00
Total	0.40	0.04	0.05	0.00	0.16

Table 8.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by stratum during the 1990 U.S.-Japan Cooperative Squid Research Project.

Stratum	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval Low	95 % Confidence Interval High
1	23	0.24	0.00	1.27
2	26	0.45	0.00	1.85
3	49	0.56	0.00	2.36
4	20	0.38	0.00	1.58
5	16	0.27	0.00	1.07
6	8	0.18	0.00	0.74
Total	142	0.41	0.00	1.55

Table 9.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by bottom depth (meters) category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Bottom Depth (meters)	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval	
			Low	High
0-200	14	0.01	0.00	0.08
201-1000	8	0.09	0.00	0.73
1001-2000	27	0.24	0.00	0.91
2001-3000	79	0.52	0.00	2.09
3001-4000	14	0.68	0.00	2.49
Total	142	0.41	0.00	1.55

Table 10.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by gear depth (meters) category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Gear Depth (meters)	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval Low	95 % Confidence Interval High
26-50	6	0.06	0.00	0.26
51-75	49	0.17	0.00	1.14
76-100	60	0.38	0.00	1.42
101-125	22	1.16	0.00	3.34
126-150	5	0.31	0.00	1.03
Total	142	0.41	0.00	1.55

Table 11.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by surface water temperature (centigrade) category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Surface Temperature (Centigrade)	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval	
			Low	High
10.1-12.0	5	0.00	-	-
12.1-14.0	4	0.14	0.00	0.62
14.1-16.0	32	0.42	0.00	1.91
16.1-18.0	38	0.12	0.00	0.48
18.1-20.0	61	0.65	0.00	2.30
>20.0	2	0.01	0.00	0.10
Total	142	0.41	0.00	1.55

Table 12.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by gear depth water temperature (centigrade) category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Gear Temperature (Centigrade)	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval	
			Low	High
6.6-7.0	1	0.74	0.74	0.74
7.1-7.5	2	0.54	0.00	9.42
7.6-8.0	8	0.18	0.00	0.81
8.1-8.5	12	0.35	0.00	1.43
8.6-9.0	7	0.67	0.00	2.99
9.1-9.5	5	0.36	0.00	2.22
Total	142	0.41	0.00	1.55

Table 13.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by lunar cycle (percent of full moon) category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Full Moon	Stations	(kg/line hr)	Low	High
0-20%	24	0.59	0.00	1.76
21-40%	24	0.61	0.00	1.99
41-60%	24	0.89	0.00	3.27
61-80%	32	0.22	0.00	1.02
81-100%	38	0.03	0.00	0.11
Total	142	0.41	0.00	1.55

Table 14.--Mean catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by cloud cover category during the 1990 U.S.-Japan Cooperative Squid Research Project.

Cloud Cover	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval Low	95 % Confidence Interval High
Clear	27	0.24	0.00	0.93
Partly Cloudy	85	0.49	0.00	2.09
Cloudy	11	0.25	0.00	0.99
Cloudy-Rain	13	0.55	0.00	2.14
Foggy	6	0.00	0.00	0.01
Total	142	0.41	0.00	1.55

Table 15.--Mean catch-per-unit effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by Beaufort sea-state category[1/] during the 1990 U.S.-Japan Cooperative Squid Research Project.

Beaufort Sea-State	Number of Stations	Mean CPUE (kg/line hr)	95 % Confidence Interval Low	95 % Confidence Interval High
1	21	0.32	0.00	1.46
2	40	0.45	0.00	2.13
3	47	0.44	0.00	1.81
4	22	0.29	0.00	1.06
5	9	0.40	0.00	2.14
6	2	1.15	0.00	19.66
7	1	0.42	0.00	0.00
Total	142	0.41	0.00	1.55

1/ Beaufort sea-state scale:

Scale	Wind Speed Knots	Wave Height (ft)	Description
0	0-1	0	Calm
1	1-3	0	Light air
2	4-6	2	Light breeze
3	7-10	2	Gentle breeze
4	11-16	4	Moderate breeze
5	17-21	6	Fresh breeze
6	22-27	10	Strong breeze
7	28-33	14	Near gale
8	34-40	18	Gale
9	41-47	23	Strong gale
10	48-55	29	Storm
11	56-63	37	Violent storm
12	64-71	45	Hurricane

Table 16.--Number of specimens and mean nidamental gland length (millimeters) by mantle length gropus (5 mm) for 1,379 female neon flying squid (<u>Ommastrephes</u> <u>bartrami</u>) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

SPECIMEN LENGTH (mm)	SPECIMEN NUMBER	MEAN GLAND LENGTH (mm)	SPECIMEN LENGTH (MM)	SPECIMEN NUMBER	MEAN GLAND LENGTH (MM)
230	2	30.5	400	43	47.6
235	3	16.7	405	22	47.6
240	7	13.8	410	33	49.3
245	2	NA	415	30	48.1
250	18	17.8	420	37	50.4
255	10	NA	425	22	56.9
260	19	20.5	430	18	NA
265	9	20.9	435	15	50.5
270	14	24.6	440	22	55.4
275	2	22.5	445	20	51.0
280	19	23.5	450	32	61.3
285	6	NA	455	23	55.5
290	14	NA	460	29	56.9
295	7	28.2	465	23	62.5
300	16	20.5	470	33	59.2
305	8	23.4	475	25	57.2
310	11	NA	480	30	62.3
315	7	NA	485	19	NA
320	17	30.0	490	26	68.9
325	10	28.2	495	21	71.7
330	13	40.3	500	24	69.4
335	17	30.5	505	25	78.4
340	31	35.0	510	24	NA
345	20	32.7	515	14	77.8
350	46	34.9	520	20	80.6
355	41	34.3	525	21	82.5
360	40	38.3	530	20	89.1
365	35	37.4	535	10	NA
370	45	37.9	540	13	87.1
375	33	39.0	545	7	77.9
380	57	40.3	550	4	83.8
385	35	40.2	560	3	93.3
390	32	45.4	570	1	85.0
395	23	40.0	590	1	110.0

NA = no measurements taken at this mantel length

Table 17.--Round weight (kilograms), product weight (kilograms) and product recovery rates (percent product weight of whole, fresh squid weight) for products processed from neon flying squid (*Ommastrephes bartrami*) during the 1990 U.S.-Japan Cooperative Squid Research Project.

Product Type	Round Weight (kg)	Processed Weight (kg)	Percent Recovery			95% Confidence Interval	
			Minimum	Maximum	Average	Lower	Upper
Whole	14.1	14.1	100.0%	100.0%	100.0%	- -	- -
Tubes	28.3	14.7	51.9%	51.9%	51.9%	- -	- -
Mantles	4,441.2	2,184.3	39.8%	62.5%	49.0%	48.7%	49.4%
Tentacles	3,957.3	753.4	12.5%	23.0%	18.8%	18.7%	18.8%
Tubes and Tentacles	1,134.1	782.6	64.7%	72.5%	68.5%	68.3%	68.6%
Middles	891.8	61.5	3.2%	8.3%	6.6%	6.6%	6.7%
Mantles & Tentacles	891.8	583.2	56.2%	71.5%	62.4%	61.4%	63.4%
Mantles, Tentacles, & Middles	891.8	644.7	59.5%	78.5%	69.1%	67.8%	70.3%

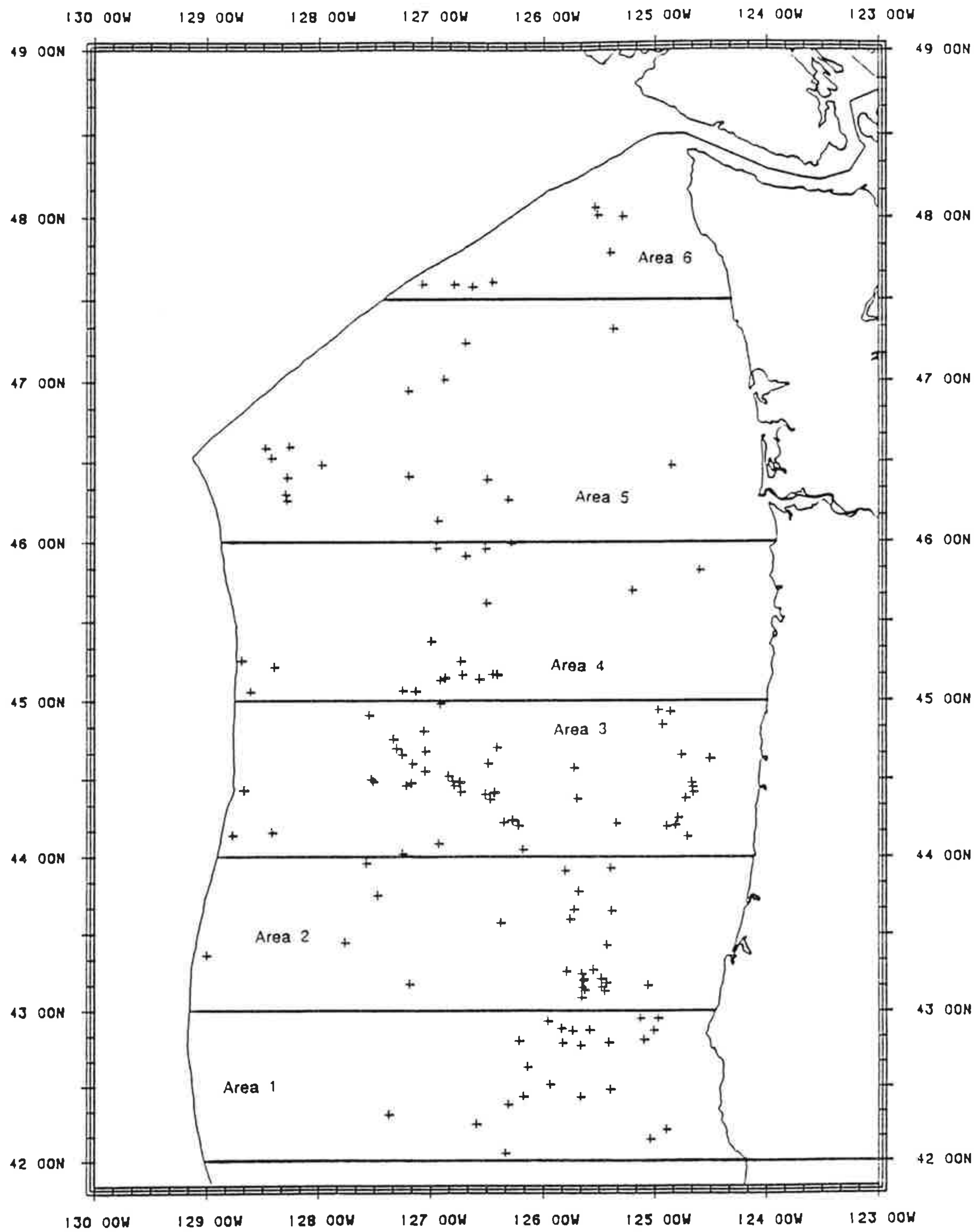


Figure 1.--Survey stratum and stations completed during the 1990 U.S.-Japan Cooperative Squid Research Project.

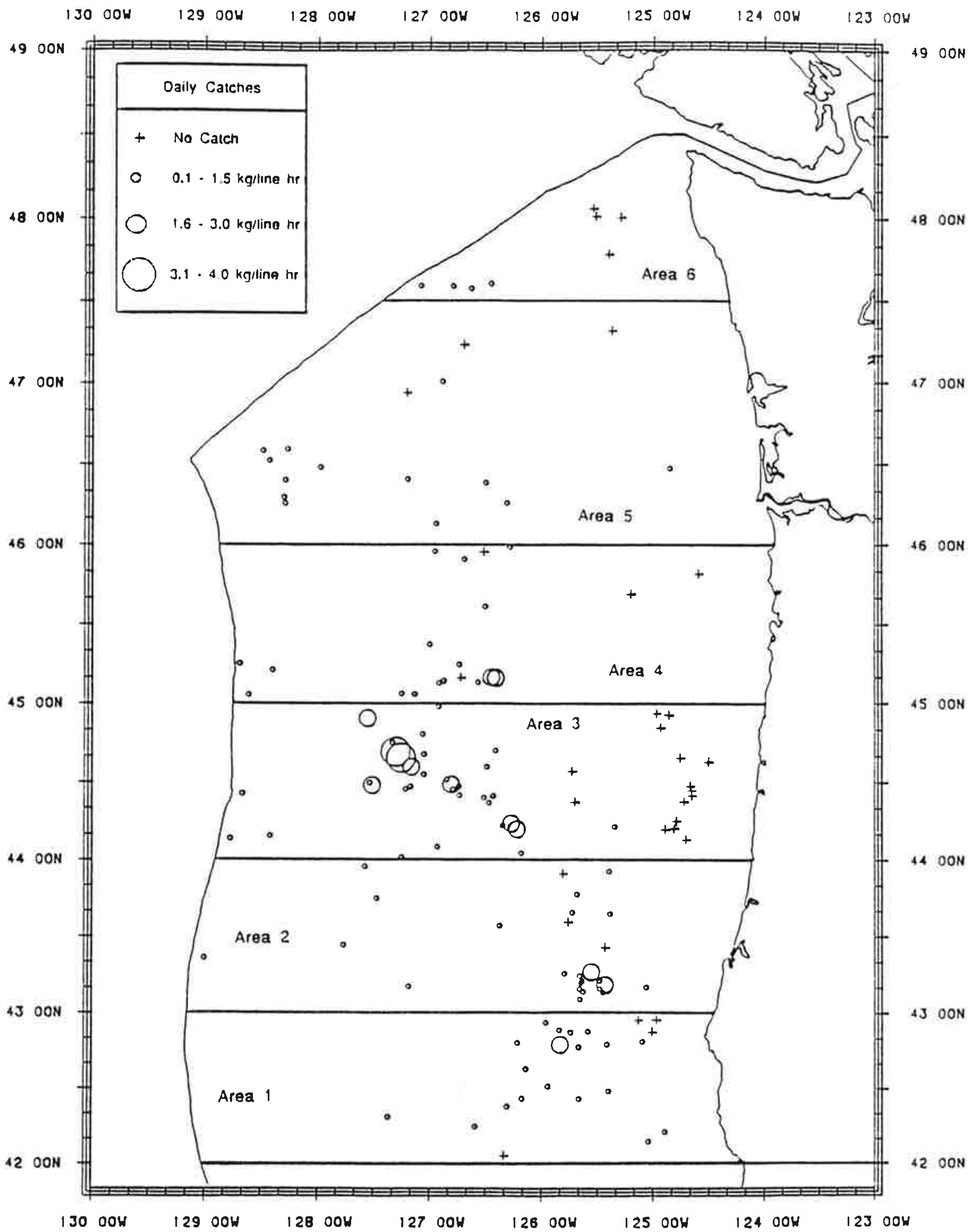


Figure 2.--Catch-per-unit-effort (kilograms per line hour) of neon flying squid (Ommastrephes bartrami) by station during the 1990 U.S.-Japan Cooperative Squid Research Project.

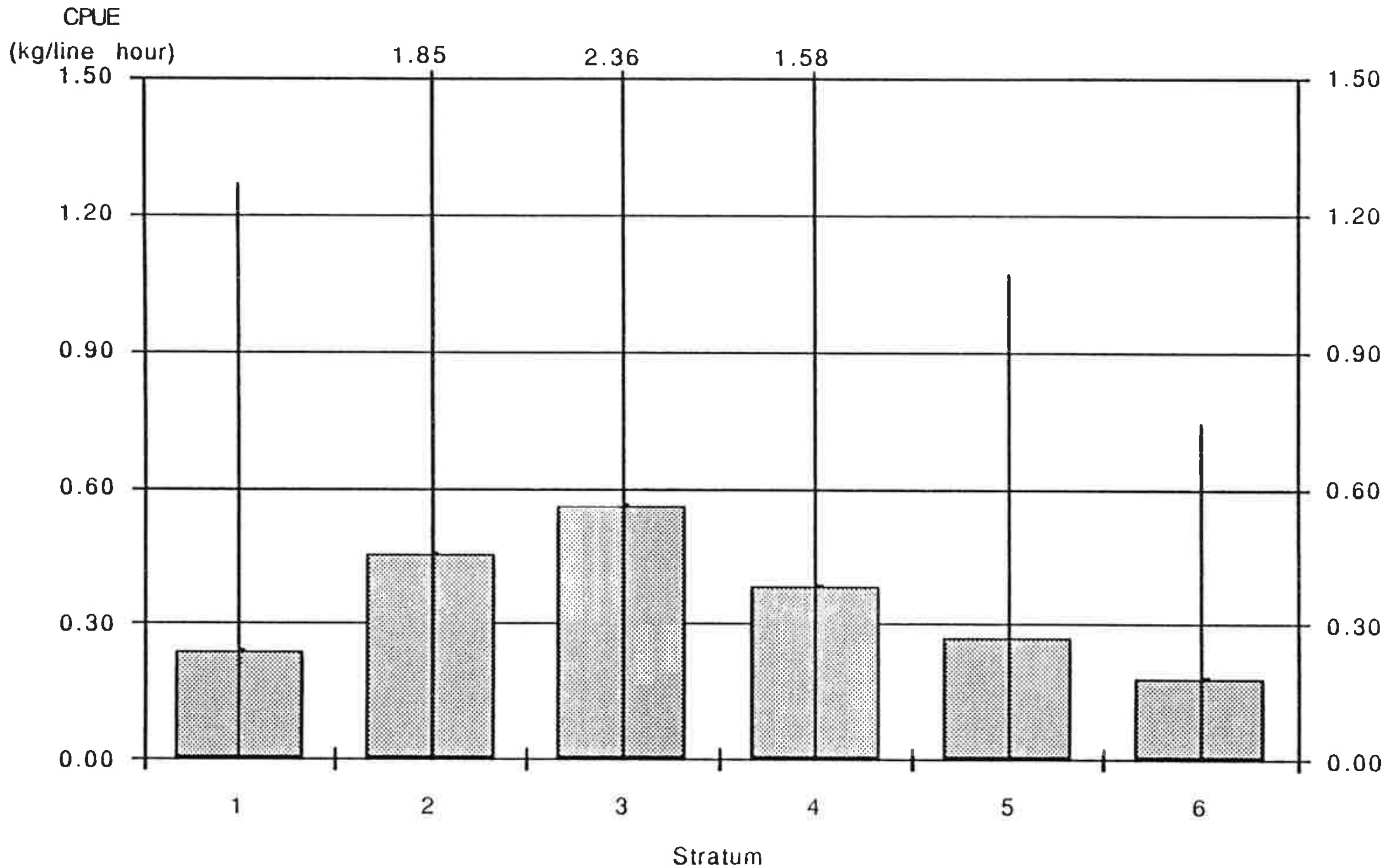


Figure 3.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by stratum during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

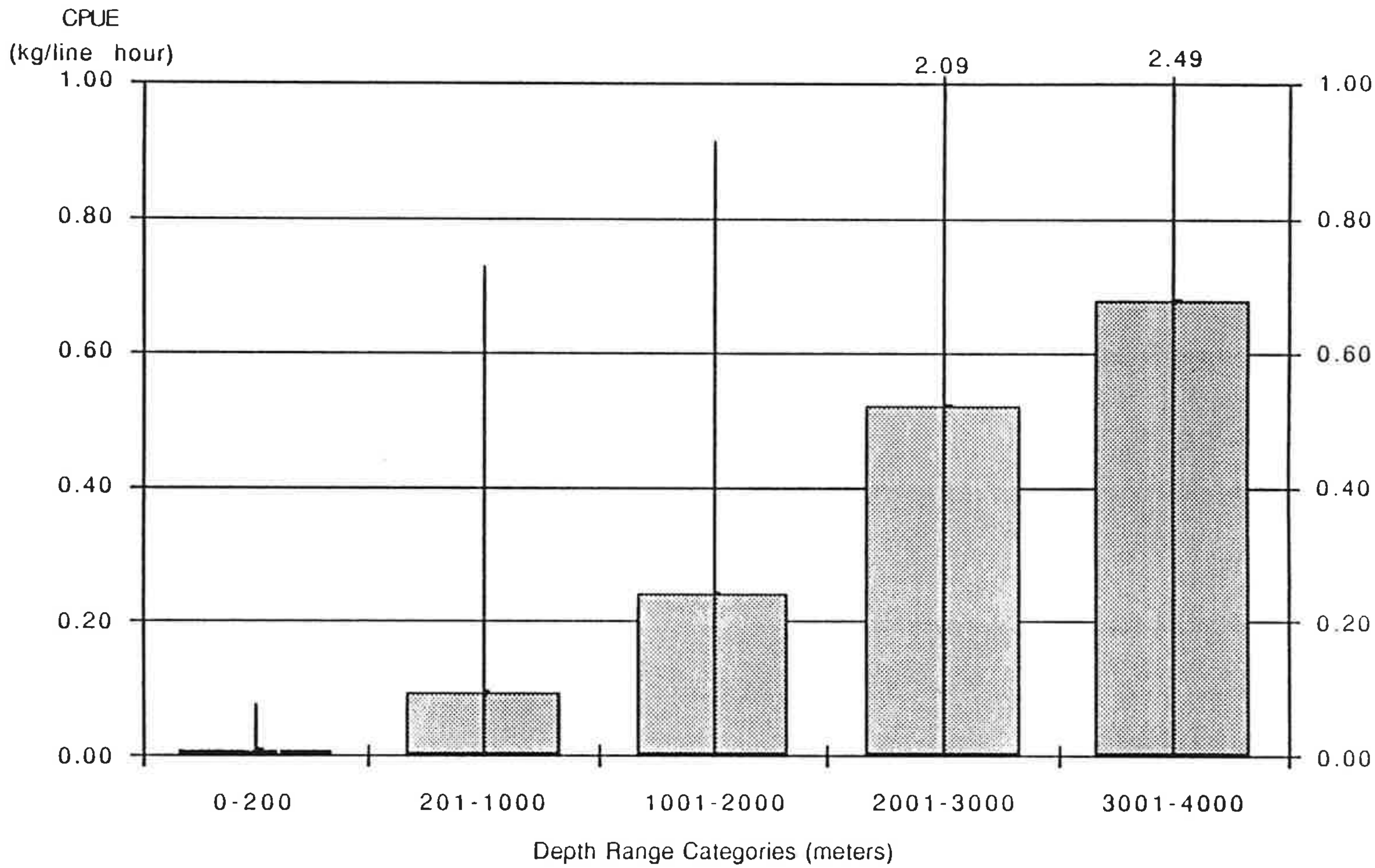


Figure 4.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by bottom depth (meters) category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

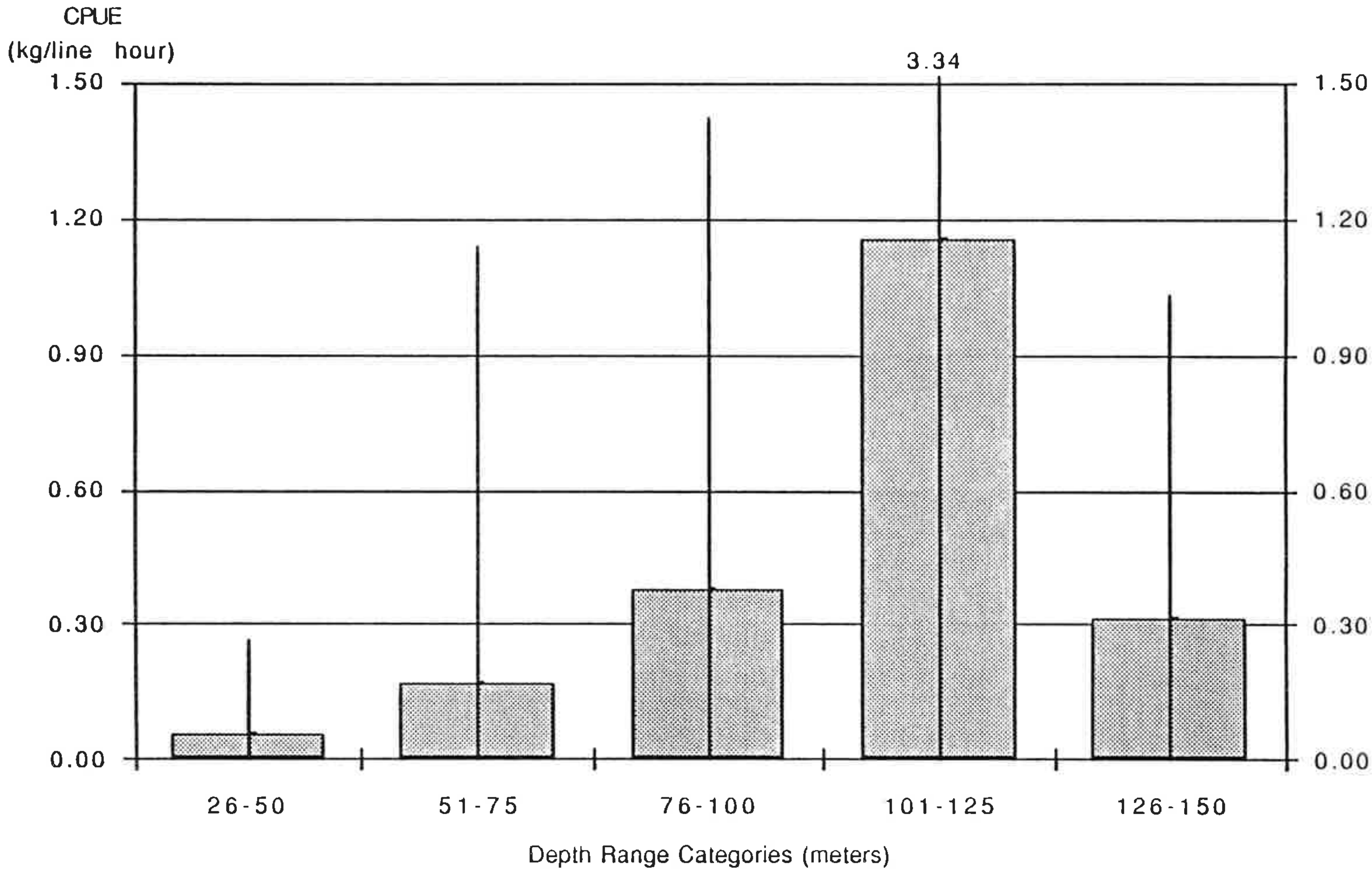


Figure 5.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by gear depth (meters) category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

