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## **Estimation of Total Chinook Mortality Associated with Seine Fishing in Johnstone Strait, Sabine Channel and Juan de Fuca Strait During 1990**

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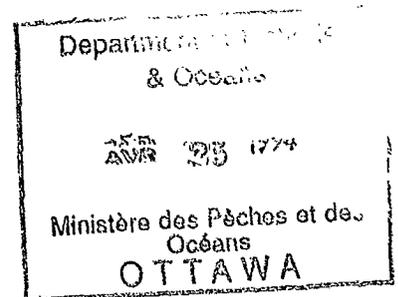
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ESTIMATION OF TOTAL CHINOOK MORTALITY ASSOCIATED WITH  
SEINE FISHING IN JOHNSTONE STRAIT, SABINE CHANNEL  
AND JUAN DE FUCA STRAIT DURING 1990

by



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## ABSTRACT

Nagtegaal, D. A. and B. Riddell. 1994. Estimation of total chinook mortality associated with seine fishing in Johnstone Strait, Sabine Channel and Juan de Fuca Strait during 1990. Can. Manuscr. Rep. Fish. Aquat. Sci. 2229: 81 p.

In 1990 the Biological Sciences Branch, Department of Fisheries and Oceans, conducted a study to assess total chinook (*Oncorhynchus tshawytscha*) mortality in the Johnstone Strait and Juan de Fuca Strait sockeye (*O. nerka*) and pink (*O. gorbuscha*) seine fisheries. Department of Fisheries and Oceans catch statistics are determined from records of salmon sales, and are suspected by some user groups to underestimate the catch of chinook by seine gear. This study independently estimated the total chinook catch in southern British Columbia seine fisheries. Total chinook mortality in the Johnstone Strait seine fishery was estimated to be 11,134 (95% CL: 7,238-16,039) of which 983 were juveniles, 2,347 jacks, and 7,804 adults. Commercial records of sales for the 1990 season reported a catch of 1,717 jack chinook and 12,154 adult chinook. Total mortality in the Juan de Fuca Strait seine fishery was estimated to be 20,037 (95% CL: 10,867-31,102) of which 9,120 were juveniles, 4,175 jacks, and 6,792 adult chinook. Commercial sales slip records for 1990 reported 4,743 jacks and 5,753 adult chinook.

## RÉSUMÉ

Nagtegaal, D. A. and B. Riddell. 1994. Estimation of total chinook mortality associated with seine fishing in Johnstone Strait, Sabine Channel and Juan de Fuca Strait during 1990. Can. Manuscr. Rep. Fish. Aquat. Sci. 2229: 81 p.

En 1990, la Direction générale des sciences biologiques du ministère des Pêches et des Océans a mené une étude pour évaluer la mortalité totale du saumon quinnat (*Oncorhynchus tshawytscha*) dans les pêcheries à la senne du saumon rouge (*O. nerka*) et du saumon rose (*O. gorbuscha*) dans les détroits de Johnstone et de Juan de Fuca. Les statistiques du ministère des Pêches et des Océans en matière de prises sont calculées à partir des relevés des ventes de saumon, et certains groupes d'utilisateurs soupçonnent que ces chiffres sous-estiment les prises de saumon quinnat à la senne. Dans cette étude, on a évalué indépendamment les prises totales de saumon quinnat dans les pêcheries à la senne du sud de la Colombie-Britannique. La mortalité totale du saumon quinnat dans la pêcherie à la senne du détroit de Johnstone a été évaluée à 11 134 (intervalle de confiance à 95 % : 7 238 - 16 039), soit 983 juvéniles, 2 347 mâles et 7 804 adultes. Les relevés des ventes de saumon quinnat pour la saison 1990 signalaient des prises de 1 717 mâles et 12 154 adultes. La mortalité totale du saumon quinnat dans la pêcherie à la senne du détroit de Juan de Fuca a été évaluée à 20 037 (intervalle de confiance à 95 % : 10 867 - 31 102), dont 9 120 juvéniles, 4 175 mâles et 6 792 adultes. Les relevés des ventes de saumon quinnat pour la saison 1990 signalaient des prises de 4 743 mâles et de 5 753 adultes.

## INTRODUCTION

In 1985, the Pacific Salmon Treaty concerning 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.

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. This was the fifth year of study in Johnstone Strait and the fourth year in Juan de Fuca Strait. In addition, a special fishery in the mainland inlets (primarily Tribune Channel) was also monitored, as well as the first fishery opening in September for Sabine Channel. The purpose of this report is to present the methodology and results of the chinook mortality studies conducted during the 1990 sockeye (*O. nerka*) and pink (*O. gorbuscha*) seine fisheries in southern B.C.

