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Estimation of Total Chinook Mortality Associated with Seine Fishing in Johnstone Strait and Juan de Fuca Strait During 1988

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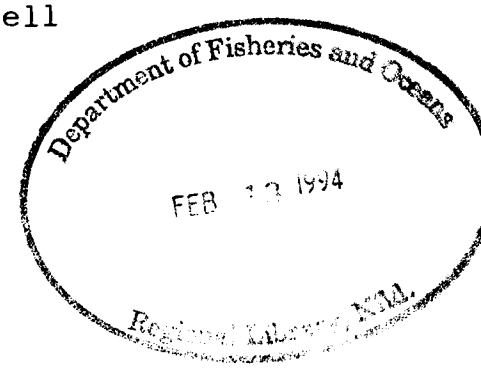

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ABSTRACT

Nagtegaal, D. A., P. J. Starr and B. Riddell. 1993. Estimation of total chinook mortality associated with seine fishing in Johnstone Strait and Juan de Fuca Strait during 1988. Can. Manuscr. Rep. Fish. Aquat. Sci. 2203: 109 p.

In 1988 the Biological Sciences Branch, Department of Fisheries and Oceans, conducted a study to assess total chinook (*Oncorhynchus tshawytscha*) mortality in the Johnstone Strait sockeye (*O. nerka*) and chum (*O. keta*) seine fishery and the Juan de Fuca Strait sockeye seine fishery . Department of Fisheries and Oceans catch statistics determined from records of salmon sales are suspected, by some user groups, to underestimate the catch of chinook by seine gear. The objective of our study was to independently estimate the total chinook catch in southern British Columbia seine fisheries. Total chinook mortality in the Johnstone Strait sockeye fishery was estimated to be 9,914 (95% CL: 5,379-16,589) of which 3,893 were recorded as juveniles, 2,033 jacks, and 3,988 adults. Commercial records of sales for the 1988 season indicated a catch of 2,269 jack chinook and 4,297 adults. Total chinook mortality in the Juan de Fuca fishery was estimated to be 42,048 (95% CL: 20,375-78,104) of which 22,245 were recorded as juveniles, 11,711 jacks, and 8,092 adults. Commercial sales slip records for 1988 reported 6,877 jacks and 3,587 adults. The ratio of estimated catch to reported catch for chinook under 2.3 kg (5 lb) in Johnstone Strait was 2.6 and for Juan de Fuca was 4.9. Total chinook mortality in the Johnstone Strait chum fishery was estimated to be 5,085 (95% CL: 1,121-15,020) of which 1,563 were adults, 1,600 jacks, and 1,922 juveniles. Commercial sales slip records for 1988 reported 623 adult and 955 jack chinook.

RÉSUMÉ

Nagtegaal, D. A., P. J. Starr et B. Riddell. 1993. Étude de la mortalité du saumon quinnat due à la pêche à la seine dans les détroits de Johnstone et de Juan de Fuca au cours de l'année 1988. Can. MS Rep. Fish. Aquat, Sci. 2203: 109 p.

Au cours de l'année 1988, la direction des sciences biologiques du ministère des Pêches et des Océans a effectué une étude de la mortalité du saumon quinnat (*Oncorhynchus tshawytscha*) due à la pêche à la seine du sockeye et du kéta dans le détroit de Johnstone, et à la pêche à la seine du sockeye dans le détroit de Juan de Fuca. Certains soupçonnent les statistiques de pêche du ministère des Pêches et des Océans, qui sont établies à partir des chiffres de vente de saumons, de sous-estimer la mortalité du quinnat due à la pêche à la seine. L'objet de notre étude était de faire une estimation indépendante de la mortalité du quinnat due à la pêche à la seine dans les eaux du sud de la Colombie-Britannique. Le nombre total de pertes de quinnat dans les pêches de sockeye du détroit de Johnstone a été estimé à 9 914 (95 %, LC : 5 379-16 589) dont 3 893 juvéniles, 2 033 saumoneaux et 3 988 adultes. Les chiffres de ventes commerciales pour la saison 1988 indiquent la prise de 2 269 saumoneaux quinnats et de 4 297 quinnats adultes. Le compte total de mortalité du quinnat dans les pêches du détroit de Juan de Fuca a été évalué à 42 048 (95 %, LC : 20 375-78 104), dont 22 245 juvéniles, 11 711 saumoneaux et 8 092 adultes. Les chiffres de ventes commerciales pour l'année 1988 indiquent 6 877 saumoneaux et 3 587 adultes. Le rapport des prises estimatives et des prises déclarées de saumons quinnats de moins de 2,3 kg (5 lb) dans le détroit de Johnstone était de 2,6, alors qu'il était de 4,9 dans le détroit Juan de Fuca. Le compte total de mortalité des quinnats dans les pêches à la seine de kéta du détroit de Johnstone a été estimé à 5 085 (95 %, LC : 1 121-15 020), dont 1 563 adultes, 1 600 saumoneaux et 1 922 juvéniles. Les factures commerciales pour l'année 1988 rapportent la vente de 623 quinnats adultes et de 955 saumoneaux quinnats.

INTRODUCTION

In 1985, the Pacific Salmon Treaty concerning the management of Pacific salmon (*Oncorhynchus* spp.) was ratified by the governments of the United States and Canada. A commitment of the treaty was the recording of all sources of chinook (*O. tshawytscha*) mortality, including non-reported mortality during fishing.

Landed catch is recorded by the Department of Fisheries and Oceans by accumulating records of sale of fish from fishermen to the primary processor (i.e. sales slips). These documents include the location of catch, the gear type used, the category of fish sold (species and grade) and the associated weight. The number of pieces sold is not routinely recorded for most size classes. All salmon sold, including chinook, should exceed or equal the 1.4 kg (round weight) legal minimum size limit. Sub-legal sized chinook (<1.4 kg round weight or <45 cm) are presumed to be either released/discarded by fishermen or at the processing plants. Small chinook salmon, usually less than 2.3 kg round weight (approx. 57 cm), are traditionally sold by the piece (not by weight) and are usually referred to as 'jacks' in catch report documents. The term 'jacks' does not imply sexual maturity in this case.

Since the inception of biological catch sampling programs (in the late 1960s), it has been conjectured that the catch of chinook in seine fisheries is under-reported, particularly for small chinook (under 2.3 kg round weight). This is based on the fact that the sampled catch frequently exceeds 50% of the reported catch (and occasionally even 100%), even though the program goals (based on vessel numbers) are to sample 20% of the catch. This potential shortfall in reported catch has led to controversy within the fishing community as to the magnitude of the mortality of chinook salmon in the seine fisheries of B.C. Various user groups have claimed that the actual catch is anywhere from 1.5 to over 10 times the reported catch. In the context of the Pacific Salmon Treaty, it is important to accurately know the magnitude of the chinook mortality in order to determine the productivity of chinook salmon. In addition, obtaining accurate estimates of total chinook catch in the seine fisheries are crucial to providing unbiased expansion factors for estimating total recoveries of coded wire tags (CWT) which are used to evaluate hatchery production and management actions.

To evaluate the impact of seine fisheries on chinook, the Biological Sciences Branch, Department of Fisheries and Oceans, undertook an independent estimation of total chinook catch to more accurately determine total mortality. This estimate could then be compared with the observed sales slip data. The purpose of this report is to present the methodology

and results of the chinook mortality studies conducted during the 1988 sockeye (*O. nerka*) , pink (*O. gorbuscha*) and chum (*O. keta*) seine fisheries in southern B.C.

METHODS

A. GENERAL METHODOLOGY

Observations were made during the sockeye and pink seine fisheries in both Johnstone Strait and Juan de Fuca Strait. A special sockeye fishery at the mouth of the Fraser River was also monitored. The Ministry of Environment conducted a similar but somewhat smaller version of this study for the fall chum fishery in Johnstone Strait. Although the main focus of this program was to estimate the incidental catch of steelhead, information concerning chinook was also collected.

Table 1 lists the commercial fishing and survey dates in Johnstone Strait, Juan de Fuca Strait, and the Fraser River (Statistical area 29).

Information required to calculate total mortality associated with the seine fishery include: i) catch per set by species and size category; ii) number of sets made in a time/area stratum per vessel; and iii) the numbers of vessels fishing by time and area stratum. The overall concept of the program was to extrapolate the estimated mean catch per seine set over all sets made.

i) Catch per set:

Data for the catch of individual sets were collected by observers boarding seine vessels as the set was being brought on board. The procedure involved approaching the vessel and requesting permission from the skipper to board, recording the catch of all species, and taking biological samples whenever possible. Observers could easily stand beside the drum on the stern of the vessel and see all the fish come on deck. Most fish were funnelled to the end of the net and were brought on deck over the stern. Undersized fish, including juvenile chinook, would sometimes be caught up in the web and rolled up on the drum as the net was being retrieved. Observation was more difficult when large catches were encountered since portions of the large catches were lifted directly into the vessel hold using a brailer (a type of a dipnet).

Chinook catch was divided into three size categories: i) adults [>2.3 kg, >57 cm fork length]; ii) jacks [1.4 kg-2.3

kg, 45-57 cm]; and iii) juveniles [<1.4 kg, <45 cm]. In all sets, the numbers of chinook caught were counted by the observers. Observers counted the numbers of all other species caught when the catch was less than approximately 50 fish. For larger catches, numbers were estimated by either the observer or the skipper. Other pertinent data such as location, tide, time of day and type of set (tied to shore vs. open sets) were also recorded.

ii) Biological sampling:

Biological data (length/sex/maturity/scale) were collected (MacLellan 1987) from most chinook in the jack and juvenile categories. Some adult chinook were also sampled. Sampling was limited by availability and cooperation of seine boat skippers. Some skippers worried that sampled fish would be mutilated and lose commercial value.

iii) Number of sets per day per vessel:

The observers would ask the skipper of each vessel boarded for the number of sets made up to and including the set being monitored. Although the type of set (beach or open) was recorded for each observation, no distinction was made as to what proportion of the effort for that day was expended on open or beach sets. The total number of sets made in a given day was determined by calculating the average number of sets made per hour over all vessels monitored that day and extrapolating this average over the total time available for fishing in that day. Available fishing time was defined by the official opening/closing times issued by the Department of Fisheries and Oceans, Fisheries Branch, or assumed to be from dawn to dusk when the fishery was continuous over a period of several days.

iv) Gear count:

Prior to each fishery opening, an overflight was routinely scheduled by the Department of Fisheries and Oceans, Fisheries Branch, to count the number of vessels participating in the fishery. When the fishery was scheduled to last more than one 24-hour period, additional overflights were made for each extra day. Usually during each week, Fishery Officers also estimated the number of vessels on the fishing grounds from their patrol vessel.

v) Cannery data:

As part of the coastwide sampling for recovery of coded-wire tags, standard biological samples were collected at major cannery facilities in Vancouver. These data were collected during the sockeye seine fisheries in Johnstone Strait and Juan de Fuca Strait and could be compared to the field biological data collected from this survey. Length-frequencies for juvenile and jack chinook from the cannery samples were combined and converted to cumulative percent frequencies and then compared with the survey sample data using a Kolmogorov-Smirnov two sample test (Zar 1984).

vi) Catch estimation and Monte-Carlo simulations of confidence regions:

Total catch for each species and size stratum was calculated according to the following equation:

$$T_{lj} = \sum_{k=1}^{m} \sum_{i=1}^{n} (\bar{C}_{ijkl} * \bar{S}_{ik} * V_{ik}) \qquad \text{(equation 1.1)}$$

where

T_{lj} is the total catch estimate for size category j of species l over the season

$\bar{C}_{ijkl}$ is the average catch per set by fishing day (k) and geographic area (i) for category j of species i

$\bar{S}_{ik}$ is the average number of sets per day per vessel within each (i, k) stratum

V_{ik} is the total number of vessels per (i, k) stratum
m is the number of days
n is the number of areas

The Monte-Carlo simulations (Efron 1982) involved resampling with replacement the data for catch per set and sets per day per vessel within each time and area stratum, and determining the average of these resampled data prior to each calculation of total catch. This process of calculating a mean value for each variable by day and estimating the total catch was repeated 1000 times. The final estimate of total catch by day or season was the mean of these 1000 iterations. Confidence regions about the average catch estimate were determined by excluding the upper and lower 2.5% of the distribution of catches resulting from the 1000 iterations. Provided sufficient data had been collected on a given day, the data for catch per set and sets per day per vessel were resampled with replacement the same number of

times as the number of data points collected for that variable on that day.

Since the daily gear counts were point estimates, the data could not be resampled in the manner described above. In 1986, an approximate estimate of the error in the overflight counts was made by looking at the variability in gear counts in Johnstone Strait between consecutive days within a fishing week. Assuming that no vessel movement in or out of Johnstone Strait occurred in a given fishing week, the changes in total gear count could be attributed to counting error. The coefficient of variation ranged from 6-16%, based on weeks 3 and 4 of that fishery (Nagtegaal et al. 1988). A similar calculation was not possible with the 1988 data due to the lack of second overflights within fishing weeks. For 1988, the coefficient of variation for overflight counts was set at 10%. This was incorporated into the calculation of catch by using a random normal deviate procedure (Subroutine GGNML of IMSL 1980) to include the error as follows:

$$\text{Standard Deviation (S)} = (10\% \text{ error} * \text{gear count})/100 \qquad \text{(equation 1.2)}$$

and

$$Y(I) = (RND(I) * S) + M \qquad \text{(equation 1.3)}$$

where the new value Y is equal to the product of the random normal deviate (RND) and the standard deviation (S), plus the mean (M). The mean in this case was the original point estimate. This new value was used as the resampled estimate of gear in the next iteration of total catch.

B. MISSING DATA

Due to equipment failures and/or inclement weather, it was often impossible to collect data for every stratum. Missing data cells were filled according to the following procedures.

i) Catch per set:

A cell was considered empty if fewer than 5 sets were observed in that day and area stratum. If the total number of sets observed during that fishing week in the area stratum was greater than 5, then the average catch per set calculated for all days in that week was used to fill the empty cell. If the total number of sets observed for that week was less than 5, then the

average catch per set calculated for the following week for the area stratum was used. Justification for this comes from an analysis of variance of catch per set by day (Nagtegaal et al. 1990). In virtually all cases, the variance within a given day was greater than among days. Therefore, it would be reasonable to use the mean for the entire week if a daily stratum was empty.

ii) Sets per day per vessel:

As described earlier, data which were used to estimate the number of sets per hour were collected each time a vessel was boarded. Table 3 contains the opening times and total available hours for fishing by DFO statistical area and date. If less than five estimates for sets per hour were collected, then all information for that week in an area was pooled to calculate the average number of sets per hour for the week. This estimate was then multiplied by the total hours available for fishing for that day.

iii) Gear counts:

Missing gear counts were filled by using the average daily number of vessels counted during that fishing week within the area stratum. These counts were compared with the number of observer boardings made in the area stratum on that day. If the number of unique boardings was greater than the overflight count, the boarding data were assumed to be the better estimate.

C. DATA COLLECTION

i) Johnstone Strait:

Johnstone Strait was split into five sub-areas corresponding to the management stratification presently used (Fig.1). Field staff consisted of five teams (one boat driver/one biological observer), one team assigned to each sub-area. One set of observers was stationed in Port Hardy to monitor the Gordon Group area. Two sets of observers were stationed in Port McNeill to cover the North Shore area of Malcolm Island and the Upper Johnstone Strait area. Two sets of observers were stationed at Kelsey Bay. One group monitored the area above Kelsey Bay to Robson Bight and the second group covered the area below Kelsey Bay to Discovery Passage.

Since limited data were collected for the Discovery Passage sub-area, the catch per set and sets per hour data from Lower Johnstone Strait were applied to the gear count for Discovery Passage as in 1988 (Nagtegaal et al. 1990).

ii) Juan de Fuca Strait:

In the Juan de Fuca Strait survey, sampling effort was stratified by fishing line. Seine vessels align themselves along imaginary fishing lines perpendicular to the coast from the western border of statistical area 20 (blue line) to Sheringham Point (Fig. 2). Seiners vie for position along these fishing lines (approximately one nautical mile apart), and during intense fishing periods, vessels will queue to make a set at a particular fishing line and depth location. The majority of fishing effort in 1988 was concentrated in the first two lines. In 1987, two survey teams (one driver/two biological observers) were stationed in Port Renfrew. It was felt that increased sampling could be achieved by having two observers per team and by placing each observer on separate boats. Due to poor equipment, communication between the driver and his observers became difficult. As a result observers were only placed on separate vessels during optimal weather conditions. In 1988, a third survey team was assigned to the area in order to increase coverage of the fishery. In addition, each inflatable boat was equipped with a more powerful marine VHF radio to improve communications. One team was assigned to monitor the first few lines and the other two teams monitored all other fishing lines. This strategy worked well when the weather was good. During foggy weather, it was still difficult for the driver to keep track of both observers, so they were placed on only one vessel at a time.

Data were stratified by grouping fishing lines 1-2 and 3-12. This combination was based on the results which indicated that the average sockeye catch per set was considerably higher in the first two fishery lines compared to subsequent lines. A more detailed stratification by fishing line may have been desirable but was impossible due to inadequate estimation of effort and catch per set data in more detailed strata.

iii) Fraser River:

Collection of data at the mouth of the Fraser River (Fig. 3) was accomplished with three observer/driver teams. Since it was scheduled to be a short and intense fishery, the priority was to concentrate on randomly boarding as many vessels as possible to obtain estimates of catch per set in the expected two hour fishery. No stratification by area was necessary since it was anticipated that most of the fishing effort would be concentrated in one small area near the mouth of the Fraser River.

RESULTS

A. JOHNSTONE STRAIT SOCKEYE FISHERY

In 1988, fewer fishermen participated in the sockeye fishery in Johnstone Strait than in 1986 or 1987. This year was the low cycle in Fraser River sockeye abundance while, at the same time, a major pink salmon fishery was conducted in the Central Coast area (DFO statistical area 8).

A total of 394 observer boardings were made between July 24 and August 21 in Johnstone Strait sockeye seine fishery. A total of 228 adult, 171 jack, and 211 juvenile chinook were recorded by the observers who boarded 162 different vessels during this time (Table 4). Because of frequent denials of permission to board vessels in the Lower Johnstone Strait sub-area, fewer samples were obtained for that area than in previous years.

i) Catch per set:

In Johnstone Strait catch per set for adult chinook ranged from 0 to 16, for jacks from 0 to 38, and for juvenile chinook from 0 to 12. The overall mean catch per set during the sockeye fishery was 0.58 for adult chinook, 0.43 for jacks, and 0.53 for juveniles (Table 5). Mean catch per set for juveniles was highest in the Upper Johnstone Strait sub-area. The highest catch rate for jacks was recorded in the Gordon Group sub-area and the North Shore sub-area recorded the highest catch rate for adult chinook. Distribution of catch per set was highly skewed in all sub-areas in Johnstone Strait (Figs. 4-7). The proportion of null sets observed was 72% for juvenile chinook, 84% for jacks, 73% for adults, and 48% for sockeye.

A two factor analysis of variance was used to examine the effect of area and week on catch per set (Table 6). Area and week had a significant effect on jack and juvenile chinook, and sockeye catch per set. Catch per set for all categories tended to be higher at the beginning of the fishing season. Jack and juvenile chinook catch per set tended to be highest in the northern areas whereas sockeye catch per set was highest in the southern areas. We also noted that area and week effects accounted for only 1-25%, depending on the category, of the total variance of catch per set.

Mean chinook catch per set was compared to the type of set (open or beach) by study area (Table 7). Some differences between open and beach set chinook catch rates were recorded but

no trends were evident. Sockeye catch per set was considerably higher in beach sets than in open sets in lower Johnstone Strait.

ii) Biological sampling:

In Johnstone Strait 168 adult chinook, 71 jacks, and 91 juveniles were sampled for length/sex/maturity/scale data (Table 8). Sampled fish were assigned to the appropriate category (adult, jack, juvenile) on the basis of length (length/weight relationship from Argue et al. 1967). A summary of age data is contained in Table 9.

Biological data were collected from 37 chinook sampled at the cannery (Table 10). The size of chinook from this sample ranged from 38 cm to 57 cm. Results of a Kolmogorov-Smirnov test indicated that cumulative distributions of cannery and survey data were not significantly different ($D_{obs}<D_{alpha}$). The lack of chinook less than 38cm in the cannery data could be due to incorrect sorting at the cannery or to the small sample size. Table 10 indicates that 21 of 37 samples were less than the 45cm legal size limit. Although sample sizes were small, this observation and the lack of significant differences between sample distributions suggest that the sales slip record of jacks is most likely a random mix of juvenile and small chinook landed by seiners.

iii) Number of sets per day per vessel:

The average number of sets per day in Johnstone Strait ranged from 1.2 to 23.7 depending on the length of day and sub-area (Table 11). In Johnstone Strait, seiners choose between open and beach set strategy (Ledbetter 1977). Choices between these strategies are made by fishermen based on whether they consider it worthwhile to wait in a lineup for a good spot hoping for a productive set or by making more sets in presumably less productive areas where no lineups exist. The geography of the area and traditional fishery patterns also play a key role in determining the proportion of beach or open sets made (Hilborn and Ledbetter 1979). These factors significantly effect the number of sets that a given vessel makes in a day.

iv) Gear count:

In Johnstone Strait the number of seiners ranged from 27 to 185 (Table 12). Only one overflight gear count was made each week of the fishery except for August 9 when an independent gear count was made on the fishing grounds by the Fishery Officers. Vessel counts were consistently highest in the Upper Johnstone Strait sub-area during the entire sockeye fishery. Comparison of overflight data with a gear count made from sales

slip data (Table 2) indicated that the two gear count estimates were considerably different, but there was no consistent trend.

v) Total catch estimate:

A summary of total catch estimates for the sockeye fishery in Johnstone Strait and of comparable sales slip information is listed in Tables 13-14. The total catch estimate for sockeye was 14% higher than the equivalent sales slip estimate, 7% lower for adult chinook, and 9% lower for jack chinook. If we look at the catch distribution by week, in most instances the estimates were comparable. The bootstrap estimates for statistical area 13 for adult and jack chinook were considerably less than the sales slip data. Part of the ongoing problem in area 13 was that not all fishermen in the lower Johnstone Strait sub-area allowed their vessels to be boarded. In all cases, except for sockeye in the first and last weeks of the survey, the sales slip catch estimates were within the confidence range of the bootstrap estimates.

Catch estimates were also compiled by sub-area, but are not presented in this report since no comparable sales slip data are recorded. The Upper Johnstone Strait sub-area accounted for 67% of the adult chinook catch and 62% of the juvenile catch. The Gordon Group sub-area accounted for 54% of the jack catch.

An examination of the bootstrap catch estimates and a plot of their frequency distribution (Fig. 12-15), indicated that the distribution of catch estimates was skewed. This is not unexpected since the catch per set distributions were highly skewed.

B. JOHNSTONE STRAIT CHUM FISHERY

A total of 316 observer boardings were made during the three openings of the chum fishery that were monitored. There were 34 adult chinook, 30 jacks, and 63 juveniles recorded by the observers. A total of 289 different vessels were boarded during this time (Table 4).

i) Catch per set:

Catch per set was recorded by day and sub-area during each fishing week (Table 5). Catch per set ranged from 0 to 7 for adults, from 0 to 7 for jacks, and from 0 to 22 for juvenile chinook. The overall mean catch per set was 0.11 for adult chinook , 0.09 for jacks, and 0.19 for juveniles. Mean catch per set for juveniles was highest in the Upper Johnstone Strait sub-

area and the highest catch rate for jacks and adult chinook was recorded in the North Shore sub-area. Chum catch per set was highest in the lower Johnstone Strait sub-area.

Distribution of catch per set was highly skewed in Johnstone Strait (Figs. 20-23). The proportion of null sets observed for juvenile chinook was 90%, for jacks and adult chinook was 95%, and for chum was 45%.

A two factor analysis of variance was used to examine the effect of area and week on catch per set (Table 15). Only week had a significant effect on catch per set for adult chinook and chum. Catch rates for adult chinook were higher in the first opening in September, while chum catch rates were the highest during the opening in October. Area and week accounted for less than 10% of the total variance in catch per set.

ii) Biological sampling:

During the chum fishery, 16 juvenile, 23 jack, and 8 adult chinook were sampled for length/sex/maturity/scale data (Table 16). Sampled fish were assigned to the jack, juvenile and adult categories as in the sockeye fishery. Most fish were not sampled for sex or maturity. Since limited data were available, no comparison was made with data collected in the processing plants.

iii) Number of sets per day per vessel:

The average number of sets per day per vessel ranged from 2.2 to 25.5 depending on the day and sub-area in Johnstone Strait (Table 11). Similar fishing strategies exist for the chum fishery as for the sockeye fishery in Johnstone Strait.

iv) Gear count:

The number of seiners that were involved in the chum fishery ranged from 45 to 409 (Table 12). One overflight was made on the first day of each fishing week. On September 15, Fishery Officers recorded the gear count on the fishing grounds, but provided no breakdown by sub-area. Fishing effort was highest in the Upper Johnstone Strait sub-area for the first two weeks and effort was concentrated in Discovery Passage during the last week that the fishery was monitored.

v) Total catch estimate:

Chum catch estimates for Johnstone Strait were comparable to the sales slip data for the first two weeks, but were significantly higher (1.8 times) for the third week (Table 13). Catch rates for chum in the Lower Johnstone Strait sub-area on October 13 were ten times greater than the comparable estimate for the following day. Since this catch rate seemed unrealistically high when compared to other sub-areas, the analysis was redone applying the catch per set values from the Lower Johnstone Strait sub-area on October 14 to the data for October 13. Using these adjusted values, catch estimates for chum in Johnstone Strait were only 17% greater than sales slip data for the third week and the total catch estimate was 11% greater. Total (adjusted) bootstrap estimate for adult chinook was 2.6 times greater than sales slip data and for jack chinook was 1.6 times greater. Catch estimates for adults and jacks were comparable to sales slip data for the first and last week but during the second week bootstrap estimates were substantially higher. In all cases the sales slip estimates were within the confidence range of the bootstrap estimates.