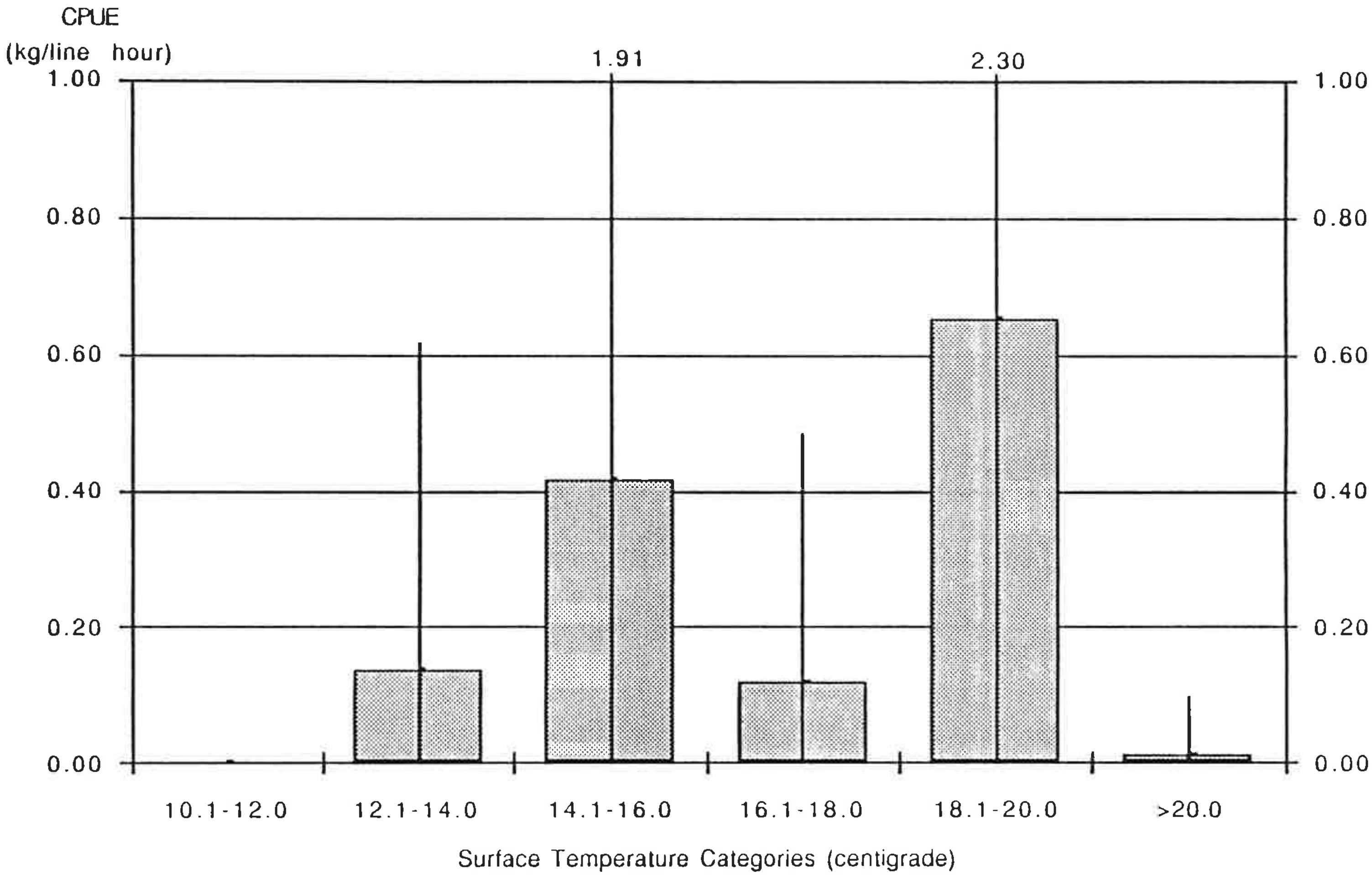


Figure 6.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by surface water temperature (centigrade) category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

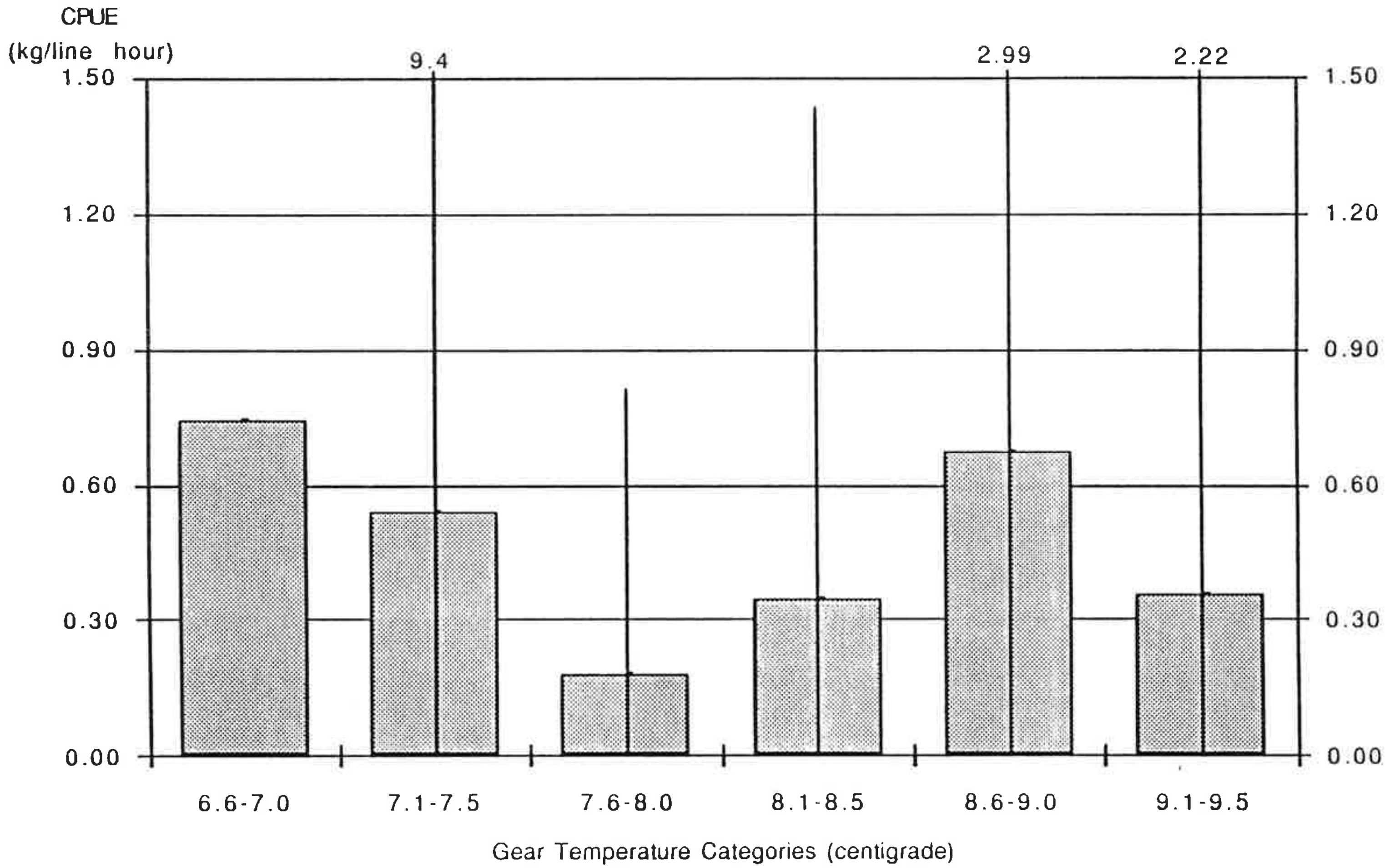


Figure 7.--Mean catch-per-unit-effort of neon flying squid (<u>Ommastrephes</u> <u>bartrami</u>) by gear depth water temperature (centigrade) category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

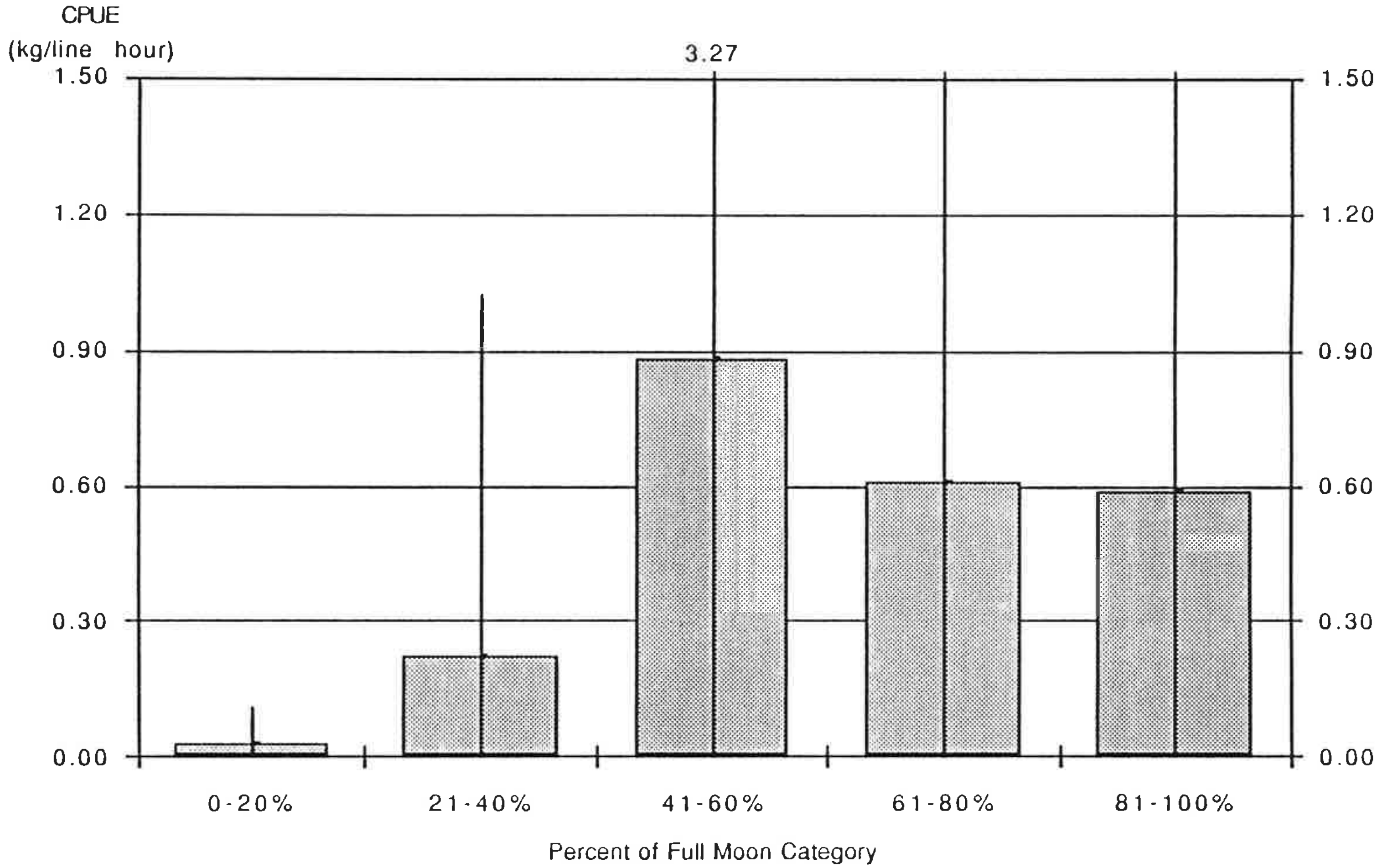


Figure 8.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by lunar cycle (percent of full moon) category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

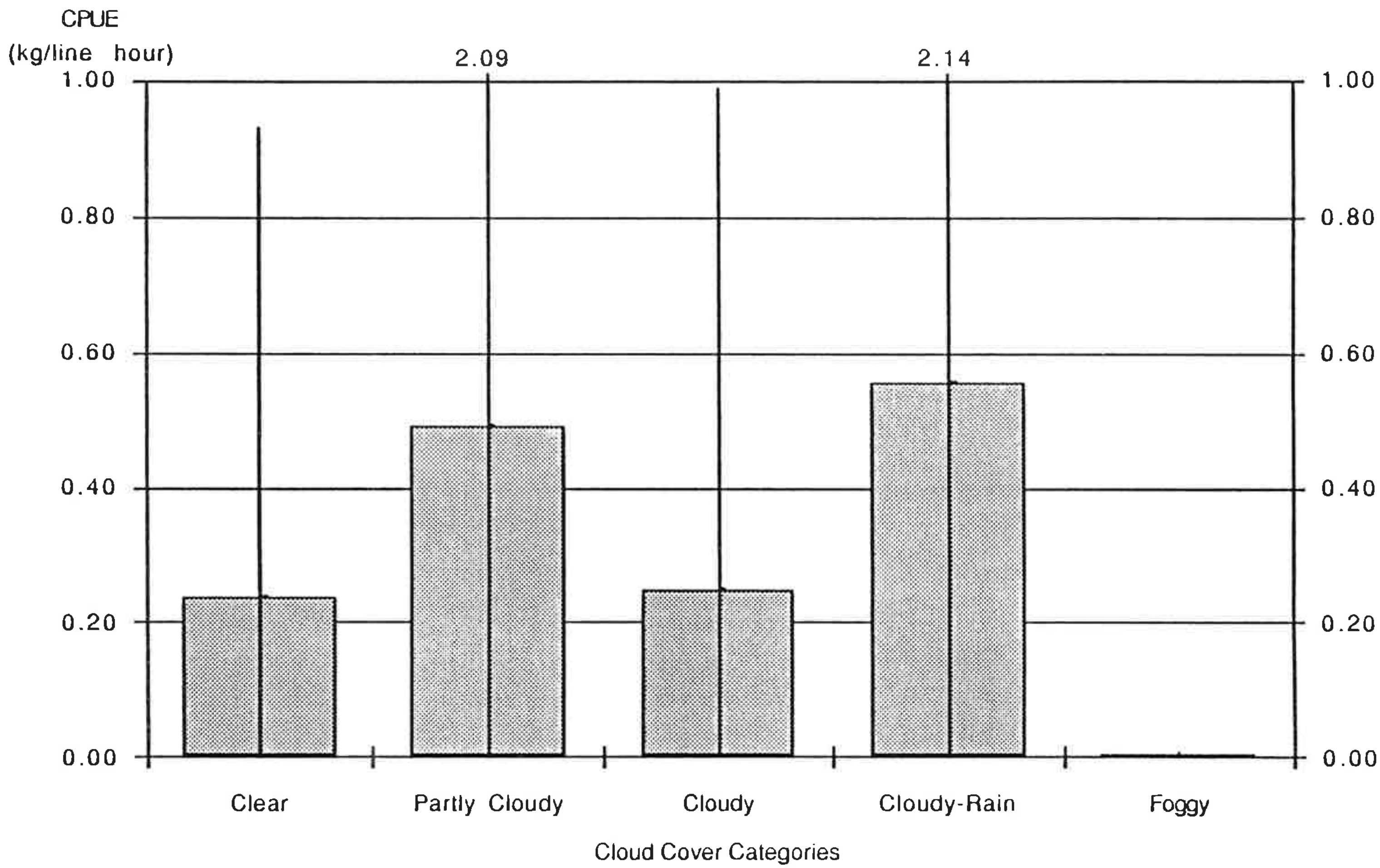


Figure 9.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by cloud cover category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

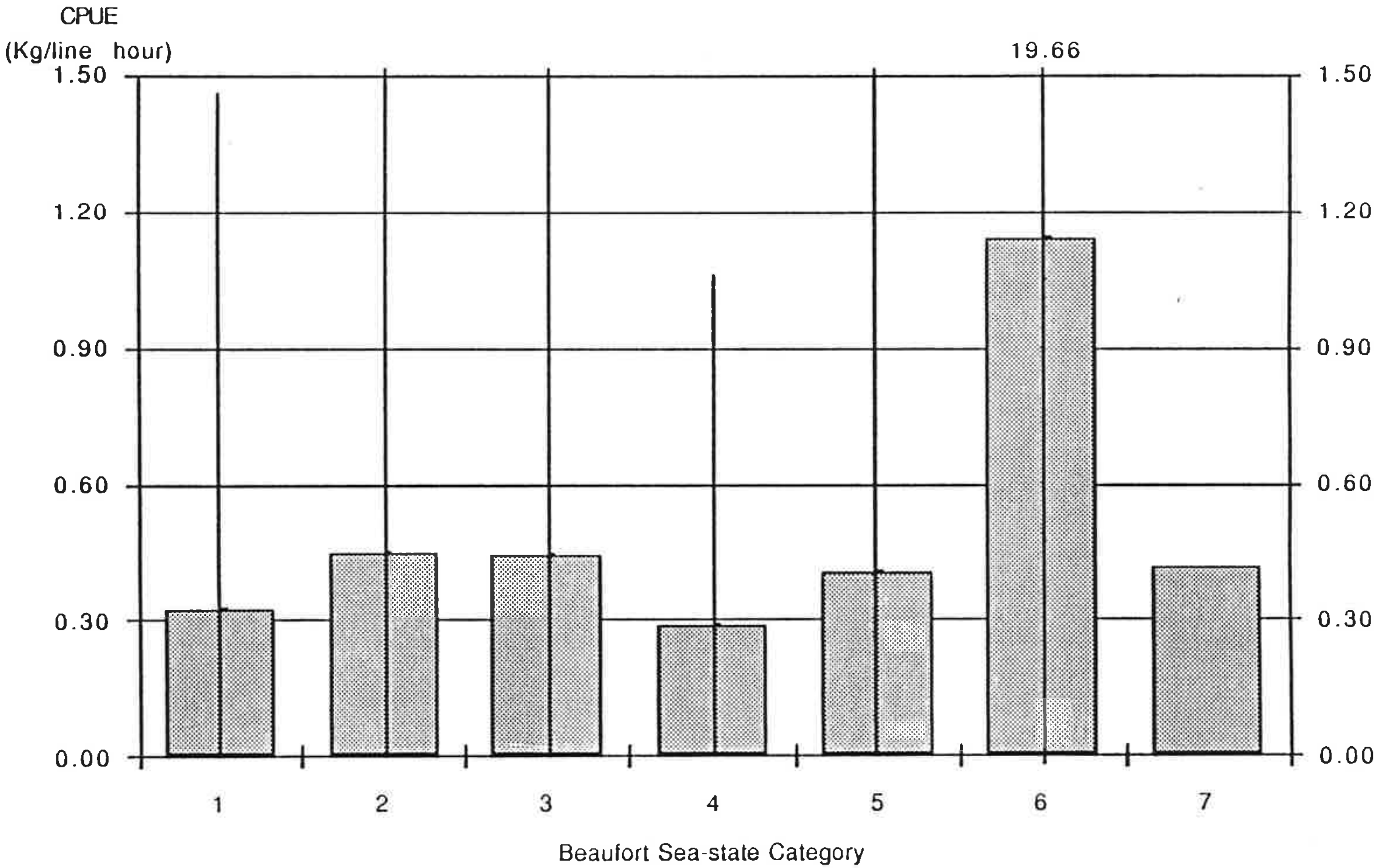


Figure 10.--Mean catch-per-unit-effort of neon flying squid (Ommastrephes bartrami) by Beaufort sea-state category during the 1990 U.S.-Japan Cooperative Squid Research Project. (Vertical lines denote 95% confidence interval for mean CPUE).

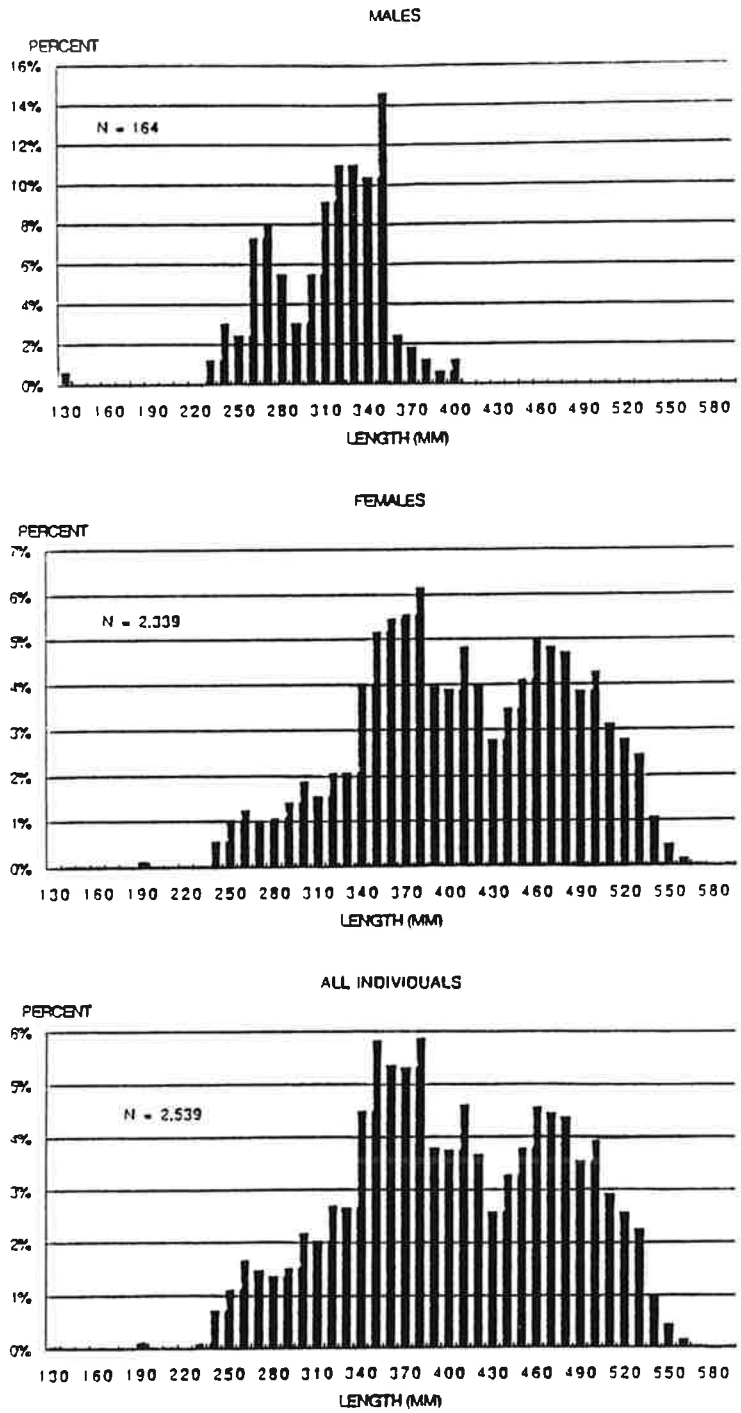


Figure 11.--Length frequency distribution of mantle length (millimeters) by sex and for sexes combined for neon flying squid (Ommastrephes bartrami) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

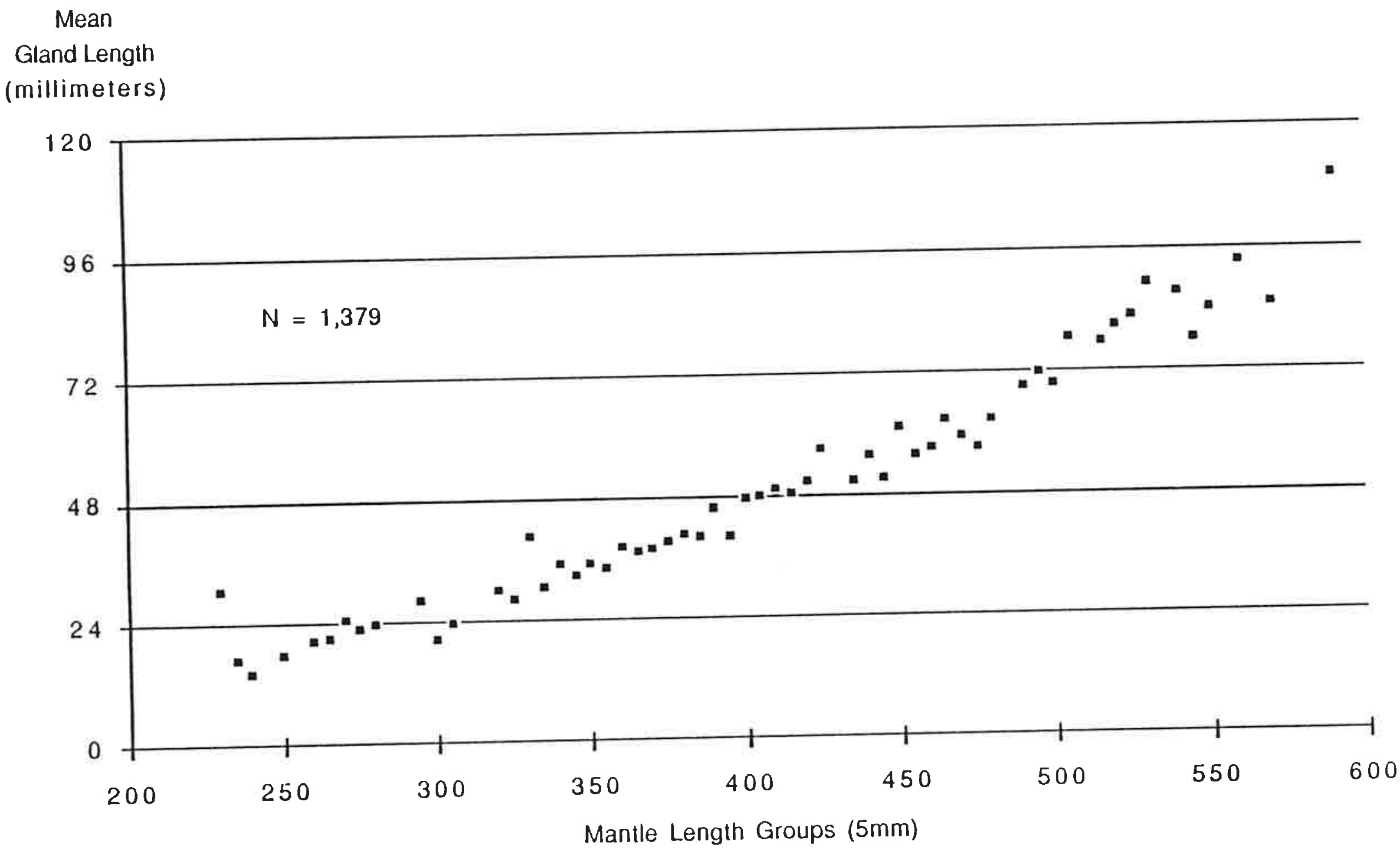


Figure 12.--Relationship of mean nidamental gland length (millimeters) to mantle length categories (5 mm groups) for female neon flying squid (Ommastrephes bartrami) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