## METHODS

### GENERAL METHODOLOGY

Information required to calculate total chinook mortality associated with the seine fishery include: i) mean catch per set by species and size category; ii) mean number of sets made per vessel in each time/area stratum; and iii) the numbers of vessels fishing by time and area. Chinook catch was recorded for three size categories: i) adults [ $>2.3$  kg (5 lb),  $>57$  cm fork length]; ii) jacks [1.4 - 2.3 kg (3-5 lb), 45-57 cm]; and juveniles [ $<1.4$  kg (3 lb),  $<45$  cm].

The overall concept of the program was to extrapolate the estimated mean catch per seine set over all sets made. Monte-Carlo simulations (Efron 1982) were conducted within strata and estimates were summed to determine the total catch estimate. A detailed description of data collection methods, treatment of missing data cells, and catch estimation procedures are presented in Nagtegaal et al. (1990). In addition to the regular survey in 1990, biological observers also monitored a seine opening in the mainland inlets (primarily Tribune Channel; Stat. area 12-35, 12-37) and Sabine Channel (Stat. Area 16). Four teams (one boat operator and one biological observer) were assigned to monitor the mainland inlet fishery and two teams were used to observe the seine fishery in Sabine Channel. A concerted effort was made to

monitor the Aug. 6 opening in Tribune Channel. The other two openings were not monitored very closely since our efforts were focussed on the Johnstone Strait fishery. Only the Sept. 2-3 fishery opening in Sabine Channel was monitored.

Table 1 lists the commercial fishing and survey dates in Johnstone Strait, Sabine Channel and Juan de Fuca Strait.

## RESULTS

### A. JOHNSTONE STRAIT

In total, 787 observer boardings were made on 310 different vessels (Table 2) between Aug. 12 and Sept. 3. A total of 238 adult, 64 jack, and 29 juvenile chinook were recorded by the observers. Because of frequent denials of permission to board vessels in the Lower Johnstone Strait sub-area fewer samples were obtained from that area than in previous years.

In Tribune Channel, 125 observer boardings were made and a total of 13 adult, 2 jack, and 8 juvenile chinook were recorded.

#### i) Catch per set:

Catch per set for adult chinook ranged from 0 to 12, for jacks from 0 to 4, and for juvenile chinook from 0 to 2 (Table 3). The overall mean catch per set during the seine fishery was 1.41 for adult chinook, 0.08 for jacks, and 0.40 for juveniles. Distribution of catch per set was highly skewed in all sub-areas in Johnstone Strait (Figs. 3-6). The proportion of null sets observed for juvenile chinook was 97%, for jacks was 94%, for adults was 82%, and for sockeye was 27%.

Few chinook were recorded by the observers in Tribune Channel. The overall mean catch per set was 0.10 for adults and juveniles, and .01 for jacks.

A two factor analysis of variance (Zar, 1984) was used to examine the effect of area and week on catch per set (Table 4). The area and week effect was significant for sockeye and the area effect was significant for jack chinook. Catch per set for sockeye was highest at the beginning of the fishing season. Catch rate for jacks was highest in the Lower Johnstone Strait

sub-area. Area and week effects accounted for less than 10% of the total variance in catch per set.

Mean chinook catch per set was compared to the type of set (open or beach) by study area in Johnstone Strait (Table 5). Comparisons were based on data from Upper and Lower Johnstone Strait sub-areas only since few beach sets were made in other areas. Beach sets were considerably more productive than open sets for all categories of chinook and sockeye. This was also the case in Tribune Channel.

ii) Biological sampling:

In Johnstone Strait, 257 adult chinook, 81 jacks, and 20 juveniles were sampled for length/sex/maturity/scale data (Table 6). 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 are contained in Table 7.

Biological data collected independently at processing plants (cannery sample) are listed in Table 8. Size ranges and modes for both the survey and cannery data were similar. The results of the Kolmogorov-Smirnov test (Zar, 1984) indicated that cumulative distributions of cannery and survey data were not significantly different ( $D_{obs} < D_{alpha}$ ).

iii) Number of sets per day per vessel:

The average number of sets per day in Johnstone Strait ranged from 2.2 to 20.5 depending on the length of day and area (Tables 9 and 10). In Johnstone Strait seiners choose between open and beach set strategy (Ledbetter 1977). Choices are made to either wait in a lineup for a preferred spot, or to make more sets in areas where no lineups exist but likely with lower catch success. The geography of the area and traditional fishery patterns are important in determining the proportion of beach or open sets made (Hilborn and Ledbetter 1979).