An examination of the bootstrap catch estimates and a plot of their frequency distribution (Fig. 24-27), indicated that the distribution of these catch estimates was skewed. This is not unexpected since the catch per set distributions were highly skewed.

C. JUAN DE FUCA STRAIT SOCKEYE FISHERY

A total of 157 boardings were made on 99 different vessels. During the three openings of this fishery, 177 adult, 263 jack, and 447 juvenile chinook were observed. In the Juan de Fuca Strait fishery, it was difficult to obtain good coverage of all fishing lines when the weather was poor. Table 4 summarizes the number of boardings made by day.

i) Catch per set:

Catch per set in the Juan de Fuca Strait fishery ranged from 0 to 19 for adult, 0 to 32 for jack, and from 0 to 78 for juvenile chinook (Table 17). The mean catch per set for adults was 1.13, 1.68 for jacks, and 2.85 for juveniles.

Catch per set for Juan de Fuca Strait was also compiled by fishing line (Table 18). There was a decreasing trend in sockeye catch per set from the blue line (line 1) towards Sheringham Point. No trend was evident for chinook.

Distribution of catch per set was highly skewed (Fig. 8-11). The proportion of null sets observed for juvenile and adult chinook was 50% and for jacks was 59%. The proportion of null sets for sockeye was 13%.

A two-way analysis of variance was used to examine the effects of week and fishing line on catch per set (Table 19). Week had a significant effect on the jack catch per set and fishing line was significant for sockeye catch per set. Jack chinook catch per set was highest during the last opening. Catch per set for sockeye was highest in the first few fishing lines.

Catch per set was also examined by 10 fathom bottom depth interval (Table 20). Although sample size was small for the shallower depth intervals, catch rates for juvenile chinook were highest in shallower waters. A similar but somewhat less distinct trend existed for adult and jack chinook while sockeye catch per set peaked at 75-85 fm depth interval.

ii) Biological sampling:

A total of 98 adult, 282 jack, and 134 juvenile chinook were sampled during the survey for length/sex/maturity/scale data (Table 21). Sampled fish were assigned to the appropriate category (adult, jack, juvenile) on the basis of length (length/weight relationship from Argue et al. 1967). A summary of age data is contained in Table 9.

Biological data collected at the processing plants are listed in Table 22. Size ranges and modes for both cannery and survey data were similar. The Kolmogorov-Smirnov test indicated that there were no significant differences between the cannery and survey biological data ($D_{obs} < D_{alpha}$). This is the same result as for Johnstone Strait and therefore similar comments can be made regarding the presumed fate of the juvenile chinook in Juan de Fuca Strait.

iii) Number of sets per day per vessel:

The average number of sets per day ranged from 8.3 to 11.2 depending on the length of day and fishing line (Table 11). In Juan de Fuca Strait, seiners choose to wait in lineups that usually exist in the first few presumably more productive fishing lines or make more sets in the less intense subsequent lines (Table 23). The fishing fleet is usually quite spread out during the first part of the day but tends to move up to the first few lines towards the end of the day. The number of sets that a vessel can make in a day is dependent on the strategy adopted.

iv) Gear count:

Gear count estimates are contained in Table 2. No regular overflights were conducted in 1988 by the Pacific Salmon Commission or the Dept. of Fisheries and Oceans. Only one overflight was made at 1 p.m. on Aug. 22 but it may not have been representative of the distribution of effort in Juan de Fuca Strait. The Pacific Salmon Commission estimated the total number of fishing vessels based on landings at the major fishing plants in Vancouver and cash buyers. Fishery Officers also estimated the number of vessels as they patrolled their area. Neither of these gear counts were consistently recorded by fishing line or geographic landmark. Since no consistent gear breakdown by fishing line was available, the proportional distribution of vessels by line from the 1987 survey was applied (Nagtegaal et al. 1990) to the mean of the two available gear count estimates for each day in 1988. For August 22 the overflight count was used. The catch per set for sockeye was considerably higher in the first lines than in subsequent lines (Table 18), although differences among fishing lines was not as pronounced as in 1987. Gear count was grouped by lines 1-2 and lines 3-12 on the basis of these catch per set data.

v) Total catch estimate:

The total catch estimate for sockeye was 1% higher than sales slip estimate, 131% higher for adults, and 71% higher for jack chinook (Table 24). Catch distribution by week varied considerably in all categories. For each week of the fishery the bootstrap estimate was greater than the sales slip estimate for adult and jack chinook, while no trend existed in the sockeye catch estimate. Poor gear count data probably introduced considerable error to the catch estimates. The best catch estimate for sockeye was recorded for the only week of the fishery (August 22) when an overflight gear count was made. Recalculation of the data without stratifying the gear count by fishing line reduces the catch estimates in all categories, but does not alter the apparent biases in catch by week and species category.

In all cases the sales slip catch estimates were within the confidence limits of the bootstrap estimates.

An examination of the bootstrap catch estimates and a plot of their frequency distribution (Fig. 16-19), indicated that the distribution of these catch estimates was skewed. This is not unexpected since the catch per set distributions were highly skewed.

D. FRASER RIVER SOCKEYE FISHERY

A special sockeye opening was granted to seine fishermen in DFO statistical area 29 (mouth of the Fraser River) on September 14 and 19. A total of 20 boardings on 19 different vessels were made during the two hour opening on September 14 (Table 4). Two jack and one juvenile chinook were recorded by the observers. The Sept. 19 opening was not monitored.

i) Catch per set:

Mean catch per set for jack chinook was 0.10 and for juveniles was 0.05. Due to limited data no further analysis was done.

ii) Biological sampling:

One of the jacks sampled was mature while the other jack and the juvenile was immature. All three were males.

iii) Number of sets per day per vessel:

The average number of sets made per vessel was 2.4 (Table 11) and ranged from 1 to 4.

iv) Gear count:

Two gear counts were made on the September 14 opening (Table 2). We used the mean of these two estimates.

v) Total catch estimate:

Total catch estimate for sockeye was 22% higher than sales slip data and the estimate for jack chinook was a little less than one-third of the sales slip estimate (Table 25). No estimate was made for adults since none were observed in the sets that were monitored. It should be noted that these catch estimates were based on very limited data.

DISCUSSION

A. GENERAL

The results of the 1988 survey support the hypothesis suggested by Nagtegaal et al. (1988) that the jack chinook category in the sales slip data represents a subset of the total jack and juvenile catch recorded in the survey data. In Johnstone Strait, the catch of chinook less than 2.3 kg was 2.6 times (95% confidence limit: 1.8-3.8) greater than the number of jacks in the sales slip data for the sockeye seine fishing period. For Juan de Fuca Strait the catch was estimated to be 4.9 times greater (95% confidence limit: 2.2-9.5). The expansion factor for Johnstone Strait is the same as in 1987 (Nagtegaal et al. 1990) but the value for Juan de Fuca Strait is considerably higher than in 1987. Differences among years and between Johnstone Strait and Juan de Fuca Strait could be due to a number of factors.

In the Johnstone Strait chum fishery, chinook catch rates were considerably less than in the sockeye fishery. During this fishery the catch of jacks and juveniles combined was 3.7 times (95% confidence limit: 1.0-9.7) greater than the amount recorded as jacks in the sales slip data. The brief look at the Fraser River opening revealed that few chinook were caught. Due to limited data no comparison with sales slip data were made.

Depending on the true fate of the small chinook, the expansion factor may be quite variable from year to year. The fate of unreported chinook is unclear. Comparison of biological samples from the cannery and the survey suggest that most fishermen do not bother to discard juvenile chinook or sort their catch. The biological observers noted that when a set with a large number of juveniles was brought on deck, fishermen did try to throw them back overboard. Whether this was done when observers were not present is unknown. If the majority of small chinook landed reach the processor, it is not clear what criteria are used to determine whether these fish are reported on a sales slip as chinook, as other salmon species, or at all.

To determine the proportion of mature males in the jack and juvenile chinook categories, the sex ratio and percent maturity values from the biological sampling survey data (Tables 10 and 11) were applied to the total bootstrap estimates. Application of the values for Johnstone Strait yielded a total of 831 mature males and 84 mature females (jacks and juveniles combined). For Juan de Fuca Strait 2426 mature males and 500 mature females were recorded. Subtracting these values from the total catch estimates yielded 5011 chinook (jacks and juveniles combined) from Johnstone Strait and 31,030 chinook from Juan de

Fuca Strait, representing the numbers of fish that could have contributed to future production.

To put the chinook mortality study in perspective relative to the total fishing effort (Table 26), we note that the survey was conducted when 100% of the sockeye, 68% of the chum, >99% of the pink, and 95% of the total commercial seine chinook catch was taken in Johnstone Strait. The entire seine fishery in Juan de Fuca Strait was monitored.

The ratio of total chinook to sockeye catch in Johnstone Strait was approximately one chinook (juvenile, jack or adult) caught for every 9 sockeye. In Juan de Fuca Strait the ratio was approximately one chinook caught for every 5 sockeye. The ratio of adult to juvenile chinook in Johnstone Strait was 1:1 and in Juan de Fuca Strait was approximately 1:3.

The large proportion of null sets observed for chinook in both Johnstone Strait and Juan de Fuca Strait indicate that the catch of chinook in these seine fisheries is truly incidental. From a management perspective this implies that any attempt to reduce the fishing effort towards chinook will have a direct impact on the target species.

In studies conducted in the southeast Alaska purse seine fishery (Rowse and Marshall 1989; Rowse 1990) underreporting of small chinook (less than 53 cm) was also observed. Numbers of chinook taken in the fishery were estimated based on dockside sampling and skipper interview data. In 1987, estimates of small chinook caught were 5.7 times greater than those reported on sales slips and 10.9 times greater in 1988. Although different estimation procedures were used the magnitude of underreporting was comparable to what we have observed in Johnstone Strait and Juan de Fuca Strait.

B. STRATIFICATION

i) Johnstone Strait:

To determine the sensitivity of the bootstrap technique to different levels of stratification, the mean catch per set and sets per day data were compiled by week instead of by day and the analysis was repeated for Johnstone Strait. Daily gear count estimates were used as before. The difference in the total catch estimate was: 14% decrease for juveniles, 30% decrease for jacks, 4% increase for adult chinook, and 8% decrease for sockeye. These differences indicate that a large catch per set recorded on a given day may have a considerable effect on the catch estimate for that day (e.g. jacks), especially when few sets were monitored. The impact of such a large set would be less pronounced when data were pooled by week. This is expected

since we are dealing with highly skewed catch per set data. Therefore, daily stratification was necessary since it offers the best comparison with sales slip data. In addition, using the average weekly catch per set and sets per day data biases the catch estimate downwards.

ii) Juan de Fuca Strait:

In Juan de Fuca Strait changes in the stratification by time (day) or area (fishing line) had considerable impact on the catch estimates. When data were recompiled by week the changes in catch estimates were: 20% decrease for juveniles, 1% decrease for jacks, 16% decrease for adult chinook, and 17% decrease for sockeye. This indicates that large catch per set values have a considerable effect on catch estimates and this effect is reduced when catch per set is pooled by week. As in Johnstone Strait, using the average weekly catch per set and sets per day data, again biases the catch estimates downward. When calculations were repeated without stratifying the data by fishing line, the catch estimate for adults was 4% higher, for jacks was 12% higher, for juveniles was 6% lower, and for sockeye was 13% higher. More detailed information about catch per set by line needs to be collected to further refine the catch estimates. It is evident that some level of stratification by line is essential to properly reflect fleet dynamics and catch patterns.

C. DATA CONSIDERATIONS

The following data concerns and potential sources of bias pertain to both the Johnstone Strait and Juan de Fuca Strait analyses. Consideration of these aspects is important in assessing the precision of our catch estimation procedure.

In the treatment of missing cells for catch per set and sets per day data problems could arise if data for a given day were significantly different than other days during the week for which data were pooled. Filling in missing data cells for overflight data was accomplished by using gear count data recorded for other days during a given week. This was done with some concern since in 1986 (Nagtegaal et al. 1988), differences in the overflight gear count between days varied considerably and, in some cases, there was a change from one day to the next as high as 55%. Unfortunately, no similar comparisons have been available since. Practically, it was not possible to anticipate such major shifts in effort; however, we felt that the 10% error incorporated into the analysis accounted for most of the day to day changes in effort. Further work is necessary to gain a better understanding of the error associated with overflight gear estimates and Fishery Officer gear counts on the fishing grounds. It is imperative that gear count data be collected for each day

of fishing. The problems experienced in Juan de Fuca Strait are a case in point. The sockeye catch estimate in Juan de Fuca Strait was most comparable to the sales slip data for the only week of the fishery (August 22) when an overflight gear count was recorded.

Some bias in the sampling for catch per set may have occurred. On short days (Sunday evenings for example) or when equipment failures occurred, it may not have been possible to observe an adequate number of sets. Because data were collected on a voluntary basis, some bias could be introduced by interviewing only those vessels that were receptive to the program. It may also be the case that the more successful a skipper was the more receptive he would be to the program. Observers may have tended to interview those vessels that were familiar to them rather than unfamiliar vessels. Most skippers in each survey area allowed the observers to board except some in the lower Johnstone Strait (Stat. area. 13), where difficulties were experienced. The lack of data from this area was overcome by using catch and effort data from the adjacent survey area.

Some other potential sources of error are also noted:
a) Estimating the chinook catch may have been difficult when there were large catches of sockeye, especially when brailling took place. This was not a major concern, however, considering the small number (15) of large catches of sockeye (>500) encountered. When no opportunity for close examination of the catch was possible, some juvenile coho or pink salmon may have been recorded as chinook or vice-versa.
b) Chinook were recorded into the juvenile, jack or adult category based on a subjective size judgment by the field crew. No attempt was made to quantify errors in judgment but it was assumed that this was not a major problem.
c) A preliminary test of the accuracy of species identification by the field crew was made by examining the scales collected for ageing. According to Bilton et al. (1964), salmon species can be readily be identified by the scale patterns. Based on the scale samples collected, in Johnstone Strait, only 4 of the 180 samples (2%), and in Juan de Fuca Strait, 1 of 218 (<1%) were incorrectly identified.
d) Since an estimate for sets per hour could be made from each boarding, ample data for this statistic were collected. However, some bias may be introduced if non-representative data were collected by type of set (beach or open) for a given day and a significant difference between open and beach catch per set existed.

To exactly what extent these potential sources of error contribute to the total error in the catch estimates is unknown, but we considered these to be only minor concerns. In summary, this study provides an independent estimate of chinook mortality during the Johnstone Strait and Juan De Fuca Strait sockeye,

pink, and chum seine fisheries. Best estimates of total catch were presented based on catch per set, sets per day, and gear count data. Further work will be required to refine catch estimation techniques, compare the chinook mortality rates with factors such as total fishing effort and chinook stock size, and examine the changes in these variables over time.

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TABLES

Table 1. Seine fishery openings by area for 1988.

SOCKEYE FISHERY

Area	Dates of survey	Scheduled fishing dates
Johnstone Strait (Stat. area: 12,13)	July 24-25[a]	July 24-25
	Aug. 8-10	Aug. 8-10
	14-16	14-16
	21-22	21-22
Juan de Fuca Strait (Stat. area: 20)	Aug. 10-12	Aug. 10-12
	17-19	17-19
	22-23[b]	22-23[b]
Fraser River (Stat. area: 29)[c]	Sept. 14	Sept. 14
		19

CHUM FISHERY

Area	Dates of survey	Scheduled fishing dates
Johnstone Strait	Sept. 14-15	Sept. 14-15
	26-27	26-27
	Oct. 13-14	Oct. 13-14
		20-21

[a]Only sub-areas 12-1, 12-3, and 12-4 and Stat. area 13 were open to fishing during this week.

[b]Seiners did not fish on Sept. 23 even though there was a scheduled opening.

[c]Only stat. sub-area 29-3 was open.

Table 2. Number of vessels that reported catch by week from sales slip data compared with overflight gear count.

SOCKEYE FISHERY

Area	Date	Sales slip count[a]	DFO overflight[b]	Ground count[c]	PSC overflight[d]	PSC count[e]
Johnstone Strait	July 24-25	6	27			
	Aug. 8	125	81			
	9			66		
	14	169	185			
	21	142	138			
Juan de Fuca Strait	Aug. 10	71		115		110
	11			110		105
	12			80		84
	17	102		150		134
	18			130		88
	22	108	116	117		
Fraser River	Sept. 14	322	357		381	

CHUM FISHERY

Area	Date	Sales slip count[a]	DFO Overflight[b]
Johnstone Strait	Sept. 14-15	158	126
	26-27	433	346
	Oct. 13-14	451	409
	20-21	442	424

[a]Unique CFV licences delivering catch by statistical area, weekly totals only.
[b]Dept. of Fisheries and Oceans regular overflight count.
[c]Gear count taken by fishery officers on fishing grounds.
[d]Overflight gear count made by the Pacific Salmon Commission.
[e]Gear count estimated by Pacific Salmon Commission, based on landings at Vancouver fish plants.

Table 3. Available fishing time by fishery opening for statistical areas 12, 13, 20, and 29.

SOCKEYE FISHERY

Date	Statistical area[a]	Time of opening[b]	Available fishing hours
July 24	12, 13	1800	3.5
25	12, 13	0600	12.0
Aug. 8	12, 13	1800	3.5
9	12, 13	0600	15.5
10	12, 13	0600	12.0
	20	0630	12.0
11	20	0630	12.0
12	20	0630	12.0
14	12, 13	1800	3.5
15	12, 13	0600	15.5
16	12, 13	0600	12.0
17	20	0630	12.0
18	20	0630	12.0
19	20	0630	12.0
21	12, 13	1800	3.5
22	12, 13	0600	12.0
	20	0700	12.0
Sept. 14	29	0800	2.0

CHUM FISHERY

Date	Statistical area[a]	Time of opening[b]	Available fishing hours
Sept. 14	12, 13	1600	3.5
15	12, 13	0600	12.0
26	12, 13	1600	3.5
27	12, 13	0600	12.0
13	12, 13	1600	3.5
14	12, 13	0600	12.0
20	12, 13	1600	3.5
21	12, 13	0600	12.0

[a]Areas 12 and 13: Johnstone Strait
Area 20: Juan de Fuca Strait
Area 29: Mouth of Fraser River
[b]Universal time

Table 4. Number of different vessels boarded and total boardings made (in parentheses) by study area and date.

SOCKEYE FISHERY

	July		August												Sept.
Area	24	25	8	9	10	11	12	14	15	16	17	18	21	22	14
Gordon Group	-	-	4(4)	12(12)	-	-	-	6(6)	23(23)	28(28)	-	-	7 (7)	13(14)	-
North Shore	-	-	3(3)	7(12)	6(10)	-	-	3(3)	7(16)	8(18)	-	-	4 (6)	6(20)	-
Upper Johnstone Strait	2(2)	-	1(2)	21(23)	17(19)	-	-	13(13)	27(29)	11(13)	-	-	12(12)	26(34)	-
Lower Johnstone Strait	3(3)	4(8)	7(7)	6 (9)	6 (7)	-	-	3 (3)	10(10)	2 (2)	-	-	4 (4)	12(12)	-
Discovery Passage	-	-	-	6 (6)	5 (5)	-	-	-	2 (2)	-	-	-	-	-	-
Johnstone Strait (Total)	5(5)	4(8)	15(16)	52(62)	34(41)	-	-	25(25)	69(80)	49(61)	-	-	27(29)	57(80)	-
Juan de Fuca Strait	-	-	-	-	18(24)	11(12)	30(32)	-	-	-	36(36)	24(25)	-	28(28)	-
Fraser River	-														19(20)

Table 4 (cont'd)

CHUM FISHERY

	Sept.				Oct.	
Area	14	15	26	27	13	14
Gordon Group	2(2)	8(9)				
North Shore		1(1)	4(4)	10(10)	3(3)	9(9)
Upper Johnstone Strait	5(5)	17(18)	17(18)	41(46)	15(17)	43(51)
Lower Johnstone Strait	3(3)	12(13)	12(12)	43(46)	14(15)	30(34)
Total	10(10)	38(41)	33(34)	94(102)	32(35)	82(94)

Table 5. Average catch per set by category compiled from data collected during the Johnstone Strait seine fishery.

SOCKEYE FISHERY

Gordon Group	Chinook			Sockeye
	Adult	Jack	Juvenile	
July 24		NOT OPENED		
25		NOT OPENED		
Aug. 8	1.00(1.41)[a]	12.50(17.92)	3.50(5.74)	15.0(12.2)
9	0.00(0.00)	1.33 (1.78)	0.33(0.65)	5.6 (5.1)
10		NO DATA		
14	0.17(0.41)	0.67 (1.21)	1.33(3.27)	2.2 (1.5)
15	0.22(0.52)	0.35 (0.88)	0.35(0.65)	1.0 (1.4)
16	0.21(0.79)	0.25 (0.65)	0.39(0.63)	2.7 (3.5)
21	0.43(0.79)	0.57 (1.51)	0.43(0.79)	1.0 (2.2)
22	0.21(0.43)	0.43 (0.76)	0.43(0.65)	2.3 (4.9)
Mean[b]	0.23(0.65)	1.01 (4.17)	0.57(1.56)	2.9 (4.9)

CHUM FISHERY

Gordon Group	Adult	Jack	Juvenile	Chum
Sept. 14	0.00(0.00)	0.50 (0.71)	1.00(1.41)	1.5 (0.70)
15	0.11(0.33)	0.00 (0.00)	0.11(0.33)	2.9 (4.0)
26		NO DATA		
27		NO DATA		
Oct. 13		NO DATA		
14		NO DATA		
Mean[b]	0.09(0.30)	0.09 (0.30)	0.27(0.65)	2.6(3.7)

Table 5 (cont'd)

SOCKEYE FISHERY

North Shore	Chinook Adult	Chinook Jack	Chinook Juvenile	Sockeye
July 24		NOT OPENED		
25		NOT OPENED		
Aug. 8	0.00(0.00)	0.00(0.00)	0.00(0.00)	2.0 (0.0)
9	0.67(0.89)	0.08(0.29)	0.17(0.39)	9.0(13.5)
10	0.40(1.26)	0.10(0.32)	0.60(0.84)	2.7 (2.9)
14	2.67(3.06)	0.33(0.58)	0.33(0.58)	14.0(18.2)
15	0.31(0.70)	0.25(0.58)	0.69(1.08)	3.4 (4.8)
16	0.61(1.24)	0.17(0.38)	0.67(1.14)	8.7(10.0)
21	1.00(1.26)	0.17(0.41)	0.00(0.00)	1.7 (2.3)
22	1.25(1.74)	0.65(1.35)	0.50(0.61)	5.6 (4.8)
Mean	0.76(1.37)	0.27(0.75)	0.48(0.83)	5.9 (8.3)

CHUM FISHERY

North Shore	Adult	Jack	Juvenile	Chum
Sept. 14		NO DATA		
15	0.00(0.00)	0.00(0.00)	0.00(0.00)	15.00(0.00)
26	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.30(0.50)
27	0.70(1.89)	0.60(1.26)	0.10(0.32)	11.1(18.3)
Oct. 13	0.00(0.00)	0.00(0.00)	0.00(0.00)	55.0(82.6)
14	0.00(0.00)	0.00(0.00)	0.00(0.00)	49.9(61.1)
Mean[b]	0.26(1.16)	0.22(0.80)	0.04(0.19)	26.9(46.3)

Table 5 (cont'd)

SOCKEYE FISHERY

Upper Johnstone Strait	Chinook Adult	Chinook Jack	Chinook Juvenile	Sockeye
July 24	1.50(0.71)	13.00(9.90)	6.00(5.66)	1.5 (2.1)
25		NO DATA		
Aug. 8	0.00(0.00)	1.00(0.00)	0.00(0.00)	92.5(46.0)
9	0.43(0.66)	0.17(0.39)	0.78(1.38)	26.2(51.5)
10	0.84(1.71)	0.05(0.23)	0.21(0.54)	43.7(75.0)
14	1.54(2.57)	0.54(1.45)	0.31(0.63)	6.8(10.1)
15	0.28(0.65)	0.21(0.49)	0.72(1.71)	11.0(32.2)
16	0.69(1.44)	0.00(0.00)	0.38(1.12)	4.0 (3.7)
21	0.33(0.49)	0.17(0.39)	0.92(1.38)	11.1(17.2)
22	0.97(2.49)	0.06(0.24)	0.82(1.49)	8.1(11.2)
Mean	0.70(1.67)	0.34(1.79)	0.70(1.53)	16.9(40.1)

CHUM FISHERY

Upper Johnstone Strait	Adult	Jack	Juvenile	Chum
Sept. 14	0.20(0.45)	0.00(0.00)	0.40(0.89)	12.4 (17.1)
15	0.89(1.97)	0.22(0.73)	0.39(0.78)	36.4 (61.7)
26	0.00(0.00)	0.00(0.00)	0.00(0.00)	11.5 (41.1)
27	0.09(0.36)	0.24(1.09)	0.13(0.40)	41.2 (91.1)
Oct. 13	0.00(0.00)	0.00(0.00)	0.12(0.00)	31.2 (59.1)
14	0.04(0.28)	0.02(0.14)	0.53(3.09)	54.6(131.6)
Mean[b]	0.15(0.75)	0.10(0.65)	0.28(1.81)	39.4 (95.9)

Table 5 (cont'd)

SOCKEYE FISHERY

Lower Johnstone Strait	Chinook Adult	Chinook Jack	Chinook Juvenile	Sockeye
July 24	0.00(0.00)	0.00(0.00)	0.00(0.00)	26.0 (38.3)
25	0.13(0.35)	0.00(0.00)	0.00(0.00)	23.6 (20.8)
Aug. 8	0.14(0.38)	0.00(0.00)	0.00(0.00)	91.4(182.2)
9	0.89(0.93)	0.22(0.67)	0.11(0.33)	90.0(119.9)
10	1.00(1.53)	0.00(0.00)	0.57(1.13)	17.6 (36.5)
14	0.00(0.00)	0.00(0.00)	1.33(1.53)	10.0 (0.00)
15	1.60(5.06)	0.00(0.00)	0.10(0.32)	5.6 (7.8)
16	0.00(0.00)	0.00(0.00)	0.00(0.00)	7.0 (7.1)
21	0.50(0.58)	0.00(0.00)	0.50(1.00)	8.0 (5.7)
22	0.08(0.29)	0.00(0.00)	0.00(0.00)	4.6 (6.4)
Mean	0.55(2.08)	0.03(0.25)	0.13(0.61)	31.2 (79.8)
Johnstone Strait (All Areas Combined)	0.58(1.52)	0.43(2.36)	0.53(1.29)	18.17 (47.72)

CHUM FISHERY

Lower Johnstone Strait	Adult	Jack	Juvenile	Chum
Sept. 14	0.00(0.00)	0.33(0.58)	0.00(0.00)	10.7 (10.0)
15	0.15(0.55)	0.08(0.28)	0.08(0.28)	6.2 (8.2)
26	0.00(0.00)	0.00(0.00)	0.00(0.00)	65.3 (107.8)
27	0.00(0.00)	0.02(0.15)	0.09(0.46)	34.3 (59.5)
Oct. 13	0.00(0.00)	0.07(0.26)	0.13(0.35)	684.3(1052.7)
14	0.03(0.17)	0.09(0.38)	0.24(0.50)	68.8 (113.4)
Mean[b]	0.02(0.20)	0.06(0.27)	0.12(0.42)	122.6 (421.5)
Johnstone Strait (all areas combined)	0.11(0.64)	0.09(0.53)	0.19(1.30)	69.4 (274.4)

[a]Standard deviation in parentheses.
[b]Weighted mean catch per set, all weeks combined.