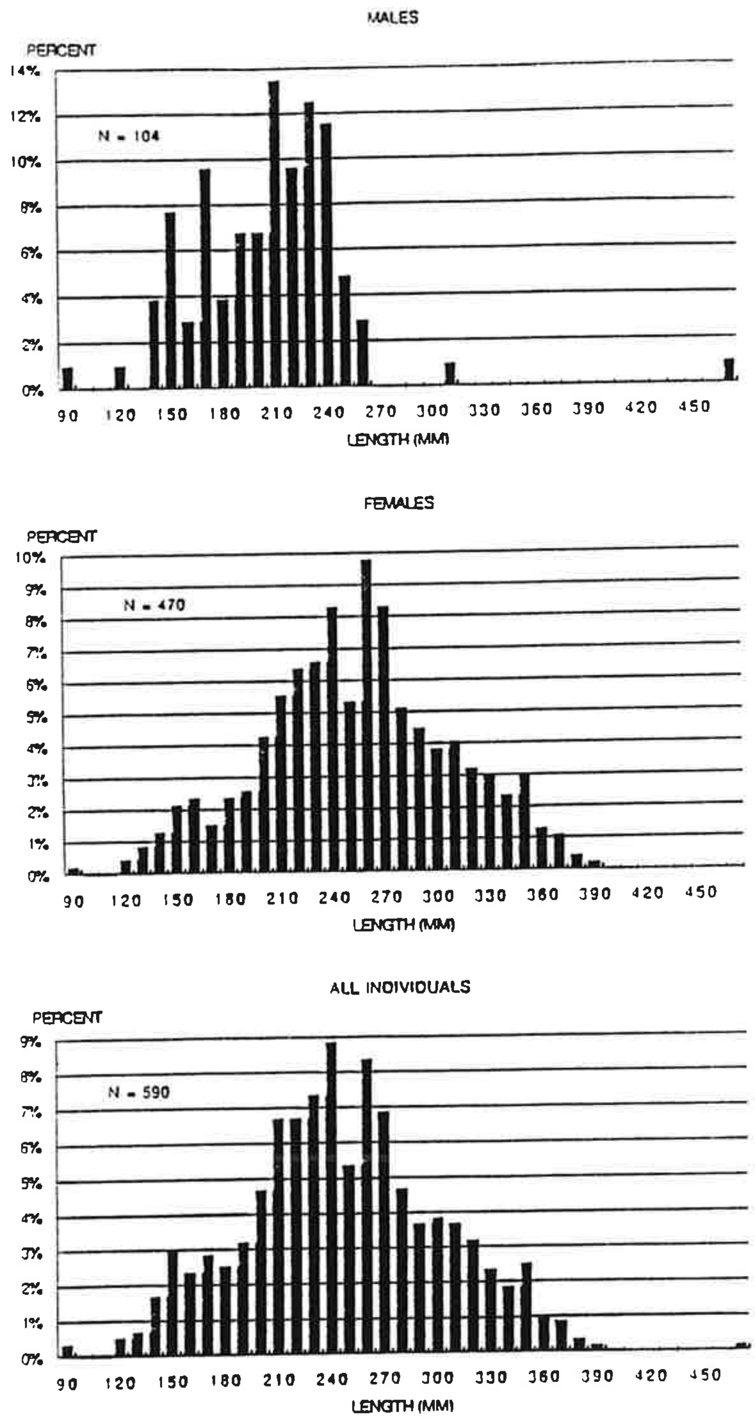


Figure 13.--Length frequency distribution of mantle length (millimeters) by sex and for sexes combined for nail squid (Onychoteuthis borealijaponcius) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

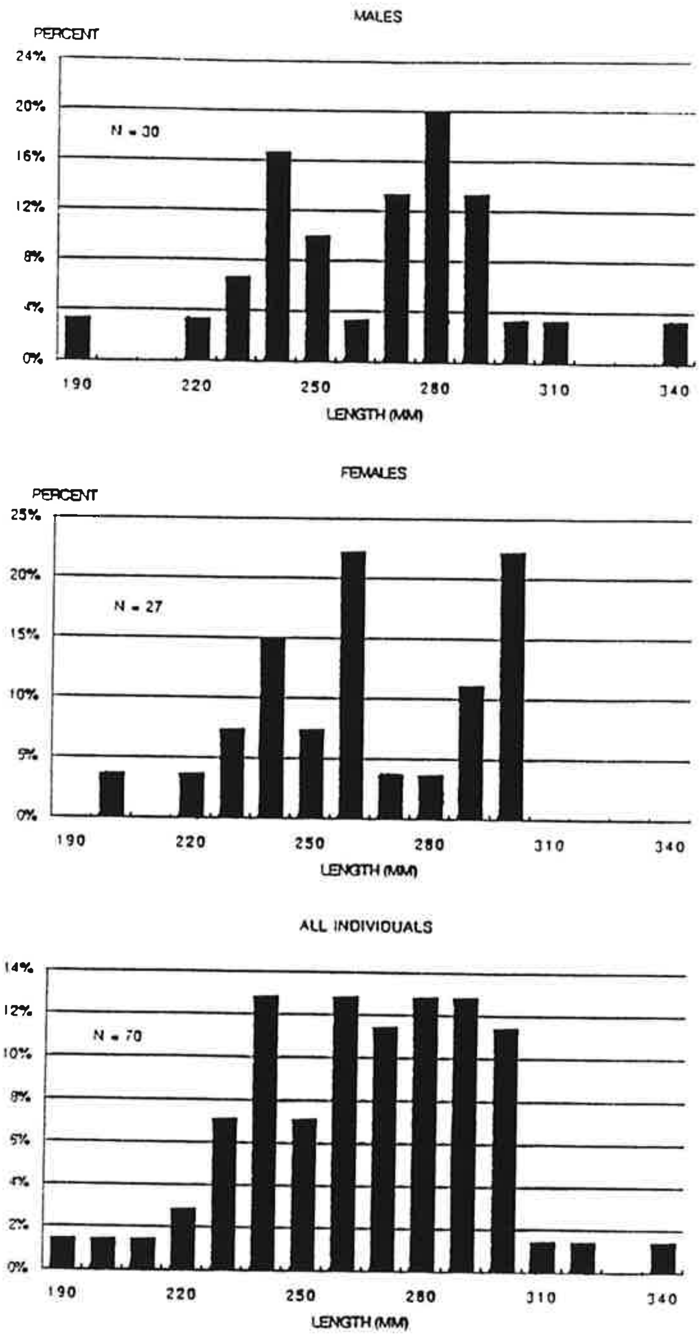


Figure 14.--Length frequency distribution of mantle length (millimeters) by sex and for sexes combined for eight armed squid (<u>Gonatopsis borealis</u>) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

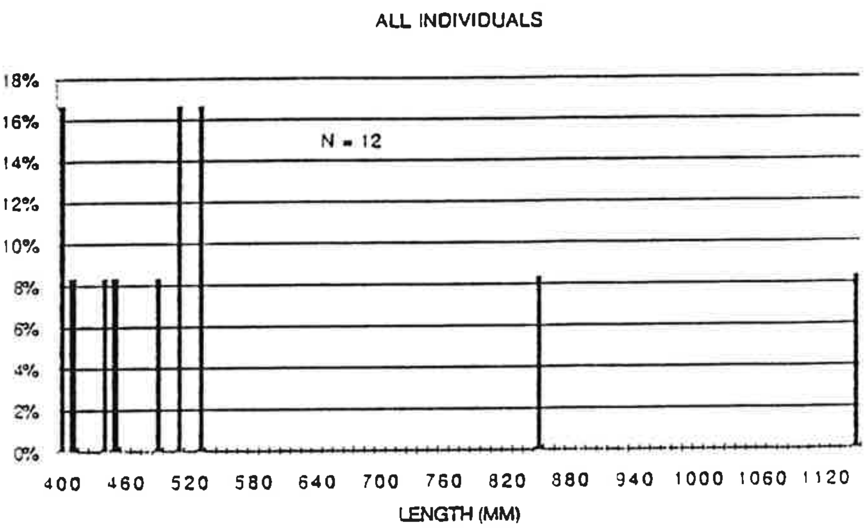


Figure 15.--Length frequency distribution of mantle length (millimeters) for sexes combined for robust clubhook squid (Moroteuthis robusta) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

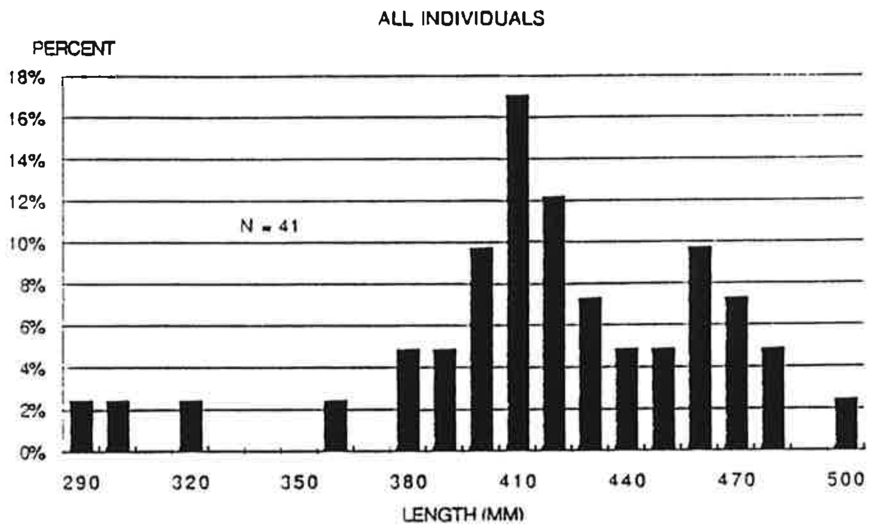


Figure 16.--Length frequency distribution of fork length (millimeters) for sexes combined for Pacific pomfret (Brama japonica) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

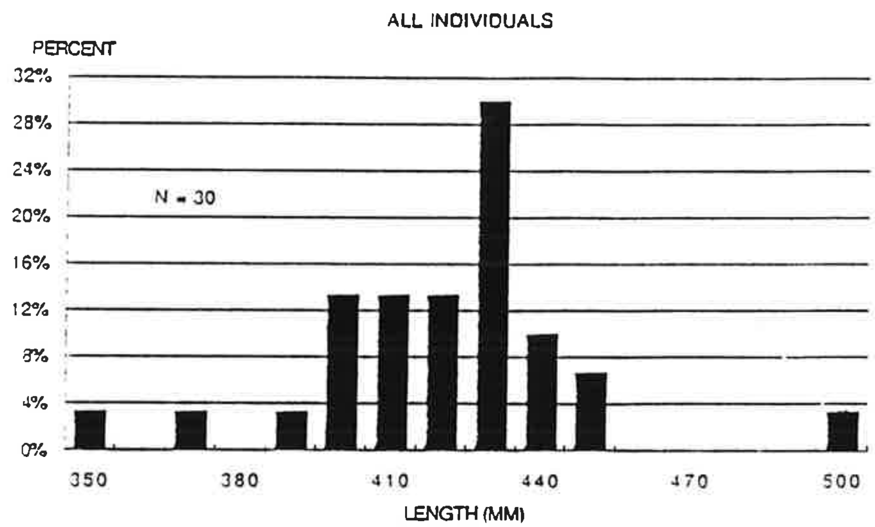


Figure 17.--Length frequency distribution of fork length (millimeters) for sexes combined for jack mackerel (Trachurus symmetricus) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

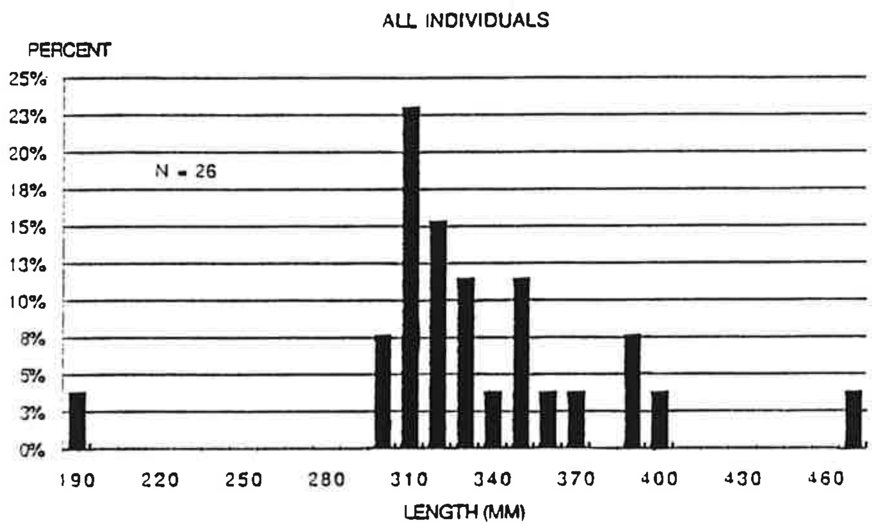


Figure 18.--Length frequency distribution of fork length (millimeters) for sexes combined for chub mackerel (Scomber japonicus) measured during the 1990 U.S.-Japan Cooperative Squid Research Project.

APPENDIX 1

Station, effort, and catch data for the 1990 U.S.-Japan Cooperative Squid Reserach Project.

Definitions

Vessel Code	Vessel Name
525	_Fuki Maru No. 58_
526	_Fuki Maru No. 63_
527	_Wakashio Maru No. 68_
528	_Narita Maru No. 37_

Units

1. Depths are in meters.

2. Effort is in line hours.

3. Catch weights are in kilograms fresh round weight.

Appendix 1: Station, effort, and catch data for stations completed during the 1990 U.S.-Japan Coorperative Squid Research Project.

Vessel	525	525	525	525	525	525	525	525	525
Station	1	2	3	4	5	6	7	8	9
Date	1-Aug-90	2-Aug-90	3-Aug-90	4-Aug-90	5-Aug-90	6-Aug-90	7-Aug-90	8-Aug-90	9-Aug-90
Start Latitude (ddmm.m)	4257.0	4237.8	4346.5	4456.3	4557.3	4656.3	4803.3	4635.5	4515.1
Start Longitude (ddmm.m)	12508.0	12608.6	12541.2	12458.4	12631.2	12712.5	12532.7	12816.3	12841.7
Bottom Depth (m)	1,977	1,244	1,665	356	2,628	2,646	89	2,714	2,743
Gear Depth (m)	70	75	69	69	69	69	69	69	69
Surface Temperature (C)	10.5	16.0	15.8	15.8	17.8	17.9	14.3	18.0	18.6
Gear Temperature (C)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Percent of Full Moon	31%	25%	19%	12%	6%	0%	7%	14%	21%
Cloud Cover	foggy	ptly cloudy	clear	clear	clear	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy
Effort (line hours)	466	264	342	282	306	294	130	270	306
Neon Flying Squid	0.0	110.5	4.0	0.0	0.0	0.0	0.0	11.6	6.5
Nail Squid	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.2	0.0
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	15.0	0.0	1.1	0.3	0.0	0.0	0.0	0.2	0.0
Blue Shark	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	15.0	9.5	1.1	0.3	0.0	0.0	0.0	0.2	0.0
Total Catch	15.0	120.0	5.1	0.3	0.0	0.0	0.0	11.8	6.5

Appendix 1: (continued)

Vessel	525	525	525	525	525	525	525	525	525
Station	10	11	12	13	14	15	16	17	18
Date	10-Aug-90	11-Aug-90	12-Aug-90	13-Aug-90	14-Aug-90	15-Aug-90	16-Aug-90	17-Aug-90	18-Aug-90
Start Latitude (ddmm.m)	4425.6	4326.5	4218.7	4247.3	4305.3	4314.5	4311.0	4308.2	4247.5
Start Longitude (ddmm.m)	12840.2	12746.2	12722.4	12550.1	12539.5	12539.6	12526.1	12537.7	12525.0
Bottom Depth (m)	2,772	2,052	2,610	2,432	3,022	3,002	3,046	3,035	2,914
Gear Depth (m)	69	70	75	70	75	69	69	100	100
Surface Temperature (C)	18.4	18.3	17.8	15.9	16.6	15.9	15.8	15.2	15.1
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	29%	36%	43%	50%	57%	64%	71%	79%	86%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy
Effort (line hours)	288	306	256	288	393	431	342	437	359
Neon Flying Squid	11.7	1.1	3.8	681.6	147.4	552.6	743.8	262.5	16.9
Nail Squid	0.2	0.0	0.3	0.0	1.4	4.8	0.0	13.2	55.7
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.8	0.0	2.0	2.3
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.2	0.0	0.3	0.0	1.4	5.6	0.0	17.3	58.0
Blue Shark	0.0	0.0	0.0	0.0	11.4	24.6	10.4	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	7.4	2.4	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	7.2	1.0	2.0	1.8
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	2.2	0.7	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	16.8	4.1	2.0	3.6
Total Other Fish	0.0	0.0	0.0	0.0	11.4	41.4	14.5	2.0	3.6
Total Bycatch	0.2	0.0	0.3	0.0	12.8	47.0	14.5	19.3	61.6
Total Catch	11.9	1.1	4.1	681.6	160.2	599.6	758.3	281.8	78.5

Appendix 1: (continued)

Vessel	525	525	525	525	525	525	525	525	525
Station	19	20	21	22	23	24	25	26	27
Date	19-Aug-90	20-Aug-90	21-Aug-90	22-Aug-90	23-Aug-90	24-Aug-90	25-Aug-90	26-Aug-90	27-Aug-90
Start Latitude (ddmm.m)	4411.9	4424.1	4424.8	4514.8	4508.6	4607.8	4735.3	4617.6	4615.4
Start Longitude (ddmm.m)	12453.7	12631.1	12626.2	12644.4	12652.7	12656.8	12647.9	12818.2	12817.5
Bottom Depth (m)	232	2,815	2,815	2,696	2,799	2,696	2,421	2,736	2,736
Gear Depth (m)	100	100	100	120	120	120	110	120	120
Surface Temperature (C)	15.9	18.8	19.0	19.1	18.8	17.6	17.4	18.0	18.1
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	93%	100%	94%	88%	81%	75%	69%	62%	56%
Cloud Cover	ptly cloudy	cloudy	cloudy	cloudy	ptly cloudy	ptly cloudy	ptly cloudy	cldy/rain	clear
Effort (line hours)	272	429	390	391	406	391	391	437	400
Neon Flying Squid	0.0	153.1	240.6	175.7	292.7	42.8	56.1	306.3	407.1
Nail Squid	146.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Robust Clubhook Squid	0.0	10.2	0.0	0.0	0.0	0.0	0.0	2.8	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	146.2	10.2	0.0	0.0	0.0	0.0	0.0	2.8	0.0
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	16.8	13.8	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	16.8	13.8	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	16.8	13.8	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	146.2	27.0	13.8	0.0	0.0	0.0	0.0	2.8	0.0
Total Catch	146.2	180.1	254.4	175.7	292.7	42.8	56.1	309.1	407.1

Appendix 1: (continued)

Vessel	525	525	525	525	525	525	525	525	526
Station	28	29	30	31	32	33	34	35	1
Date	28-Aug-90	29-Aug-90	30-Aug-90	31-Aug-90	1-Sep-90	2-Sep-90	3-Sep-90	4-Sep-90	1-Aug-90
Start Latitude (ddmm.m)	4503.7	4428.9	4429.8	4401.1	4402.7	4434.3	4422.4	4415.2	4248.6
Start Longitude (ddmm.m)	12715.3	12730.9	12732.1	12715.3	12611.2	12543.9	12542.2	12447.7	12506.0
Bottom Depth (m)	2,736	2,867	2,867	2,599	2,853	2,813	2,900	65	2,825
Gear Depth (m)	120	120	120	150	150	100	100	50	70
Surface Temperature (C)	18.7	18.8	18.8	18.6	19.2	18.9	18.4	15.7	16.7
Gear Temperature (C)	- -	- -	- -	- -	- -	- -	- -	- -	7.9
Percent of Full Moon	50%	43%	36%	29%	21%	14%	7%	0%	31%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	clear	cldy/rain	cldy/rain	ptly cloudy	clear
Effort (line hours)	363	429	396	374	367	333	324	34	650
Neon Flying Squid	101.0	679.4	315.0	63.0	42.0	0.0	0.0	0.0	11.4
Nail Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Catch	101.0	679.4	315.0	63.0	42.0	0.0	0.0	0.0	11.4

Appendix 1: (continued)

Vessel	526	526	526	526	526	526	526	526	526
Station	2	3	4	5	6	7	8	9	10
Date	2-Aug-90	3-Aug-90	4-Aug-90	5-Aug-90	6-Aug-90	7-Aug-90	8-Aug-90	9-Aug-90	10-Aug-90
Start Latitude (ddmm.m)	4226.0	4354.5	4455.7	4557.5	4700.5	4800.5	4624.0	4503.3	4408.3
Start Longitude (ddmm.m)	12610.6	12548.7	12451.7	12657.4	12653.5	12531.3	12817.5	12836.9	12846.5
Bottom Depth (m)	2,839	2,972	347	2,722	2,448	160	2,736	2,448	2,255
Gear Depth (m)	70	100	87	80	75	100	85	100	100
Surface Temperature (C)	16.7	16.2	15.0	24.4	17.7	14.9	18.5	18.9	18.7
Gear Temperature (C)	8.8	7.4	8.0	8.0	8.3	7.7	7.6	8.1	8.1
Percent of Full Moon	25%	19%	12%	6%	0%	7%	14%	21%	29%
Cloud Cover	clear	clear	clear	cloudy	clear	clear	ptly cloudy	cloudy	cloudy
Effort (line hours)	1,089	493	294	307	224	288	380	425	385
Neon Flying Squid	47.3	0.0	0.0	5.2	2.4	0.0	20.8	10.0	26.2
Nail Squid	0.0	0.0	20.9	0.0	0.3	0.0	0.0	0.7	0.1
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	20.9	0.0	0.3	0.0	0.0	0.7	0.1
Blue Shark	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	7.4	0.0	20.9	0.0	0.3	0.0	0.0	0.7	0.1
Total Catch	54.7	0.0	20.9	5.2	2.7	0.0	20.8	10.7	26.3

Appendix 1: (continued)

Vessel	526	526	526	526	526	526	526	526	526
Station	11	12	13	14	15	16	17	18	19
Date	11-Aug-90	12-Aug-90	13-Aug-90	14-Aug-90	15-Aug-90	16-Aug-90	17-Aug-90	18-Aug-90	19-Aug-90
Start Latitude (ddmm.m)	4321.6	4203.1	4212.6	4252.5	4256.0	4316.1	4307.9	4312.5	4408.0
Start Longitude (ddmm.m)	12900.3	12620.3	12453.8	12535.2	12557.8	12533.3	12527.2	12538.3	12442.6
Bottom Depth (m)	3,137	2,493	1,224	3,017	2,430	3,002	3,046	3,017	113
Gear Depth (m)	100	100	100	70	75	100	100	100	100
Surface Temperature (C)	21.7	17.4	15.6	15.6	13.2	15.7	15.7	16.4	14.9
Gear Temperature (C)	9.0	8.2	8.5	8.2	8.2	9.0	8.9	8.7	8.6
Percent of Full Moon	36%	43%	50%	57%	64%	71%	79%	86%	93%
Cloud Cover	cloudy	cloudy	clear	clear	ptly cloudy	cldy/rain	cldy/rain	clear	clear
Effort (line hours)	272	360	256	306	408	438	422	328	391
Neon Flying Squid	2.0	0.0	34.8	100.9	122.2	1,137.3	449.4	260.2	0.0
Nail Squid	0.0	0.0	0.0	3.0	8.0	2.1	1.7	0.9	0.9
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	0.0	3.0	8.0	3.6	1.7	0.9	0.9
Blue Shark	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0
Pacific Pomfret	4.0	0.0	0.0	0.0	0.0	4.1	0.0	1.5	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	4.0	0.0	0.0	0.0	0.0	4.1	0.0	14.7	0.0
Total Other Fish	4.0	0.0	0.0	0.0	0.0	17.3	0.0	14.7	0.0
Total Bycatch	4.0	0.0	0.0	3.0	8.0	20.9	1.7	15.6	0.9
Total Catch	6.0	0.0	34.8	103.9	130.2	1,158.2	451.1	275.8	0.9

Appendix 1: (continued)

Vessel	526	526	526	526	526	526	526	526	526
Station	20	21	22	23	24	25	26	27	28
Date	20-Aug-90	21-Aug-90	22-Aug-90	23-Aug-90	24-Aug-90	25-Aug-90	26-Aug-90	27-Aug-90	28-Aug-90
Start Latitude (ddmm.m)	4442.1	4428.7	4522.4	4503.5	4624.4	4735.4	4635.0	4631.3	4454.4
Start Longitude (ddmm.m)	12624.9	12644.6	12700.2	12708.2	12712.2	12705.0	12829.2	12825.9	12733.3
Bottom Depth (m)	2,810	2,826	2,799	2,772	2,673	2,605	2,653	2,691	2,777
Gear Depth (m)	100	100	100	100	100	110	100	135	100
Surface Temperature (C)	19.7	19.1	18.3	18.7	17.7	17.4	18.4	18.3	18.7
Gear Temperature (C)	8.0	8.1	8.1	7.8	7.9	8.0	7.3	6.7	8.4
Percent of Full Moon	100%	94%	88%	81%	75%	69%	62%	56%	50%
Cloud Cover	cldy/rain	cloudy	ptly cloudy	ptly cloudy	ptly cloudy	clear	clear	clear	ptly cloudy
Effort (line hours)	398	474	436	410	339	380	425	414	309
Neon Flying Squid	215.9	402.1	94.6	311.1	67.4	141.9	438.5	307.5	520.3
Nail Squid	0.0	0.0	0.0	0.0	4.2	1.4	0.0	0.0	0.0
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	0.0	0.0	4.2	1.4	0.0	0.0	0.0
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	3.1	8.3	2.2	0.0	0.0	0.0	20.2	4.2	8.2
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	3.1	8.3	2.2	10.4	0.0	0.0	20.2	4.2	8.2
Total Other Fish	3.1	8.3	2.2	10.4	0.0	0.0	20.2	4.2	8.2
Total Bycatch	3.1	8.3	2.2	10.4	4.2	1.4	20.2	4.2	8.2
Total Catch	219.0	410.4	96.8	321.5	71.6	143.3	458.7	311.7	528.5

Appendix 1: (continued)

Vessel	526	526	526	526	526	526	526	526	527
Station	29	30	31	32	33	34	35	36	1
Date	29-Aug-90	30-Aug-90	31-Aug-90	1-Sep-90	2-Sep-90	3-Sep-90	4-Sep-90	4-Sep-90	1-Aug-90
Start Latitude (ddmm.m)	4425.0	4429.2	4344.9	4422.1	4431.2	4427.3	4428.6	4427.0	4252.3
Start Longitude (ddmm.m)	12439.5	12648.5	12728.5	12628.4	12650.9	12647.7	12440.4	12439.9	12500.7
Bottom Depth (m)	126	2,833	2,894	2,851	2,815	2,815	145	97	1,200
Gear Depth (m)	60	100	100	100	100	100	100	80	60
Surface Temperature (C)	15.9	18.8	18.9	18.8	18.8	18.9	15.9	15.9	11.0
Gear Temperature (C)	8.4	9.4	8.8	9.3	9.1	9.3	8.7	- -	- -
Percent of Full Moon	43%	36%	29%	21%	14%	7%	0%	0%	31%
Cloud Cover	ptly cloudy	ptly cloudy	clear	ptly cloudy	ptly cloudy	clear	ptly cloudy	foggy	cldy/rain
Effort (line hours)	224	306	169	377	224	249	10	26	333
Neon Flying Squid	0.0	475.2	34.2	21.8	21.9	16.1	0.0	0.0	0.0
Nail Squid	10.7	0.0	0.4	0.2	0.0	0.0	2.4	6.9	18.9
Robust Clubhook Squid	0.0	0.0	0.0	4.5	3.7	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	11.0	0.0	0.4	4.7	3.7	0.0	2.4	6.9	19.6
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Total Bycatch	11.0	0.0	0.4	5.9	3.7	0.0	2.4	6.9	19.6
Total Catch	11.0	475.2	34.6	27.7	25.6	16.1	2.4	6.9	19.6