In Tribune Channel, the average number of sets per day ranged from 5.3 to 10.5.

iv) Gear count:

The number of seiners in Johnstone Strait ranged from 125 to 286 (Table 11). Overflights were made in statistical area 12 only. Fishery officers recorded the number of vessels fishing on most days and for most study areas. Vessel count was consistently highest in the Upper Johnstone Strait sub-area. Comparison of the overflight data with a gear count made from the

sales slip data (Table 12) revealed only minor differences except for the count recorded on Sept. 2.

Some differences were noted for the mainland inlet gear counts. Fishery officers indicated that there was considerable movement of gear between Johnstone Strait and the mainland inlets making it difficult to get an accurate count.

v) Total catch estimate:

A summary of catch estimates for this seine fishery and comparable sales slip information is listed in Tables 13-14. Catch estimates include the data for the mainland inlet openings. The catch estimate for sockeye was 5.1% higher than the equivalent sales slip estimate, 35% lower for adult chinook, and 36% higher for jack chinook. The catch distribution by week for both the sales slip and bootstrap catch estimates were comparable for jack chinook, although considerable differences were recorded for adult chinook and sockeye. These differences were particularly evident in the second and third week of the fishery. This may have been due to the difficulty in acquiring accurate gear counts for those fishery openings. Differences between bootstrap estimates and sales slip data were recorded in both statistical areas 12 and 13 (Table 14). In most cases the sales slip catch estimates were within the confidence range of the bootstrap estimates.

Catch estimates were compiled by sub-area, but are not presented in this report since no comparable sales slip data were recorded. The Upper Johnstone Strait sub-area accounted for 63% of the adult chinook catch, 61% of the juvenile catch and 58% of the jack catch.

The distribution of bootstrap catch estimates was skewed (Fig. 7-10). This was not unexpected since the distribution of catch per set was highly skewed.

**B. SABINE CHANNEL**

Since the Sabine Channel fishery is concentrated in a small area, we were able to board most vessels that fished in the area during the one opening this fishery was monitored. A total of 69 boardings were made on 51 different seiners during the Sept. 2-3 opening (Table 2). Seven adult, 25 jack, and 24 juvenile chinook were observed.

i) Catch per set:

The overall mean catch per set was 0.10 for adults, 0.36 for jacks and 0.35 for juvenile chinook (Table 3).

When catch per set was compared to the type of set (Table 5) we note that except for adult chinook, catch rates were highest in beach sets.

ii) Biological sampling:

Samples were taken from only 7 adults and 14 jacks. A summary of age data is contained in Table 7. Length frequencies were not analyzed due to limited data.

iii) Number of sets/day/vessel:

The number of sets per day ranged from 3.9 to 11.3 (Table 9). A combination of open and beach set strategy existed in this area and affected the number of sets made by each vessel.

iv) Gear count:

There were 120 seiners fishing during the opening that was monitored (Tables 11 and 12). The gear count determined from sales slip information (166) was considerably higher than the fishery officer count. One of the inherent problems in sales slip data is that information from multiple areas may often be assigned to a single statistical area. Sales slip data from the Sabine channel fishery may be combined with Johnstone Strait (statistical areas 12 and 13) because of the movement of seiners between these two areas.

v) Total catch estimate:

A summary of total catch estimates using the bootstrap technique as well as sales slip information are listed in Table 13. The sales slip estimates for sockeye were within 5% of the bootstrap estimates. Catch estimates for adult chinook were 64% less than sales slip estimates while the jack estimate was 54% greater. The survey estimate for jacks and juveniles combined was 4.6 times greater than the sales slip estimate for jack chinook. Since data were limited no frequency distribution of catch estimates was plotted.

### C. JUAN DE FUCA STRAIT

In total, 357 observer boardings were made on 160 different vessels (Table 2). During the seven openings of this fishery, 271 adult, 165 jack, and 417 juvenile chinook were observed. As in past years, in the Juan de Fuca Strait fishery it was difficult to obtain good coverage of all fishing lines when the weather was poor.

#### i) Catch per set:

Catch per set ranged from 0 to 20 for adult, 0 to 45 for jack, and from 0 to 35 for juvenile chinook (Table 15). The overall mean for adults was 0.76, 0.46 for jacks, and 1.17 for juveniles.

Catch per set was also compiled by fishing line (Table 16). Sockeye catch rates were higher on the first few fishing lines than on subsequent lines. A similar trend was evident for chinook, especially for adults and juveniles. Catch rates were also examined by fishing line and time of day (Table 17). Catch rates by fishing line remained much the same in the morning and afternoon, although there was some decrease past line 8 in the afternoon.