Table 6. Two way analysis of variance of catch per set vs area and week for the Johnstone Strait sockeye fishery.

	Source of variation	DF	SS	MS	F OBS	F 0.05
Jacks	Total	393	2182.8			
	Model	13	561.3	43.2	10.1	1.9
	Error	380	1621.5	4.3		
	Area	3	45.4		3.5	4.3
	Week	3	89.5		6.9	4.3*
	Area and Week	7	426.3		14.3	3.5*
Juveniles	Total	393	664.0			
	Model	13	81.3	6.2	4.1	1.9
	Error	380	582.7	1.5		
	Area	3	12.4		2.7	4.3
	Week	3	6.7		1.5	4.3
	Area and Week	7	62.0		5.8	3.5*
Adults	Total	393	904.0			
	Model	13	34.9	2.7	1.18	1.9
	Error	380	869.1	2.3		
	Area	3	16.3		2.4	4.3
	Week	3	2.9		.4	4.3
	Area and week	7	15.6		.9	3.5
Sockeye	Total	393	687658			
	Model	13	114999	8846	5.8	1.9
	Error	380	572658	1506		
	Area	3	37639		8.3	4.3*
	Week	3	42528		9.4	4.3*
	Area and Week	7	34831		3.3	3.5

*Indicates significance

Table 7. Comparison between type of set and catch per set by study area for the sockeye fishery.

		Chinook			
Johnstone Strait:	N	Adults	Jacks	Juveniles	Sockeye
Gordon Group					
Open	76	.2(.1)[a]	1.2(.6)	.6(.2)	3.2 (.6)
Beach	16	.2(.1)	.4(.2)	.4(.1)	2.0 (1.1)
North Shore					
Open	87	.7(.1)	.3(.1)	.5(.1)	5.9 (.9)
Beach	1	4.0	1.0	1.0	0
Upper Johnstone Strait					
Open	62	.5(.2)	.5(.3)	.4(.2)	12.2 (4.2)
Beach	85	.2(.2)	.2(.1)	.9(.2)	20.4 (4.8)
Lower Johnstone Strait					
Open	10	0	0	.3(.3)	4.7 (2.1)
Beach	55	.6(.3)	.1(.1)	.2(.1)	36.0(11.6)
Total[b]					
Open	235	.5(.1)	.6(.2)	.5(.1)	6.6 (1.2)
Beach	157	.7(.2)	.2(.1)	.6(.1)	23.8 (4.9)
Juan de Fuca Strait					
Open	156	1.1(.2)	1.7(.3)	2.8(.6)	27.8 (2.2)
Beach	-	-	-	-	-

[a]Standard error of the mean.
[b]All areas combined (Johnstone Strait).

Table 8. Summary of chinook biological samples collected during the sockeye fishery in Johnstone Strait.

Length	Juveniles			Length	Jacks			Length	Adults		
(cm)	M	F	U[a]	(cm)	M	F	U	(cm)	M	F	U
26			2	43	1 (4)	4(23)	5	59	2 (7)	1 (3)	5
27			2	44	6(26)	3(17)	1	60	2 (7)	0	2
28			0	45	2 (9)	3(17)	2	61	2 (7)	0	7
29			0	46	2 (9)	1 (6)	2	65	0	0	3
30	1 (4)	1 (4)	2	47	2 (9)	2(12)	2	66	1 (3)	0	1
31	2 (7)	2 (8)	0	48	3(13)	1 (6)	3	67	3(10)	0	0
32	0	0	1	49	2 (9)	2(12)	1	68	1 (3)	1 (3)	3
33	0	5(21)	0	50	1 (4)	1 (6)	4	69	0	0	3
34	1 (4)	0	4	51	0		1	71	1 (3)	0	6
35	2 (7)	0	0	52	2 (9)		2	73	1 (3)	0	6
36	1 (4)	0	0	53	0		0	74	1 (3)	0	4
37	1 (4)	1 (4)	5	54	1 (4)		4	76	1 (3)	0	1
38	4(15)	0	3	55	1 (4)		3	77	0	1 (3)	1
39	1 (4)	0	3	56			0	78	1 (3)	4(12)	1
40	3(11)	7(29)	12	57			1	79	1 (3)	0	1
41	4(15)	6(25)	3					80	2 (7)	0	2
42	6(23)	2 (8)	4					81	1 (3)	1 (3)	2
								82	0	1 (3)	2
								83	1 (3)	0	5
								84	0	5(15)	3
								86	0	2 (6)	1
								87	0	1 (3)	3
								88	0	5(15)	4
								89	0	0	6
								90	1 (3)	4(12)	6
								91	2 (7)	1 (3)	5
								92	0	0	4
								94	1 (3)	1 (3)	1
								95	1 (3)	1 (3)	3
								97	0	0	3
								100	1 (3)	2 (6)	2
								101	0	0	1
								103	1 (3)	0	3
								104	0	1 (3)	1
								107	0	0	2
								110	1 (3)	0	2
								117		2 (6)	
Total	26	24	41		23	17	31		29	34	105
Weighted Mean Length	38.3	37.7			47.3	45.5			77.4	86.3	
Percent Mature	27%	5%	-		22%	-	-		-	-	-
Sex Ratio (% males)		52%				57%				46%	

[a]Fish not sampled for sex and maturity.
[b]Percent frequency in parentheses.

Table 9. Summary of chinook age samples collected during the sockeye fishery.

Johnstone Strait				
Age[1]	M	F	U[3]	T
0.1	23	24	35	82
0.2	10	-	21	31
0.3	8	13	35	56
0.4	1	-	10	11
Total	42	37	101	180
Unknown[2]: 130				

Juan de Fuca Strait				
Age[1]	M	F	U	T
0.1	74	65	5	144
0.2	14	4	4	22
0.3	7	12	19	38
0.4	3	3	3	9
1.1	5	-	-	5
Total	103	84	31	218
Unknown[2]: 157				

[1]European notation: the first digit indicates the number of annuli formed in fresh water and the second digit indicates the number of annuli formed in the ocean.

[2]Unknown age: scales were unreadable.

[3]Unknown sex: sex not determined by samplers.

Table 10. Summary of chinook biological samples collected at the canneries in Vancouver during the sockeye fishery in Johnstone Strait.

Juveniles[c]					Jacks		
Length (cm)	M	F	U[a]	Length (cm)	M	F	U
38	1 (7)[b]	1		43	2(10)		
39	3(21)			44	4(20)		
40	2(14)			45	2(10)		
41	3(21)			46	0		
42	5(36)			47	2(10)		
				48	1 (5)		
				49	1 (5)		
				50	2(10)	1	
				51	0	0	
				52	1 (5)	0	
				53	1 (5)	1	
				54	0		
				55	0		
				56	3(15)		
				57	1 (5)		
Total	14	1	-		20	2	-
Weighted Mean Length	40.6	-	-		48.7	51.5	-
Percent Immature	14%	100%	-		20%	100%	-
Sex Ratio (% males)	93%				91%		

[a]Fish not sampled for sex and maturity.
[b]Percent frequency in parentheses.
[c]For purposes of comparison with the survey data, the cannery sample data are assigned to jack and juvenile categories according to the criteria used for the survey data.

Table 11. Average number of sets made by day[1] for Johnstone Strait and Juan de Fuca Strait.

SOCKEYE FISHERY

Study Area	July		August							
	24	25	8	9	10	14	15	16	21	22
Gordon Group	-	-	3.7 (1.1)	16.6 (1.1)	-	3.3 (1.0)	13.3 (0.9)	23.7 (1.3)	7.0 (0.9)	-
North Shore	-	-	4.7 (1.4)	14.8 (0.9)	15.2 (1.3)	8.0 (1.7)	14.2 (0.9)	14.2 (1.2)	4.5 (1.4)	13.5 (1.2)
Upper Johnstone Strait	-	-	3.5 (1.2)	13.2 (0.9)	9.5 (0.8)	3.7 (1.2)	13.7 (0.9)	11.4 (1.0)	3.0 (1.0)	12.2 (1.0)
Lower Johnstone Strait	5.0 (1.3)	24.0 (1.2)	4.6 (1.4)	11.2 (0.8)	6.8 (0.6)	3.7 (1.2)	13.6 (0.9)	6.0 (0.5)	1.2 (0.5)	9.2 (0.8)

Table 11 (cont'd)

	August						Sept.
	10	11	12	17	18	22	14
Juan de Fuca	9.9 (0.9)	8.7 (0.8)	8.3 (0.7)	11.2 (1.0)	11.0 (1.0)	10.4 (0.8)	-
Fraser River	-	-	-	-	-	-	2.4 (1.2)

CHUM FISHERY

	Sept.					Oct.
	14	15	26	27	13	14
Gordon Group	2.5 (0.7)	9.0 (1.0)	-	-	-	-
North Shore	-	4.0 (0.4)	2.2 (0.6)	18.6 (1.1)	7.0 (1.6)	25.5 (2.6)
Upper Johnstone Strait	5.6 (1.4)	7.1 (0.8)	5.6 (1.3)	10.7 (1.1)	5.3 (1.3)	17.1 (1.7)
Lower Johnstone Strait	4.3 (1.1)	5.2 (0.5)	3.7 (1.0)	9.1 (1.0)	7.8 (1.0)	9.3 (1.0)

[1]average number of sets per hour in parenthesis

Table 12. Gear count of seiners by day for Johnstone Strait.

SOCKEYE FISHERY

Study Area	July		August							
	24	25[a]	8	9[bc]	10[a]	14	15[a]	16[c]	21	22[a]
Gordon Group	-	-	25	16	-	25	-	-	20	-
North Shore	-	-	10	2	-	10	-	-	20	-
Upper Johnstone Strait	20	-	33	30	-	93	-	-	44	-
Lower Johnstone Strait	6	-	13	12	-	33	-	-	34	-
Discovery Pass	1	-	0	6	-	24	-	-	20	-
Total	27	-	81	66	-	185	-	-	138	-

Table 12 (cont'd)

CHUM FISHERY

	Sept.				Oct.	
	14	15[a]	26	27[a]	13	14[a]
Gordon Group	5	-	16	-	2	-
North Shore	12	-	67	-	95	-
Upper Johnstone Strait	26	-	160	-	92	-
Lower Johnstone Strait	0	-	53	-	57	-
Discovery Pass	2	-	50	-	163	-
Total	45	126	346	-	409	-

[a]overflight not routinely made on second day of a 24 hour fishery or third day of a 48 hour fishery.
[b]Gear count taken by fishery officers on fishery grounds.
[c]No overflight made.

Table 13. Comparison of bootstrap estimates and sales slip data (numbers caught) by week for Johnstone Strait.[a]

SOCKEYE FISHERY

Week	Adult	Jack	Juvenile	Sockeye
July 24-25	22[b]	0	0	4,473
	0-94[c]			1,041- 9,406
	33[d]	11	[e]	626
Aug. 8-10	885	903	788	56,537
	405-1,681	186-2,394	326-1,433	28,805- 99,267
	1,348	647	[e]	47,297
Aug. 14-16	1,974	805	2,336	32,302
	635-3,841	285-1,658	893-4,869	16,416- 65,178
	1,277	760	[e]	26,976
Aug. 21-22	1,108	324	769	10,222
	411-2,216	82- 960	339-1,427	549- 15,495
	1,639	851	[e]	16,010
Total	3,988	2,033	3,893	103,534
	2,231-6,434	943-3,581	2,205-6,574	67,019-156,470
	4,297	2,269	[e]	90,909

Table 13 (cont'd)

CHUM FISHERY

Week	Adult	Jack	Juvenile	Chum
Sept. 14-15	304[b] 76- 669[c] 413[d]	89 1- 272 94	143 35- 310 [e]	11,836 4,396- 24,447 18,331
Sept. 26-27	1,129 8-5,178 170	1,245 73-4,202 518	437 30-1,154 [e]	151,766 54,451- 240,724 153,502
Oct. 13-14	107 0- 551 40	368 0-1,263 343	1,335 223-3,961 [e]	648,187 272,911-1,243,164 399,869
Total	1,540 192-5,580 623	1,702 293-4,565 955	1,914 455-5,033 [e]	811,789 426,924-1,448,817 571,702
Oct. 13-14[f] (adjusted)	129 0- 528 40	266 0- 827 343	1,342 248-3,714 [e]	418,979 199,335- 676,224 399,869
Total[f] (adjusted)	1,563 192-5,690 623	1,600 287-4,507 955	1,922 642-4,823 [e]	582,581 345,226- 865,246 571,702

[a]For the fishing period of July 24-25 only Stat. areas 13, 12-1, 12-3, 12-4 were open to fishing.
[b]Bootstrap estimates.
[c]Upper and lower 95% confidence limits.
[d]Sales slip data collected by the Dept. of Fisheries and Oceans (1988).
[e]No data recorded for juveniles in sales slip data.
[f]Catch per set data for Lower Johnstone Strait sub-area from Oct. 14 was applied to calculations for Oct. 13.

Table 14. Comparison of bootstrap estimates and sales slip data (numbers caught) by statistical area for the Johnstone Strait sockeye fishery.

Statistical Area	Adult	Jack	Juvenile	Sockeye
12	3,617[a]	1,990	3,538	62,510
	2,011-5,877[b]	943-3,462	2,057-6,187	32,799-101,975
	3,497[c]	1,950	d	56,043
13	371	43	355	41,024
	122- 743	0- 209	88- 869	18,620- 77,632
	800	319	d	34,866
Total	3,988	2,033	3,893	103,534
	2,231-6,434	943-3,581	2,205-6,574	67,019-156,470
	4,297	2,269	d	90,909

[a]Bootstrap estimates.
[b]Upper and lower 95% confidence limits.
[c]Sales slip data collected by the Dept. of Fisheries and Oceans (1988).
[d]No data recorded for juveniles in sales slip data.

Table 15. Two way analysis of variance of catch per set vs. area and week in Johnstone Strait chum fishery.

	Source of Variation	DF	SS	MS	F_{OBS}	$F_{0.05}$
Jacks	Total	315	91			
	Model	9	3	.3		
	Error	306	88	.2		
	Area	3	.6		0.7	3.2
	Week	2	.8		1.3	3.7
	Area/week	4	1.6		1.4	2.8
Juveniles	Total	315	534			
	Model	9	7	.8		
	Error	306	527	1.7		
	Area	3	2.6		0.5	3.2
	Week	2	3.0		0.9	3.7
	Area/week	4	1.5		0.2	2.8
Adults	Total	315	130			
	Model	9	13	1.4		
	Error	306	117	.4		
	Area	3	1.7		1.5	3.2
	Week	2	6.7		8.8	3.7*
	Area/week	4	4.6		3.0	2.8*
Chum	Total	315	23,726,173			
	Model	9	2,098,041	233,115		
	Error	306	21,628,131	70,680		
	Area	3	585,419		2.7	3.2
	Week	2	762,435		5.4	3.7*
	Area/week	4	750,187		2.6	2.8

*Denotes significance.

Table 16. Summary of chinook biological samples collected during the chum fishery in Johnstone Strait.

Juveniles				Jacks				Adults			
Length (cm)	M	F	U[a]	Length (cm)	M	F	U	Length (cm)	M	F	U
38			5	48			5	85			1
39			1	49			0	86			0
40			10	50	1		8	87			1
				51			5	94			2
				52			0	97			1
				53			0	107			2
				54			0	112			1
				55			5				
Totals	-	-	16		1	-	23		-	-	8

aFish not sampled for sex or maturity.

Table 17. Average catch per set by category compiled from data collected during the Juan de Fuca Strait sockeye fishery.

	Adult	Jack	Juvenile	Sockeye
Aug. 10	1.58(2.32)[a]	2.50(2.28)	0.88 (2.03)	37.5(29.8)
Aug. 11	2.50(3.03)	0.42(0.90)	1.75 (3.67)	39.5(34.6)
Aug. 12	1.44(3.39)	0.59(1.10)	1.06 (1.58)	27.9(20.5)
Aug. 17	0.75(1.63)	1.08(2.39)	2.17 (3.44)	19.8(22.7)
Aug. 18	0.32(0.48)	0.88(1.56)	7.28(16.72)	32.5(41.4)
Aug. 22	1.00(2.22)	4.21(7.96)	3.96 (6.56)	21.1(15.8)
Mean[b]	1.13(2.22)	1.68(3.94)	2.85 (7.74)	27.9(27.8)

[a]Standard deviation in parentheses.
[b]Weighted mean catch per set, all weeks combined.

Table 18. Summary of catch per set by fishing line for Juan de Fuca Strait.[a]

Fishing line	N	Chinook			Sockeye
		Adult	Jack	Juvenile	
1	61	1.2(0.2)	2.7(0.6)	1.6(0.5)	44.9(3.9)[b]
2	14	1.4(0.6)	0.7(0.3)	2.8(0.9)	29.1(8.9)
3	15	0.5(0.2)	0.9(0.4)	10.2(5.5)	13.1(3.9)
4	19	0.5(0.1)	0.7(0.3)	1.8(0.8)	11.0(2.3)
5	7	0.1(0.1)	4.4(3.8)	1.1(0.7)	8.4(4.7)
6	14	1.5(0.6)	1.3(0.6)	1.6(0.6)	26.2(4.3)
7	12	2.0(1.6)	0.6(0.3)	4.0(1.7)	14.1(4.6)
8	11	1.8(1.0)	0.4(0.3)	3.4(1.2)	17.1(4.6)
9	2	1.5(1.5)	0	1.5(1.5)	16.5(5.5)
10	-	-	-	-	-
11	-	-	-	-	-
12	2	0	0	1.0(1.0)	6.5(5.5)

[a]All weeks combined.
[b]Standard error of the mean.

Table 19. Two way analysis of variance of catch per set vs. week and fishing line for Juan de Fuca Strait.

	Source of variation	DF	SS	MS	F_{OBS}	$F_{0.05}$
Jacks	Total	156	2,420			
	Model	25	1,066	43	4.1	1.7
	Error	131	1,353	10		
	Week	2	221		10.7	4.3*
	Line	9	201		2.2	2.7
	Week and Line	14	643		4.4	2.4*
Juveniles	Total	156	9,356			
	Model	25	2,128	85	1.5	1.7
	Error	131	7,227	55		
	Week	2	360		3.3	4.3
	Line	9	949		1.9	2.7
	Week and Line	14	818		1.1	2.4
Adults	Total	156	771			
	Model	25	165	6	1.4	1.7
	Error	131	606	4		
	Week	2	39		4.3	4.3
	Line	9	33		.8	2.7
	Week and Line	14	91		1.4	2.4
Sockeye	Total	156	120,507			
	Model	25	45,946	1,837	3.2	1.7
	Error	131	74,561	569		
	Week	2	3,794		3.3	4.3
	Line	9	33,751		6.6	2.7*
	Week and Line	14	8,400		1.0	2.4

*Indicates significance

Table 20. Comparison of catch per set and bottom depth for Juan de Fuca.

Depth[1] (fm)	N	Chinook			Sockeye
		Adult	Jack	Juvenile	
30-35	1	0.0	0.0	30.0	1.0
36-45	4	4.2	0.7	23.5	16.7
46-55	9	2.4	1.0	5.9	17.0
56-65	8	0.2	0.9	7.4	12.9
66-75	9	2.0	0.9	1.5	17.9
76-85	11	0.5	0.4	2.1	27.8
86-95	7	0.8	0.1	3.4	10.3
96-105	8	0.5	0.1	1.2	13.6
106-115	6	0.0	0.0	0.7	9.8
116-125	7	0.4	0.3	2.1	7.7
126-135	5	0.8	0.4	1.4	6.4
25-65	22	1.8	0.8	10.7	14.7
66-135	53	0.8	0.3	1.8	14.9

[1]A 30 fm compliance boundary is in effect for the commercial seine fleet in Juan de Fuca.

Table 21. Summary of chinook biological samples collected during the sockeye fishery in Juan de Fuca Strait.

Length (cm)	Juveniles			Length (cm)	Jacks			Length (cm)	Adults		
	M	F	U[a]		M	F	U		M	F	U
25	1			43	22(13)	13(11)		58	2 (5)	2 (6)	
26	1			44	23(14)	18(16)		59		1 (3)	
27				45	20(12)	19(16)		60			1
28				46	25(15)	20(17)		62	1 (3)		
29				47	21(13)	8 (7)		63	1 (3)		
30				48	9 (5)	10 (9)	2	64	2 (5)		
31				49	14 (9)	7 (6)	1	65			1
32				50	7 (4)	10 (9)	1	68	3 (7)	1 (3)	
33				51	4 (2)	2 (2)	1	70		1 (3)	
34	1 (1)a			52	5 (3)	3 (3)	1	71		1 (3)	
35	2 (2)	1 (2)		53	5 (3)	0		72	2 (5)		1
36	1 (1)	1 (2)		54	4 (2)	1 (1)		73	1 (3)		
37	3 (4)	3 (6)		55	1 (1)	0		74	1 (3)	2 (6)	2
38	7 (8)	8(15)		56	2 (1)	0		75	2 (5)		
39	5 (6)	4 (7)		57	1 (1)	3 (3)		76	4(10)		
40	20(25)	7(13)						77	1 (3)	1 (3)	
41	22(27)	17(32)						78	1 (3)	2 (6)	2
42	18(22)	12(23)						79	1 (3)		1
								80	1 (3)	1 (3)	1
								81			1
								83		1 (3)	
								84	1 (3)	3 (9)	2
								85	1 (3)	1 (3)	
								86			1
								87			1
								88	2 (5)	1 (3)	1
								89			1
								90	1 (3)	3 (9)	1
								91		1 (3)	
								92	4(10)	4(12)	
								93			1
								94	1 (3)		
								95			2
								96	1 (3)		
								97	1 (3)	1 (3)	
								98	1 (3)		
								100		2 (6)	2
								101	2 (5)	1 (3)	1
								102		2 (6)	1
								104	2 (5)		
								105			2
Total	81	53			162	114	6		40	32	26
Weighted Mean Length	39.1	40.0			46.8	46.5			80.7	83.9	
Percent Mature	13%	4%			10%	3%					
Sex Ratio	60%	40%			59%	41%			55%	45%	

[a]Fish could not be sampled for sex and maturity.
[b]Percent frequency in parentheses.

Table 22. Summary of chinook biological samples collected at the canneries in Vancouver during the sockeye fishery in Juan de Fuca Strait.

Juveniles[a]				Jacks			
Length (cm)	M	F	U[b]	Length (cm)	M	F	U
36		1(12)		43	4(9)	3(16)	
37		0		44	4(9)	2(10)	
38	4(18)[c]	1(12)		45	5(11)	2(10)	
39	2(9)	1(12)		46	4 (9)	3(16)	
40	5(23)	0		47	3 (7)	2(10)	
41	4(18)	1(12)		48	5(11)	0	
42	7(32)	4(50)		49	5(11)	1(5)	
				50	3(7)	1(5)	
				51	1(2)	2(10)	
				52	1(2)	0	
				53	1(2)	0	
				54	2(5)	1(5)	
				55	0	1(5)	
				56	2(5)	1(5)	
				57	3(7)		
Total	22	8	-		43	19	
Weighted Mean Length	40.4	39.7	-		48.4	47.6	
Percent Immature	54%	100%			55%	94%	
Sex Ratio (% males)	73%				69%		

[a]For purposes of comparison with the survey data we split the cannery sample data into jacks and juvenile according to the criteria used for the survey data.

[b]Fish could not be sampled for sex and maturity.

[c]Percent frequency in parentheses.

Table 23. Average number of sets made per day per vessel by fishing line in Juan de Fuca.

Fishing Line	N	Number of sets/day
1	58	6.5
2	13	11.2
3	14	10.5
4	19	12.9
5	7	13.0
6	14	11.3
7	11	13.0
8	10	13.8
9	2	8.0
10	-	-
11	-	-
12	2	13.0

Table 24. Comparison of bootstrap estimates and sales slip data (numbers caught) by week for Juan de Fuca Strait.