Appendix 1: (continued)

Vessel	527	527	527	527	527	527	527	527	527
Station	2	3	4	5	6	7	8	9	10
Date	2-Aug-90	3-Aug-90	4-Aug-90	5-Aug-90	6-Aug-90	7-Aug-90	8-Aug-90	9-Aug-90	10-Aug-90
Start Latitude (ddmm.m)	4222.7	4335.6	4450.8	4554.6	4713.9	4746.8	4628.8	4512.7	4409.3
Start Longitude (ddmm.m)	12618.7	12545.8	12456.2	12641.6	12641.9	12524.4	12759.0	12824.1	12825.3
Bottom Depth (m)	2,900	3,300	450	2,900	2,720	800	2,960	3,020	3,000
Gear Depth (m)	80	50	55	55	60	60	60	60	60
Surface Temperature (C)	16.0	16.3	15.4	17.6	18.0	16.4	18.6	19.2	19.0
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	25%	19%	12%	6%	0%	7%	14%	21%	29%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	clear	ptly cloudy	ptly cloudy	ptly cloudy
Effort (line hours)	490	518	538	520	501	464	524	501	519
Neon Flying Squid	9.9	0.0	0.0	2.3	0.0	0.0	4.4	6.6	26.9
Nail Squid	0.0	0.0	0.0	1.6	0.0	1.6	0.2	0.0	0.1
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	0.0	1.6	0.0	1.6	0.2	0.0	0.1
Blue Shark	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Chub Mackerel	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Total Other Fish	0.0	0.7	0.0	0.0	2.9	0.0	0.0	0.0	1.5
Total Bycatch	0.0	0.7	0.0	1.6	2.9	1.6	0.2	0.0	1.6
Total Catch	9.9	0.7	0.0	3.9	2.9	1.6	4.6	6.6	28.5

Appendix 1: (continued)

Vessel	527	527	527	527	527	527	527	527	527
Station	11	12	13	14	15	16	17	18	19
Date	11-Aug-90	12-Aug-90	13-Aug-90	14-Aug-90	15-Aug-90	16-Aug-90	17-Aug-90	18-Aug-90	19-Aug-90
Start Latitude (ddmm.m)	4310.4	4214.8	4248.1	4325.7	4355.6	4338.9	4253.1	4246.3	4413.0
Start Longitude (ddmm.m)	12711.5	12635.8	12613.2	12526.0	12524.0	12523.4	12550.6	12540.1	12521.1
Bottom Depth (m)	2,900	3,000	2,500	3,200	3,000	2,980	2,600	3,020	2,745
Gear Depth (m)	60	55	45	50	50	55	55	100	130
Surface Temperature (C)	17.6	18.0	17.4	15.8	17.4	16.9	15.4	16.6	18.4
Gear Temperature (C)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Percent of Full Moon	36%	43%	50%	57%	64%	71%	79%	86%	93%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	cldy/rain	cloudy	cloudy	ptly cloudy
Effort (line hours)	530	407	532	528	557	292	271	253	238
Neon Flying Squid	17.7	7.4	11.9	0.0	107.5	37.7	22.4	67.0	86.6
Nail Squid	1.5	2.1	0.7	2.9	3.4	12.2	8.3	25.6	13.0
Robust Clubhook Squid	0.0	1.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.2	9.0	0.9	1.2	7.6	4.0	4.1	19.9	6.3
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	1.7	12.6	3.6	4.1	11.0	16.2	12.4	45.5	19.3
Blue Shark	0.0	0.0	1.5	0.0	3.1	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	2.0
Jack Mackerel	0.4	1.4	0.8	0.3	2.1	0.0	9.0	18.1	0.0
Chub Mackerel	0.8	1.0	0.2	1.0	2.7	2.8	1.2	49.6	3.9
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	1.2	2.4	1.0	1.3	11.1	2.8	10.2	67.7	5.9
Total Other Fish	1.2	2.4	2.5	1.3	14.2	2.8	10.2	67.7	5.9
Total Bycatch	2.9	15.0	6.1	5.4	25.2	19.0	22.6	113.2	25.2
Total Catch	20.6	22.4	18.0	5.4	132.7	56.7	45.0	180.2	111.8

Appendix 1: (continued)

Vessel	527	527	527	527	527	527	527	527	527
Station	20	21	22	23	24	25	26	27	28
Date	20-Aug-90	21-Aug-90	22-Aug-90	23-Aug-90	24-Aug-90	25-Aug-90	26-Aug-90	27-Aug-90	28-Aug-90
Start Latitude (ddmm.m)	4414.2	4412.0	4509.7	4509.9	4615.6	4736.2	4536.7	4441.7	4439.3
Start Longitude (ddmm.m)	12616.5	12613.4	12624.7	12627.1	12619.0	12627.6	12630.6	12718.3	12715.4
Bottom Depth (m)	2,928	2,900	2,650	2,750	2,670	2,380	2,655	2,850	2,900
Gear Depth (m)	100	120	110	110	120	110	110	110	115
Surface Temperature (C)	19.2	19.4	19.4	19.1	18.2	18.2	18.8	19.0	19.3
Gear Temperature (C)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Percent of Full Moon	100%	94%	88%	81%	75%	69%	62%	56%	50%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy
Effort (line hours)	219	241	165	201	181	174	198	211	197
Neon Flying Squid	330.8	381.2	293.2	376.2	59.4	115.5	185.4	727.0	729.1
Nail Squid	0.0	0.0	0.0	0.0	2.6	1.8	0.8	0.0	0.0
Robust Clubhook Squid	0.0	0.0	0.0	2.3	1.6	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	0.0	2.3	4.2	1.8	0.8	0.0	0.6
Blue Shark	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	4.4
Pacific Pomfret	12.8	7.9	1.2	0.0	0.0	7.8	12.9	4.2	2.9
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Chub Mackerel	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	12.8	8.7	1.2	0.0	0.0	7.8	12.9	4.2	5.4
Total Other Fish	12.8	8.7	3.7	0.0	0.0	7.8	12.9	4.2	9.8
Total Bycatch	12.8	8.7	3.7	2.3	4.2	9.6	13.7	4.2	10.4
Total Catch	343.6	389.9	296.9	378.5	63.6	125.1	199.1	731.2	739.5

Appendix 1: (continued)

Vessel	527	527	527	527	527	527	527	528	528
Station	29	30	31	32	33	34	35	1	2
Date	29-Aug-90	30-Aug-90	31-Aug-90	1-Sep-90	2-Sep-90	3-Sep-90	4-Sep-90	1-Aug-90	2-Aug-90
Start Latitude (ddmm.m)	4435.9	4433.0	4357.4	4413.3	4448.3	4440.7	4422.6	4257.1	4230.8
Start Longitude (ddmm.m)	12709.9	12703.3	12734.7	12621.1	12704.0	12703.2	12443.6	12458.2	12556.7
Bottom Depth (m)	2,891	2,890	2,890	2,840	2,875	2,855	128	1,077	660
Gear Depth (m)	125	125	120	130	125	75	75	60	80
Surface Temperature (C)	19.3	19.1	19.1	19.6	19.2	19.2	16.4	10.2	15.5
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	43%	36%	29%	21%	14%	7%	0%	31%	25%
Cloud Cover	ptly cloudy	ptly cloudy	clear	clear	ptly cloudy	ptly cloudy	ptly cloudy	clear	clear
Effort (line hours)	218	192	209	168	91	129	84	319	420
Neon Flying Squid	632.8	269.2	108.2	27.6	13.5	2.3	0.0	0.0	318.3
Nail Squid	0.0	0.0	0.4	0.0	0.5	0.0	27.2	107.5	0.0
Robust Clubhook Squid	0.0	1.9	0.0	0.0	0.0	1.8	0.0	0.0	0.0
Eight Armed Squid	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	2.4	0.4	0.0	0.5	1.8	27.2	107.5	0.0
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3
Pacific Pomfret	6.0	6.0	2.2	0.0	2.5	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.5	0.7	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Total Boney Fish	6.5	6.7	2.2	0.0	2.5	0.0	1.9	0.0	0.0
Total Other Fish	6.5	6.7	2.2	0.0	2.5	0.0	1.9	0.0	22.3
Total Bycatch	6.5	9.1	2.6	0.0	3.0	1.8	29.1	107.5	22.3
Total Catch	639.3	278.3	110.8	27.6	16.5	4.1	29.1	107.5	340.6

Appendix 1: (continued)

Vessel	528	528	528	528	528	528	528	528	528
Station	3	4	5	6	7	8	9	10	11
Date	3-Aug-90	4-Aug-90	4-Aug-90	5-Aug-90	6-Aug-90	7-Aug-90	8-Aug-90	9-Aug-90	10-Aug-90
Start Latitude (ddmm.m)	4339.4	4439.3	4437.9	4541.5	4719.1	4800.1	4628.5	4549.1	4412.4
Start Longitude (ddmm.m)	12543.6	12445.7	12430.9	12512.3	12522.6	12517.9	12451.4	12436.1	12448.9
Bottom Depth (m)	3,043	200	127	575	310	160	2,000	175	95
Gear Depth (m)	75	70	60	55	60	60	60	60	60
Surface Temperature (C)	18.0	13.2	11.0	17.3	16.0	14.4	16.3	15.0	12.2
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	19%	12%	12%	6%	0%	7%	14%	21%	29%
Cloud Cover	clear	foggy	foggy	ptly cloudy	clear	ptly cloudy	ptly cloudy	ptly cloudy	foggy
Effort (line hours)	473	104	312	440	396	396	442	436	391
Neon Flying Squid	2.9	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
Nail Squid	0.0	0.0	1.1	0.1	2.3	0.0	6.2	5.5	5.9
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Total Other Squids	0.0	0.0	1.2	0.1	2.3	0.0	6.2	5.5	6.0
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	0.0	0.0	1.2	0.1	2.3	0.0	6.2	5.5	6.0
Total Catch	2.9	0.0	1.2	0.1	2.3	0.0	8.4	5.5	6.0

Appendix 1: (continued)

Vessel	528	528	528	528	528	528	528	528	528
Station	12	13	14	15	16	17	18	19	20
Date	11-Aug-90	12-Aug-90	13-Aug-90	14-Aug-90	15-Aug-90	16-Aug-90	17-Aug-90	18-Aug-90	19-Aug-90
Start Latitude (ddmm.m)	4309.3	4228.8	4208.7	4252.1	4315.4	4311.7	4312.6	4309.4	4310.1
Start Longitude (ddmm.m)	12539.6	12524.1	12502.6	12544.4	12547.8	12539.0	12528.9	12528.8	12503.8
Bottom Depth (m)	1,500	2,400	2,000	2,500	2,150	2,000	2,000	2,000	2,000
Gear Depth (m)	60	60	60	90	90	90	85	85	85
Surface Temperature (C)	13.7	16.2	17.0	13.3	17.4	15.5	15.1	16.3	16.1
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	36%	43%	50%	57%	64%	71%	79%	86%	93%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	cldy/rain	cldy/rain	ptly cloudy	ptly cloudy
Effort (line hours)	437	558	554	431	475	429	485	456	352
Neon Flying Squid	7.1	33.0	103.0	101.3	37.5	132.7	470.1	69.0	17.0
Nail Squid	3.1	0.0	2.3	3.1	2.0	2.3	0.0	2.0	60.2
Robust Clubhook Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	3.1	0.0	2.3	3.1	2.0	2.3	0.0	2.0	63.6
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	46.3	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	49.1	0.0	0.0
Total Other Fish	0.0	0.0	0.0	0.0	0.0	0.0	49.1	0.0	8.1
Total Bycatch	3.1	0.0	2.3	3.1	2.0	2.3	49.1	2.0	71.7
Total Catch	10.2	33.0	105.3	104.4	39.5	135.0	519.2	71.0	88.7

Appendix 1: (continued)

Vessel	528	528	528	528	528	528	528	528	528
Station	21	22	23	24	25	26	27	28	29
Date	20-Aug-90	21-Aug-90	22-Aug-90	23-Aug-90	24-Aug-90	25-Aug-90	26-Aug-90	27-Aug-90	28-Aug-90
Start Latitude (ddmm.m)	4225.8	4334.2	4425.0	4508.0	4623.2	4734.4	4559.1	4509.7	4445.1
Start Longitude (ddmm.m)	12540.1	12622.7	12644.2	12634.3	12630.3	12638.1	12617.4	12643.4	12720.0
Bottom Depth (m)	2,000	2,000	2,000	2,000	2,000	2,000	2,200	2,000	2,000
Gear Depth (m)	85	85	100	100	90	90	90	80	85
Surface Temperature (C)	17.1	18.8	18.9	18.8	17.1	17.1	18.4	18.8	18.5
Gear Temperature (C)	--	--	--	--	--	--	--	--	--
Percent of Full Moon	100%	94%	88%	81%	75%	69%	62%	56%	50%
Cloud Cover	ptly cloudy	cldy/rain	cldy/rain	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	cldy/rain	ptly cloudy
Effort (line hours)	454	437	313	310	412	405	428	466	475
Neon Flying Squid	44.7	38.6	179.0	134.4	13.7	95.3	24.6	0.0	452.2
Nail Squid	11.5	0.0	0.0	0.0	3.7	1.6	3.1	318.8	0.0
Robust Clubhook Squid	0.0	0.0	0.0	0.0	27.5	0.0	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	11.5	0.0	0.0	0.0	31.2	1.6	4.7	318.8	0.0
Blue Shark	0.0	0.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	1.3	1.8	0.0	1.5	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	1.3	1.8	0.0	1.5	0.0	0.0	0.0
Total Other Fish	0.0	0.0	11.5	1.8	0.0	1.5	0.0	0.0	0.0
Total Bycatch	11.5	0.0	11.5	1.8	31.2	3.1	4.7	318.8	0.0
Total Catch	56.2	38.6	190.5	136.2	44.9	98.4	29.3	318.8	452.2

Appendix 1: (continued)

Vessel	528	528	528	528	528	528	528
Station	30	31	32	33	34	35	36
Date	29-Aug-90	30-Aug-90	31-Aug-90	1-Sep-90	2-Sep-90	3-Sep-90	4-Sep-90
Start Latitude (ddmm.m)	4427.4	4428.5	4405.1	4435.9	4507.7	4458.8	4437.8
Start Longitude (ddmm.m)	12713.1	12710.5	12656.0	12629.6	12655.2	12655.3	12430.4
Bottom Depth (m)	2,000	2,000	2,000	2,000	2,000	2,000	140
Gear Depth (m)	80	80	90	90	90	90	50
Surface Temperature (C)	18.8	18.8	18.8	19.0	18.5	18.2	14.9
Gear Temperature (C)	--	--	--	--	--	--	--
Percent of Full Moon	43%	36%	29%	21%	14%	7%	0%
Cloud Cover	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	ptly cloudy	foggy
Effort (line hours)	504	515	519	451	321	391	33
Neon Flying Squid	589.7	216.6	73.7	15.2	16.3	11.8	0.0
Nail Squid	0.0	0.0	0.0	0.0	0.6	0.0	4.6
Robust Clubhook Squid	0.0	0.0	4.9	0.8	0.0	0.0	0.0
Eight Armed Squid	0.0	0.0	0.0	1.2	0.0	0.0	0.0
Schoolmaster Gonate Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opal Squid	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Squids	0.0	0.0	4.9	2.0	0.6	0.0	4.6
Blue Shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Pomfret	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chub Mackerel	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King-of-the-Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockfish Unid.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Boney Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Bycatch	0.0	0.0	4.9	2.0	0.6	0.0	4.6
Total Catch	589.7	216.6	78.6	17.2	16.9	11.8	4.6

APPENDIX 2

Water temperature depth profiles and environmental data for stations surveyed by the Fuki Maru No. 63 (vessel code 526) during the 1990 U.S.-Japan Cooperative Squid Research Project.

Units

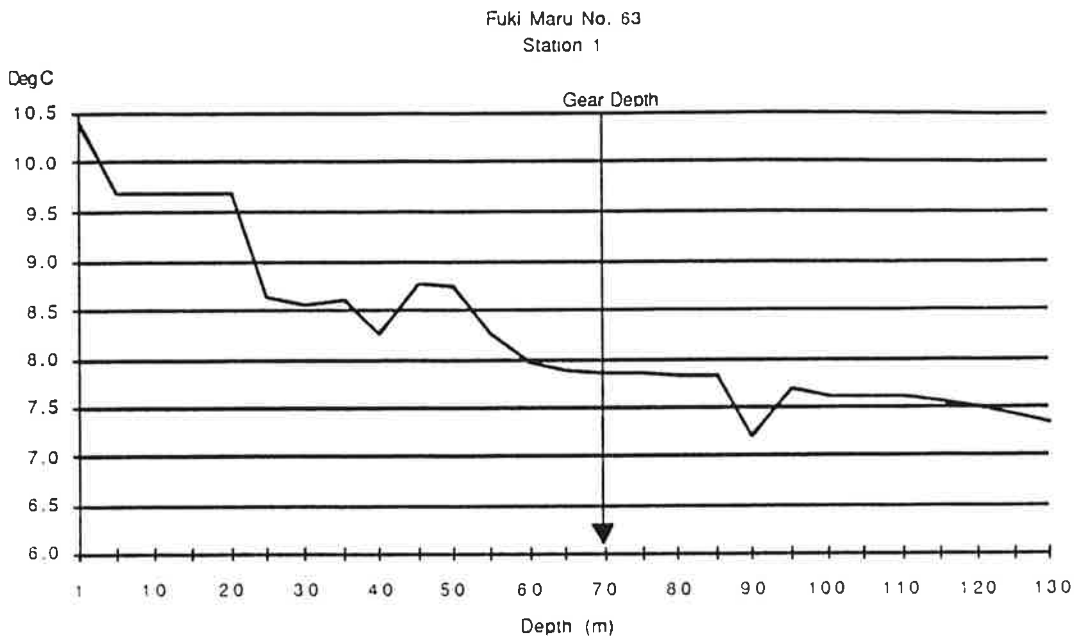
1. Depths are in meters.
2. Tempertures are in degrees centigrade.
3. Wind speeds are in knots.
4. Water color codes:

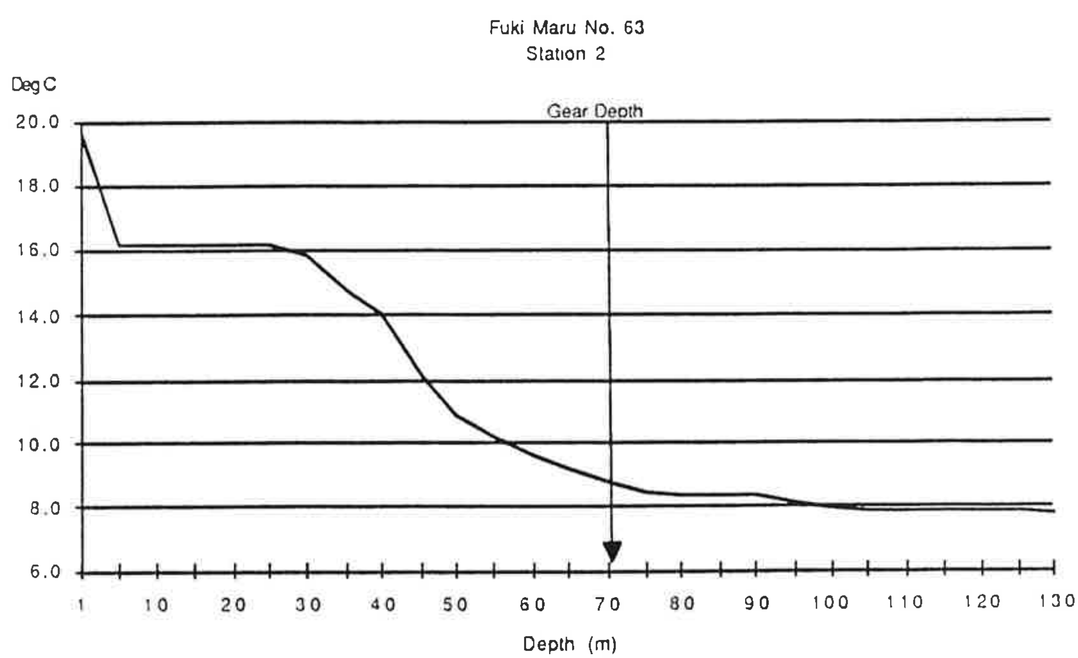
Code	Water Color
3	light blue
4	blue
5	dark blue
6	light green
7	green
8	dark green

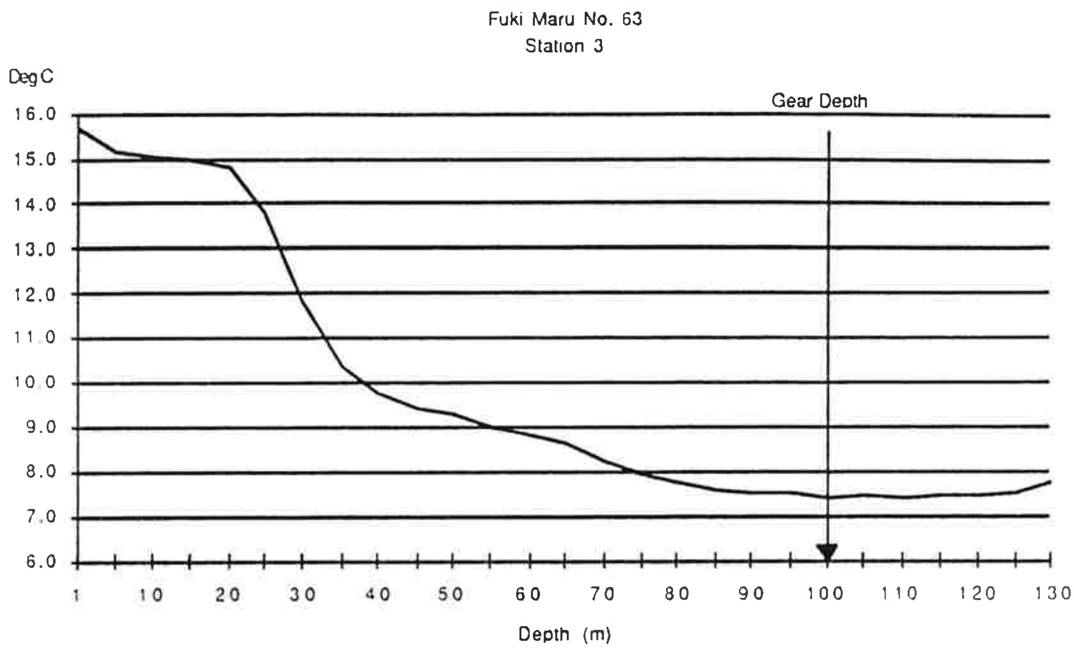
Vessel	526	526	526	526	526	526	526	526	526	526	526	526	526	526
Cruise	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haul	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Latatitude	42.48.5	42.27.8	43.43.6	44.55.7	45.57.8	47.20.3	47.59.4	46.23.9	45.02.9	44.08.7	43.21.6	42.04.3	42.11.2	42.54.6
Longitude	125.06.2	126.10.4	125.45.1	124.51.6	126.57.3	126.57.6	125.29.9	128.17.3	128.37.1	128.46.6	129.00.3	126.20.6	124.51.5	125.37.1
Wind Direction	North	North	North	SSWest	WSWest	North	NWest	NNWest	North	North	-	WNWest	WNWest	WSWest
Wind Spd. (Knts.)	5	5	4	3	2	2	3	3	4	3	-	1	4	2
Beaufort Sea State	5	5	4	3	2	2	2	3	3	3	-	1	4	2
Water Color	5	4	4	5	3-4	3	8	4	4	4	3	4	5	7
Sechi Depth (m)	-	-	10.0	8.0	18.0	20.0	4.0	16.0	13.0	15.0	25.0	14.0	8.5	7.0
Depth In Meters							Temperature (C)							
1	10.4	19.7	15.7	15.0	24.5	20.9	19.4	21.1	20.8	19.8	21.3	22.3	17.7	14.1
5	9.7	16.2	15.2	14.6	17.4	18.1	15.0	18.5	19.1	18.8	18.7	17.5	15.6	13.9
10	9.7	16.2	15.1	13.9	17.4	17.6	11.0	17.9	19.0	18.6	18.2	17.1	15.6	11.1
15	9.7	16.2	15.0	12.7	16.9	17.3	9.7	17.3	18.8	17.6	18.1	16.5	14.3	10.3
20	9.7	16.2	14.8	11.0	16.7	16.6	8.8	16.9	18.0	17.3	18.0	16.1	13.6	9.8
25	8.6	16.1	13.8	9.9	16.5	16.5	7.8	16.7	17.5	17.1	17.1	15.6	13.0	9.5
30	8.5	15.8	11.8	8.9	16.4	16.3	7.5	16.8	16.8	16.5	16.7	14.8	12.5	9.4
35	8.6	14.8	10.4	8.6	15.1	15.8	7.6	13.2	16.3	14.8	16.1	13.6	11.2	9.2
40	8.3	14.0	9.7	8.5	13.2	12.7	7.6	12.1	15.7	13.8	15.4	12.7	10.8	9.0
45	8.8	12.1	9.4	8.3	12.1	11.0	7.7	11.0	14.7	12.3	15.0	10.3	10.4	8.6
50	8.7	10.9	9.3	8.3	10.9	10.8	7.8	10.2	13.3	11.1	14.5	9.6	10.4	8.5
55	8.3	10.2	9.0	8.3	9.8	9.4	7.9	9.5	11.3	10.3	13.3	9.5	9.6	8.5
60	8.0	9.6	8.8	8.3	9.0	8.6	7.9	9.1	10.3	9.5	12.5	9.0	9.0	8.4
65	7.9	9.2	8.6	8.3	8.7	8.4	7.9	8.7	9.4	9.1	12.0	8.6	8.7	8.3
70	7.9	8.8	8.2	8.3	8.2	8.3	7.9	8.2	9.0	8.9	10.9	8.6	8.7	8.2
75	7.9	8.4	8.0	8.2	8.3	8.3	7.9	8.0	8.7	8.6	10.3	8.5	8.6	8.1
80	7.8	8.4	7.7	8.2	8.0	8.2	7.9	7.8	8.6	8.5	10.1	8.6	8.4	8.0
85	7.8	8.4	7.6	8.1	8.0	8.2	7.8	7.6	8.4	8.4	9.7	8.4	8.4	8.0
90	7.2	8.3	7.5	8.0	8.0	8.2	7.8	7.5	8.3	8.3	9.4	8.3	8.5	7.9
95	7.7	8.1	7.5	8.0	7.6	8.2	7.7	7.3	8.2	8.2	9.3	8.2	8.7	7.9
100	7.6	8.0	7.4	8.0	7.8	8.2	7.7	7.2	8.1	8.1	9.0	8.2	8.5	7.9
105	7.6	7.9	7.5	7.9	8.1	8.2	7.7	7.0	8.1	7.9	8.9	8.3	8.2	7.8
110	7.6	7.9	7.4	7.8	8.4	8.2	7.6	6.9	8.1	7.8	8.7	8.3	8.2	7.7
115	7.6	7.9	7.4	7.8	8.4	7.9	7.5	6.8	8.0	7.9	8.5	8.2	8.0	7.6
120	7.5	7.9	7.5	7.7	8.5	7.4	7.5	6.7	8.0	7.8	8.2	8.2	7.8	7.5
125	7.4	7.9	7.5	7.5	8.4	7.3	7.4	6.6	7.9	7.8	7.9	8.1	7.7	7.4
130	7.4	7.8	7.7	7.4	8.5	7.3	7.3	6.3	7.9	7.6	7.9	8.1	7.7	7.4