Distribution of catch per set was highly skewed (Fig. 11-14). The proportion of null sets observed for adult chinook was 67%, for jacks was 79%, and for juveniles was 65%. The proportion of null sets for sockeye was 3%.

A two-way analysis of variance was used to examine the effects of week and fishing line on catch per set (Table 18). The effect of week on catch per set was significant for juvenile chinook and for sockeye. Catch rates for juvenile chinook and sockeye were highest during the first week of the fishery. The effect of fishing line was not significant. The high variance in catch rates within each fishing line (especially lines 1 and 3; Table 16) may tend to mask the differences in mean catch rates among fishing lines.

Catch per set was also examined by 10 fathom bottom depth interval (Table 19). Catch rates for all categories of chinook and sockeye were highest in shallower waters.

#### ii) Biological sampling:

A total of 430 adult, 339 jack and 38 juvenile chinook were sampled during the survey for length/sex/maturity/scale data (Table 20). 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 are contained in Table 7.

Biological data collected at the processing plants (cannery sample) are listed in Table 21. Size ranges for both cannery and survey data were similar but modes were not. The Kolmogorov-Smirnov test indicated that significant differences between cumulative distributions of cannery and survey biological data were detected ( $D_{obs} > D_{alpha}$ ). This may be due to the small number of juvenile chinook sampled by the observers.

iii) Number of sets per day per vessel:

The average number of sets per day ranged from 5.6 to 14.0 depending on the length of day (Table 22) and fishing line (Table 9). Seiners may choose to wait in lineups that usually exist in the first few fishing lines or make more sets in the less intense subsequent lines (Table 23). The number of sets that a vessel can make in a day is dependent on the strategy adopted. The seine fleet is usually quite spread out during the first part of the day but tend to move up to the first few lines towards the end of the day.

iv) Gear count:

Only three overflights were conducted by the Pacific Salmon Commission in Juan de Fuca Strait. In addition, the Commission estimated gear counts 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 (Table 12). Gear counts were compiled from radar counts of seine gear and were recorded by time of day and four geographic areas that corresponded to fishing lines (Table 24). These were; a) Bonilla Pt. (lines 1-2), b) Owen Pt. (lines 3-9), c) Owen Pt. to Sombrio (lines 10-12, and d) Sombrio to Sheringham Pt. (lines > 12). It was decided to apply the breakdown of gear by line from the data collected on Aug. 20-22 to all weeks in the fishery since this was the only available measure of effort by fishing line. This distribution of gear by fishing line was also similar to results from the 1989 survey. A potential source of error in the radar gear count was the fact that the gillnet fleet was present on the fishing grounds when the radar counts were taken. According to the fishery officers, it was sometimes difficult to distinguish between a seiner and a gillnetter on a radar screen. Comparison of the radar count and the fishery officer ground count data with a gear count made from the sales slip data (Table 12) revealed considerable differences. In all cases, the sales slip gear count was higher than the other two gear counts. We therefore considered the combination of ground count and overflight count to be the best estimate of effort.

v) Total catch estimate:

Catch estimates were determined on the basis of catch per set, sets per day and gear count data stratified by fishery line (grouping lines 1-3 and 4-16) and time of day (before noon/after noon). The intent was to incorporate the changes in both fishing effort and distribution of the fleet during a given day. The total catch estimate for sockeye was <1% lower than sales slip data, 18% higher for adult chinook, and 12% lower for jacks (Table 25). Although the bootstrap and sales slip catch distribution by week varied considerably for jacks, no trend was evident. Poor gear count data may have had an effect on the accuracy of the catch estimates. Recalculation of the data without stratifying the gear count by fishing line increased the catch estimates (4-28%) in all categories, but did not alter the catch distribution by week. In all cases except for jacks, the sales slip catch estimates were within the confidence limits of the bootstrap estimates.

The distribution of bootstrap catch estimates was skewed (Fig. 15-18). This was not unexpected since the distribution of catch per set was highly skewed.

## DISCUSSION

The estimate of total chinook mortality in Johnstone Strait (including the mainland inlets) during the sockeye and pink seine fisheries in 1990 was determined to be 11,134 of which 983 were recorded as juveniles, 2,347 as jacks, and 7,804 as adults. Although the catch estimate for sockeye was within 5% of the sales slip recorded catch, estimates for jack and adult chinook were approximately 36% higher and 35% lower, respectively, than the sales slip data. During the first opening in September in Sabine Channel, the sockeye catch estimate was within 5% of the sales slip catch, while estimates for jack and adult chinook were 54% higher and 64% lower, respectively, than the sales slip data. The total chinook mortality in Juan de Fuca Strait was determined to be 20,087 of which 9,120 were recorded as juveniles, 4,175 as jacks, and 6,792 as adults. The estimate for sockeye was within 1% of the sales slip records, while the estimates for jack and adult chinook were 12% lower and 18% higher, respectively, than the catch recorded in the sales slip data.