Week	Adult	Jack	Juvenile	Sockeye
Aug. 10-12	5,163[a]	3,640	3,392	99,342
	2,172- 9,630[b]	1,306- 6,378	1,103- 8,191	51,563-146,634
	2,241[c]	1,443	[d]	138,173
Aug. 17-18	1,721	3,053	14,027	79,484
	602- 3,604	991- 6,597	4,494-35,242	39,930-151,196
	760	2,960	[d]	42,716
Aug. 22	1,208	5,017	4,826	25,403
	458- 2,510	528-12,201	887-11,631	13,484- 45,357
	586	2,474	[d]	23,691
Total	8,092	11,711	22,245	204,229
	4,805-12,937	5,982-19,157	9,588-46,010	146,527-297,457
	3,587	6,877	[d]	204,580

[a]Bootstrap estimates.
[b]Upper and lower 95% confidence limits.
[c]Sales slip data collected by the Dept. of Fisheries and Oceans (1988).
[d]No data recorded for juveniles in sales slip data.

Table 25. Comparison of bootstrap estimates and sales slip data (numbers caught) for the Fraser River opening.

	Adult	Jack	Juvenile	Sockeye
Sept. 14	0[a]	77	52	259,286
	-[b]	0-248	0-200	63,686-545,636
	58[c]	273	[d]	212,304

[a]Bootstrap estimates.
[b]Upper and lower 95% confidence limits.
[c]Sales slip data collected by the Dept. of Fisheries and Oceans (1988).
[d]No data recorded for juveniles in sales slip data.

Table 26. Comparison of the seine commercial catch by species in Johnstone Strait and Juan de Fuca Strait during the survey and total commercial catch for 1988.

	Johnstone Strait			
	Sockeye	Chum	Pink	Chinook
Survey catch[1]	95,408	549,775	806,912	8,146
Total catch[2]	95,408	812,160	807,249	8,561
Difference	-	68%	>99%	95%

	Juan de Fuca Strait			
	Sockeye	Chum	Pink	Chinook
Survey catch	202,529	1,049	8,868	10,354
Total catch	202,529	1,049	8,868	10,354
Difference	-	-	-	-

[1]Commercial catch recorded during the survey (sockeye and chum fisheries combined).
[2]Total commercial seine catch for 1988, from sales slip data collected by Dept. of Fisheries and Oceans.

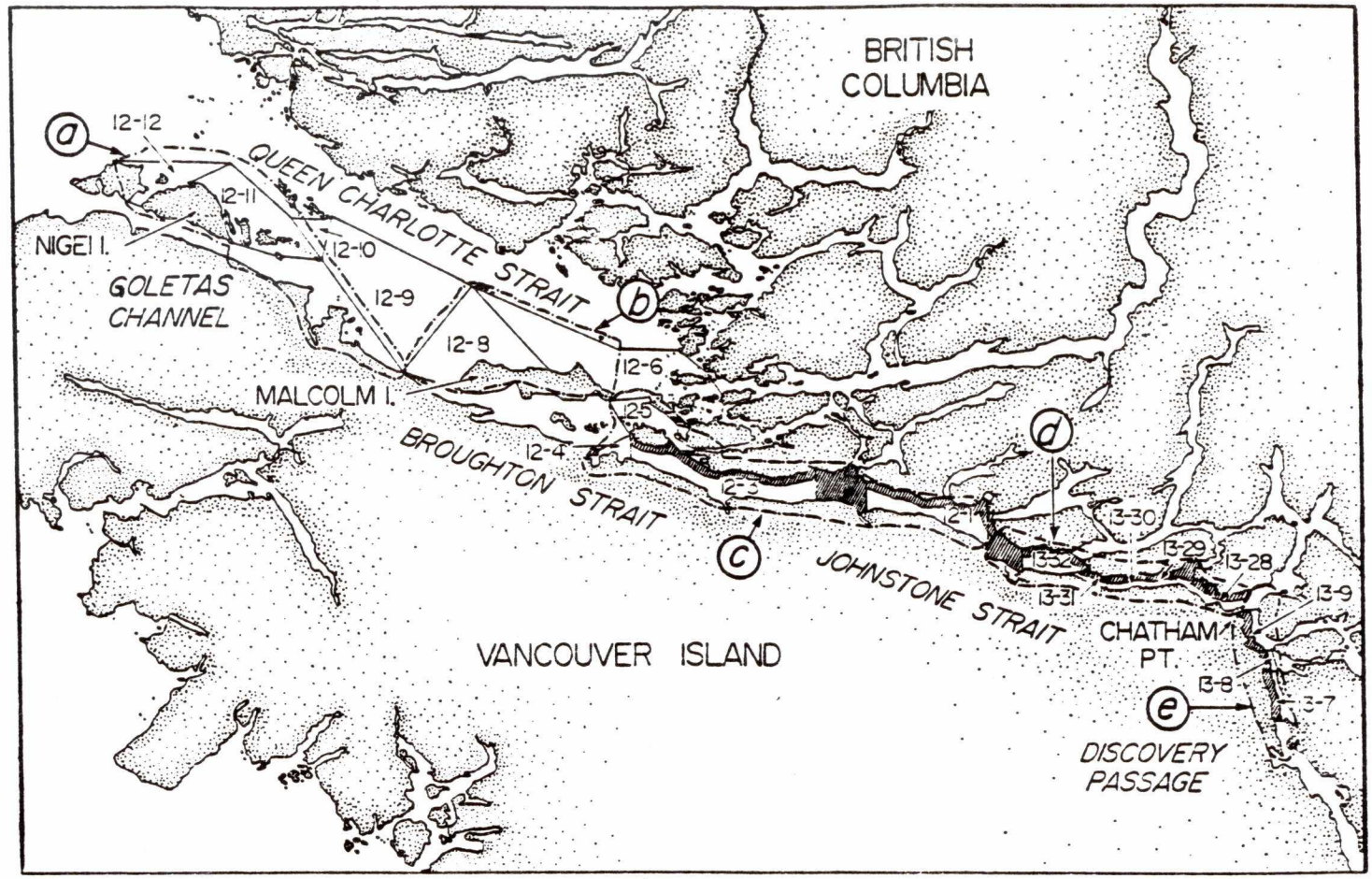


Fig. 1. Locations of management areas and study areas (a - Gordon Group, b - North Shore, c - Upper Johnstone Strait, d - Lower Johnstone Strait, e - Discovery Passage). Hatched sections represent areas closed to commercial fishing.

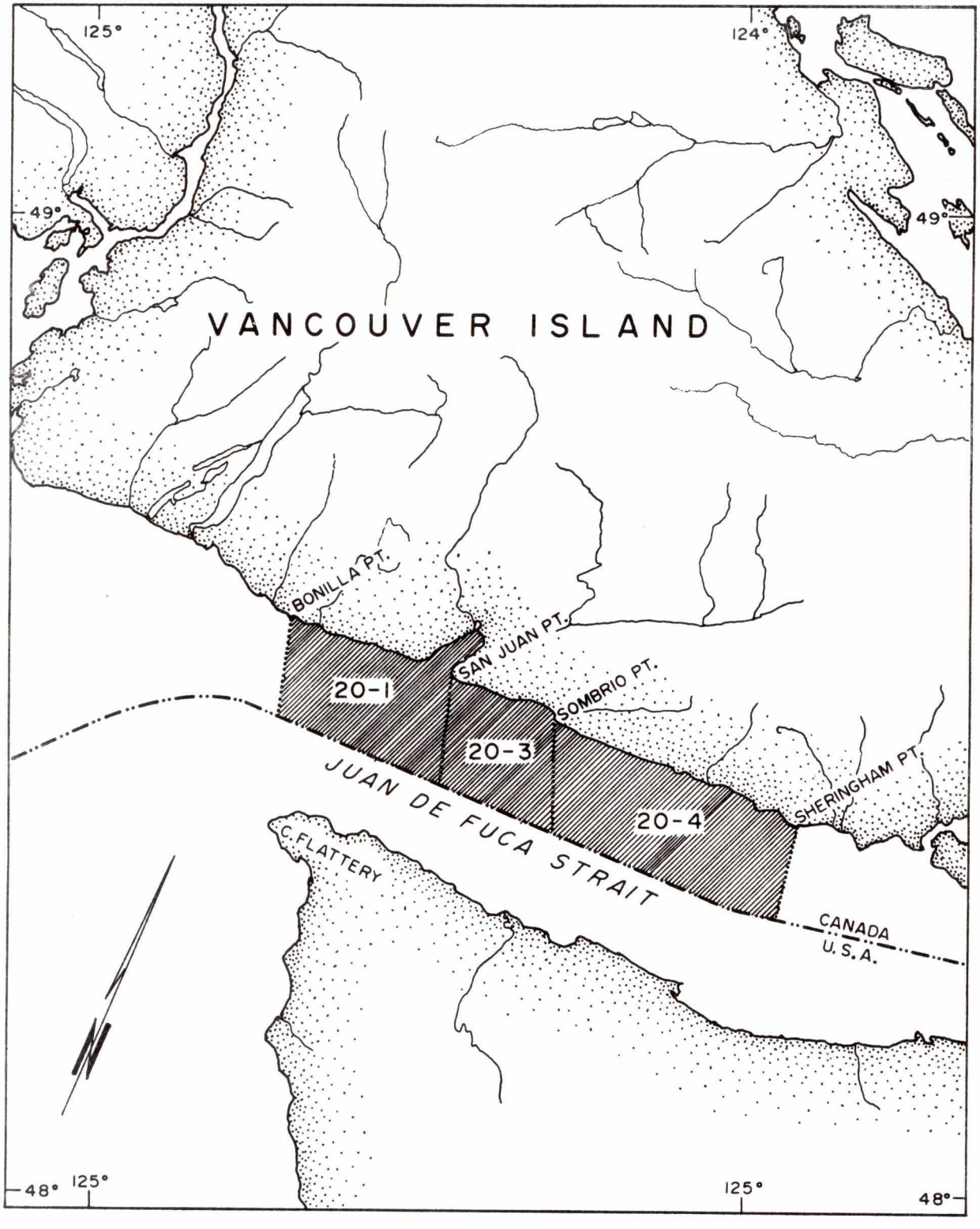


Fig. 2 Study areas in Juan de Fuca Strait sockeye seine fishery.

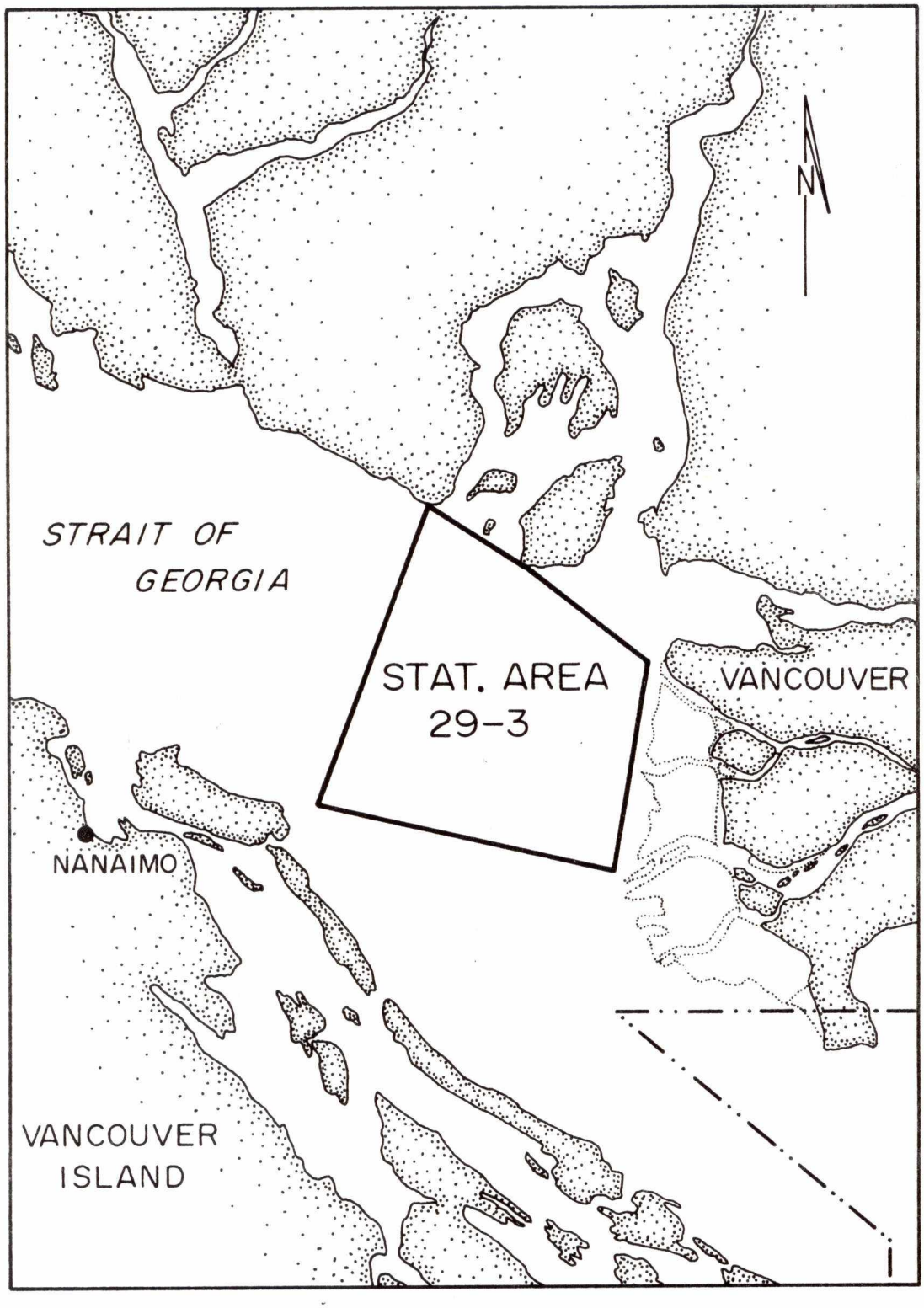
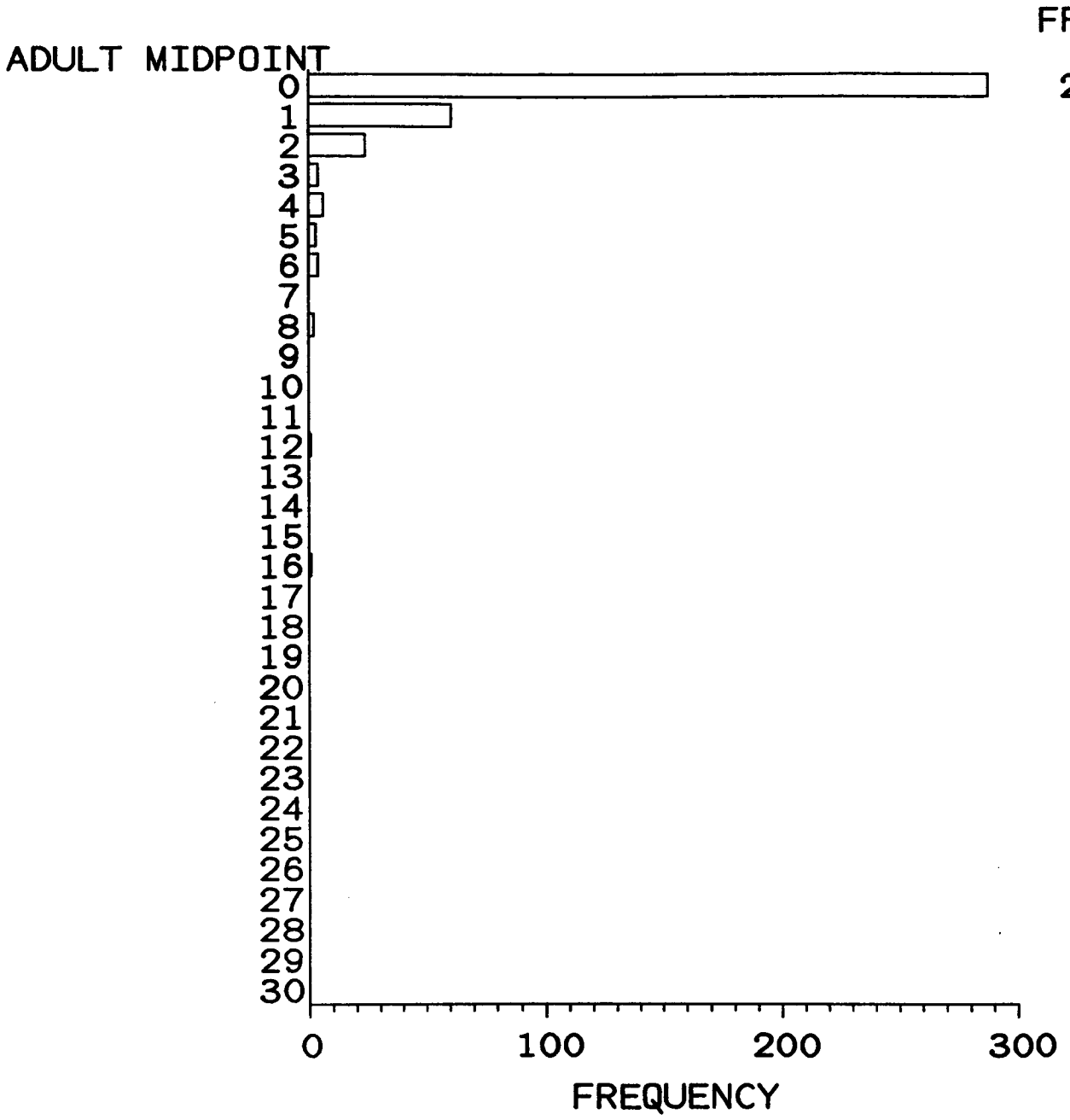
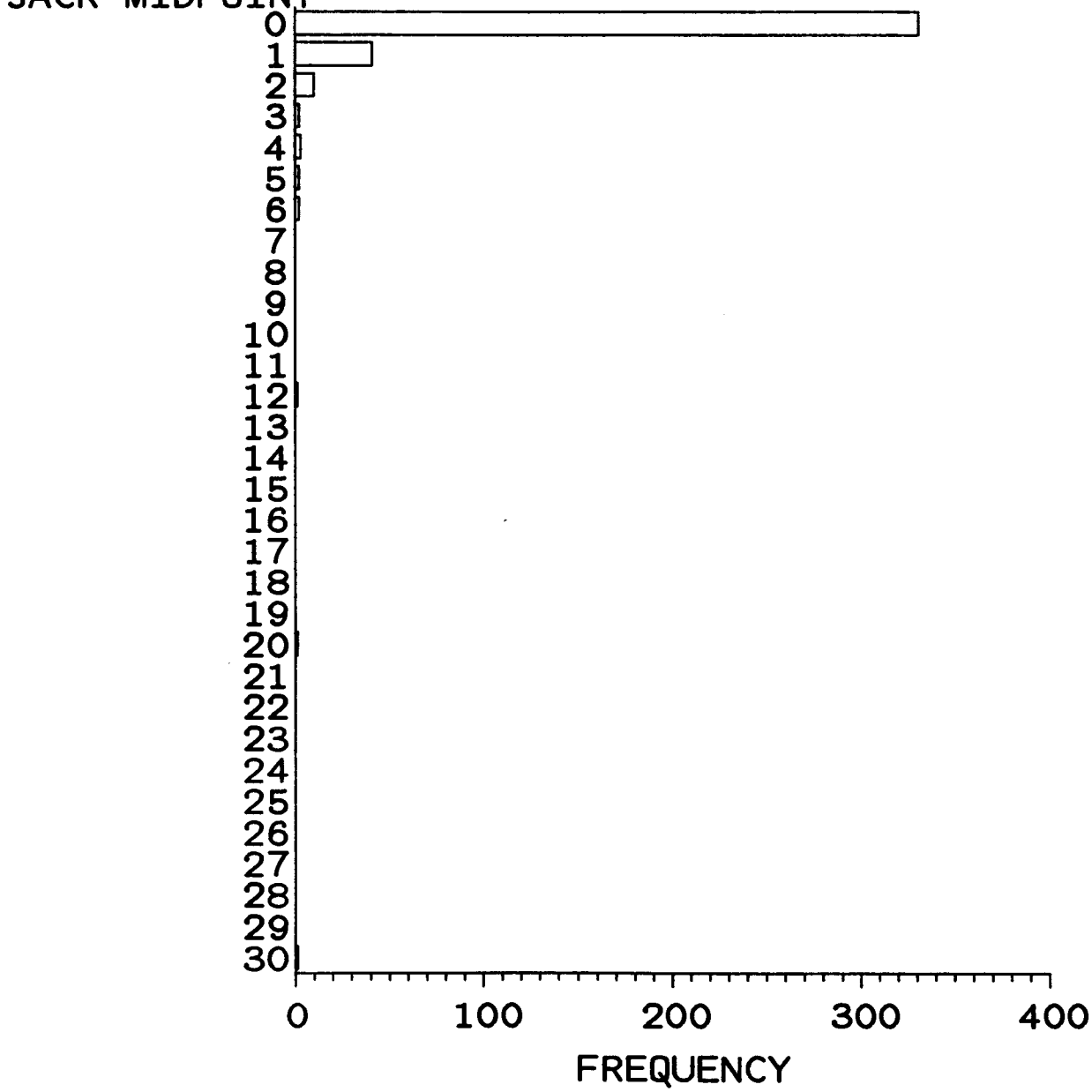


Fig. 3 Study area for Fraser River sockeye seine fishery.



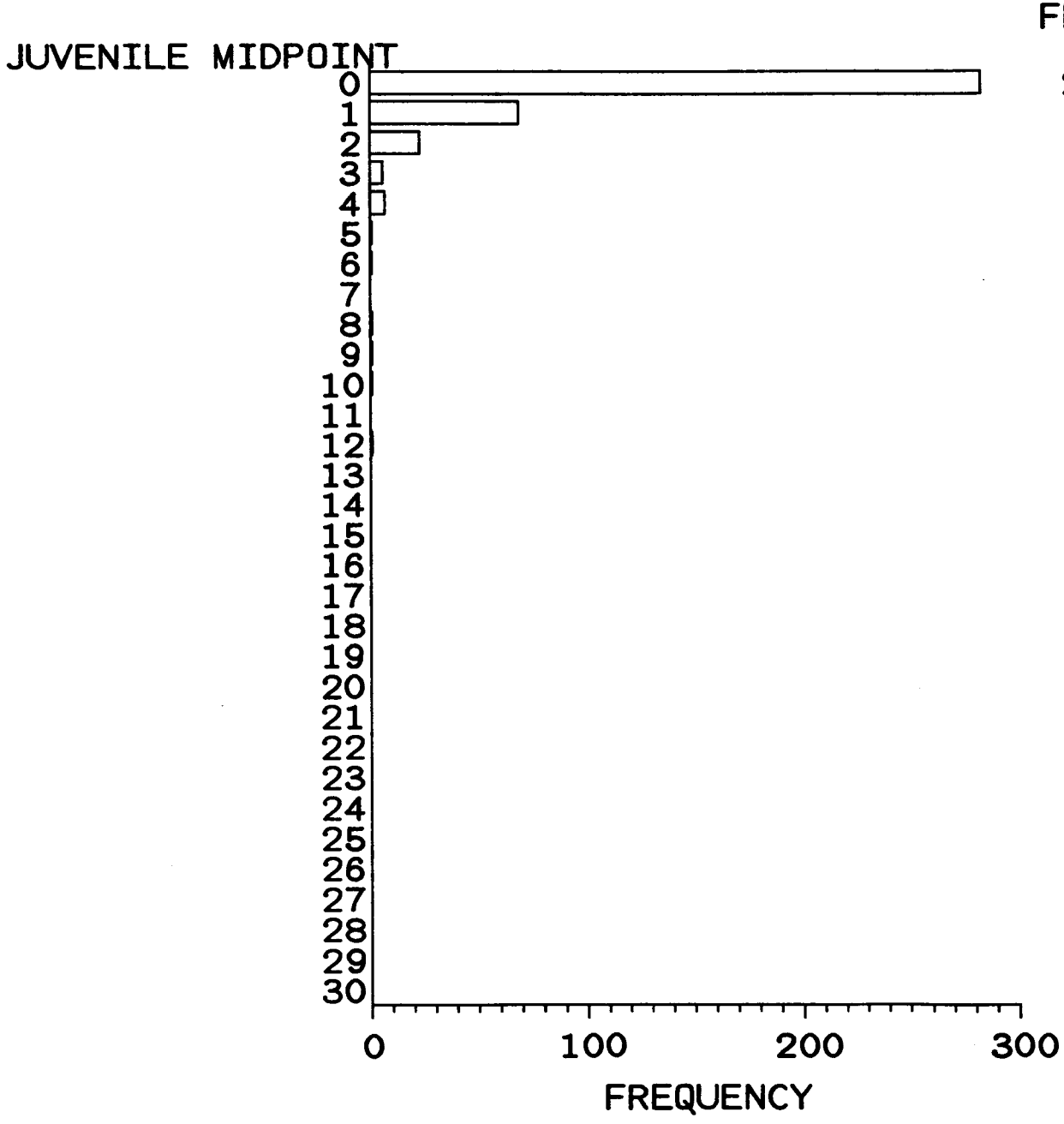
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	288	288	73.10	73.10
1	61	349	15.48	88.58
2	24	373	6.09	94.67
3	4	377	1.02	95.69
4	6	383	1.52	97.21
5	3	386	0.76	97.97
6	4	390	1.02	98.98
7	0	390	0.00	98.98
8	2	392	0.51	99.49
9	0	392	0.00	99.49
10	0	392	0.00	99.49
11	0	392	0.00	99.49
12	1	393	0.25	99.75
13	0	393	0.00	99.75
14	0	393	0.00	99.75
15	0	393	0.00	99.75
16	1	394	0.25	100.00
17	0	394	0.00	100.00
18	0	394	0.00	100.00
19	0	394	0.00	100.00
20	0	394	0.00	100.00
21	0	394	0.00	100.00
22	0	394	0.00	100.00
23	0	394	0.00	100.00
24	0	394	0.00	100.00
25	0	394	0.00	100.00
26	0	394	0.00	100.00
27	0	394	0.00	100.00
28	0	394	0.00	100.00
29	0	394	0.00	100.00
30	0	394	0.00	100.00