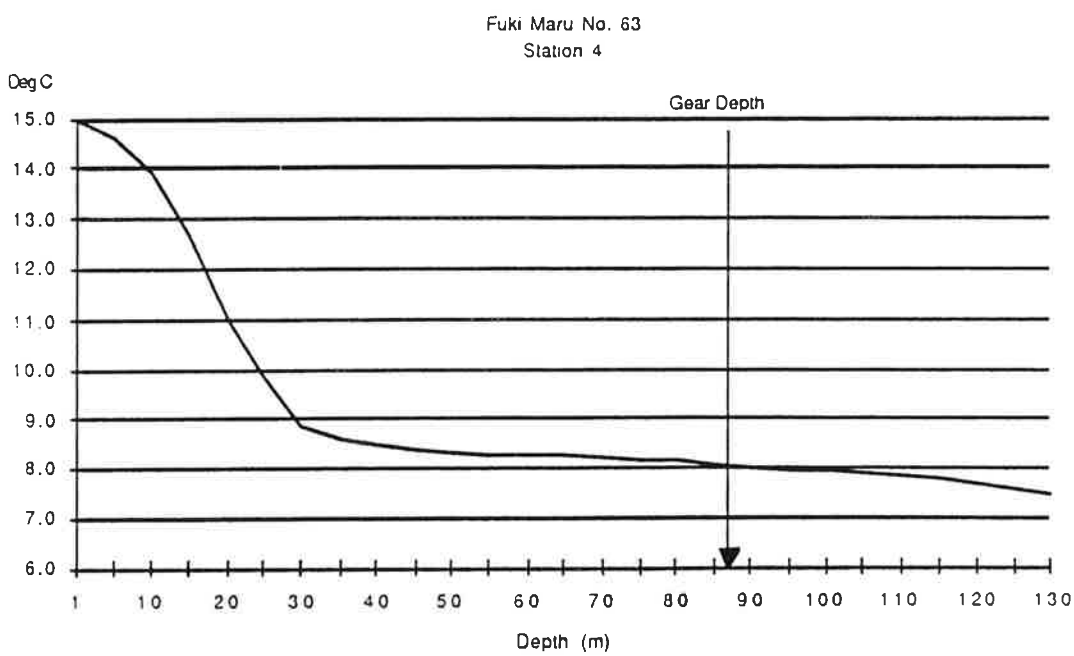
Vessel	526	526	526	526	526	526	526	526	526	526	526	526	526	526
Cruise	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haul	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Latatitude	42.57.4	43.16.1	43.07.9	43.12.6	44.08.5	44.42.3	44.28.6	45.21.0	45.03.5	46.24.4	47.35.5	46.35.0	46.31.3	44.54.3
Longitude	125.43.7	125.32.3	125.27.6	125.58.0	124.58.6	126.25.9	126.44.5	127.00.5	127.08.2	127.12.1	127.05.3	128.29.2	128.25.9	127.33.3
Wind Direction	WSWest	South	South	-	North	NNWest	NNWest	North	NNWest	NNWest	ESEast	ENEast	East	SSEast
Wind Spd. (Knts.)	3	5	4	-	4	4	4	5	5	4	2	3	4	3
Beaufort Sea State	2	4	3	1	3	3	3	4	4	4	2	3	3	2
Water Color	6 - 7	6 - 7	5	5	4	4	3 - 4	4	4	4	5	3	3	3
Sechi Depth (m)	6.0	5.5	7.0	7.0	11.0	16.0	16.5	16.0	14.5	16.0	16.0	23.0	15.0	18.0
Depth In Meters						Temperature (C)								
1	20.1	19.3	15.7	22.6	16.0	20.5	19.9	16.8	19.3	18.7	19.2	18.4	18.6	18.8
5	13.7	15.8	15.7	16.1	14.9	19.6	19.7	18.4	18.1	17.8	17.1	18.4	18.4	18.8
10	11.6	15.8	14.7	15.3	11.2	19.4	19.1	18.4	18.8	17.8	17.0	18.3	18.4	18.8
15	10.5	15.8	12.2	12.7	9.8	18.8	19.0	18.4	18.6	17.8	16.9	18.3	18.4	18.7
20	10.3	15.2	11.7	12.0	9.2	18.6	18.2	18.2	18.3	17.6	15.8	18.3	18.3	18.6
25	10.0	14.1	11.2	11.5	9.3	18.2	17.1	17.4	17.4	17.5	12.0	16.5	18.3	18.2
30	9.8	13.3	10.8	11.2	9.1	17.3	16.4	17.2	17.1	15.5	11.3	15.3	18.1	17.2
35	9.6	11.9	10.4	10.7	9.3	16.7	15.8	15.2	16.1	14.9	11.1	13.0	15.8	16.1
40	9.2	11.4	10.1	10.5	9.1	16.0	14.8	13.2	12.7	13.3	9.3	12.1	14.4	13.7
45	9.0	10.9	10.1	10.2	9.0	14.3	12.9	11.9	11.5	11.2	8.6	11.4	13.1	12.3
50	9.0	10.7	9.9	10.0	9.0	11.7	12.4	10.8	10.4	10.0	8.0	10.1	11.8	11.1
55	8.3	10.2	9.7	9.9	8.9	10.3	12.0	9.8	9.3	9.1	7.8	9.3	11.2	10.2
60	8.2	9.9	9.6	9.7	8.9	9.8	10.5	9.1	8.8	8.4	7.8	8.8	9.5	9.5
65	8.2	9.8	9.5	9.6	8.9	9.1	9.3	8.9	8.6	7.3	7.8	8.5	8.8	9.0
70	8.3	10.0	9.3	9.5	8.8	8.7	9.0	8.6	8.4	8.2	7.7	8.3	8.5	8.6
75	8.2	9.8	9.3	9.3	8.8	8.6	8.6	8.6	7.9	7.4	7.6	8.0	8.3	8.4
80	8.2	9.6	9.2	9.2	8.8	8.4	8.4	8.2	7.6	7.3	7.7	7.9	8.1	8.2
85	8.2	9.4	9.1	9.1	8.7	8.3	8.3	8.2	7.5	7.3	7.6	7.7	7.9	8.2
90	8.2	9.2	9.0	9.0	8.6	8.2	8.2	8.4	7.3	7.6	7.7	7.6	7.8	8.2
95	8.1	9.2	8.9	8.9	8.6	8.1	8.1	8.3	7.0	7.9	6.9	7.5	7.7	8.3
100	8.0	9.0	8.9	8.7	8.6	8.0	8.1	8.1	7.8	7.9	6.8	7.3	7.6	8.4
105	7.9	8.7	8.7	8.6	8.4	8.0	8.5	8.2	8.1	8.1	6.7	7.2	7.5	8.4
110	7.9	8.4	8.6	8.5	8.3	8.0	8.5	8.1	8.4	8.2	8.0	7.2	7.3	8.3
115	7.9	8.6	8.4	8.5	8.1	8.0	8.4	7.8	8.3	8.2	7.5	6.9	7.2	8.3
120	7.8	8.3	8.3	8.4	8.1	8.1	8.3	7.9	8.2	8.2	7.4	6.8	7.0	8.2
125	7.8	8.1	8.3	8.4	7.8	8.9	8.3	7.6	8.2	8.2	7.4	6.7	6.9	8.2
130	7.7	8.0	8.3	8.3	7.7	8.1	8.1	7.7	8.2	8.1	7.4	6.6	6.7	8.1

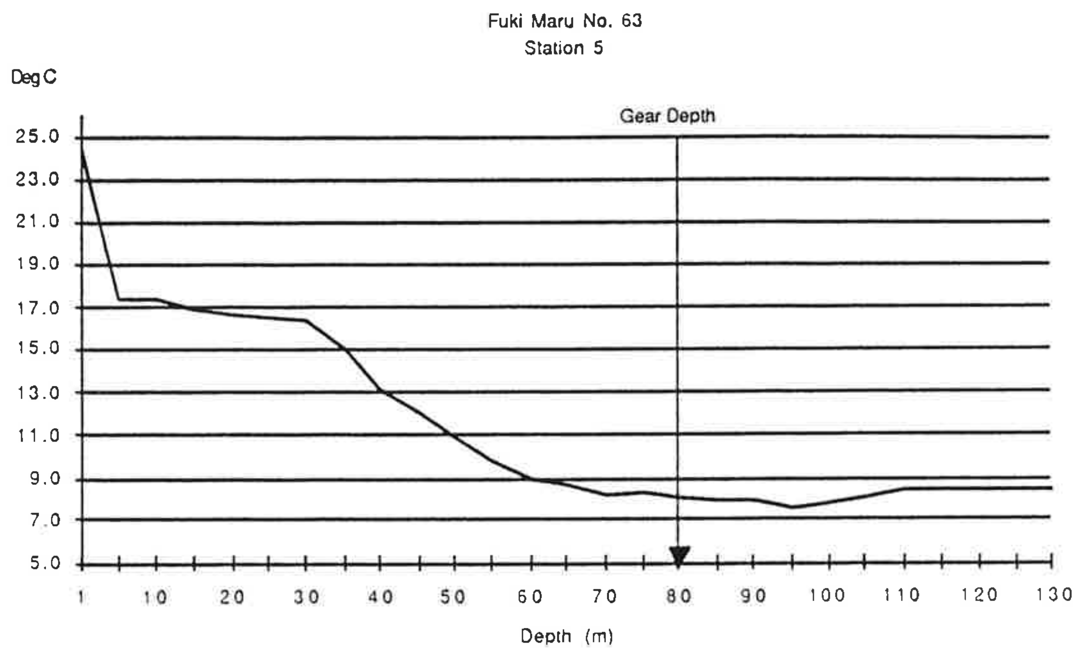
Vessel	526	526	526	526	526	526	526	526	526	526	526
Cruise	1	1	1	1	1	1	1	1	1	1	1
Haul	29	30-A	30-B	31-A	31-B	32-A	32-B	33	34	35-A	35-B
Latatitude	44.24.9	44.29.7	44.27.9	43.45.5	43.39.9	44.21.9	44.22.2	44.31.9	44.26.0	44.27.4	44.28.4
Longitude	124.39.8	126.49.8	126.44.1	127.28.3	127.30.0	126.28.7	126.24.7	126.50.8	126.48.2	124.42.3	124.40.1
Wind Direction	NWest	WNWest	-	NWest	-	NWest	-	NWest	Nwest	NWest	-
Wind Spd. (Knts.)	7	2	-	4	-	3	-	7	18	17	-
Beaufort Sea State	5	4	-	2	-	2	-	4	5	4	-
Water Color	7	3	-	4	-	3	-	4	4	6	-
Sechi Depth (m)	-	-	-	21.0	-	19.0	-	-	-	-	-
Depth In Meters					Temperature (C)						
1	16.2	18.9	20.1	18.5	18.3	19.3	18.8	19.0	18.5	19.3	17.2
5	15.6	18.9	18.9	19.1	18.9	18.9	18.9	19.0	18.5	16.0	16.9
10	13.3	18.9	18.7	18.7	18.7	18.9	18.9	19.0	18.5	15.7	16.8
15	11.4	18.8	18.6	17.8	18.7	18.8	18.8	19.0	18.5	11.9	14.8
20	10.1	18.6	17.7	16.6	17.6	18.8	18.8	18.9	17.7	11.0	11.1
25	9.2	17.2	17.0	16.2	16.4	17.5	18.1	18.6	17.0	10.5	9.8
30	8.8	17.6	16.5	14.0	16.2	15.8	16.6	18.0	15.9	9.5	9.1
35	9.0	14.7	15.9	12.4	15.1	14.6	15.3	16.7	14.9	9.3	8.9
40	9.3	12.7	14.7	11.2	12.9	13.5	13.7	14.5	12.9	8.9	8.9
45	8.9	11.5	13.9	10.3	11.3	11.8	12.3	12.2	11.7	8.9	8.9
50	8.8	10.8	11.8	9.8	10.7	10.8	11.0	10.9	10.7	9.0	9.0
55	8.6	9.8	10.6	9.1	9.2	9.6	10.0	9.9	9.9	8.8	8.9
60	8.4	9.4	9.6	8.8	9.1	9.3	9.2	9.1	9.3	8.7	8.9
65	8.3	9.0	9.0	8.5	8.9	8.9	9.0	8.7	9.0	8.6	8.8
70	8.2	8.9	8.6	8.4	8.8	8.4	8.5	8.3	8.8	8.5	8.5
75	8.2	8.6	8.3	8.3	8.7	8.2	8.3	7.9	8.6	8.4	8.4
80	8.1	8.5	8.3	8.1	8.6	8.0	8.1	8.0	8.4	8.3	8.4
85	8.0	8.4	8.2	7.7	8.6	8.0	8.0	8.0	8.2	8.2	8.2
90	8.0	8.3	7.8	7.6	8.4	8.0	7.9	7.9	8.1	8.2	8.2
95	7.9	8.0	7.7	7.4	8.1	7.9	7.8	7.2	8.0	8.2	8.1
100	8.0	7.8	7.7	7.2	8.0	7.8	8.0	7.3	8.1	8.1	8.1
105	7.9	7.7	7.7	7.5	7.8	7.9	7.9	7.8	8.1	8.1	8.1
110	7.9	7.7	7.7	7.8	7.8	8.0	7.9	7.8	8.0	8.1	8.0
115	-	7.7	7.7	7.8	7.5	7.9	7.9	8.1	7.7	8.1	8.0
120	-	7.8	7.7	7.8	7.4	7.9	7.8	7.8	7.8	8.0	8.1
125	-	7.8	7.7	7.7	7.4	8.1	7.8	7.7	7.7	8.0	8.0
130	-	7.7	7.7	7.7	7.6	8.0	7.8	7.8	7.7	8.0	8.0

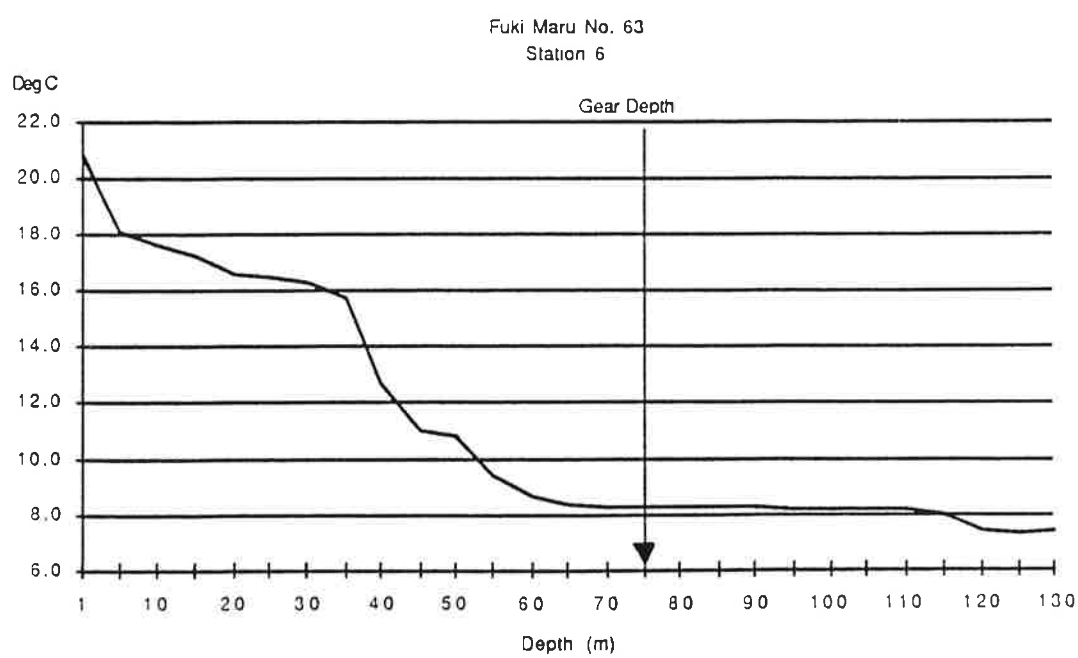

Fuki Maru No. 63
Station 1
Deg C
Gear Depth
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

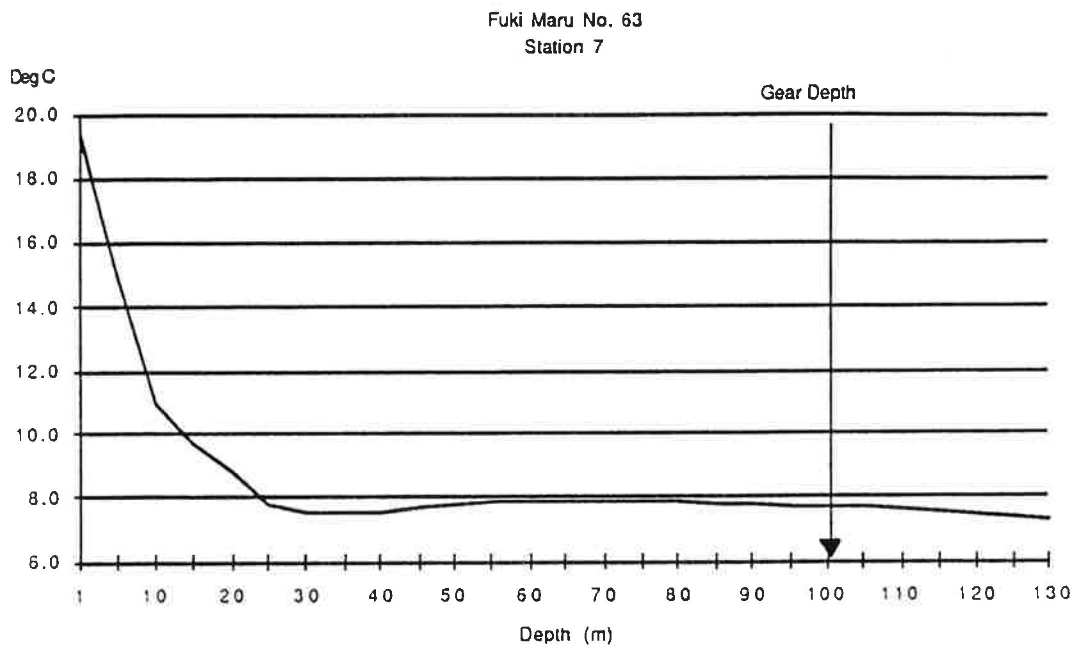

Fuki Maru No. 63
Station 2
Deg C
Gear Depth
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

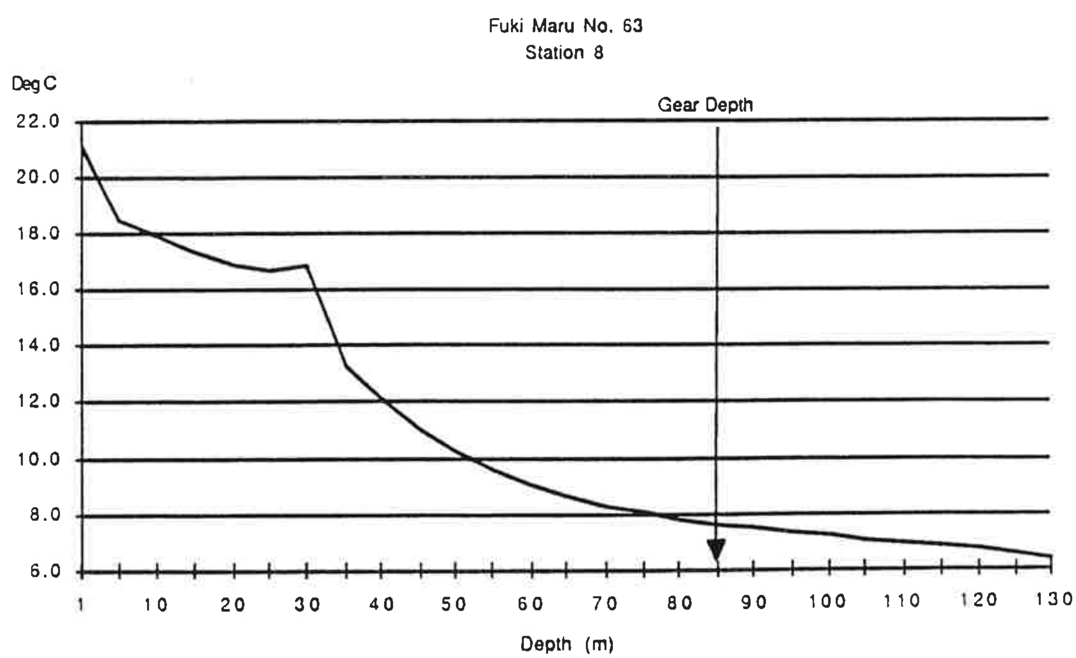

Fuki Maru No. 63
Station 3
Deg C
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

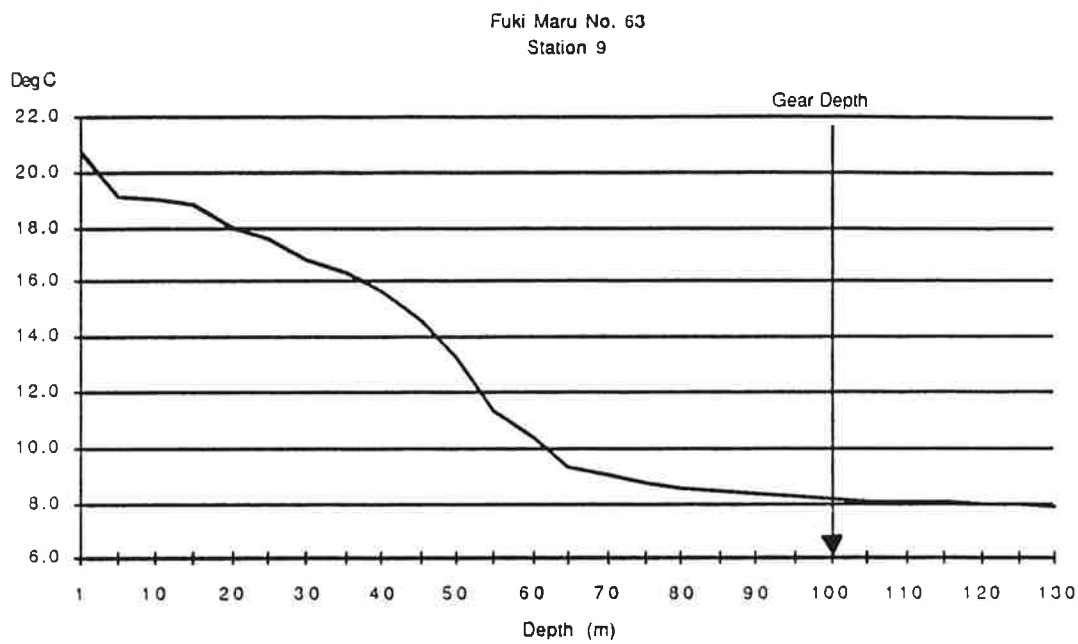

Fuki Maru No. 63
Station 4
Deg C
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

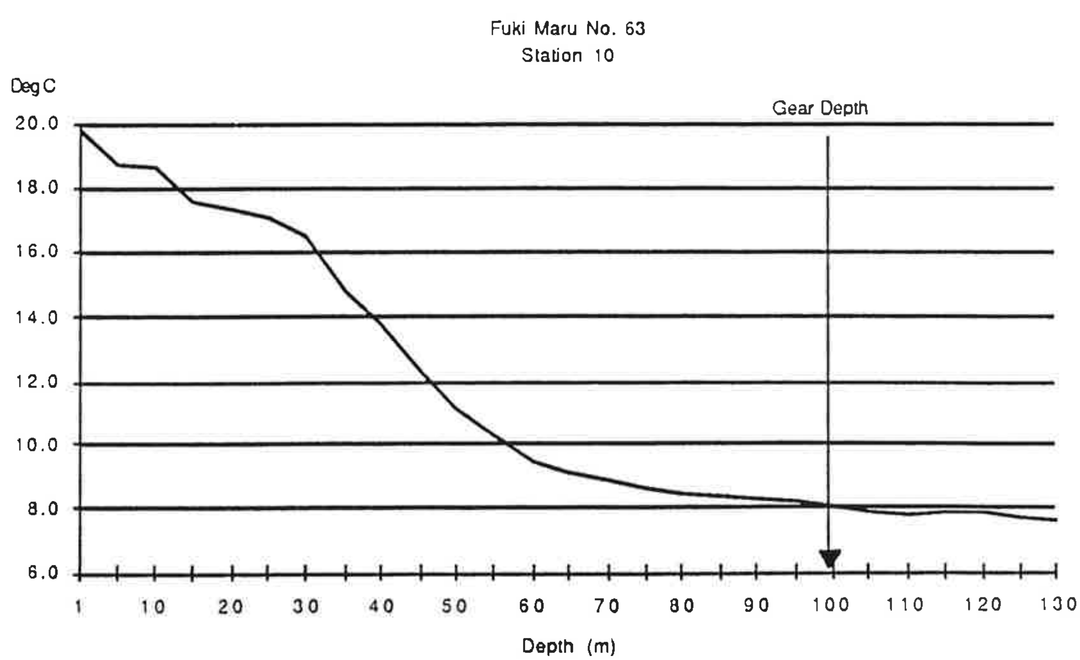

Fuki Maru No. 63
Station 5
Deg C
Gear Depth
25.0
23.0
21.0
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

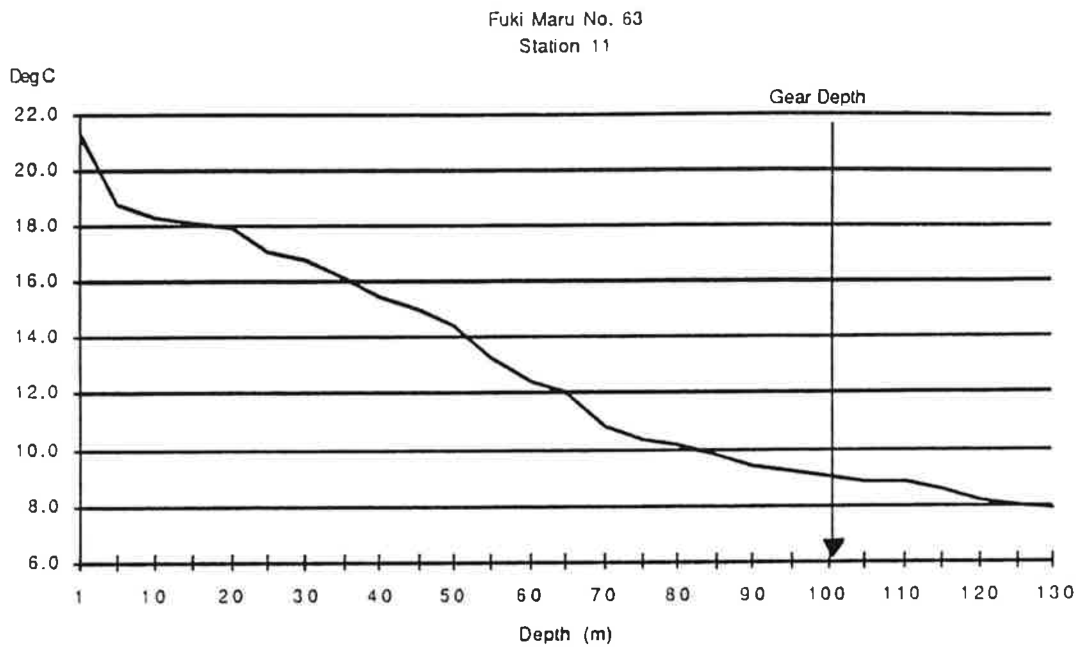

Fuki Maru No. 63
Station 6
Deg C
Gear Depth
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

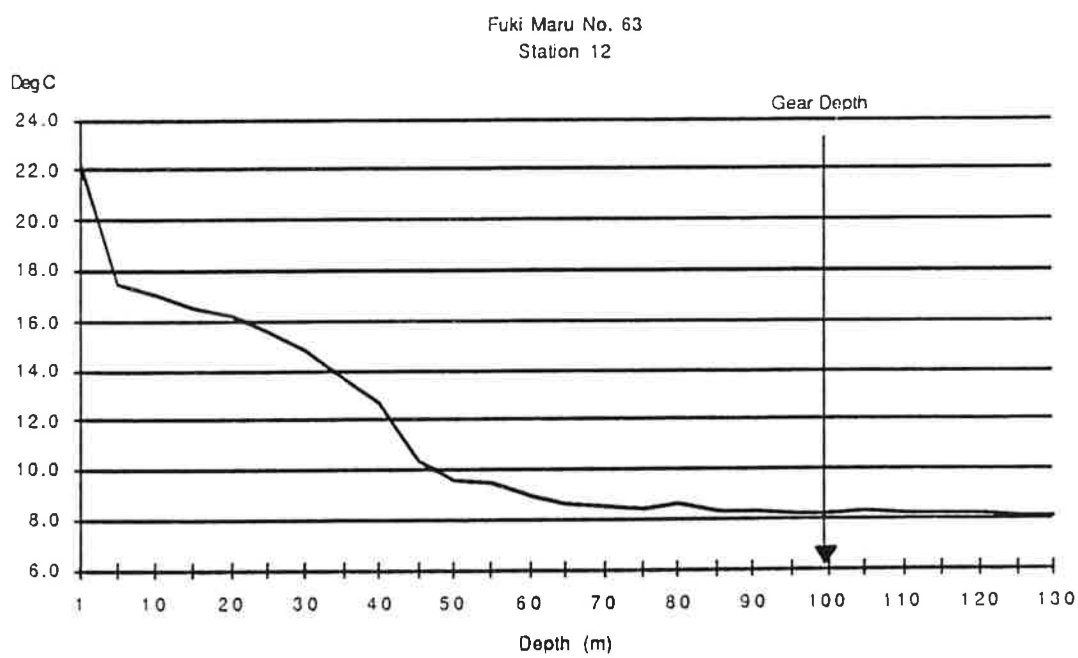

Fuki Maru No. 63
Station 7
Deg C
Gear Depth
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

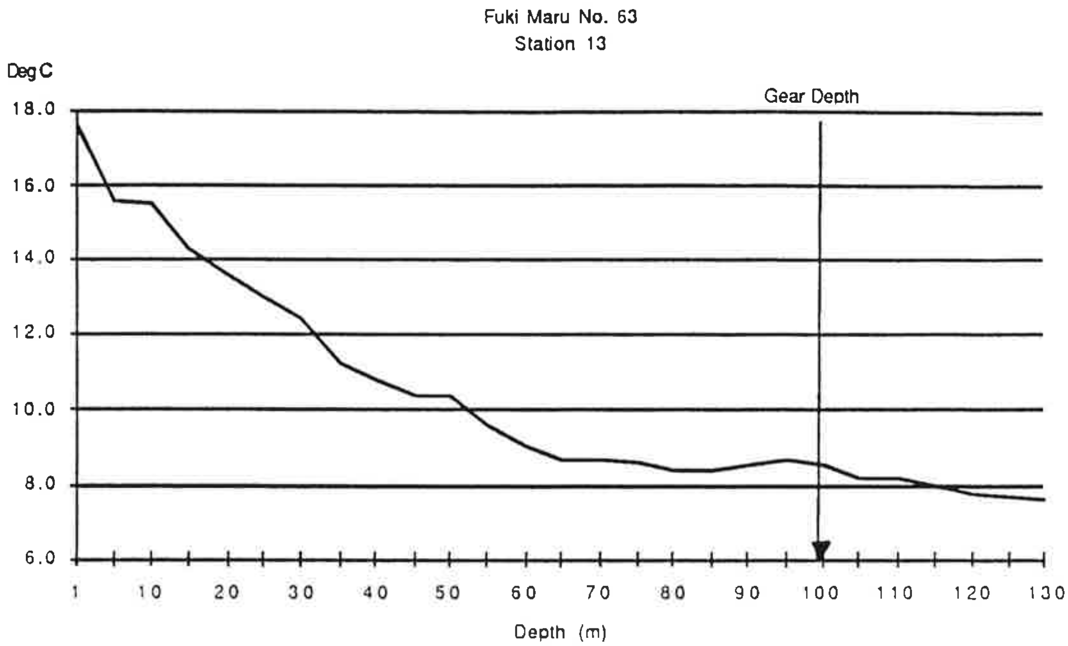

Fuki Maru No. 63
Station 8
Deg C
Gear Depth
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 9
Deg C
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

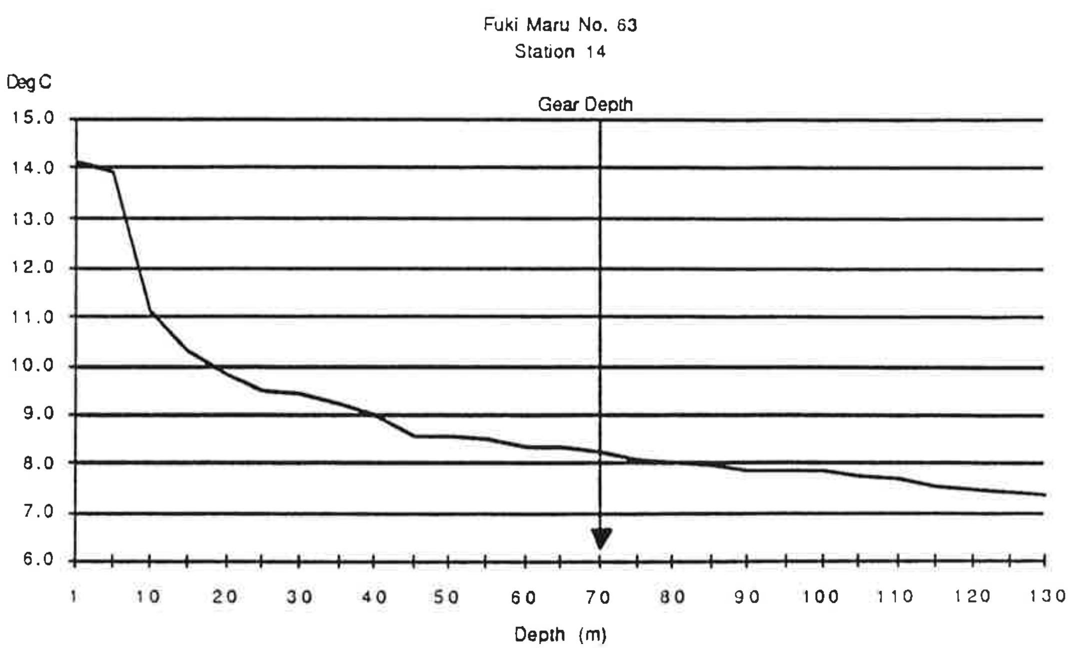

Fuki Maru No. 63
Station 10
Deg C
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 11
Deg C
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 12
Deg C
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

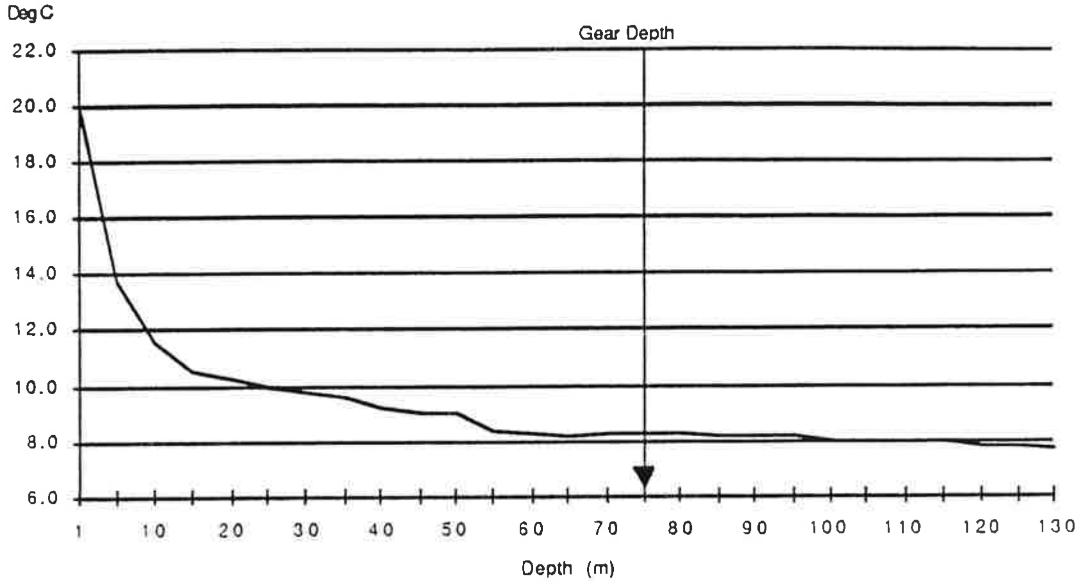


Fuki Maru No. 63
Station 13
Deg C
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

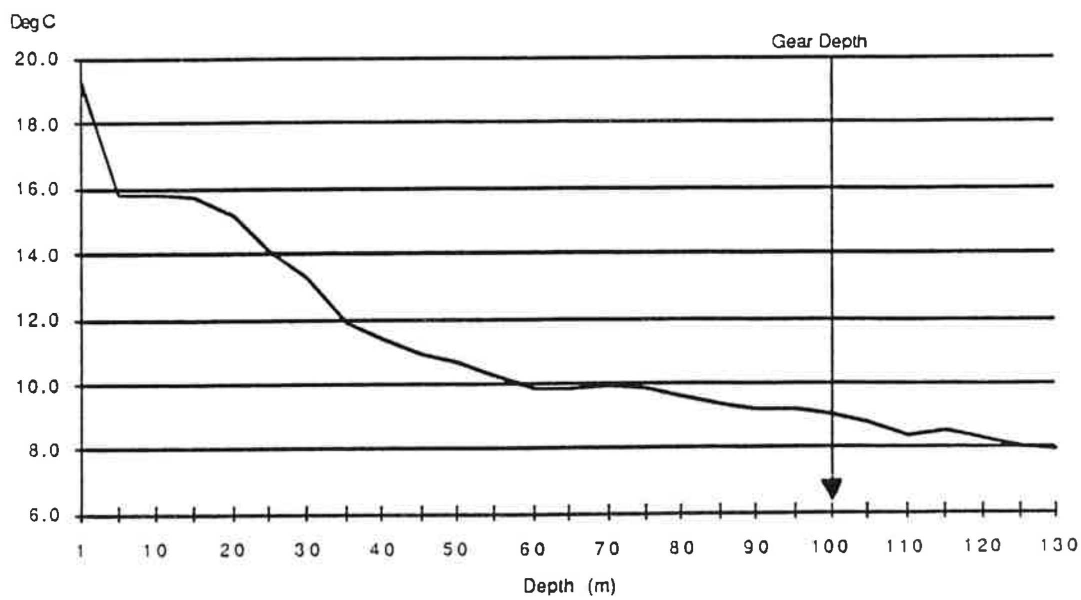


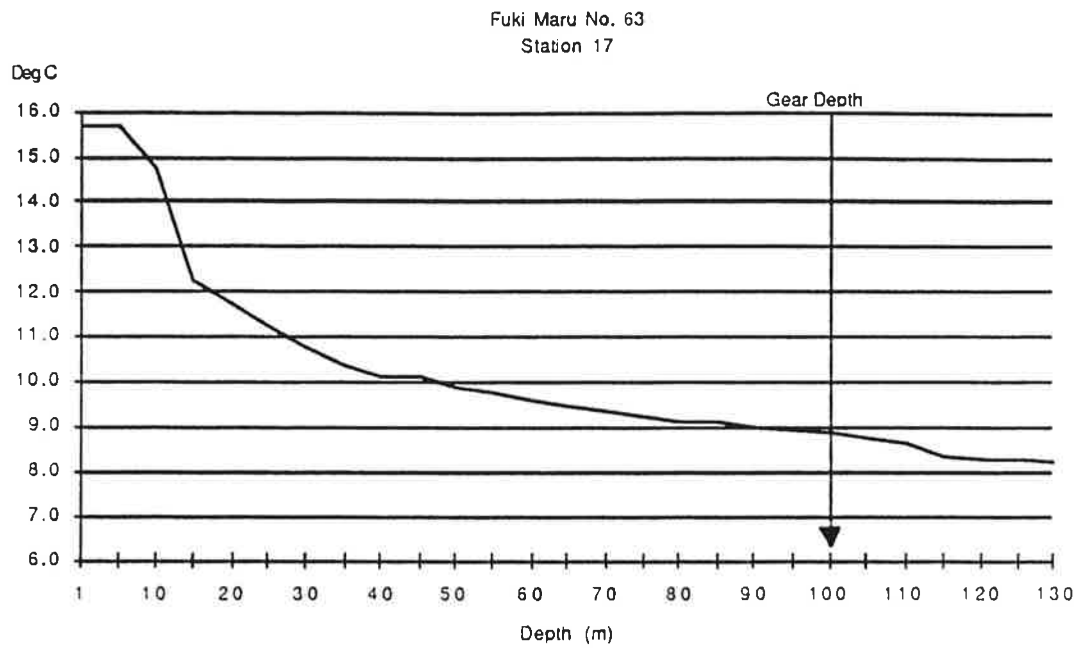
Fuki Maru No. 63
Station 14
Deg C
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

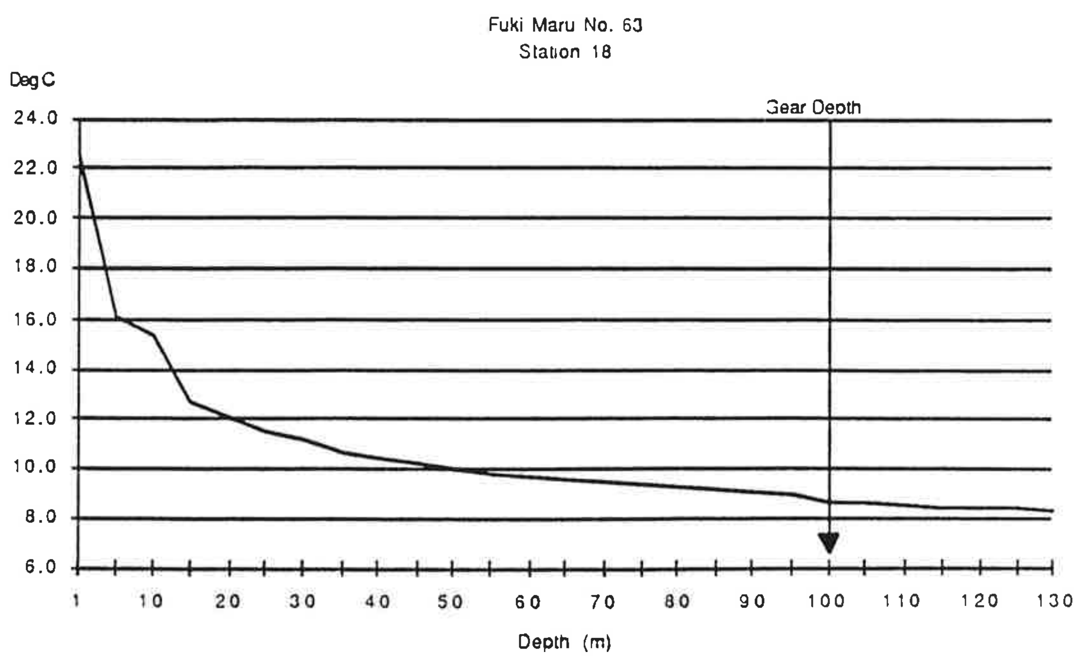
Fuki Maru No. 63
Station 15



Fuki Maru No. 63
Station 16




Fuki Maru No. 63
Station 17
Deg C
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
Gear Depth
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)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Station 18
Deg C
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8.0
6.0
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1
10
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30
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50
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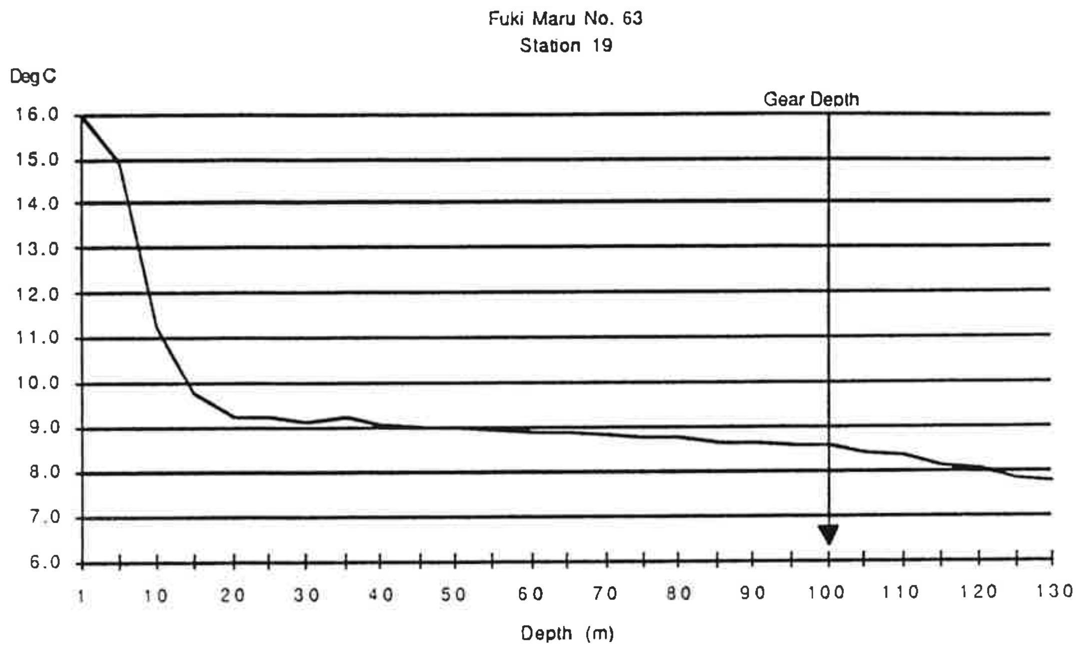
80
90
100
110
120
130
Depth (m)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Station 19
Deg C
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13.0
12.0
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7.0
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Gear Depth
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10
20
30
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50
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80
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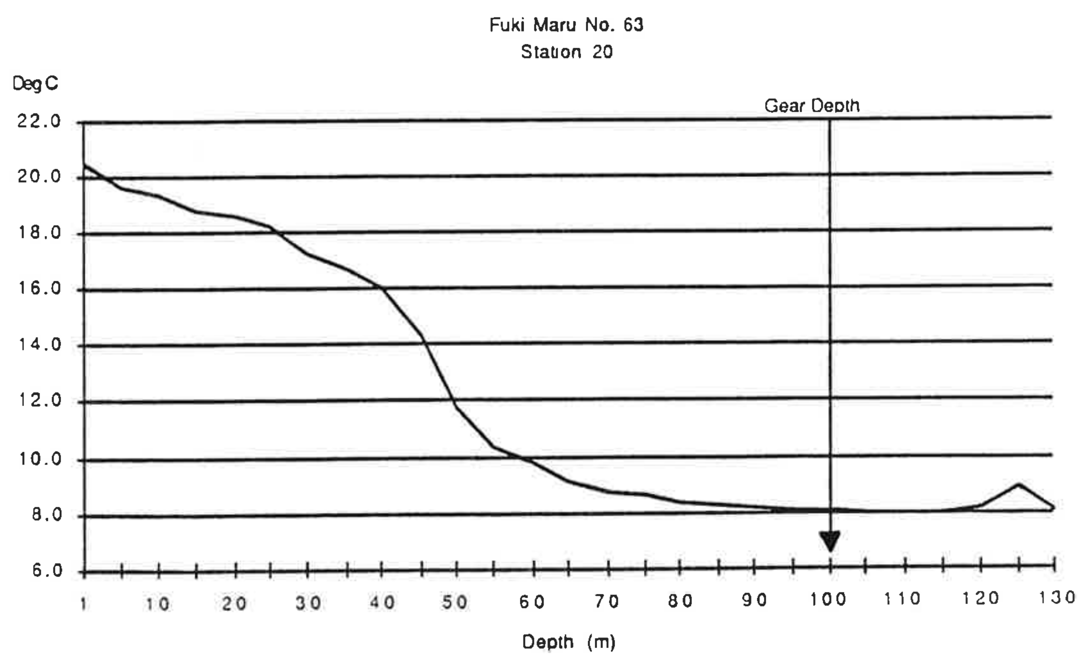
100
110
120
130
Depth (m)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Station 20
Deg C
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8.0
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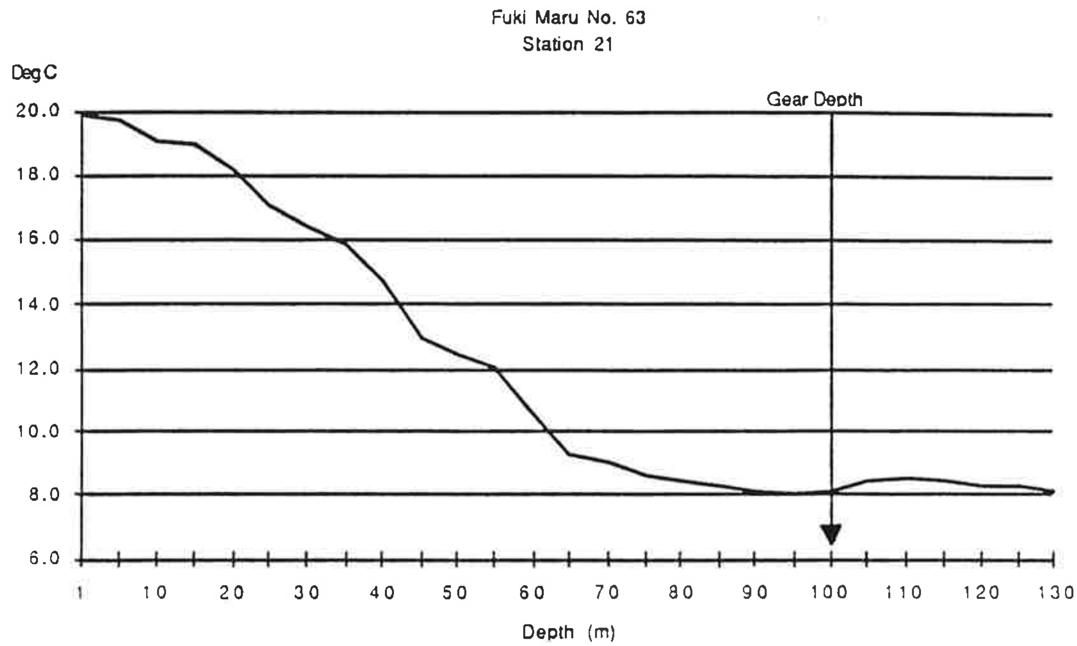
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)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Station 21
Deg C
Gear Depth
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16.0
14.0
12.0
10.0
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1
10
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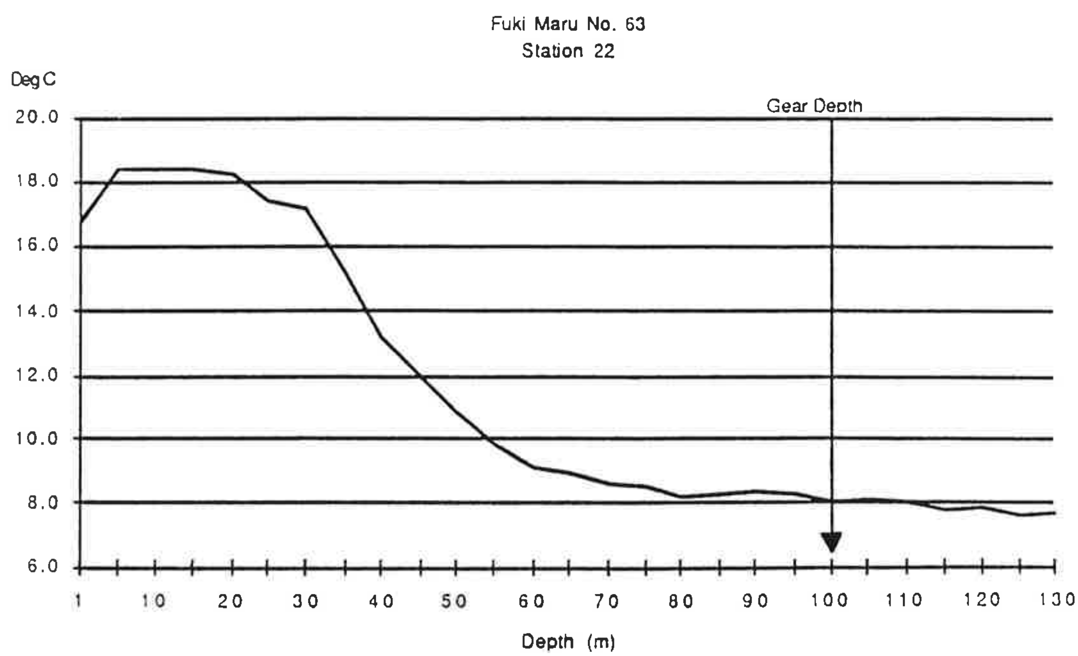
40
50
60
70
80
90
100
110
120
130
Depth (m)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Deg C
Gear Depth
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14.0
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10.0
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6.0
1
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40
50
60
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80
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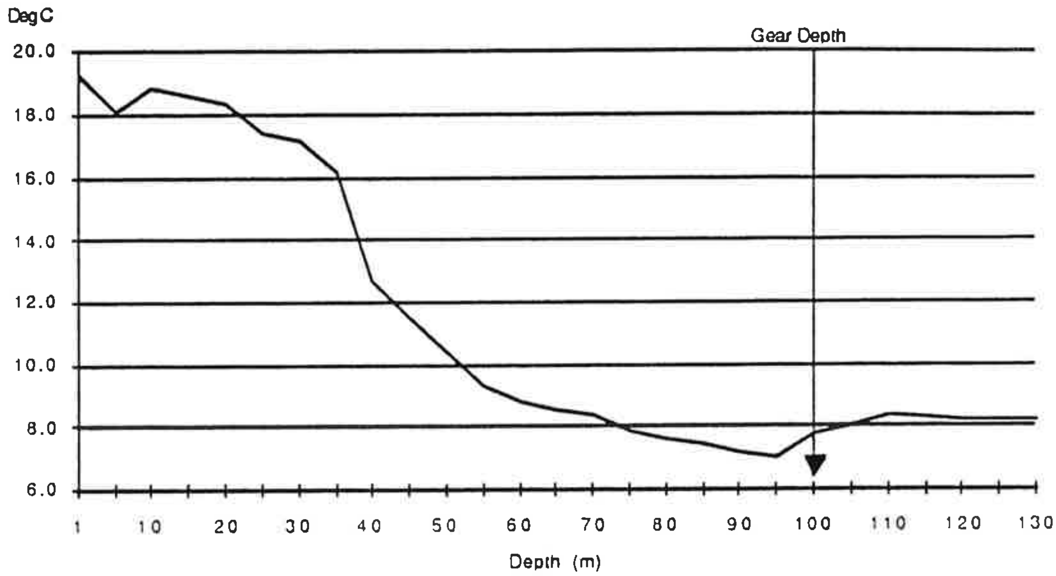
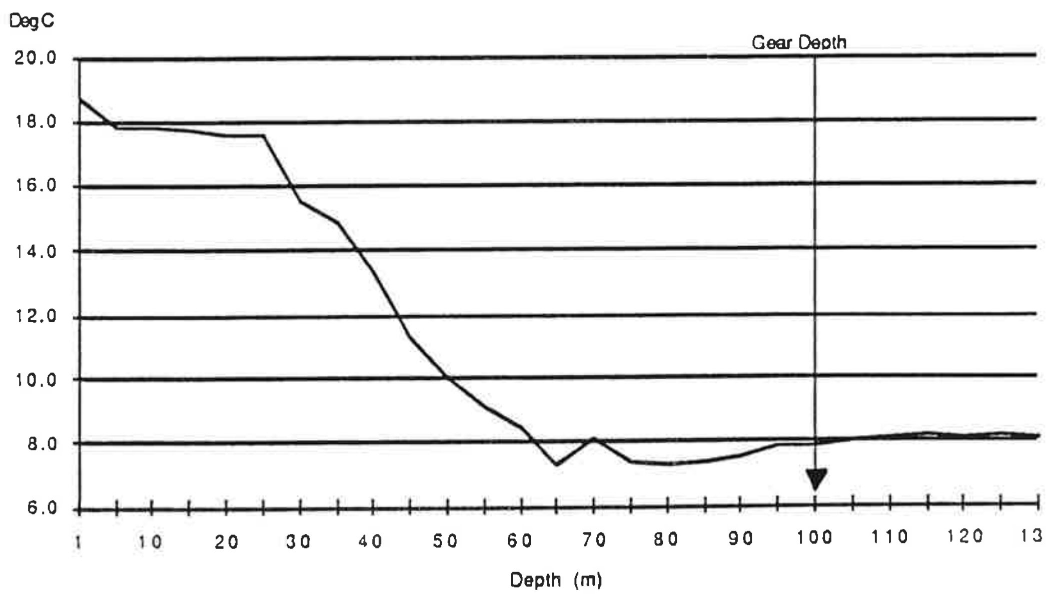
100
110
120
130
Depth (m)