Fig.4 Catch/set for adult chinook in Johnstone Strait, 1988



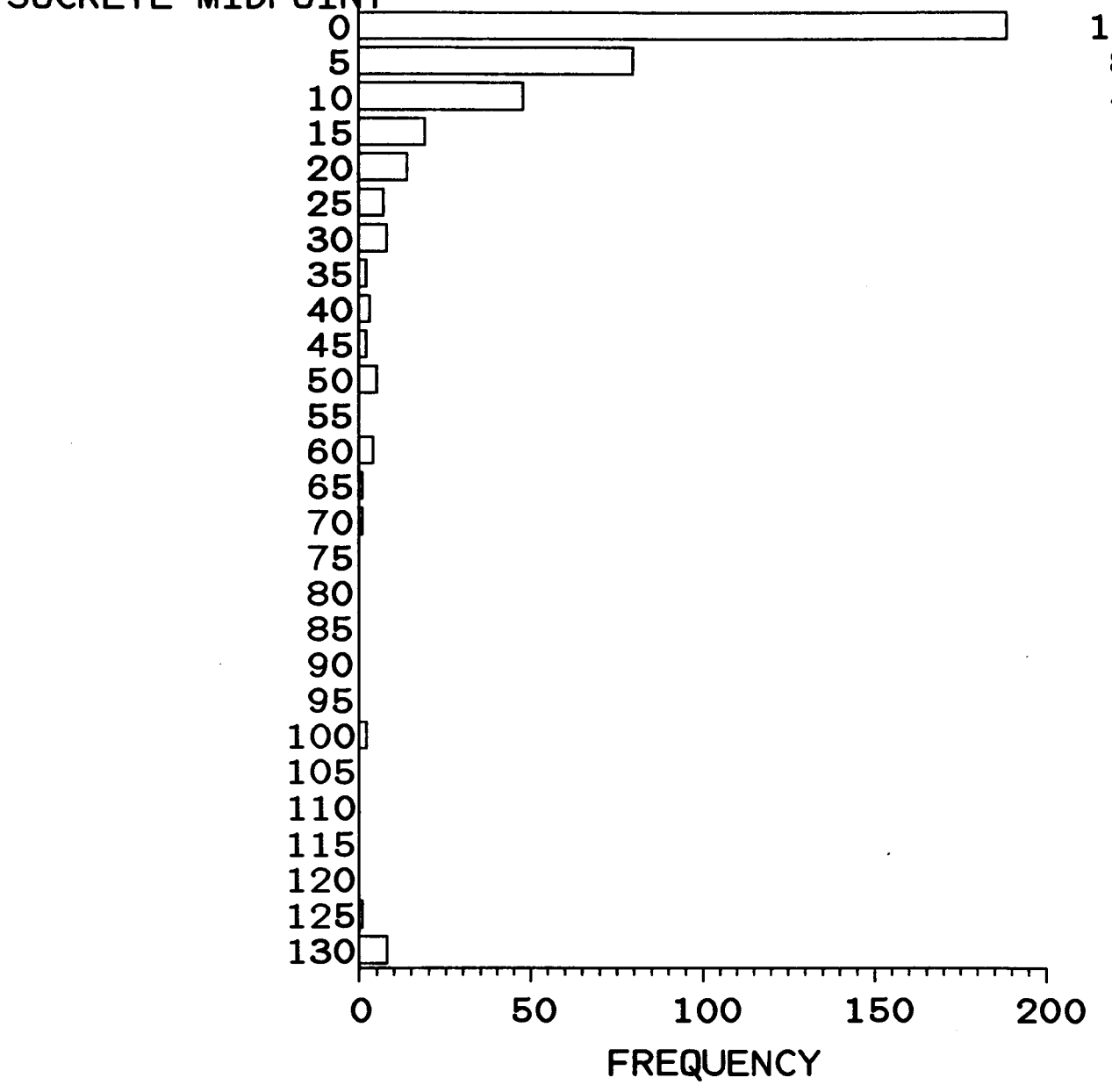
JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	331	331	84.01	84.01
1	41	372	10.41	94.42
2	10	382	2.54	96.95
3	2	384	0.51	97.46
4	3	387	0.76	98.22
5	2	389	0.51	98.73
6	2	391	0.51	99.24
7	0	391	0.00	99.24
8	0	391	0.00	99.24
9	0	391	0.00	99.24
10	0	391	0.00	99.24
11	0	391	0.00	99.24
12	1	392	0.25	99.49
13	0	392	0.00	99.49
14	0	392	0.00	99.49
15	0	392	0.00	99.49
16	0	392	0.00	99.49
17	0	392	0.00	99.49
18	0	392	0.00	99.49
19	0	392	0.00	99.49
20	1	393	0.25	99.75
21	0	393	0.00	99.75
22	0	393	0.00	99.75
23	0	393	0.00	99.75
24	0	393	0.00	99.75
25	0	393	0.00	99.75
26	0	393	0.00	99.75
27	0	393	0.00	99.75
28	0	393	0.00	99.75
29	0	393	0.00	99.75
30	1	394	0.25	100.00

Fig.5 Catch/set for jack chinook in Johnstone Strait, 1988



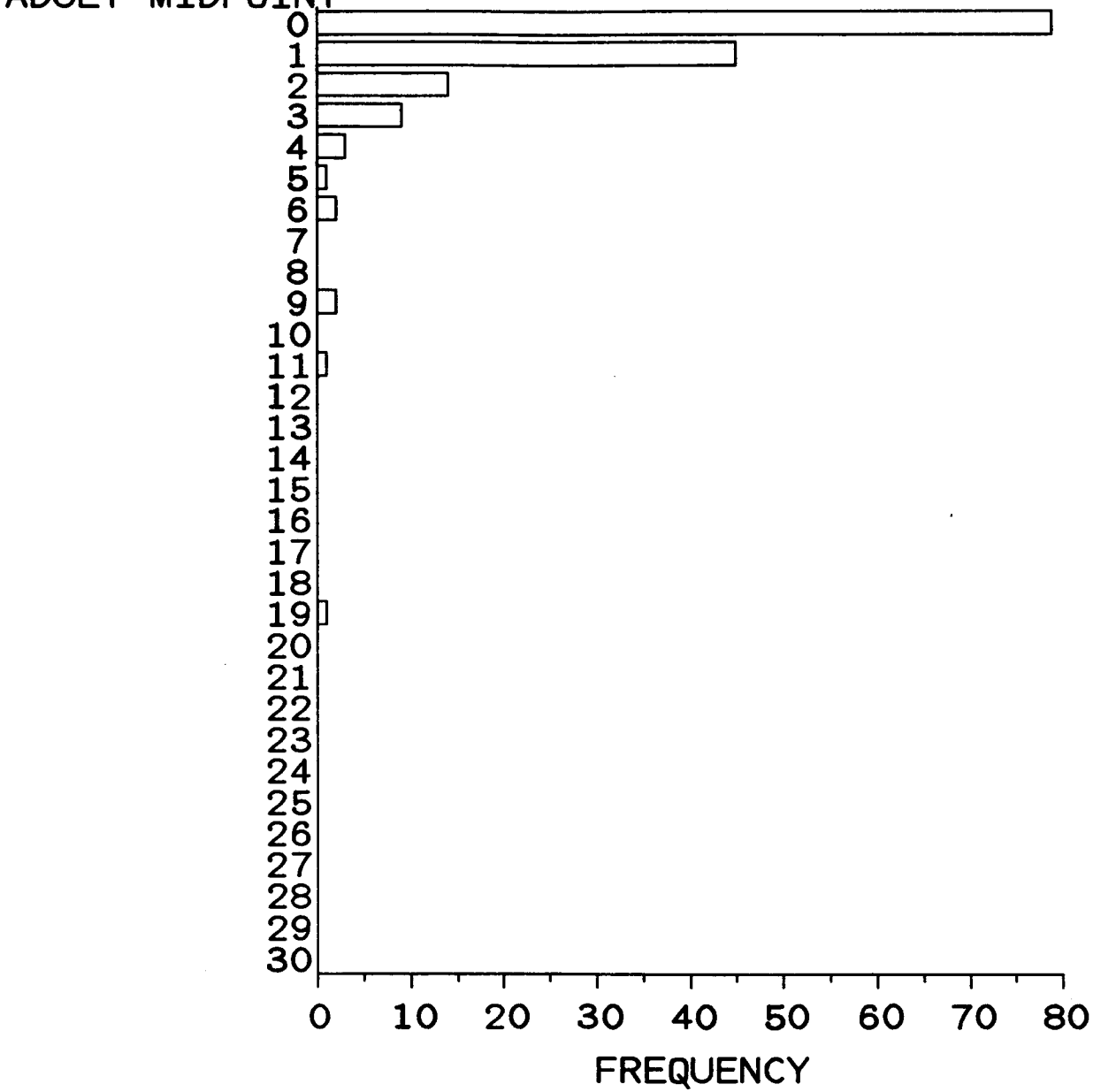
JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	283	283	71.83	71.83
1	69	352	17.51	89.34
2	23	375	5.84	95.18
3	6	381	1.52	96.70
4	7	388	1.78	98.48
5	1	389	0.25	98.73
6	1	390	0.25	98.98
7	0	390	0.00	98.98
8	1	391	0.25	99.24
9	1	392	0.25	99.49
10	1	393	0.25	99.75
11	0	393	0.00	99.75
12	1	394	0.25	100.00
13	0	394	0.00	100.00
14	0	394	0.00	100.00
15	0	394	0.00	100.00
16	0	394	0.00	100.00
17	0	394	0.00	100.00
18	0	394	0.00	100.00
19	0	394	0.00	100.00
20	0	394	0.00	100.00
21	0	394	0.00	100.00
22	0	394	0.00	100.00
23	0	394	0.00	100.00
24	0	394	0.00	100.00
25	0	394	0.00	100.00
26	0	394	0.00	100.00
27	0	394	0.00	100.00
28	0	394	0.00	100.00
29	0	394	0.00	100.00
30	0	394	0.00	100.00

Fig.6 Catch/set for juvenile chinook in Johnstone Strait, 1988



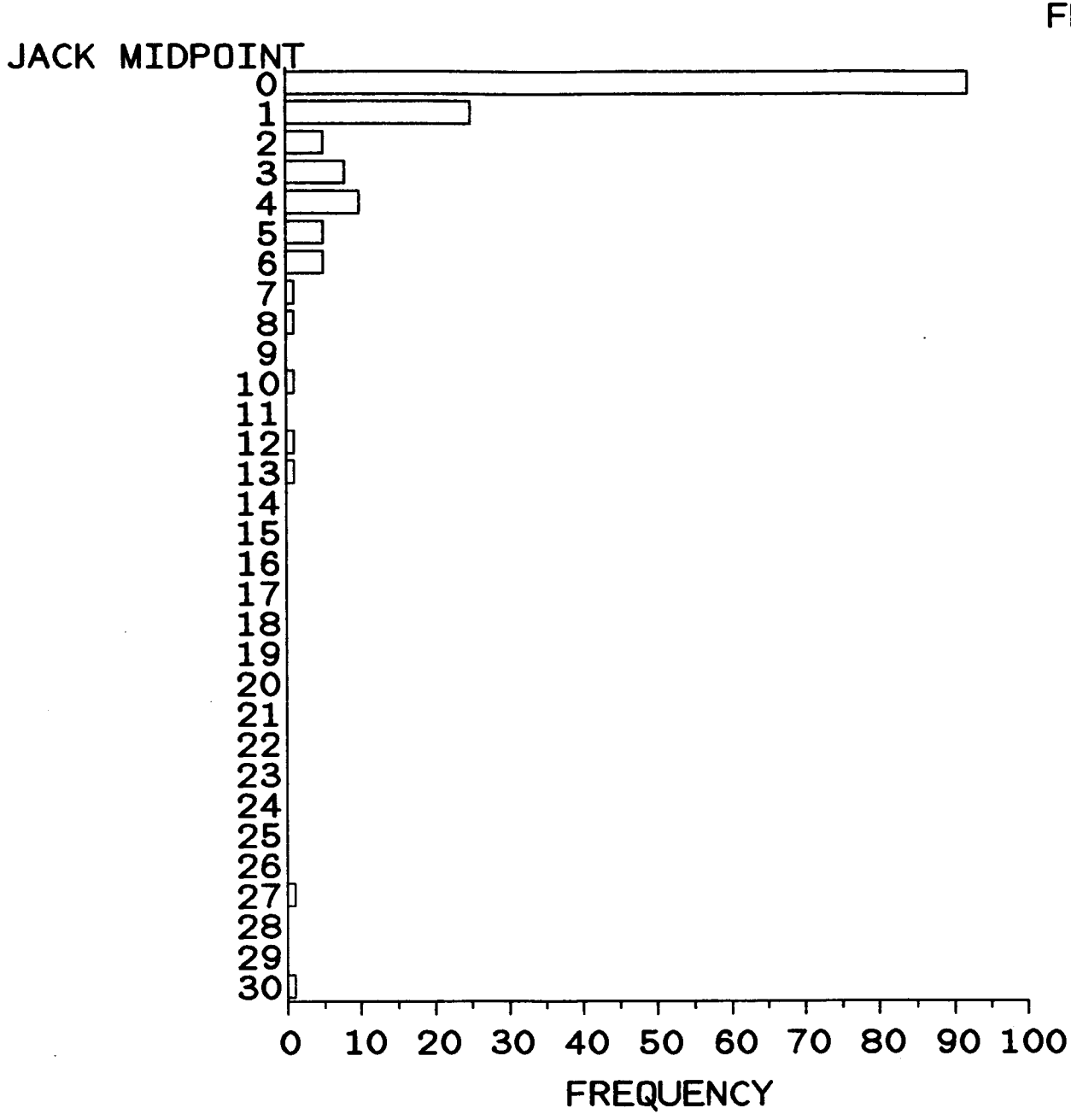
SOCKEYE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	189	189	47.97	47.97
5	80	269	20.30	68.27
10	48	317	12.18	80.46
15	19	336	4.82	85.28
20	14	350	3.55	88.83
25	7	357	1.78	90.61
30	8	365	2.03	92.64
35	2	367	0.51	93.15
40	3	370	0.76	93.91
45	2	372	0.51	94.42
50	5	377	1.27	95.69
55	0	377	0.00	95.69
60	4	381	1.02	96.70
65	1	382	0.25	96.95
70	1	383	0.25	97.21
75	0	383	0.00	97.21
80	0	383	0.00	97.21
85	0	383	0.00	97.21
90	0	383	0.00	97.21
95	0	383	0.00	97.21
100	2	385	0.51	97.72
105	0	385	0.00	97.72
110	0	385	0.00	97.72
115	0	385	0.00	97.72
120	0	385	0.00	97.72
125	1	386	0.25	97.97
130	8	394	2.03	100.00

Fig.7 Catch/set for sockeye in Johnstone Strait, 1988



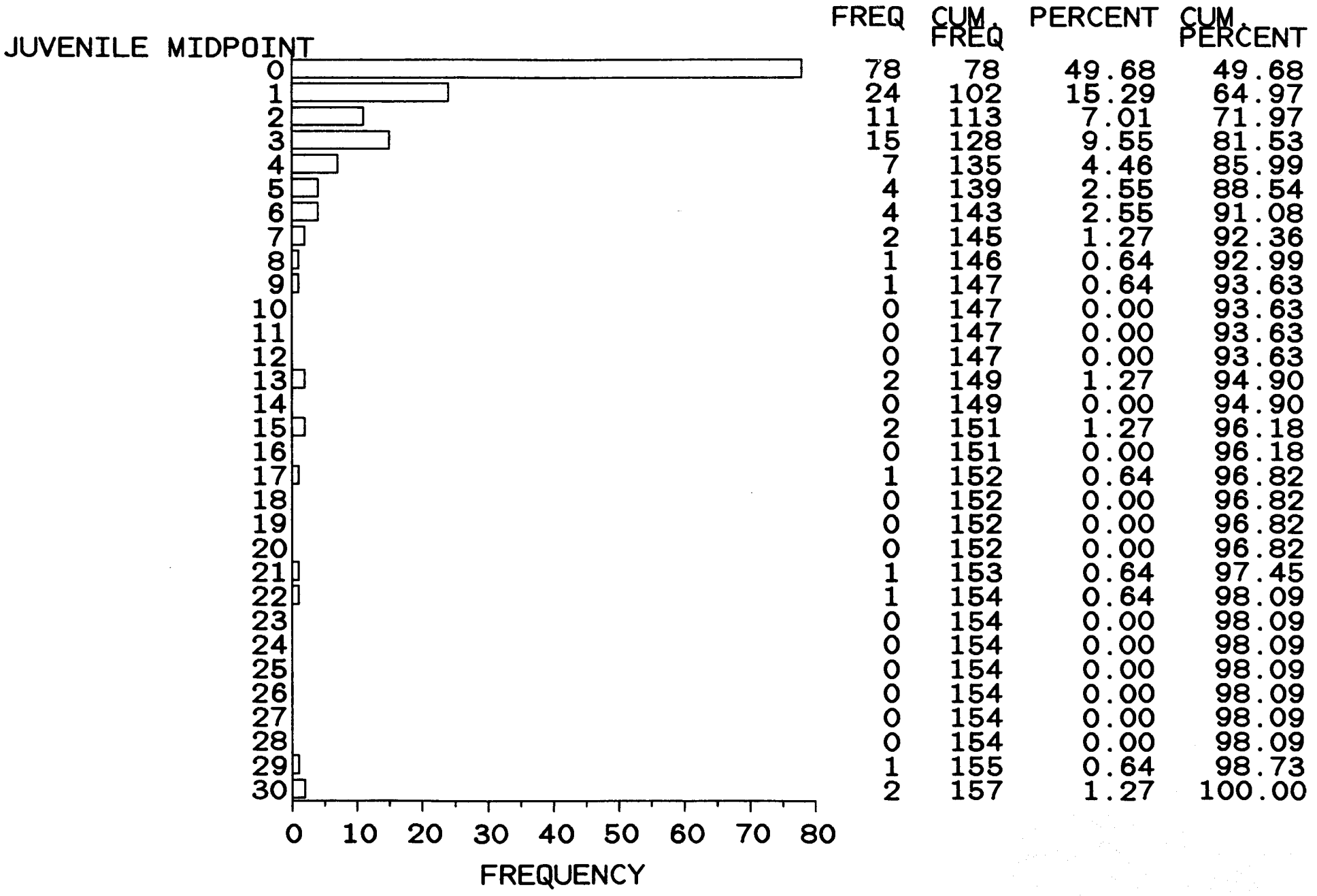
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	79	79	50.32	50.32
1	45	124	28.66	78.98
2	14	138	8.92	87.90
3	9	147	5.73	93.63
4	3	150	1.91	95.54
5	1	151	0.64	96.18
6	2	153	1.27	97.45
7	0	153	0.00	97.45
8	0	153	0.00	97.45
9	2	155	1.27	98.73
10	0	155	0.00	98.73
11	1	156	0.64	99.36
12	0	156	0.00	99.36
13	0	156	0.00	99.36
14	0	156	0.00	99.36
15	0	156	0.00	99.36
16	0	156	0.00	99.36
17	0	156	0.00	99.36
18	0	156	0.00	99.36
19	1	157	0.64	100.00
20	0	157	0.00	100.00
21	0	157	0.00	100.00
22	0	157	0.00	100.00
23	0	157	0.00	100.00
24	0	157	0.00	100.00
25	0	157	0.00	100.00
26	0	157	0.00	100.00
27	0	157	0.00	100.00
28	0	157	0.00	100.00
29	0	157	0.00	100.00
30	0	157	0.00	100.00

Fig.8 Catch/set for adult chinook in Juan de Fuca, 1988



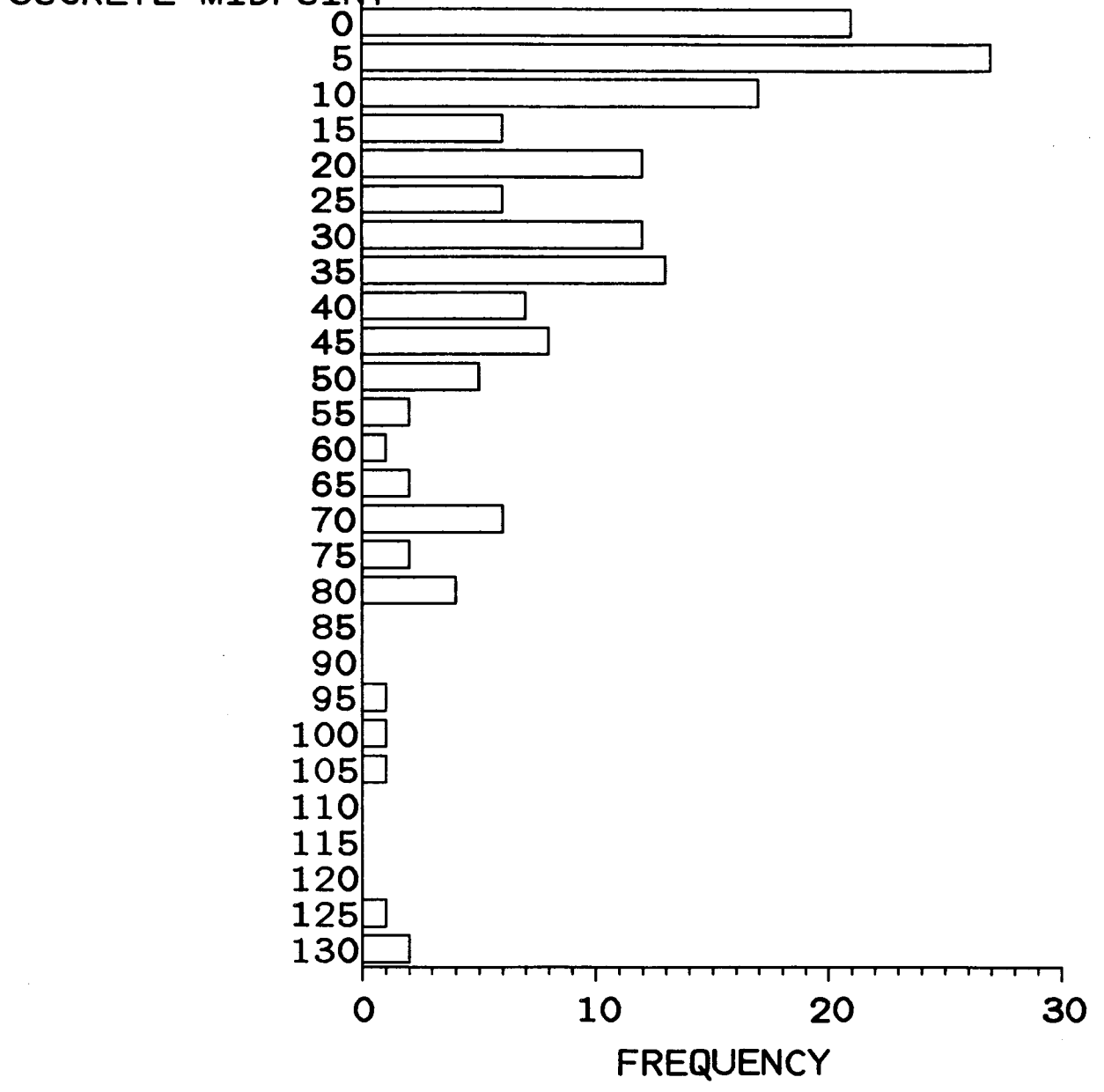
JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	92	92	58.60	58.60
1	25	117	15.92	74.52
2	5	122	3.18	77.71
3	8	130	5.10	82.80
4	10	140	6.37	89.17
5	5	145	3.18	92.36
6	5	150	3.18	95.54
7	1	151	0.64	96.18
8	1	152	0.64	96.82
9	0	152	0.00	96.82
10	1	153	0.64	97.45
11	0	153	0.00	97.45
12	1	154	0.64	98.09
13	1	155	0.64	98.73
14	0	155	0.00	98.73
15	0	155	0.00	98.73
16	0	155	0.00	98.73
17	0	155	0.00	98.73
18	0	155	0.00	98.73
19	0	155	0.00	98.73
20	0	155	0.00	98.73
21	0	155	0.00	98.73
22	0	155	0.00	98.73
23	0	155	0.00	98.73
24	0	155	0.00	98.73
25	0	155	0.00	98.73
26	0	155	0.00	98.73
27	1	156	0.64	99.36
28	0	156	0.00	99.36
29	0	156	0.00	99.36
30	1	157	0.64	100.00