Fuki Maru No. 63
Station 23



Fuki Maru No. 63
Station 24



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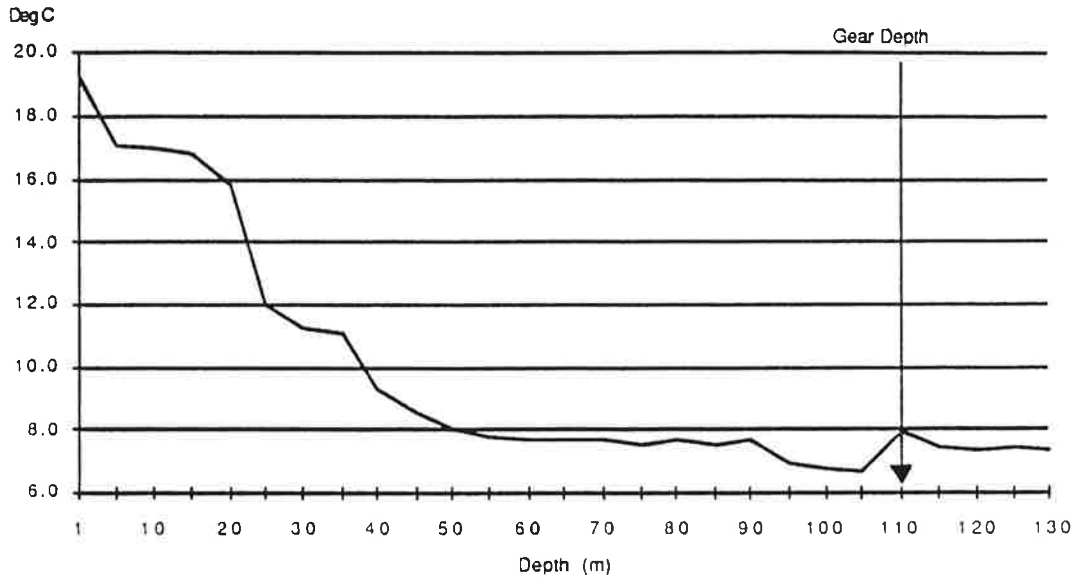
Station 25



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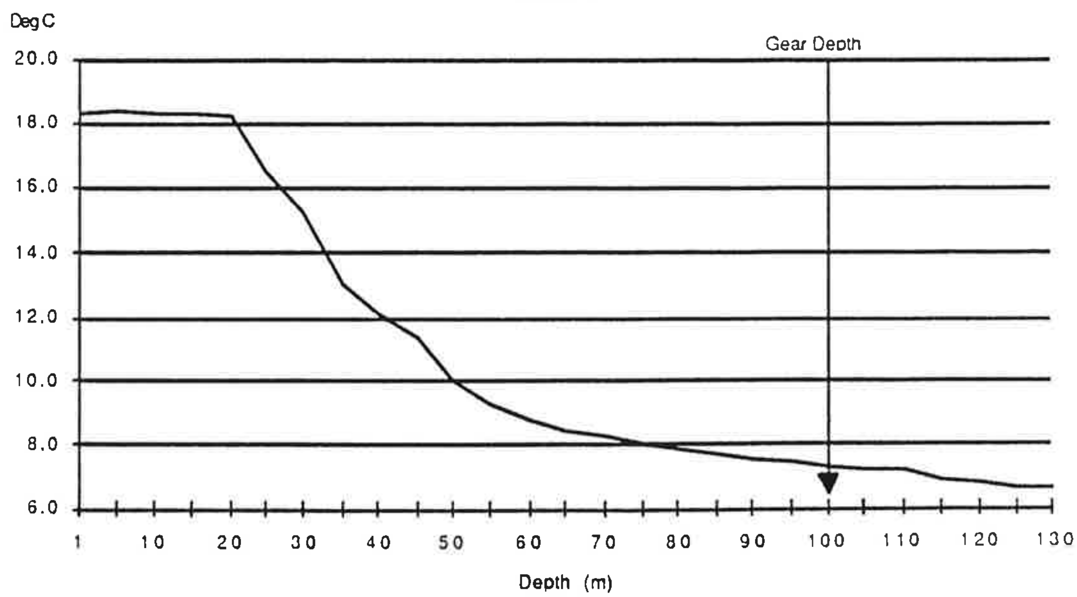
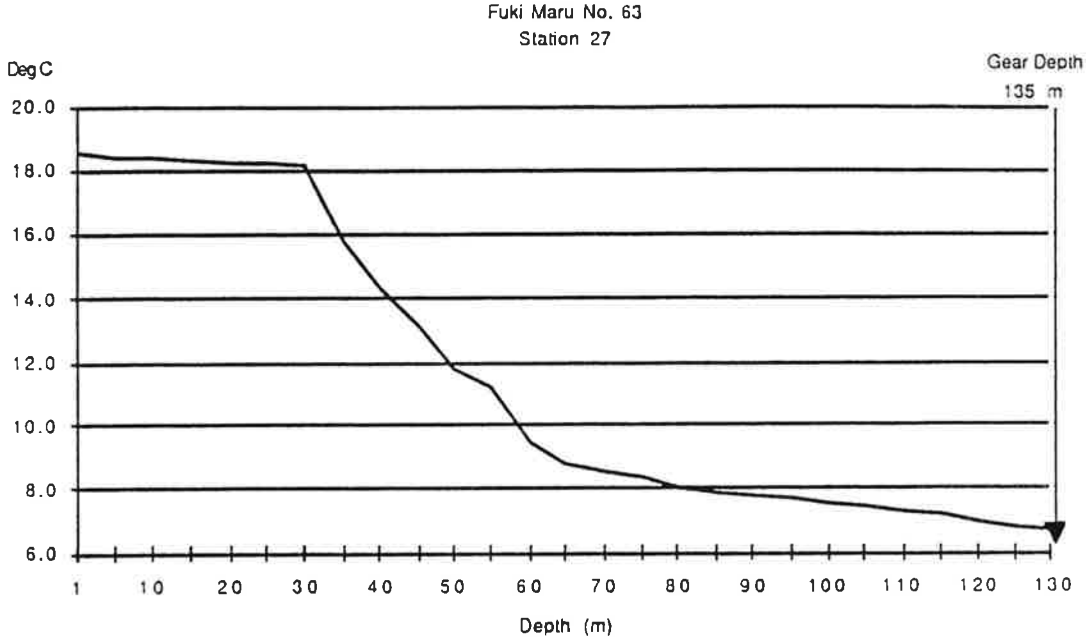
Station 26

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Station 27
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Gear Depth
135 m
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12.0
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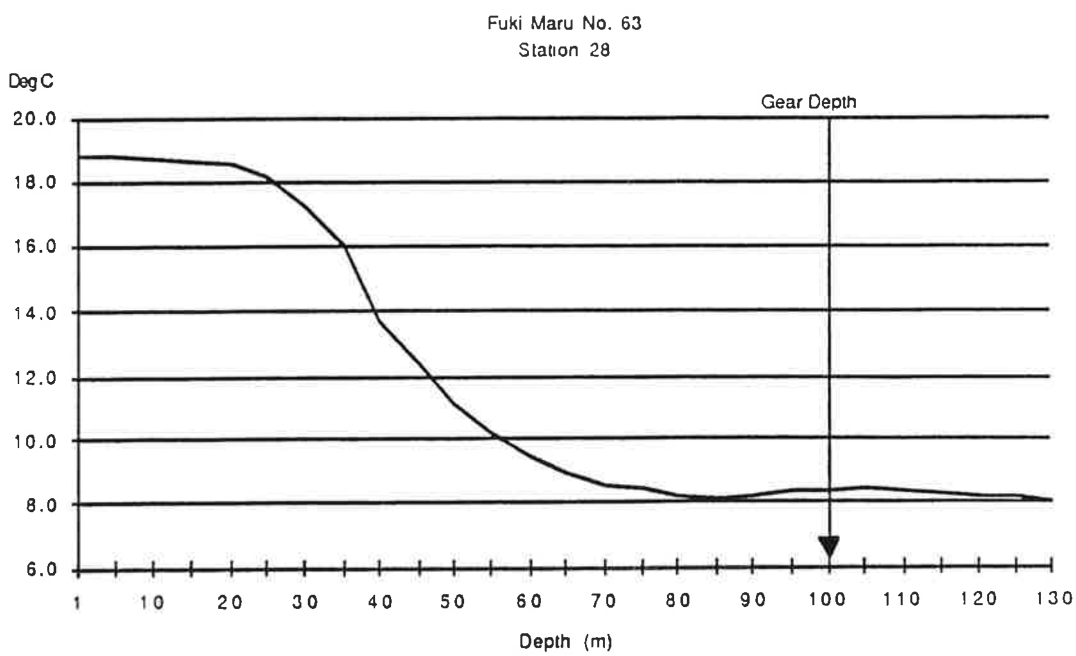
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)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Deg C
Gear Depth
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14.0
12.0
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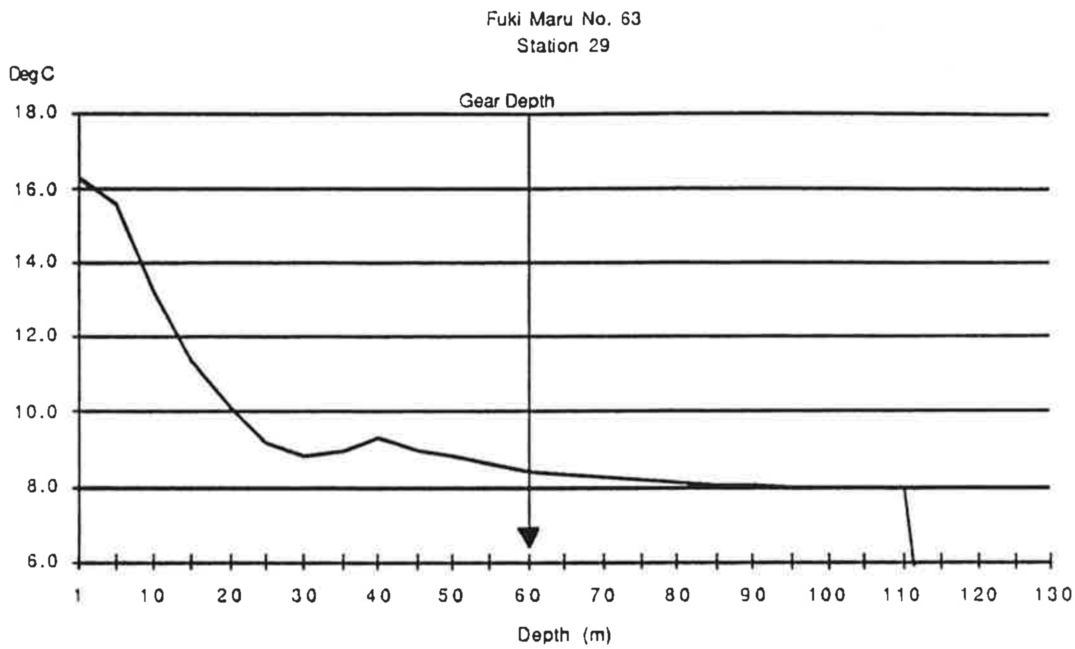
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)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Station 29
Deg C
Gear Depth
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12.0
10.0
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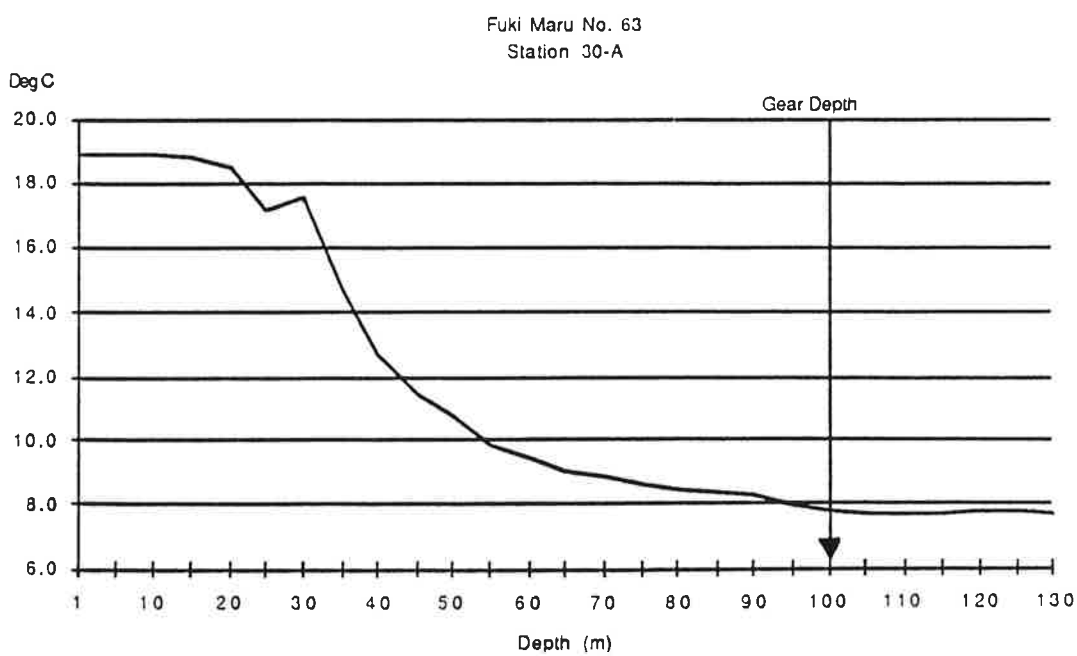
110
120
130
Depth (m)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Deg C
Gear Depth
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10
20
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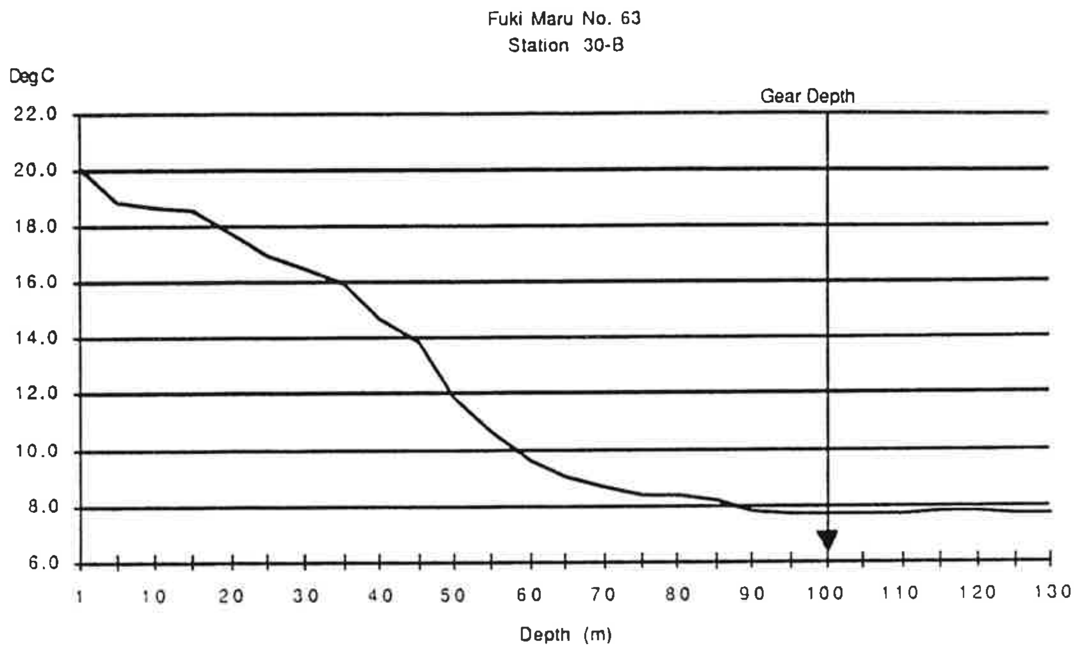
50
60
70
80
90
100
110
120
130
Depth (m)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Station 30-B
Deg C
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50
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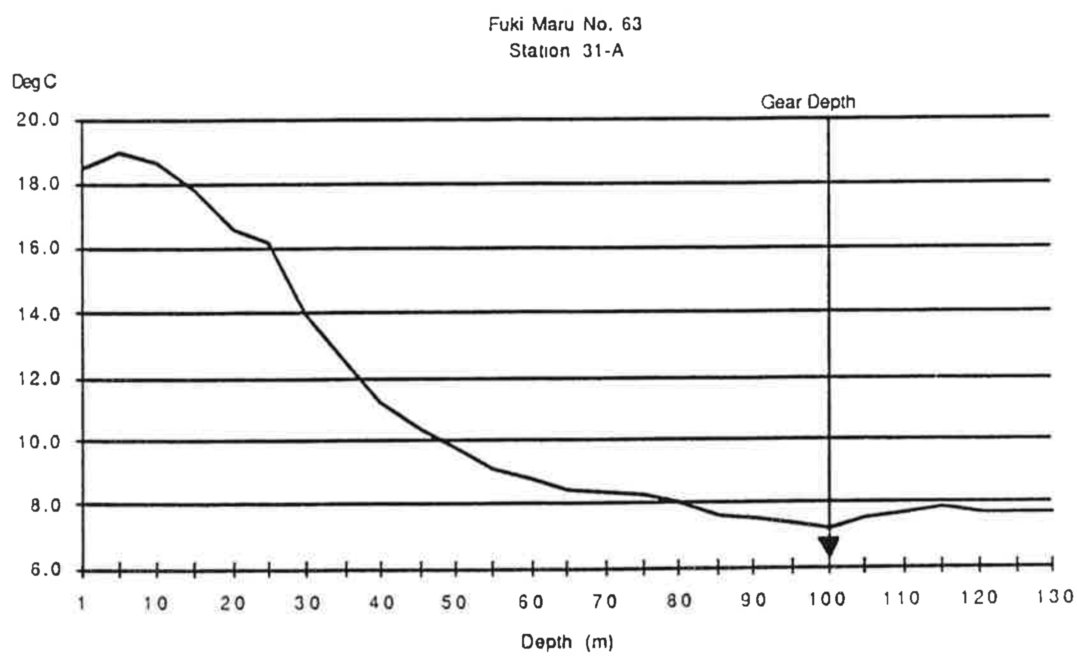
Depth (m)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100
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120
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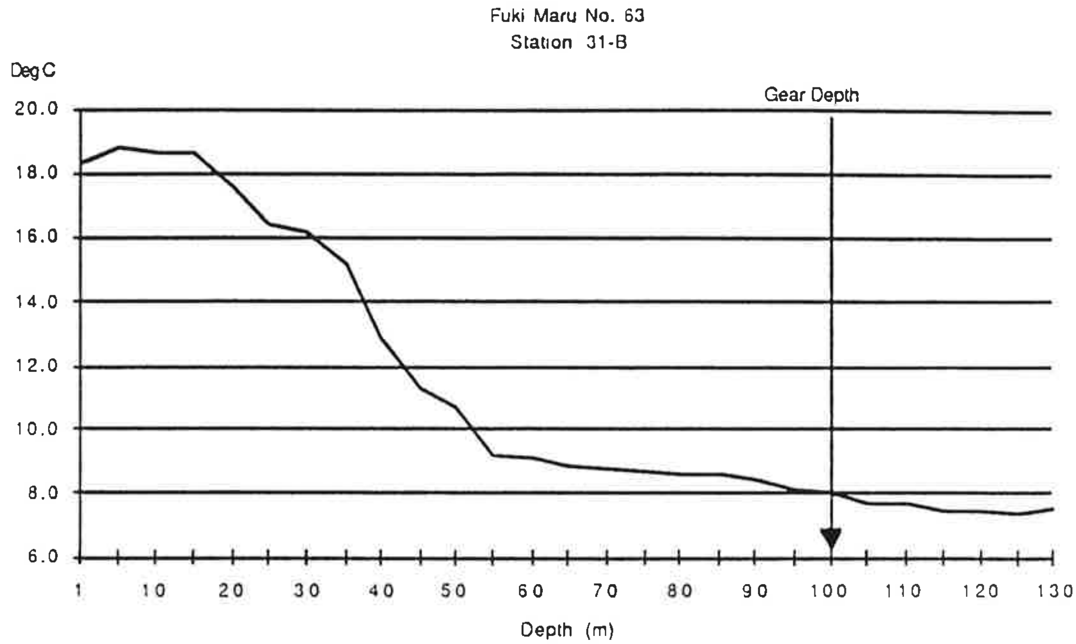
Depth (m)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Deg C
Gear Depth
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110
120
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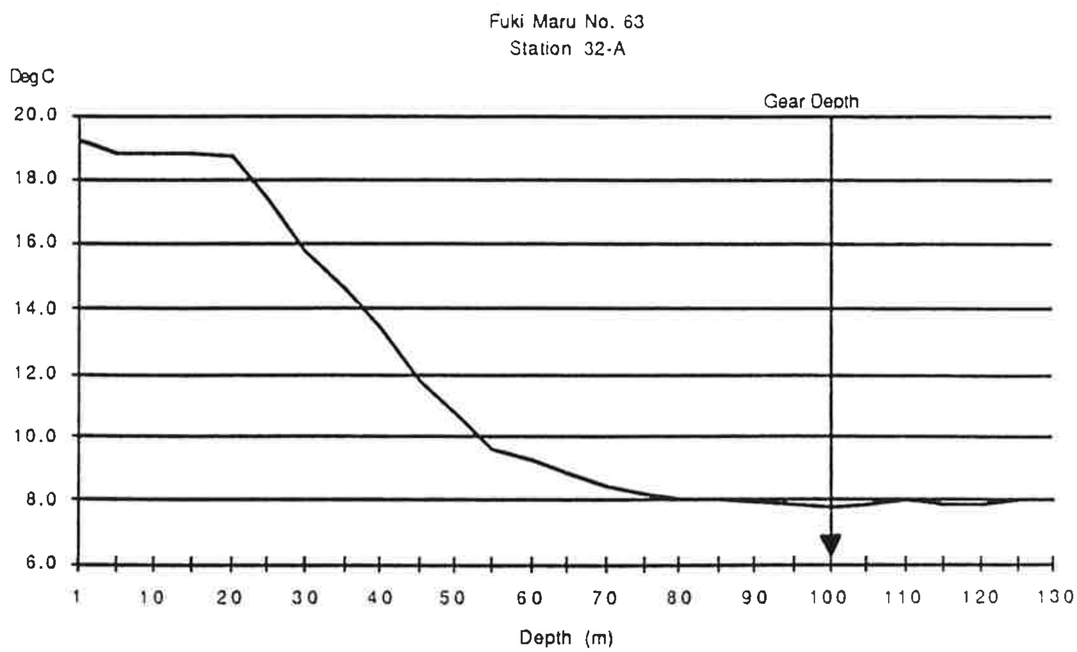
Depth (m)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Station 32-A
Deg C
Gear Depth
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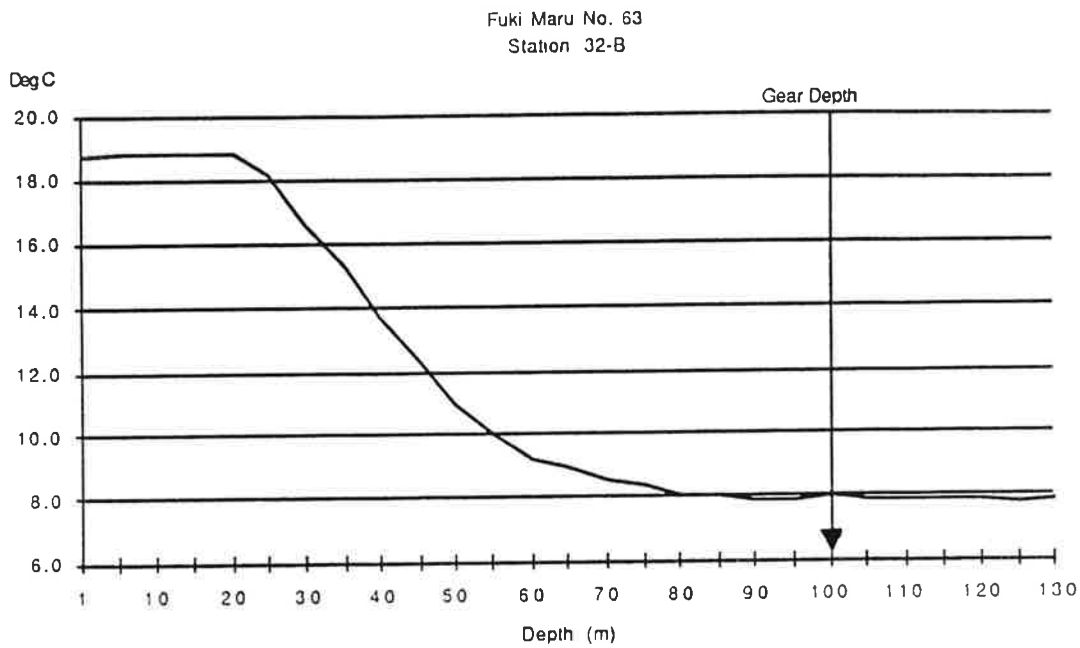
110
120
130
Depth (m)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Deg C
Gear Depth
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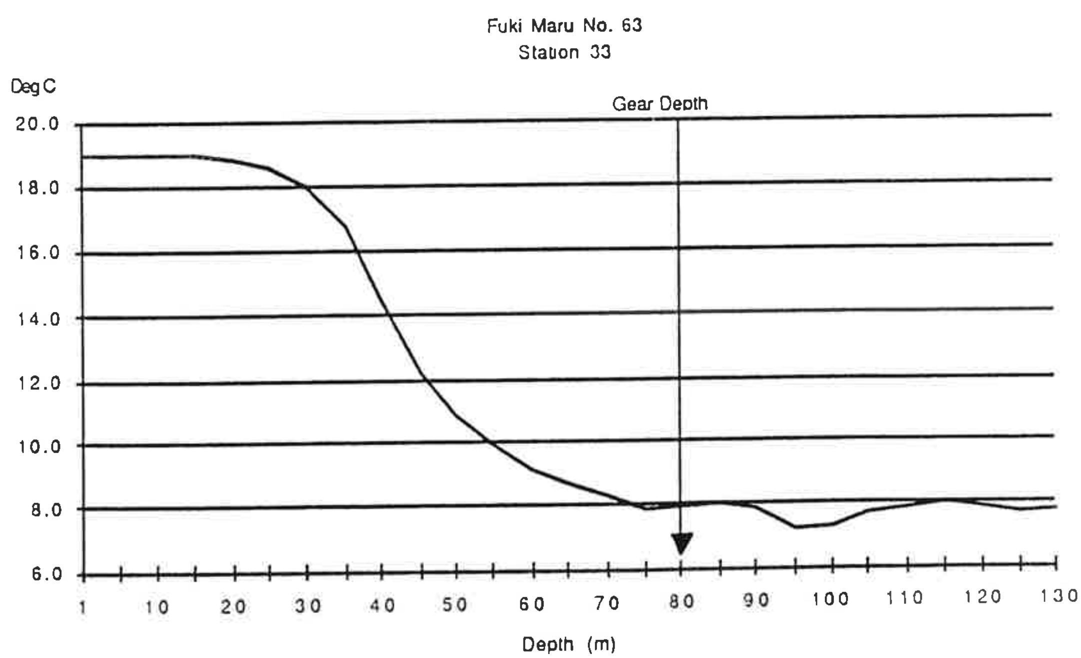
130
Depth (m)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Station 33
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1
10
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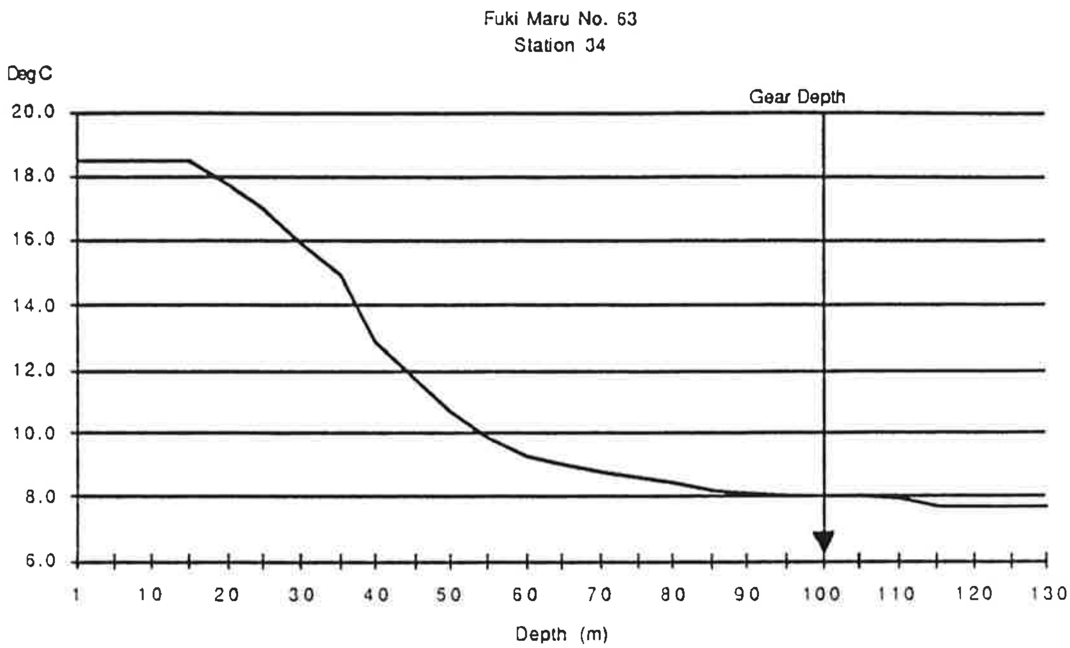
30
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 34
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Gear Depth
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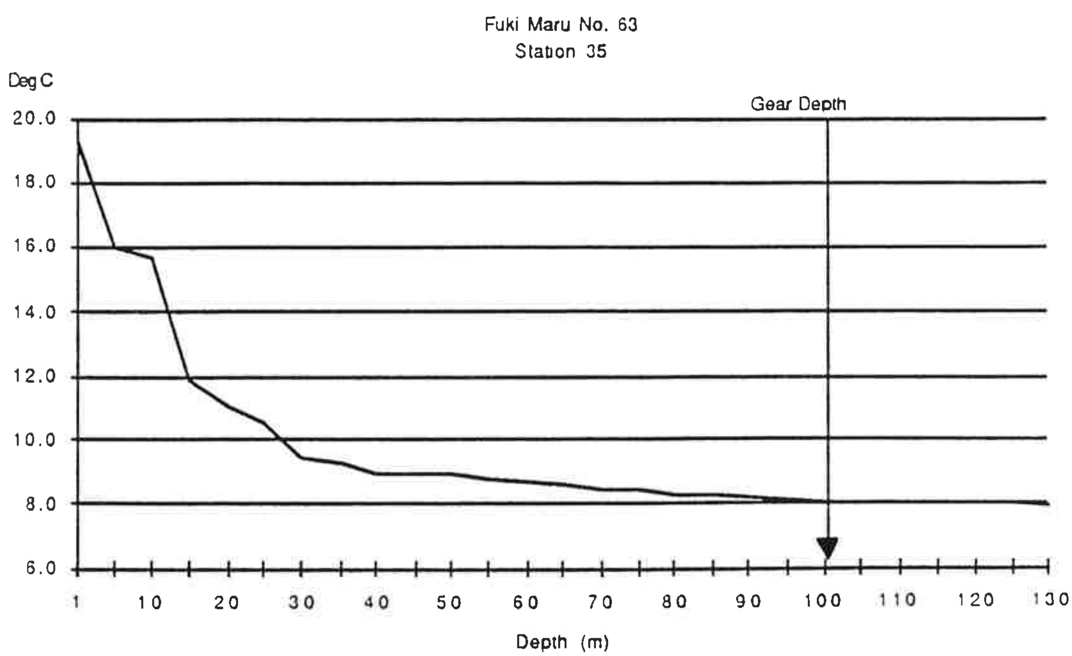
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 35
Deg C
Gear Depth
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1
10
20
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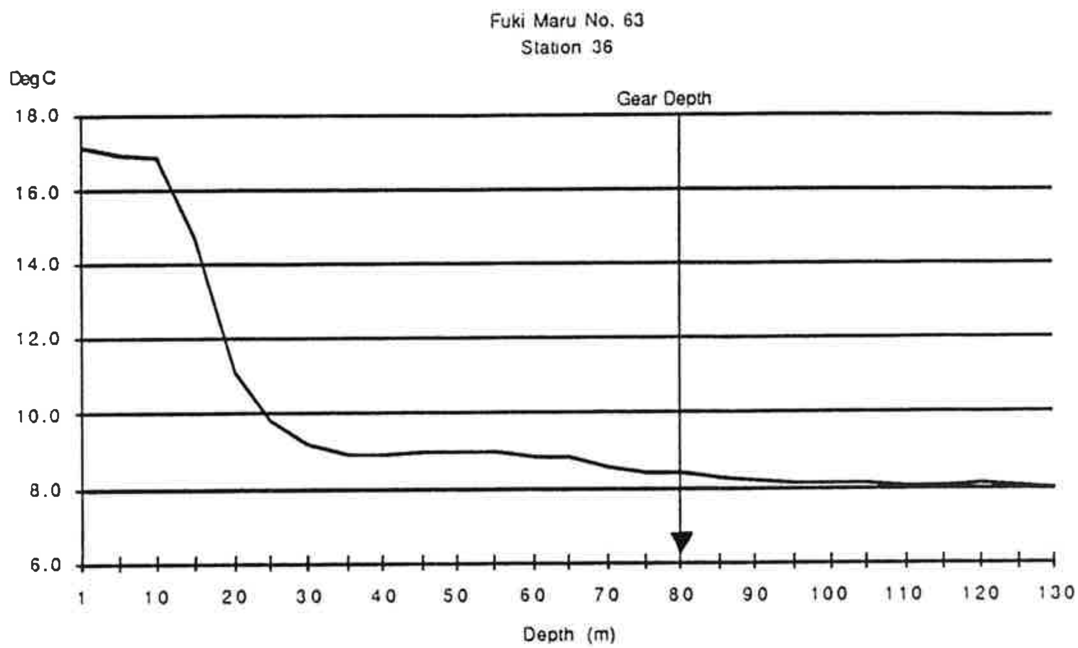
40
50
60
70
80
90
100
110
120
130
Depth (m)


Fuki Maru No. 63
Station 36
Deg C
Gear Depth
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12.0
10.0
8.0
6.0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
Depth (m)

APPENDIX 3

Length-weight relationships for cephalopods caught during the 1990 U.S.-Japan Cooperative Squid Research Project.

Length-Weight Coefficients by Species and Sex

where:

$$\log w = \log A * (\log l)^b$$

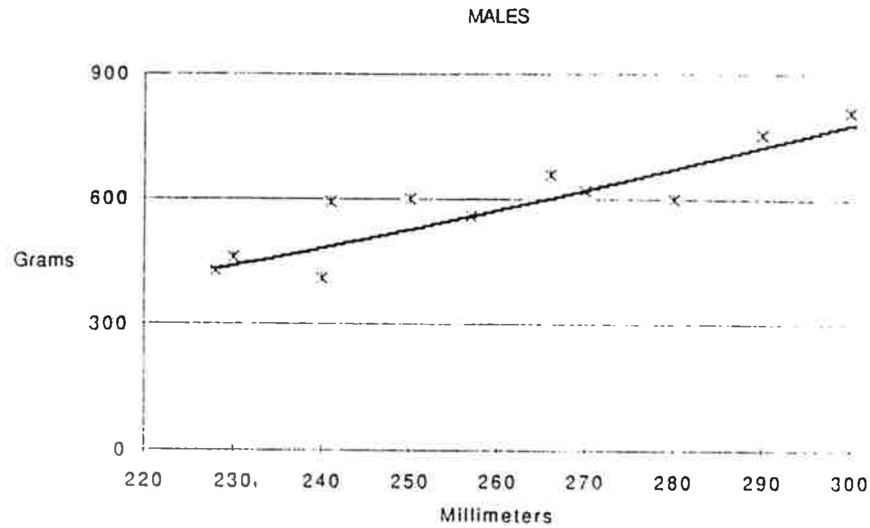
and

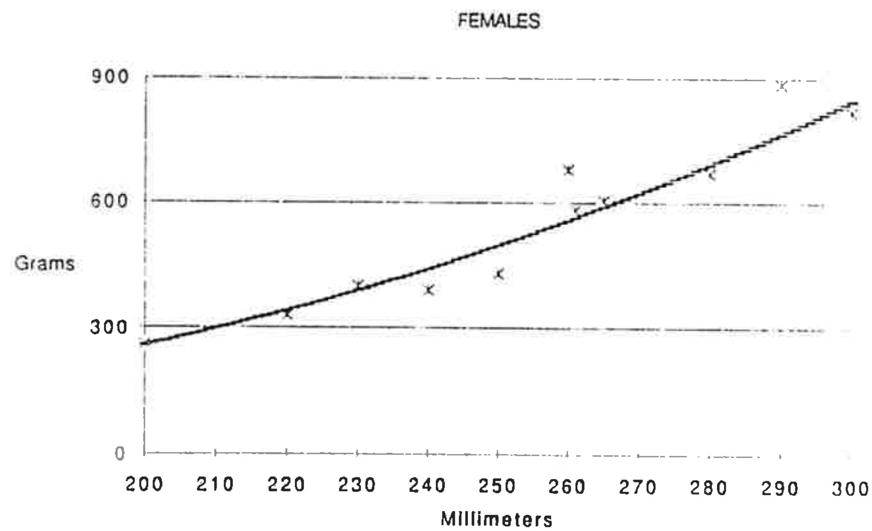
w = weight in grams,
l = length in millimeters.

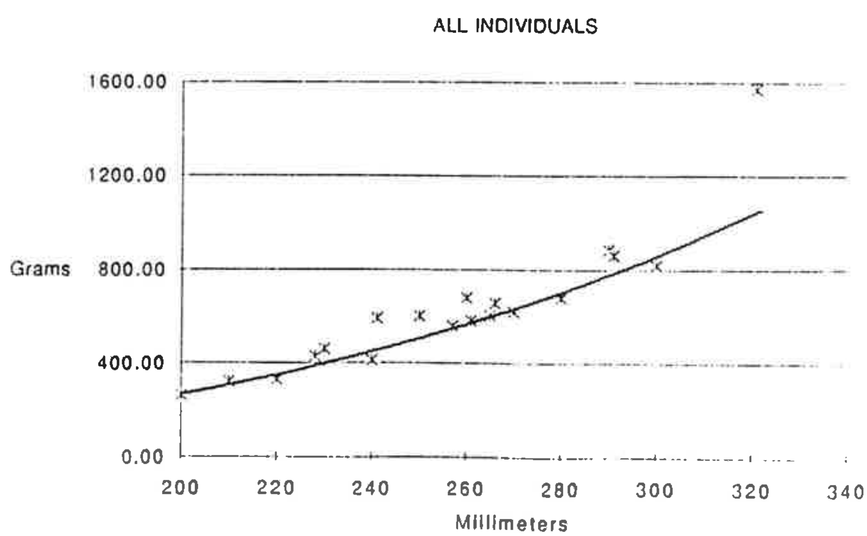
Species	Sex	N	A	b
Gonatopsis borealis				
Eight Armed Squid	Males	18	3.50E-03	2.159
	Females	23	4.81E-05	2.925
	Sexes Combined	48	5.58E-05	2.902
Ommastrephes bartrami				
Neon Flying Squid	Males	126	3.47E-05	2.972
	Females	1,379	1.70E-05	3.102
	Sexes Combined	1,507	1.63E-05	3.109
Onychoteuthis borealijaponicus				
Nail Squid	Males	94	2.73E-05	2.968
	Females	349	2.32E-05	3.007
	Sexes Combined	461	2.22E-05	3.013
Moroteuthis robusta				
Robust Clubhook Squid	Sexes Combined	11	1.16E-03	2.330

Note: Male and female counts do not sum to sexes combined becaused of inclusion of individuals for which sex could not be determined in sexes combined.

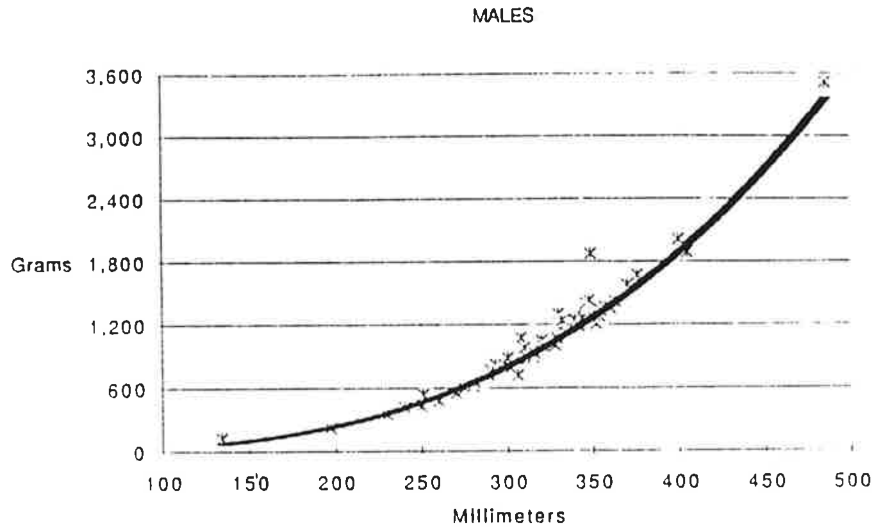
LENGTH-WEIGHT RELATIONSHIPS FOR THE EIGHT-ARMED SQUID (Gonatopsis borealis)

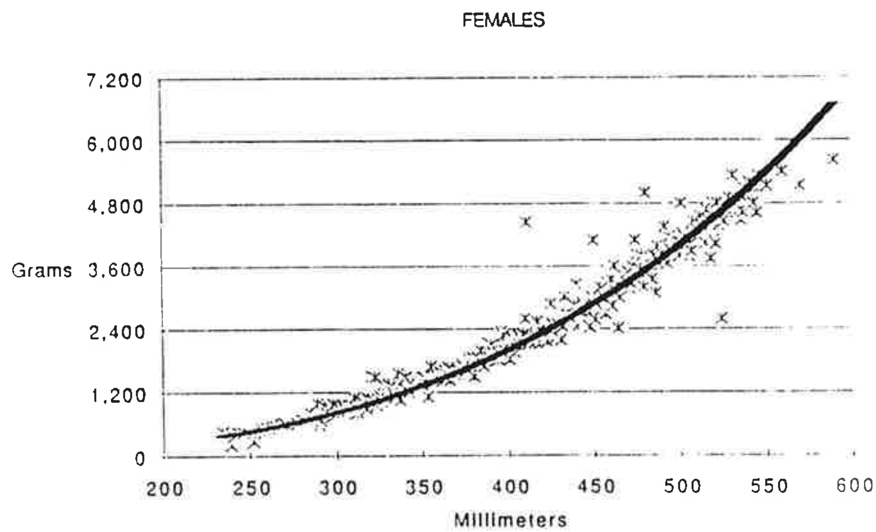


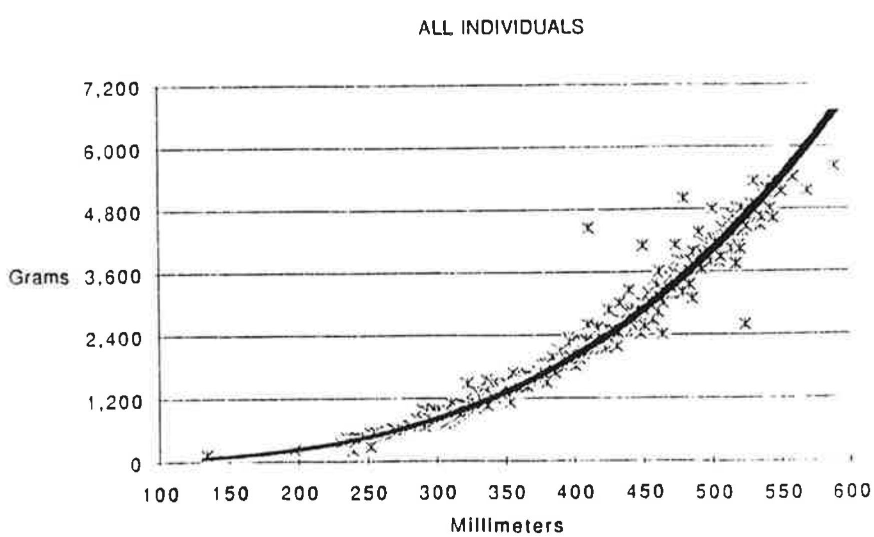




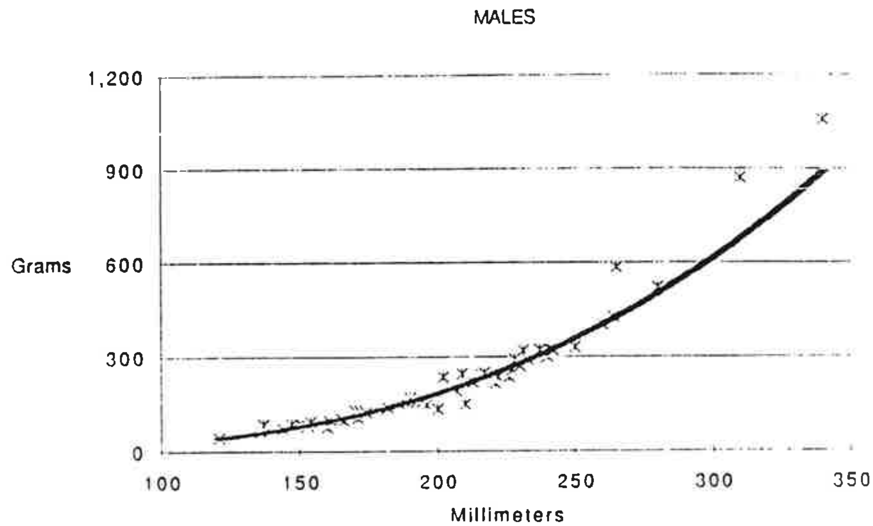
LENGTH-WEIGHT RELATIONSHIPS FOR THE NEON FLYING SQUID (Ommastrephes bartrami)

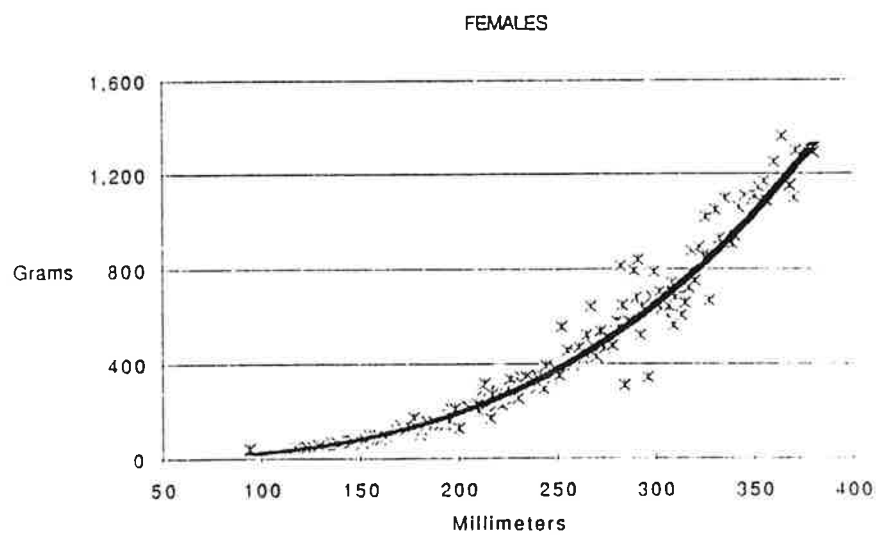


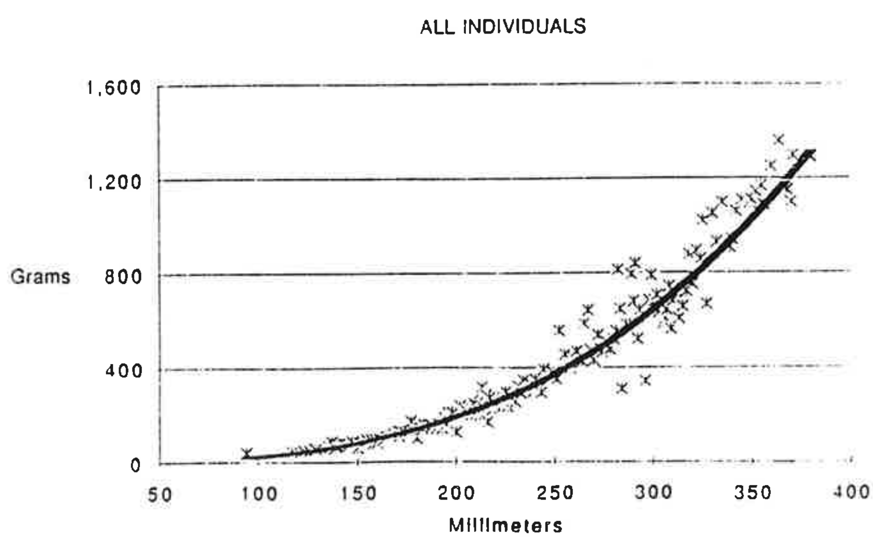




LENGTH-WEIGHT RELATIONSHIPS FOR THE NAIL SQUID (<u>Onychoteuthis</u> <u>borealijaponicus</u>)







LENGTH-WEIGHT RELATIONSHIPS FOR THE ROBUST CLUBHOOK SQUID
(Moroteuthis robusta)