Fig.9 Catch/set for jack chinook in Juan de Fuca, 1988



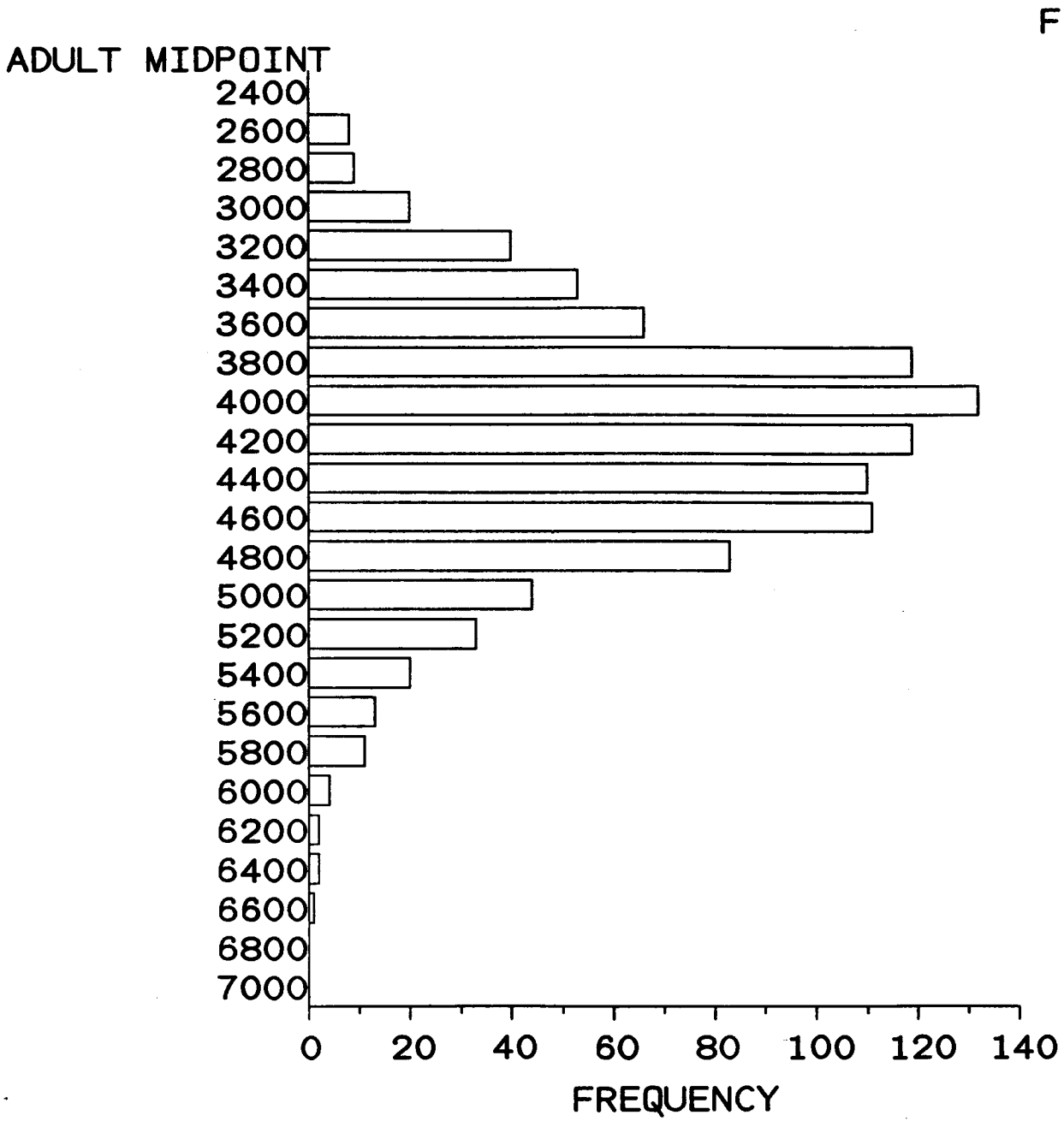
JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	78	78	49.68	49.68
1	24	102	15.29	64.97
2	11	113	7.01	71.97
3	15	128	9.55	81.53
4	7	135	4.46	85.99
5	4	139	2.55	88.54
6	4	143	2.55	91.08
7	2	145	1.27	92.36
8	1	146	0.64	92.99
9	1	147	0.64	93.63
10	0	147	0.00	93.63
11	0	147	0.00	93.63
12	0	147	0.00	93.63
13	2	149	1.27	94.90
14	0	149	0.00	94.90
15	2	151	1.27	96.18
16	0	151	0.00	96.18
17	1	152	0.64	96.82
18	0	152	0.00	96.82
19	0	152	0.00	96.82
20	0	152	0.00	96.82
21	1	153	0.64	97.45
22	1	154	0.64	98.09
23	0	154	0.00	98.09
24	0	154	0.00	98.09
25	0	154	0.00	98.09
26	0	154	0.00	98.09
27	0	154	0.00	98.09
28	0	154	0.00	98.09
29	1	155	0.64	98.73
30	2	157	1.27	100.00

Fig.10 Catch/set for juvenile chinook in Juan de Fuca, 1988



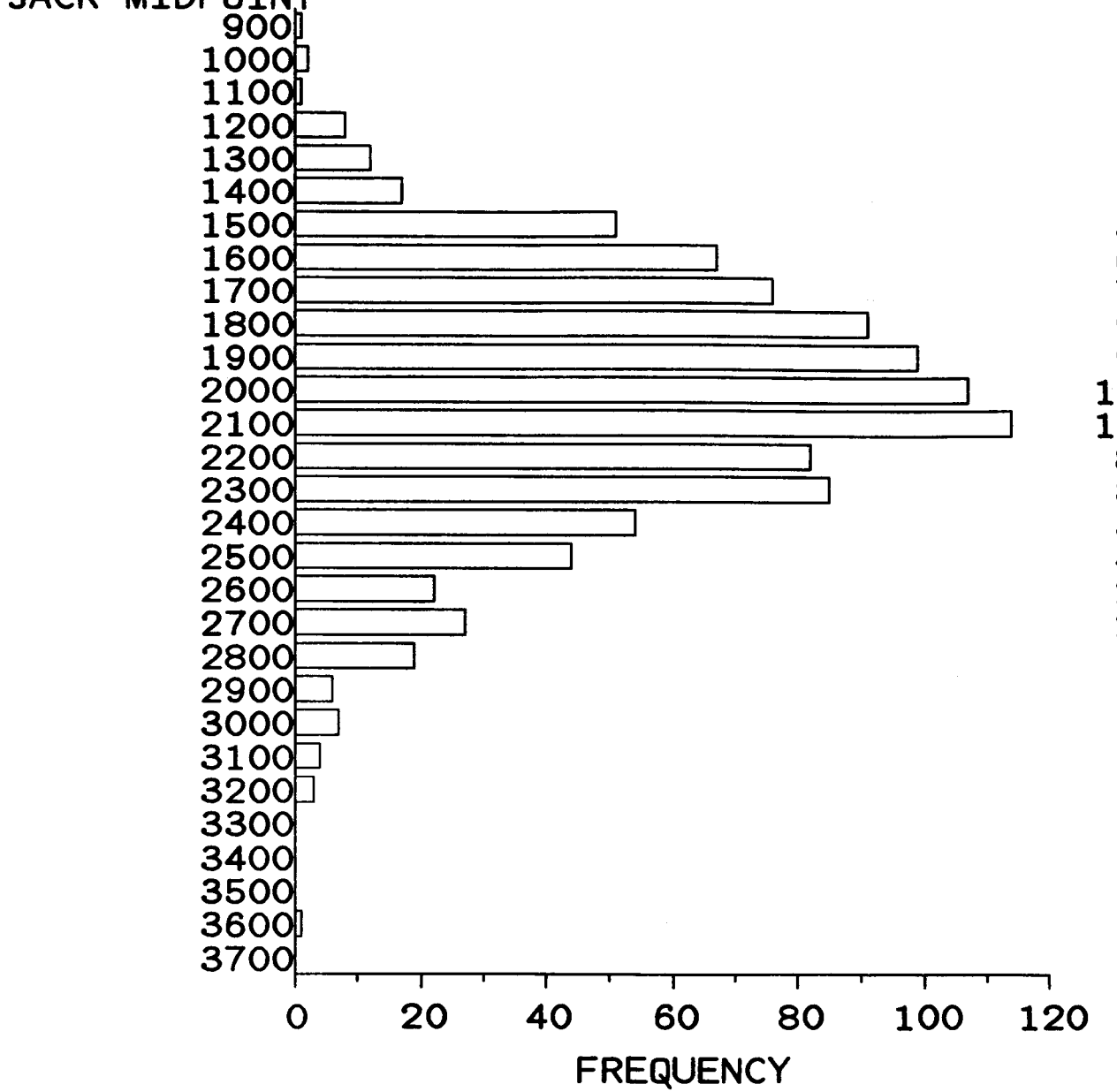
SOCKEYE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	21	21	13.38	13.38
5	27	48	17.20	30.57
10	17	65	10.83	41.40
15	6	71	3.82	45.22
20	12	83	7.64	52.87
25	6	89	3.82	56.69
30	12	101	7.64	64.33
35	13	114	8.28	72.61
40	7	121	4.46	77.07
45	8	129	5.10	82.17
50	5	134	3.18	85.35
55	2	136	1.27	86.62
60	1	137	0.64	87.26
65	2	139	1.27	88.54
70	6	145	3.82	92.36
75	2	147	1.27	93.63
80	4	151	2.55	96.18
85	0	151	0.00	96.18
90	0	151	0.00	96.18
95	1	152	0.64	96.82
100	1	153	0.64	97.45
105	1	154	0.64	98.09
110	0	154	0.00	98.09
115	0	154	0.00	98.09
120	0	154	0.00	98.09
125	1	155	0.64	98.73
130	2	157	1.27	100.00

Fig.11 Catch/set for sockeye in Juan de Fuca, 1988



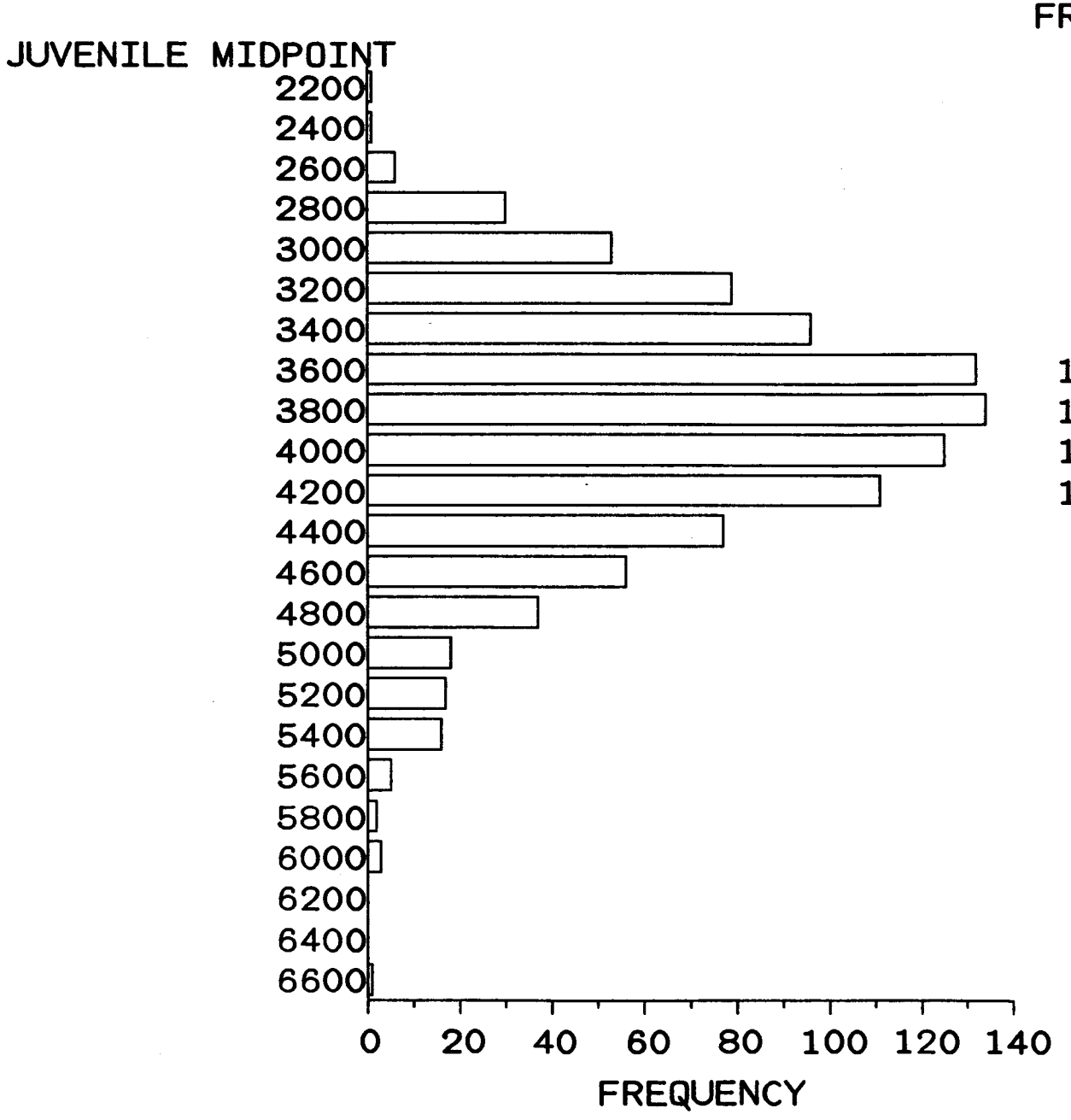
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2400	0	0	0.0	0
2600	8	8	0.8	1
2800	9	17	0.9	2
3000	20	37	2.0	4
3200	40	77	4.0	8
3400	53	130	5.3	13
3600	66	196	6.6	20
3800	119	315	11.9	32
4000	132	447	13.2	45
4200	119	566	11.9	57
4400	110	676	11.0	68
4600	111	787	11.1	79
4800	83	870	8.3	87
5000	44	914	4.4	91
5200	33	947	3.3	95
5400	20	967	2.0	97
5600	13	980	1.3	98
5800	11	991	1.1	99
6000	4	995	0.4	100
6200	2	997	0.2	100
6400	2	999	0.2	100
6600	1	1000	0.1	100
6800	0	1000	0.0	100
7000	0	1000	0.0	100

Fig.12 Bootstrap estimates for adult chinook in Johnstone Strait, 1988



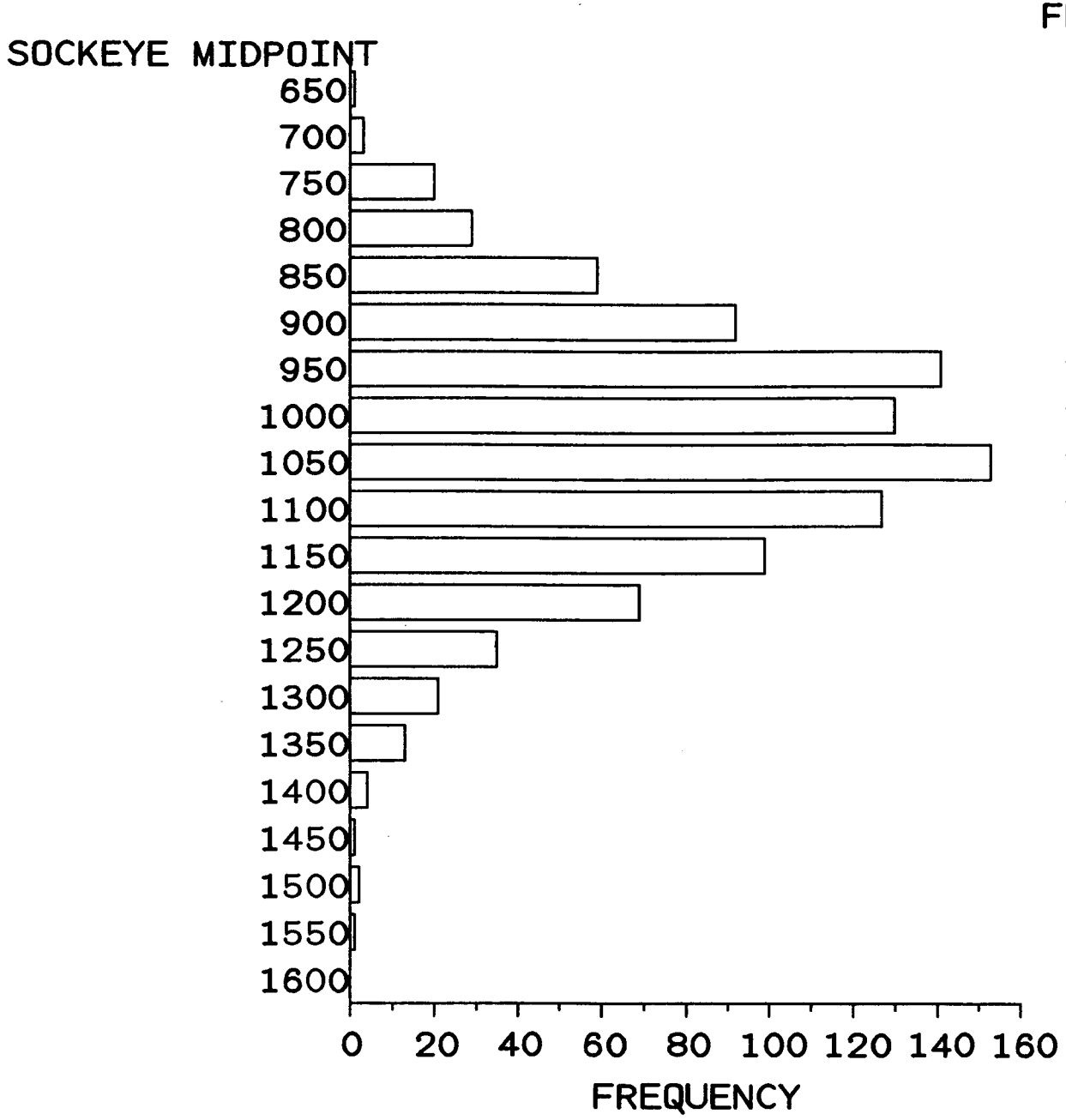
JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
900	1	1	0.1	0.1
1000	2	3	0.2	0.3
1100	1	4	0.1	0.4
1200	8	12	0.8	1.2
1300	12	24	1.2	2.4
1400	17	41	1.7	4.1
1500	51	92	5.1	9.2
1600	67	159	6.7	15.9
1700	76	235	7.6	23.5
1800	91	326	9.1	32.6
1900	99	425	9.9	42.5
2000	107	532	10.7	53.2
2100	114	646	11.4	64.6
2200	82	728	8.2	72.8
2300	85	813	8.5	81.3
2400	54	867	5.4	86.7
2500	44	911	4.4	91.1
2600	22	933	2.2	93.3
2700	27	960	2.7	96.0
2800	19	979	1.9	97.9
2900	6	985	0.6	98.5
3000	7	992	0.7	99.2
3100	4	996	0.4	99.6
3200	3	999	0.3	99.9
3300	0	999	0.0	99.9
3400	0	999	0.0	99.9
3500	0	999	0.0	99.9
3600	1	1000	0.1	100.0
3700	0	1000	0.0	100.0

Fig.13 Bootstrap estimates for jack chinook in Johnstone Strait, 1988



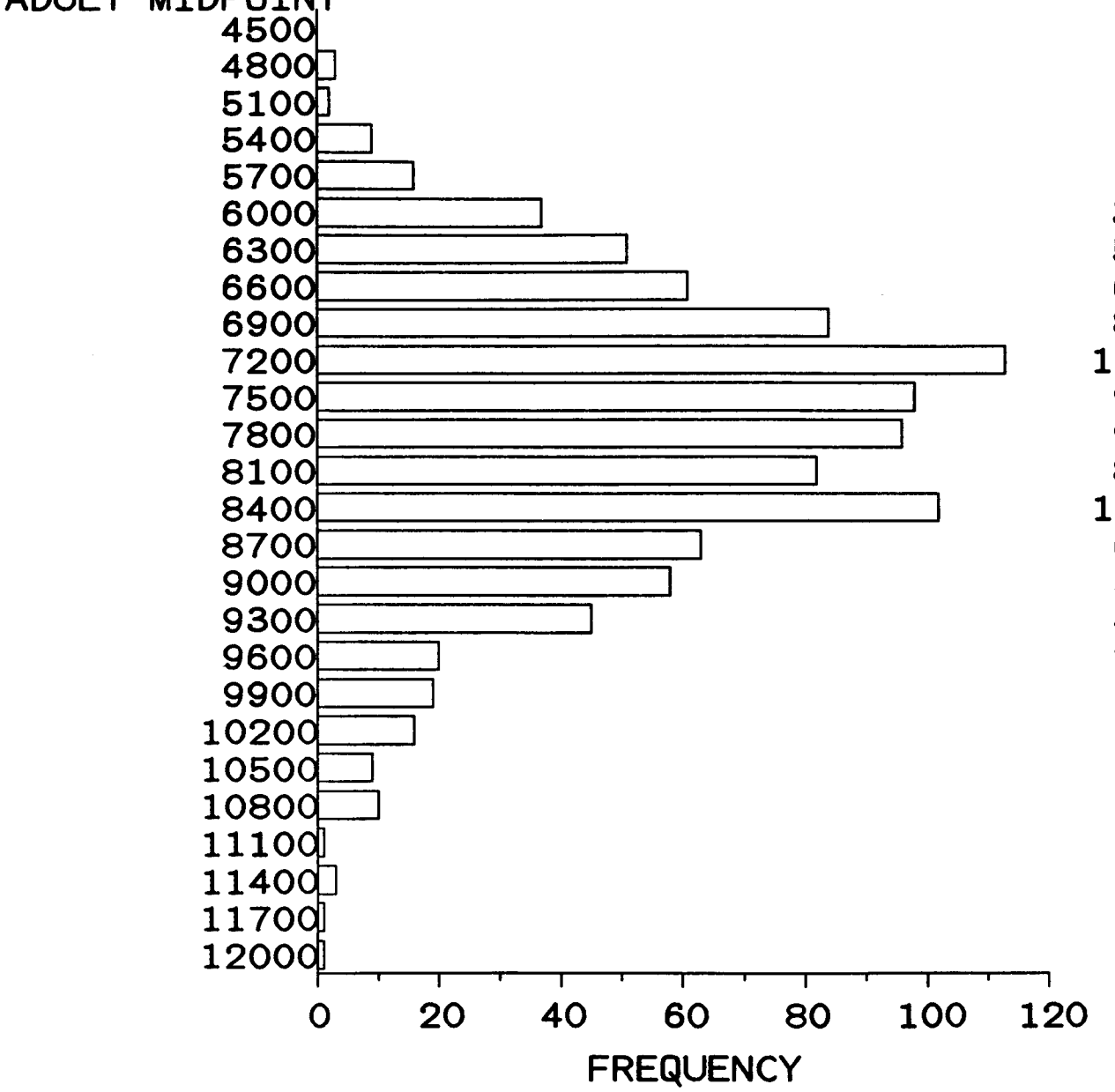
JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2200	1	1	0.1	0.1
2400	1	2	0.1	0.2
2600	6	8	0.6	0.8
2800	30	38	3.0	3.8
3000	53	91	5.3	9.1
3200	79	170	7.9	17.0
3400	96	266	9.6	26.6
3600	132	398	13.2	39.8
3800	134	532	13.4	53.2
4000	125	657	12.5	65.7
4200	111	768	11.1	76.8
4400	77	845	7.7	84.5
4600	56	901	5.6	90.1
4800	37	938	3.7	93.8
5000	18	956	1.8	95.6
5200	17	973	1.7	97.3
5400	16	989	1.6	98.9
5600	5	994	0.5	99.4
5800	2	996	0.2	99.6
6000	3	999	0.3	99.9
6200	0	999	0.0	99.9
6400	0	999	0.0	99.9
6600	1	1000	0.1	100.0

Fig.14 Bootstrap estimates for juvenile chinook in Johnstone Strait, 198



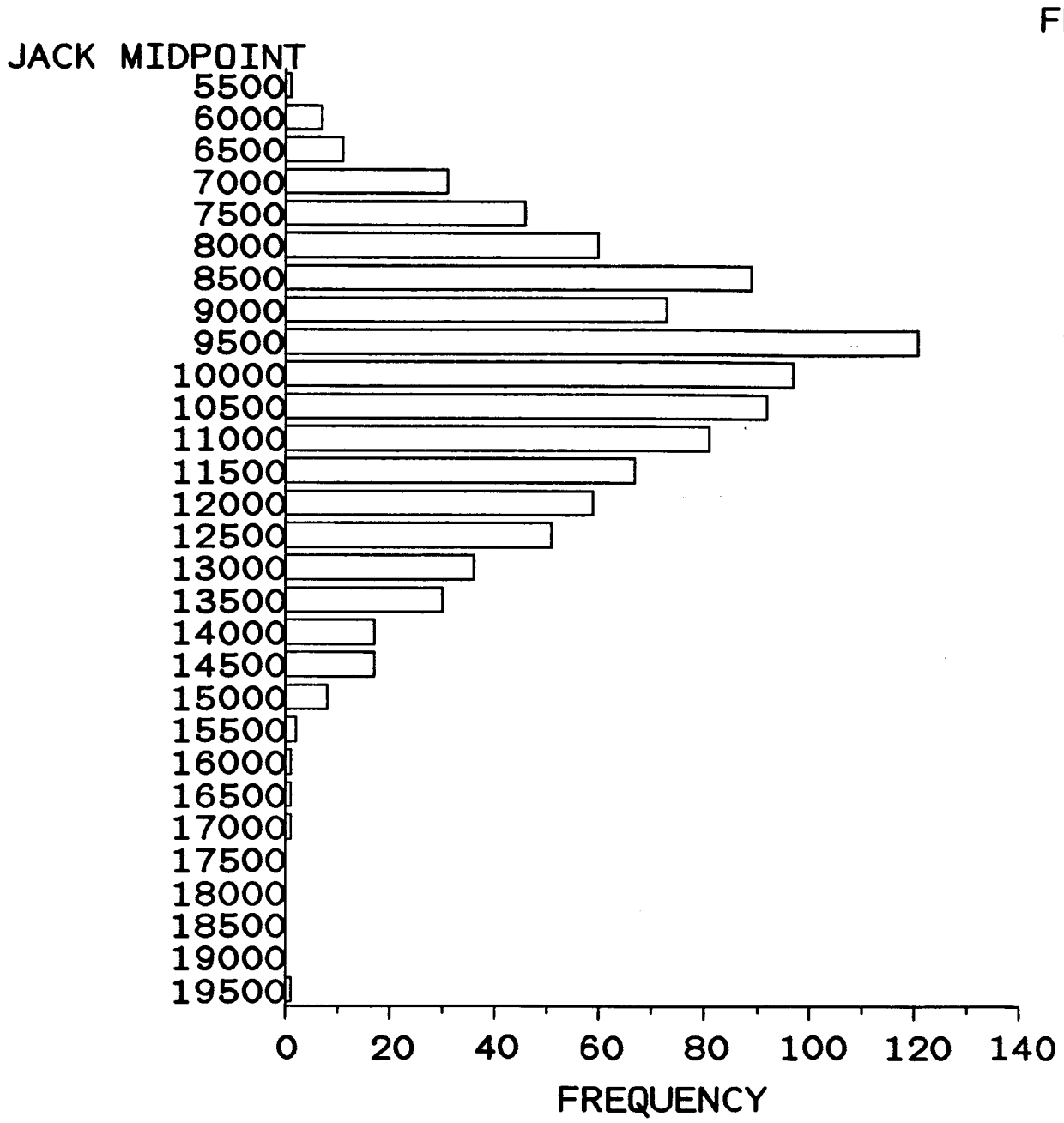
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
650	1	1	0.1	0.1
700	3	4	0.3	0.4
750	20	24	2.0	2.4
800	29	53	2.9	5.3
850	59	112	5.9	11.2
900	92	204	9.2	20.4
950	141	345	14.1	34.5
1000	130	475	13.0	47.5
1050	153	628	15.3	62.8
1100	127	755	12.7	75.5
1150	99	854	9.9	85.4
1200	69	923	6.9	92.3
1250	35	958	3.5	95.8
1300	21	979	2.1	97.9
1350	13	992	1.3	99.2
1400	4	996	0.4	99.6
1450	1	997	0.1	99.7
1500	2	999	0.2	99.9
1550	1	1000	0.1	100.0
1600	0	1000	0.0	100.0

Fig.15 Bootstrap estimates for sockeye in Johnstone Strait, 1988



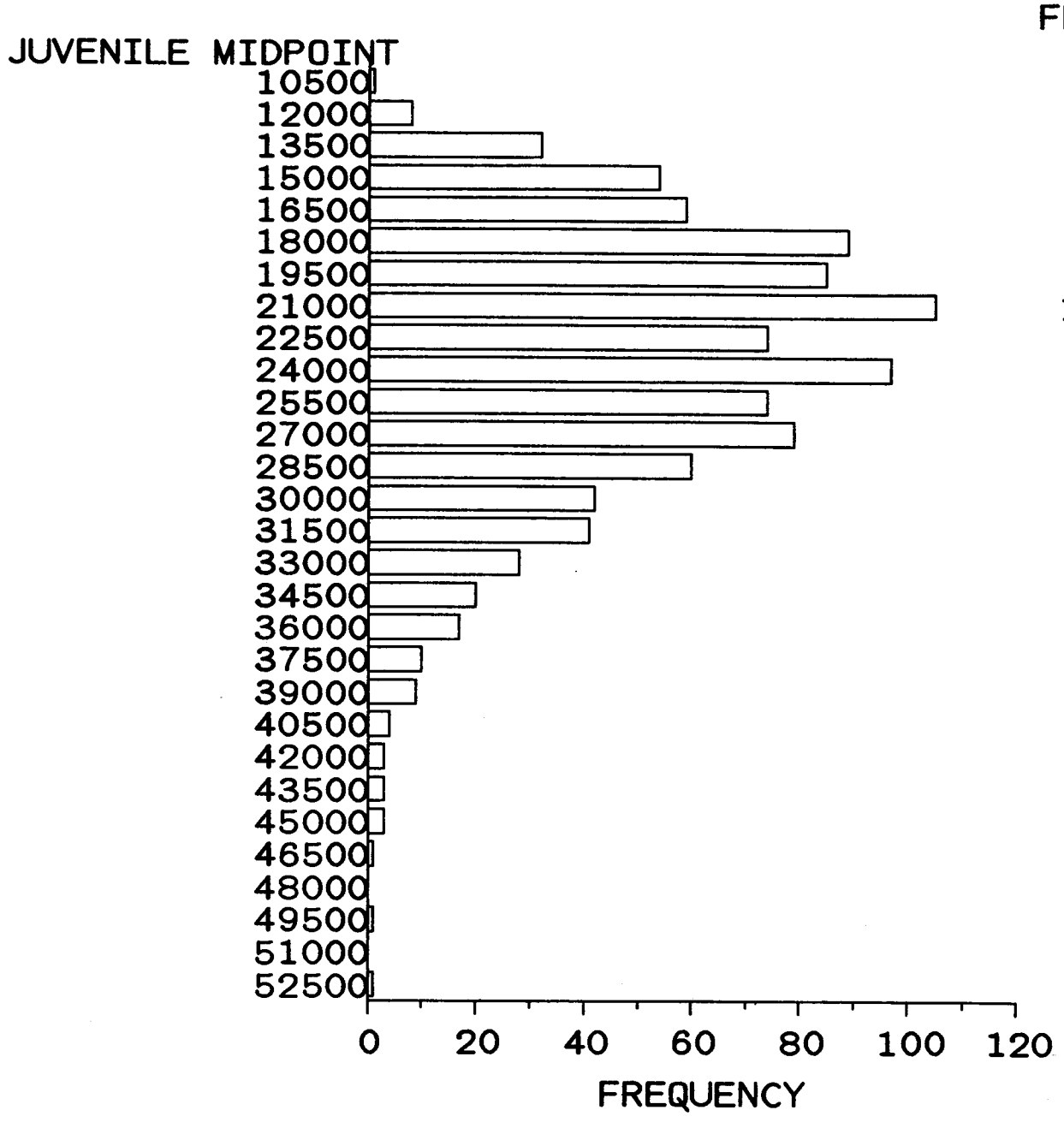
ADULT MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4500	0	0	0.0	0
4800	3	3	0.3	0
5100	2	5	0.2	1
5400	9	14	0.9	1
5700	16	30	1.6	3
6000	37	67	3.7	7
6300	51	118	5.1	12
6600	61	179	6.1	18
6900	84	263	8.4	26
7200	113	376	11.3	38
7500	98	474	9.8	47
7800	96	570	9.6	57
8100	82	652	8.2	65
8400	102	754	10.2	75
8700	63	817	6.3	82
9000	58	875	5.8	88
9300	45	920	4.5	92
9600	20	940	2.0	94
9900	19	959	1.9	96
10200	16	975	1.6	98
10500	9	984	0.9	98
10800	10	994	1.0	99
11100	1	995	0.1	100
11400	3	998	0.3	100
11700	1	999	0.1	100
12000	1	1000	0.1	100

Fig.16 Bootstrap estimates for adult chinook in Juan de Fuca, 1988



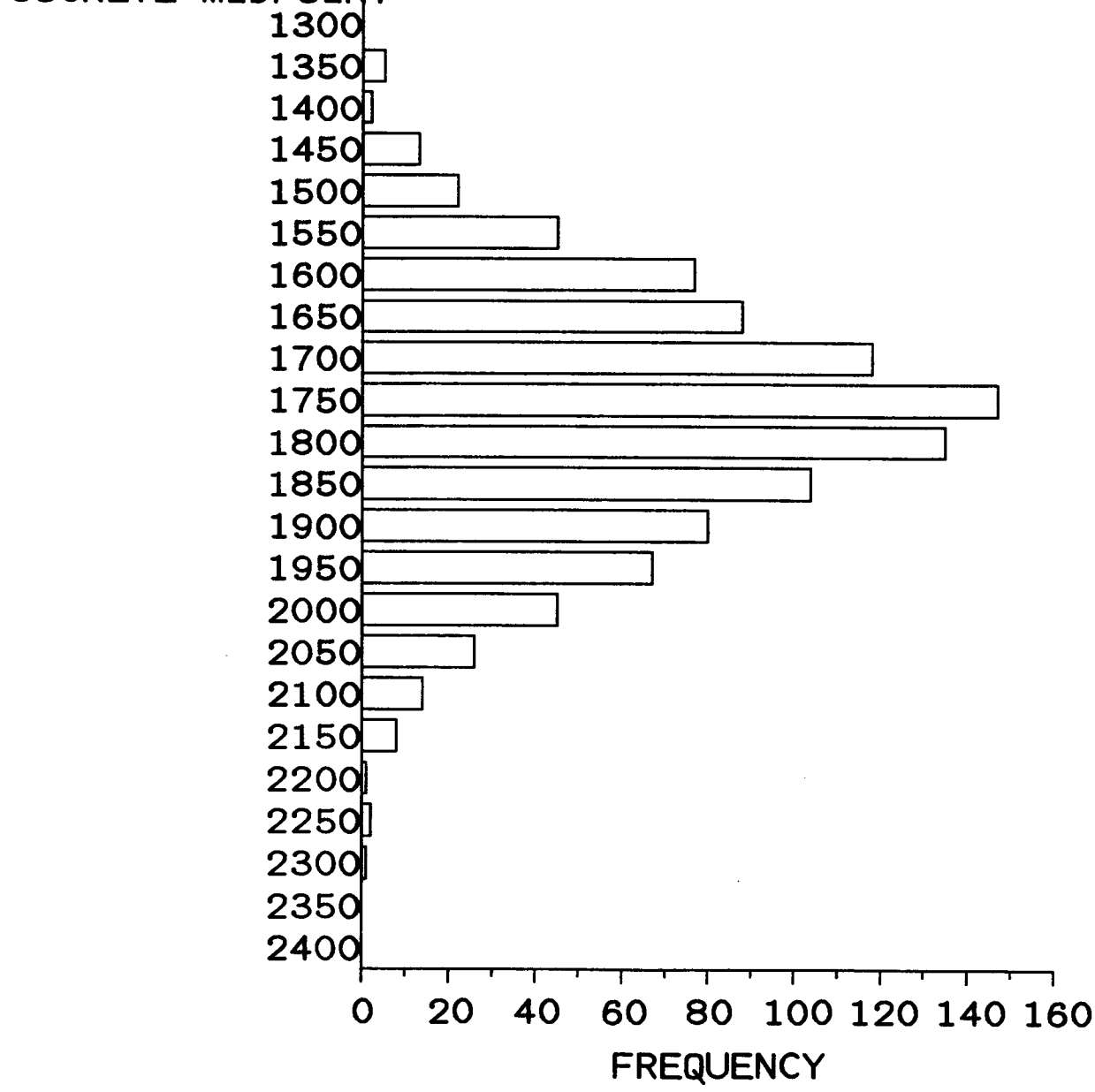
JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5500	1	1	0.1	0.1
6000	7	8	0.7	0.8
6500	11	19	1.1	1.9
7000	31	50	3.1	5.0
7500	46	96	4.6	9.6
8000	60	156	6.0	15.6
8500	89	245	8.9	24.5
9000	73	318	7.3	31.8
9500	121	439	12.1	43.9
10000	97	536	9.7	53.6
10500	92	628	9.2	62.8
11000	81	709	8.1	70.9
11500	67	776	6.7	77.6
12000	59	835	5.9	83.5
12500	51	886	5.1	88.6
13000	36	922	3.6	92.2
13500	30	952	3.0	95.2
14000	17	969	1.7	96.9
14500	17	986	1.7	98.6
15000	8	994	0.8	99.4
15500	2	996	0.2	99.6
16000	1	997	0.1	99.7
16500	1	998	0.1	99.8
17000	1	999	0.1	99.9
17500	0	999	0.0	99.9
18000	0	999	0.0	99.9
18500	0	999	0.0	99.9
19000	0	999	0.0	99.9
19500	1	1000	0.1	100.0

Fig.17 Bootstrap estimates for jack chinook in Juan de Fuca, 1988



JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
10500	1	1	0.1	0.1
12000	8	9	0.8	0.9
13500	32	41	3.2	4.1
15000	54	95	5.4	9.5
16500	59	154	5.9	15.4
18000	89	243	8.9	24.3
19500	85	328	8.5	32.8
21000	105	433	10.5	43.3
22500	74	507	7.4	50.7
24000	97	604	9.7	60.4
25500	74	678	7.4	67.8
27000	79	757	7.9	75.7
28500	60	817	6.0	81.7
30000	42	859	4.2	85.9
31500	41	900	4.1	90.0
33000	28	928	2.8	92.8
34500	20	948	2.0	94.8
36000	17	965	1.7	96.5
37500	10	975	1.0	97.5
39000	9	984	0.9	98.4
40500	4	988	0.4	98.8
42000	3	991	0.3	99.1
43500	3	994	0.3	99.4
45000	3	997	0.3	99.7
46500	1	998	0.1	99.8
48000	0	998	0.0	99.8
49500	1	999	0.1	99.9
51000	0	999	0.0	99.9
52500	1	1000	0.1	100.0

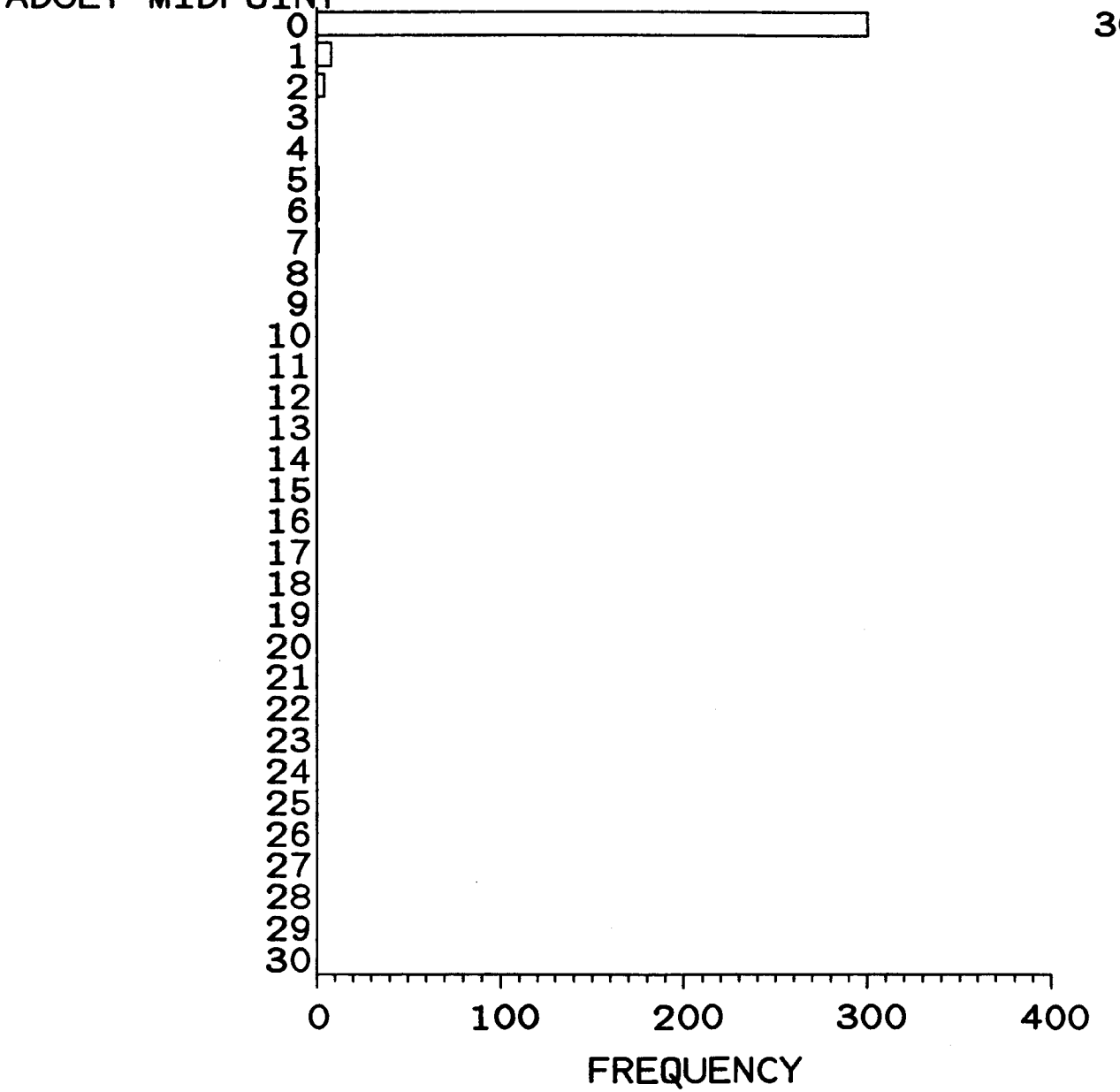
Fig.18 Bootstrap estimates for juvenile chinook in Juan de Fuca, 1988



SOCKEYE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1300	0	0	0.0	0
1350	5	5	0.5	1
1400	2	7	0.2	1
1450	13	20	1.3	2
1500	22	42	2.2	4
1550	45	87	4.5	9
1600	77	164	7.7	16
1650	88	252	8.8	25
1700	118	370	11.8	37
1750	147	517	14.7	52
1800	135	652	13.5	65
1850	104	756	10.4	76
1900	80	836	8.0	84
1950	67	903	6.7	90
2000	45	948	4.5	95
2050	26	974	2.6	97
2100	14	988	1.4	99
2150	8	996	0.8	100
2200	1	997	0.1	100
2250	2	999	0.2	100
2300	1	1000	0.1	100
2350	0	1000	0.0	100
2400	0	1000	0.0	100

Fig.19 Bootstrap estimates for sockeye in Juan de Fuca, 1988

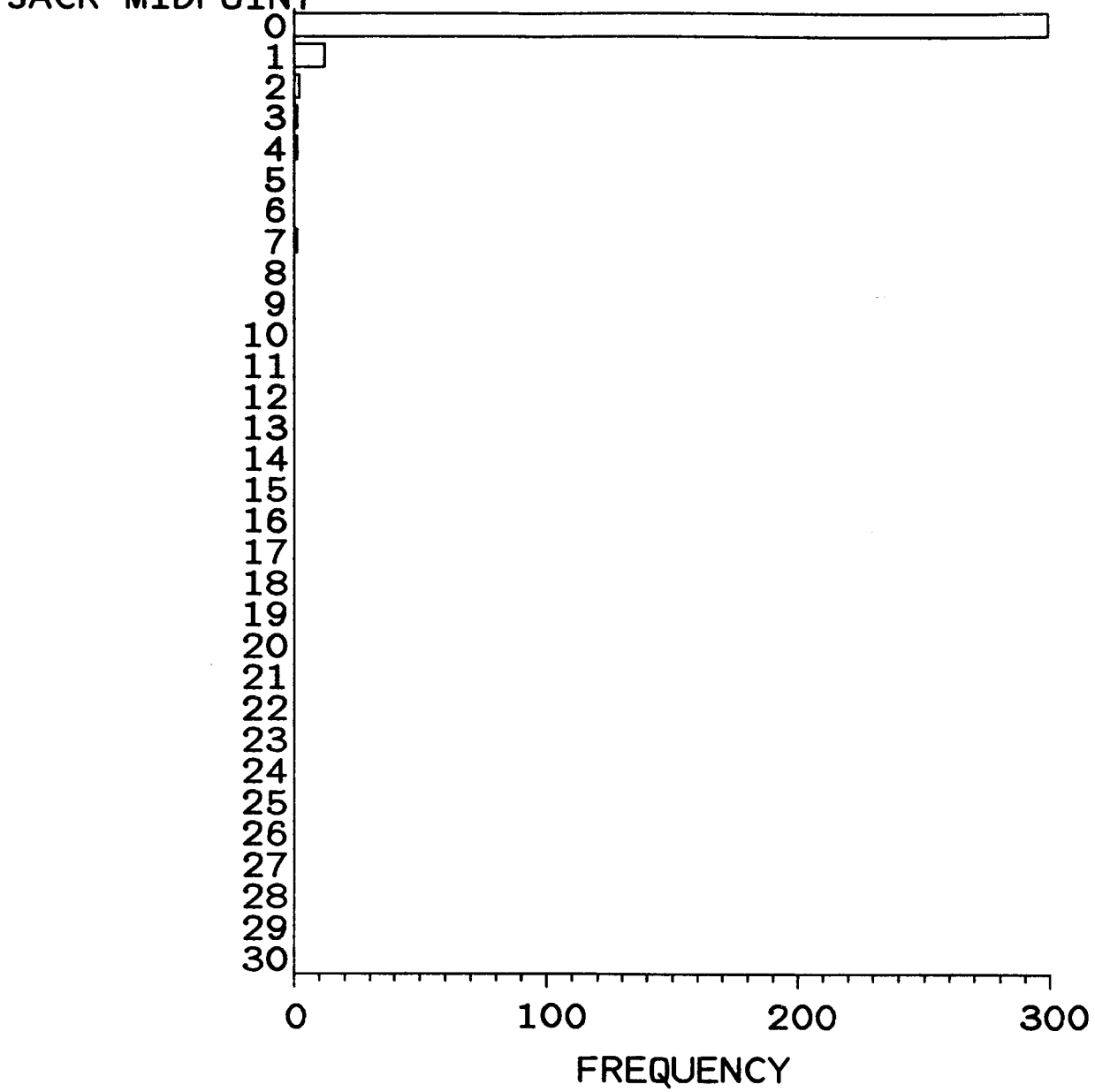
Chum Fishery



	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	301	301	95.25	95.25
1	8	309	2.53	97.78
2	4	313	1.27	99.05
3	0	313	0.00	99.05
4	0	313	0.00	99.05
5	1	314	0.32	99.37
6	1	315	0.32	99.68
7	1	316	0.32	100.00
8	0	316	0.00	100.00
9	0	316	0.00	100.00
10	0	316	0.00	100.00
11	0	316	0.00	100.00
12	0	316	0.00	100.00
13	0	316	0.00	100.00
14	0	316	0.00	100.00
15	0	316	0.00	100.00
16	0	316	0.00	100.00
17	0	316	0.00	100.00
18	0	316	0.00	100.00
19	0	316	0.00	100.00
20	0	316	0.00	100.00
21	0	316	0.00	100.00
22	0	316	0.00	100.00
23	0	316	0.00	100.00
24	0	316	0.00	100.00
25	0	316	0.00	100.00
26	0	316	0.00	100.00
27	0	316	0.00	100.00
28	0	316	0.00	100.00
29	0	316	0.00	100.00
30	0	316	0.00	100.00

Fig.20 Catch/set for adult chinook in Johnstone Strait, 1988

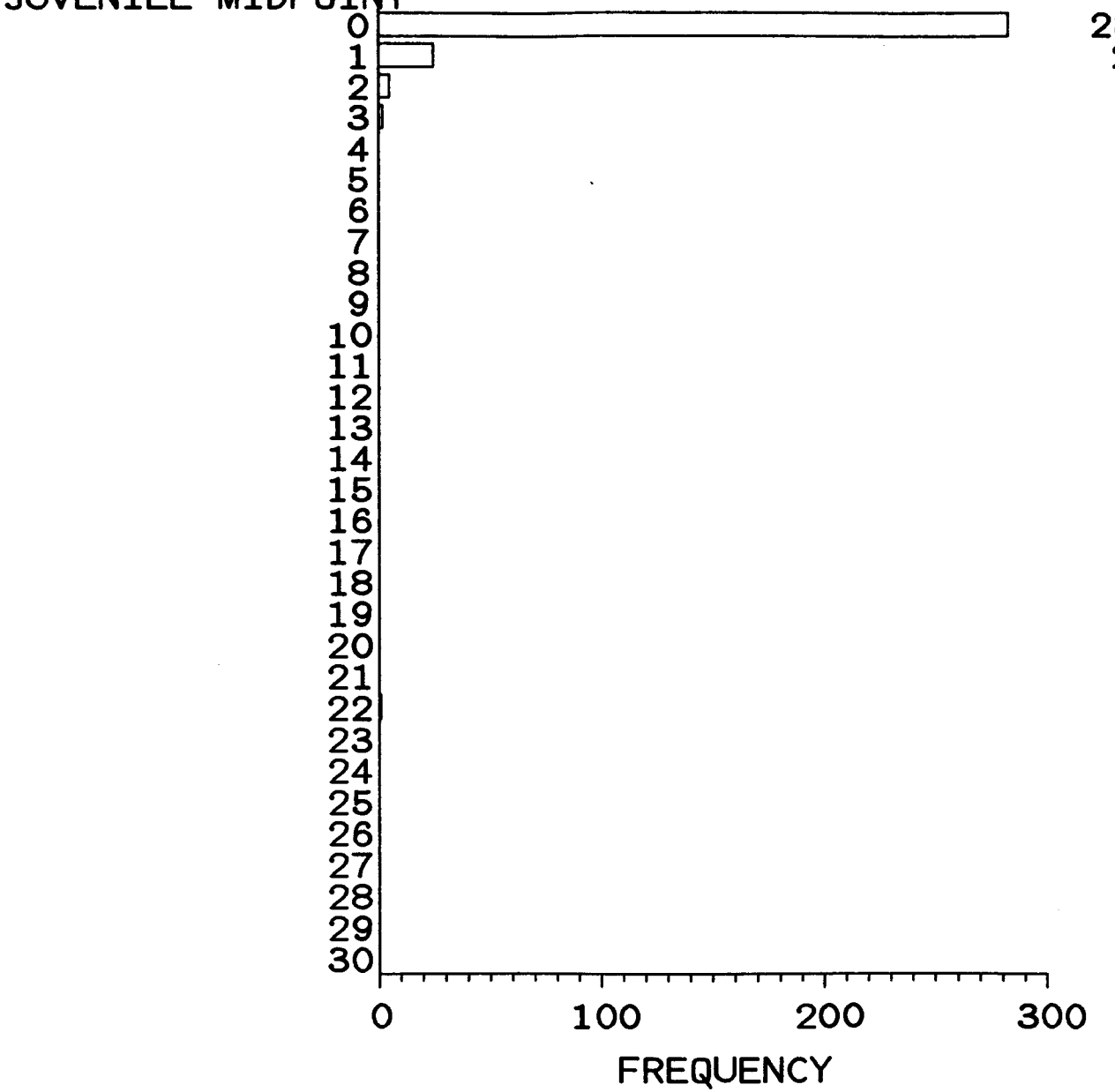
Chum Fishery



JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	299	299	94.62	94.62
1	12	311	3.80	98.42
2	2	313	0.63	99.05
3	1	314	0.32	99.37
4	1	315	0.32	99.68
5	0	315	0.00	99.68
6	0	315	0.00	99.68
7	1	316	0.32	100.00
8	0	316	0.00	100.00
9	0	316	0.00	100.00
10	0	316	0.00	100.00
11	0	316	0.00	100.00
12	0	316	0.00	100.00
13	0	316	0.00	100.00
14	0	316	0.00	100.00
15	0	316	0.00	100.00
16	0	316	0.00	100.00
17	0	316	0.00	100.00
18	0	316	0.00	100.00
19	0	316	0.00	100.00
20	0	316	0.00	100.00
21	0	316	0.00	100.00
22	0	316	0.00	100.00
23	0	316	0.00	100.00
24	0	316	0.00	100.00
25	0	316	0.00	100.00
26	0	316	0.00	100.00
27	0	316	0.00	100.00
28	0	316	0.00	100.00
29	0	316	0.00	100.00
30	0	316	0.00	100.00

Fig.21 Catch/set for jack chinook in Johnstone Strait, 1988

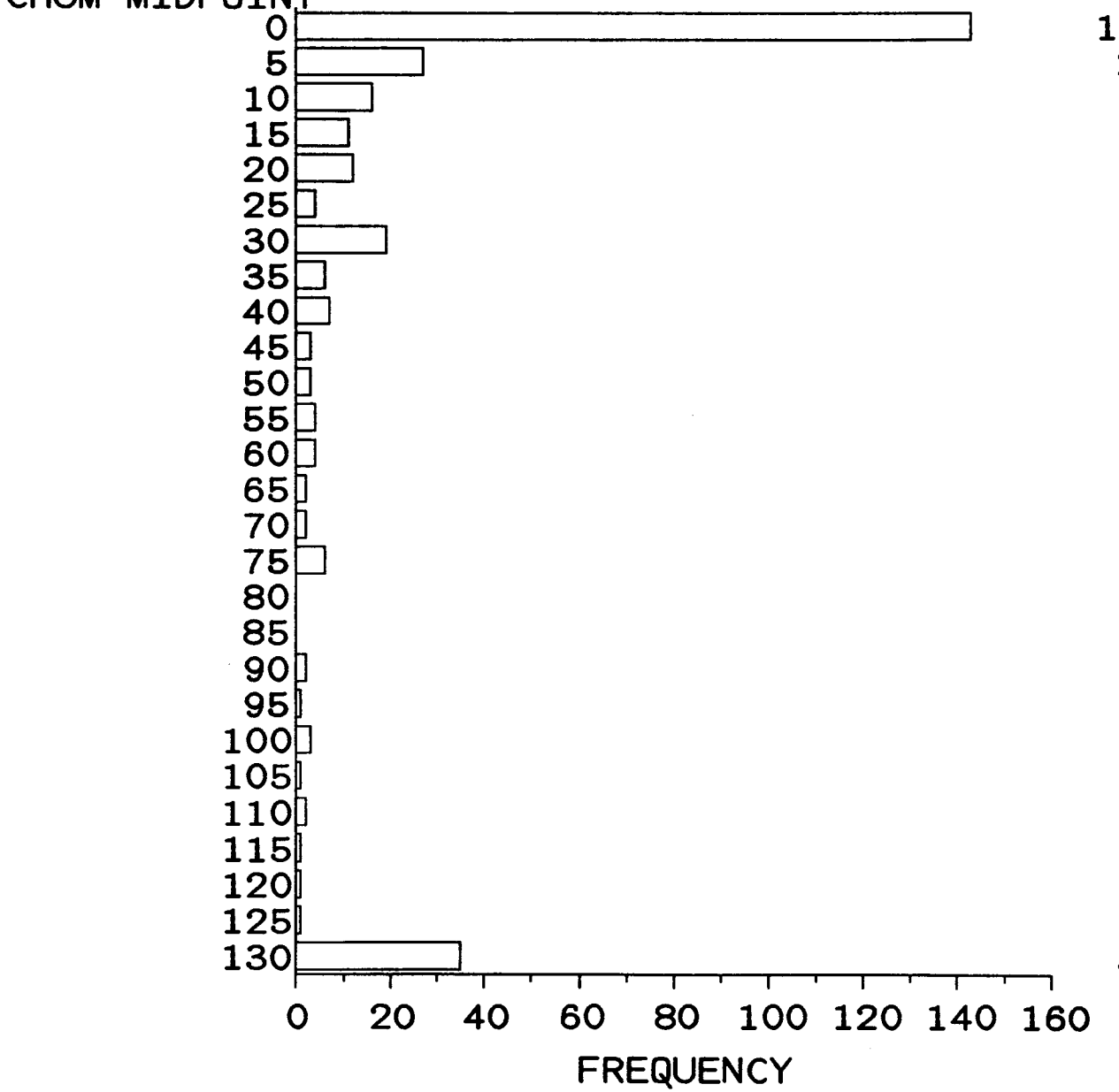
Chum Fishery



JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	283	283	89.56	89.56
1	25	308	7.91	97.47
2	5	313	1.58	99.05
3	2	315	0.63	99.68
4	0	315	0.00	99.68
5	0	315	0.00	99.68
6	0	315	0.00	99.68
7	0	315	0.00	99.68
8	0	315	0.00	99.68
9	0	315	0.00	99.68
10	0	315	0.00	99.68
11	0	315	0.00	99.68
12	0	315	0.00	99.68
13	0	315	0.00	99.68
14	0	315	0.00	99.68
15	0	315	0.00	99.68
16	0	315	0.00	99.68
17	0	315	0.00	99.68
18	0	315	0.00	99.68
19	0	315	0.00	99.68
20	0	315	0.00	99.68
21	0	315	0.00	99.68
22	1	316	0.32	100.00
23	0	316	0.00	100.00
24	0	316	0.00	100.00
25	0	316	0.00	100.00
26	0	316	0.00	100.00
27	0	316	0.00	100.00
28	0	316	0.00	100.00
29	0	316	0.00	100.00
30	0	316	0.00	100.00

Fig.22 Catch/set for juvenile chinook in Johnstone Strait, 1988

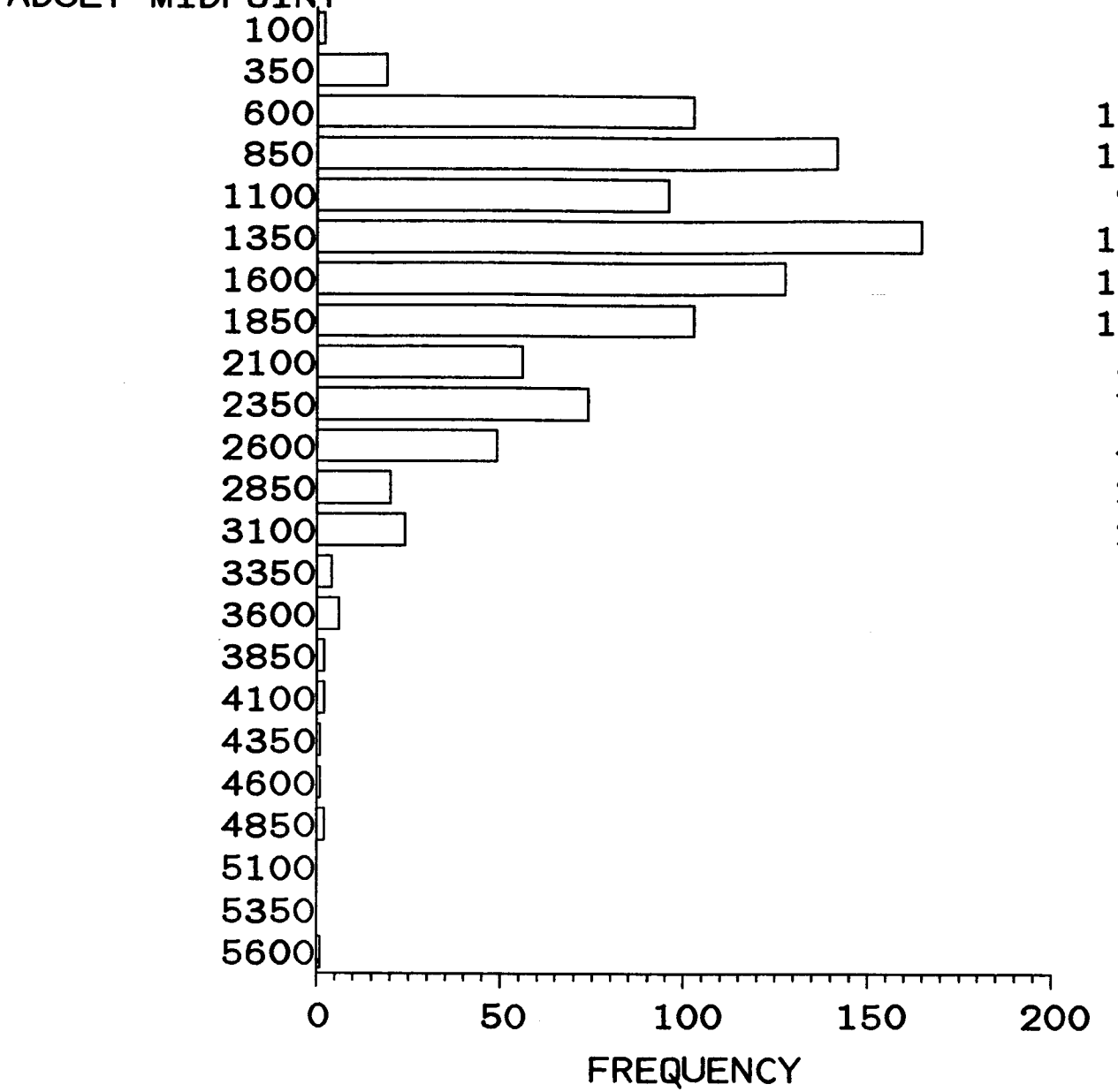
Chum Fishery



CHUM MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	143	143	45.25	45.25
5	27	170	8.54	53.80
10	16	186	5.06	58.86
15	11	197	3.48	62.34
20	12	209	3.80	66.14
25	4	213	1.27	67.41
30	19	232	6.01	73.42
35	6	238	1.90	75.32
40	7	245	2.22	77.53
45	3	248	0.95	78.48
50	3	251	0.95	79.43
55	4	255	1.27	80.70
60	4	259	1.27	81.96
65	2	261	0.63	82.59
70	2	263	0.63	83.23
75	6	269	1.90	85.13
80	0	269	0.00	85.13
85	0	269	0.00	85.13
90	2	271	0.63	85.76
95	1	272	0.32	86.08
100	3	275	0.95	87.03
105	1	276	0.32	87.34
110	2	278	0.63	87.97
115	1	279	0.32	88.29
120	1	280	0.32	88.61
125	1	281	0.32	88.92
130	35	316	11.08	100.00

Fig.23 Catch/set for chum in Johnstone Strait, 1988

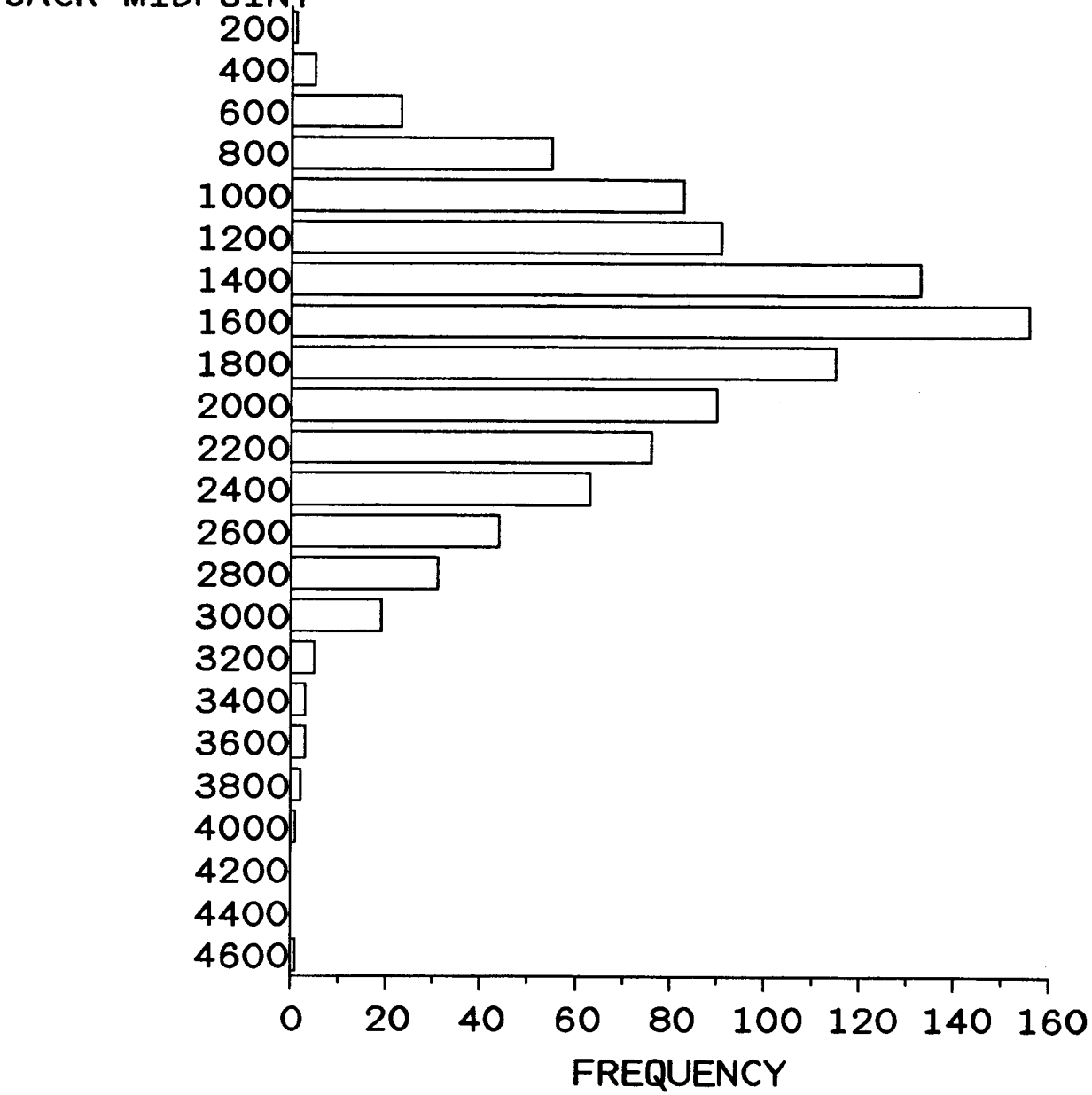
Chum Fishery



ADULT MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
100	2	2	0.2	0.2
350	19	21	1.9	2.1
600	103	124	10.3	12.4
850	142	266	14.2	26.6
1100	96	362	9.6	36.2
1350	165	527	16.5	52.7
1600	128	655	12.8	65.5
1850	103	758	10.3	75.8
2100	56	814	5.6	81.4
2350	74	888	7.4	88.8
2600	49	937	4.9	93.7
2850	20	957	2.0	95.7
3100	24	981	2.4	98.1
3350	4	985	0.4	98.5
3600	6	991	0.6	99.1
3850	2	993	0.2	99.3
4100	2	995	0.2	99.5
4350	1	996	0.1	99.6
4600	1	997	0.1	99.7
4850	2	999	0.2	99.9
5100	0	999	0.0	99.9
5350	0	999	0.0	99.9
5600	1	1000	0.1	100.0

Fig.24 Bootstrap estimates for adult chinook in Johnstone Strait, 1988

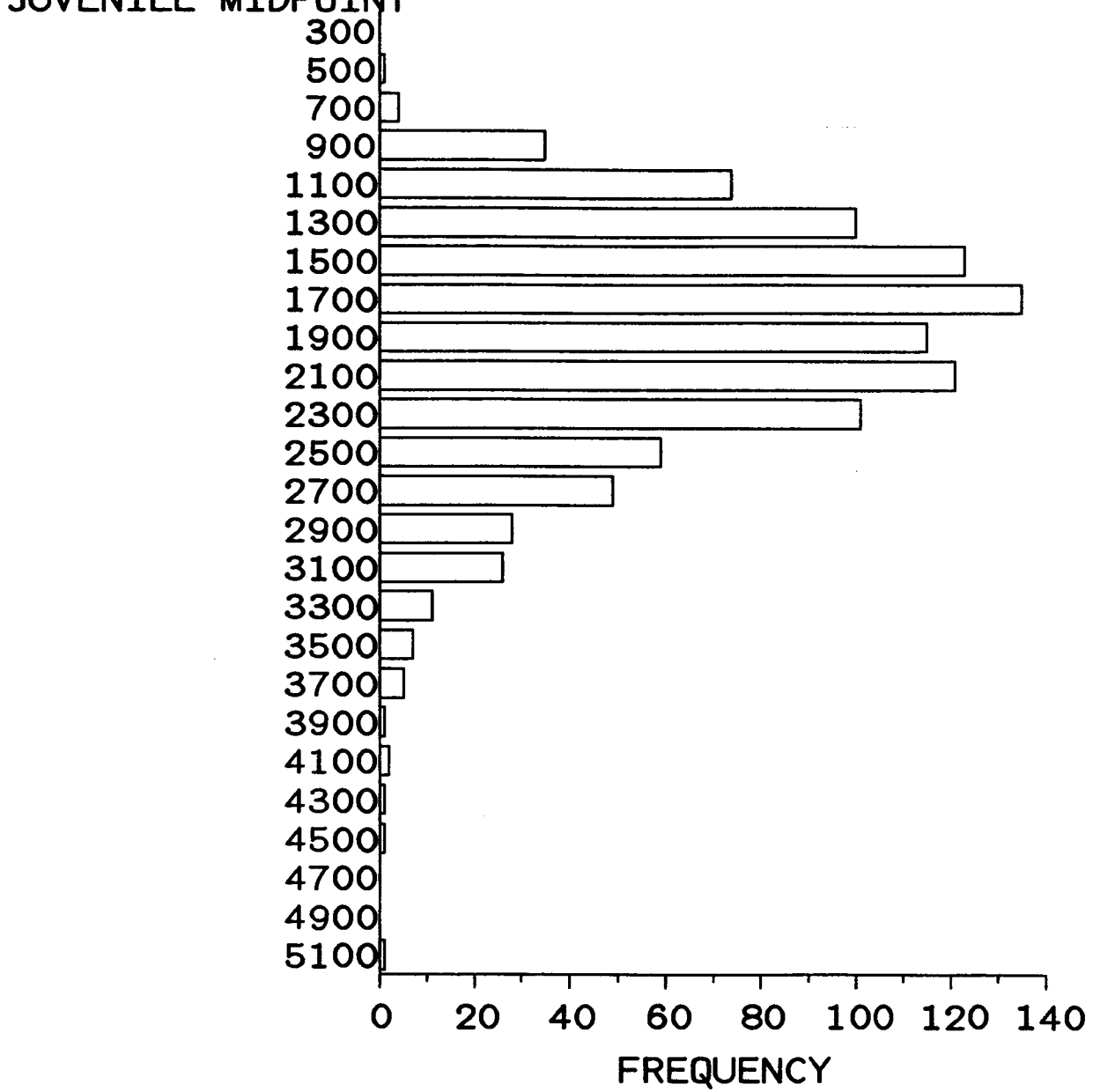
Chum Fishery



JACK MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
200	1	1	0.1	0.1
400	5	6	0.5	0.6
600	23	29	2.3	2.9
800	55	84	5.5	8.4
1000	83	167	8.3	16.7
1200	91	258	9.1	25.8
1400	133	391	13.3	39.1
1600	156	547	15.6	54.7
1800	115	662	11.5	66.2
2000	90	752	9.0	75.2
2200	76	828	7.6	82.8
2400	63	891	6.3	89.1
2600	44	935	4.4	93.5
2800	31	966	3.1	96.6
3000	19	985	1.9	98.5
3200	5	990	0.5	99.0
3400	3	993	0.3	99.3
3600	3	996	0.3	99.6
3800	2	998	0.2	99.8
4000	1	999	0.1	99.9
4200	0	999	0.0	99.9
4400	0	999	0.0	99.9
4600	1	1000	0.1	100.0

Fig.25 Bootstrap estimates for jack chinook in Johnstone Strait, 1988

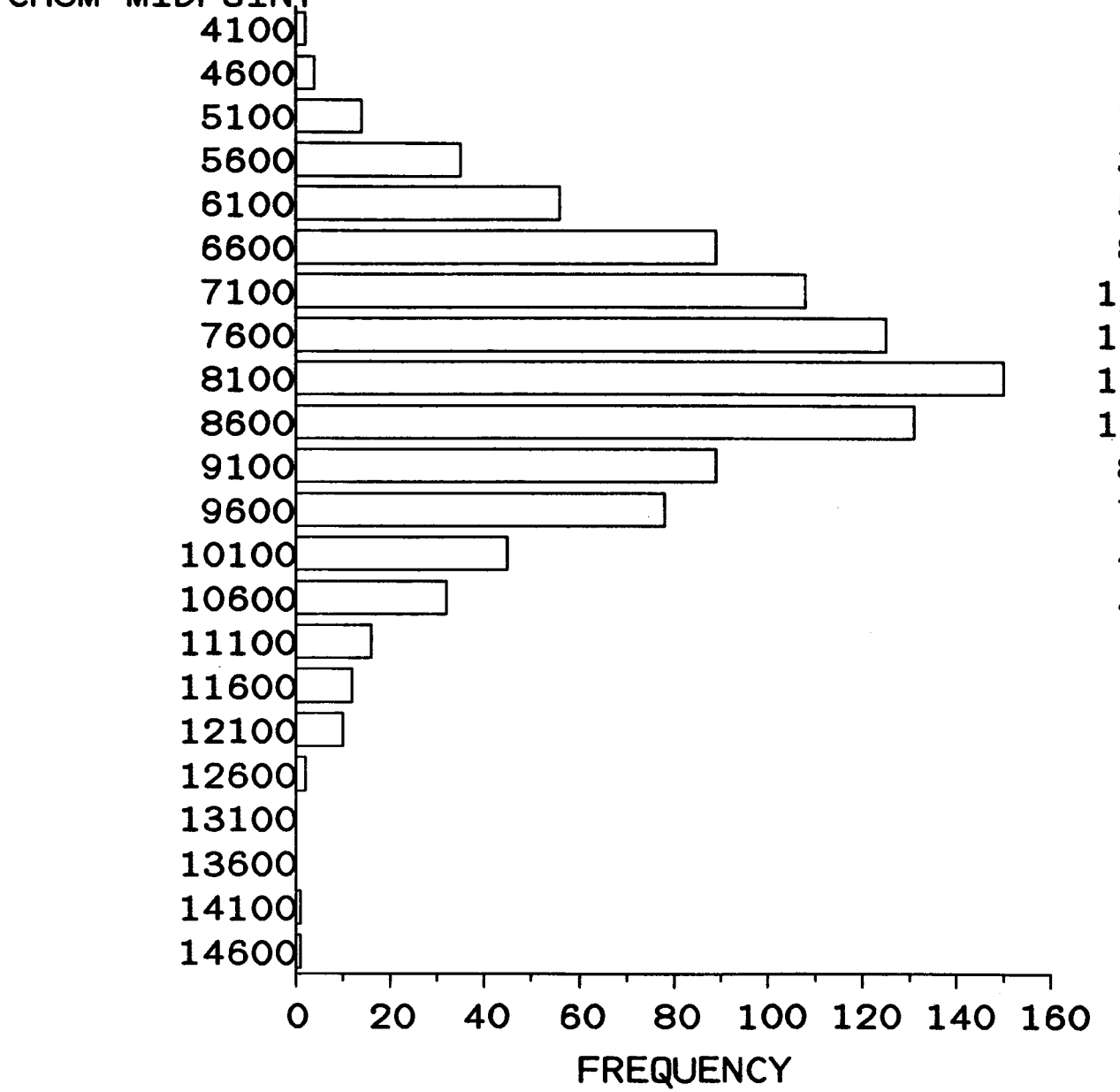
Chum Fishery



JUVENILE MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
300	0	0	0.0	0
500	1	1	0.1	0
700	4	5	0.4	1
900	35	40	3.5	4
1100	74	114	7.4	11
1300	100	214	10.0	21
1500	123	337	12.3	34
1700	135	472	13.5	47
1900	115	587	11.5	59
2100	121	708	12.1	71
2300	101	809	10.1	81
2500	59	868	5.9	87
2700	49	917	4.9	92
2900	28	945	2.8	95
3100	26	971	2.6	97
3300	11	982	1.1	98
3500	7	989	0.7	99
3700	5	994	0.5	99
3900	1	995	0.1	100
4100	2	997	0.2	100
4300	1	998	0.1	100
4500	1	999	0.1	100
4700	0	999	0.0	100
4900	0	999	0.0	100
5100	1	1000	0.1	100

Fig.26 Bootstrap estimates for juvenile chinook in Johnstone Strait, 198

Chum Fishery



CHUM MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4100	2	2	0.2	0.2
4600	4	6	0.4	0.6
5100	14	20	1.4	2.0
5600	35	55	3.5	5.5
6100	56	111	5.6	11.1
6600	89	200	8.9	20.0
7100	108	308	10.8	30.8
7600	125	433	12.5	43.3
8100	150	583	15.0	58.3
8600	131	714	13.1	71.4
9100	89	803	8.9	80.3
9600	78	881	7.8	88.1
10100	45	926	4.5	92.6
10600	32	958	3.2	95.8
11100	16	974	1.6	97.4
11600	12	986	1.2	98.6
12100	10	996	1.0	99.6
12600	2	998	0.2	99.8
13100	0	998	0.0	99.8
13600	0	998	0.0	99.8
14100	1	999	0.1	99.9
14600	1	1000	0.1	100.0

Fig.27 Bootstrap estimates for chum in Johnstone Strait, 1988