Best estimates of total catch were calculated based on catch per set, sets made per day, and gear count data. In most cases, the sales slip catch estimates were within the confidence range of the bootstrap estimates. Some considerations of the

data collected and potential sources of error are discussed by Nagtegaal (1990) and apply here as well. Sockeye catch estimates compared favourably to the saleslip data. In each study area, jack chinook catch was less than the sales slip estimate by approximately the same proportion as adult catch was greater than the estimate, or vice-versa. The possibility exists that observers incorrectly assigned some of the jack chinook as adults and/or vice-versa, however, chinook were routinely measured prior to being assigned to a size category. The magnitude of this error, if it occurred at all, could not be determined. A preliminary test of the accuracy of species identification by the field crew was accomplished by examining the scale data. Salmon species can quite readily be identified from scale patterns (Bilton et al. 1964). Out of 548 chinook scales read only 7 (1.2%) were incorrectly identified as other species.

In Johnstone Strait the catch of chinook less than 2.3 kg (5 lb) was calculated to be 1.9 times (95% confidence limits: 1.0-3.1) greater than the number of jacks recorded in the sales slip data. This expansion factor could be considered to be on the low side due to the low estimate for juvenile chinook. Considerably fewer juvenile chinook were observed this year than in previous years. In Juan de Fuca Strait, the chinook catch was calculated to be 2.8 times greater (95% confidence limits: 1.5-4.2) than the number of jacks recorded in the sales slip data.

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.

The results of the 1990 survey support the hypothesis suggested by Nagtegaal et al. (1988) that the jack category in the sales slip data represents a subset of the total jack and juvenile catch recorded in the survey data. These results also compare favourably with the data from previous surveys (Nagtegaal et. al, 1990, 1993).

The fate of chinook caught but not sold and/or recorded is uncertain. The consistency of biological samples from the surveys and canneries indicates that small chinook that are caught are not sorted by size. Under-reporting of small chinook could result from some fishers discarding/releasing all small chinook or mis-identification of small chinooks during sale. It is unknown to what extent each of these two factors contribute to the problem of under-reporting. According to a catch

verification study conducted by Lettic and Gould (1988), the error rate in commercial sales receipts collected from the seine and gillnet fishery in Johnstone Strait from 1985-87 averaged around 40%. Although the errors were primarily associated with incorrect CFV numbers and gear type designation, the relative magnitude of the error may be an indication of the potential for mis-identification of small chinooks during sale.

To determine the proportion of mature males in the jack and juvenile categories, the sex ratio and percent maturity values from the biological sampling survey data (Tables 6 and 20) were applied to the total bootstrap estimates. Application of maturity rates for Johnstone Strait yielded a total of 1,540 mature males and 810 mature females (jacks and juveniles combined). For Juan de Fuca Strait 5,140 mature males and 4,280 mature females were recorded. Subtracting these values from the total catch estimates yielded 980 chinook (jacks and juveniles combined) from Johnstone Strait and 3,875 chinook from Juan de Fuca Strait, representing the numbers of fish that could have contributed to future production.

In summary, this study provides us with an independent estimate of the chinook mortality during the Johnstone Strait and Juan de Fuca Strait sockeye and pink seine fisheries. Further work will be required to 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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## LITERATURE CITED

- Argue, A. W., D. E. Marshall and J. F. Coursley. 1967. Size and age of chinook and coho salmon for subdivision of the Strait of Georgia troll fishery, 1967. Canada Dept. of Fisheries and Marine Service, Pacific Region, Tech. Rep. PAC/T-77-20. 150 p.
- Bilton, H. T., D. W. Jenkinson and M. P. Shepard. 1964. A key to five species of Pacific salmon (Genus Oncorhynchus) based on scale characters. J. Fish. Res. Board Can. 21(5).
- Dept. of Fisheries and Oceans, Canada, Pacific Region. Annual Summary of British Columbia catch statistics, 1990.
- Efron, B. 1982. The jackknife, the bootstrap, and other resampling plans. SIAM, CBMS-NSF Regional Conference Series in Applied Mathematics, No. 38, Philadelphia, Pennsylvania, USA.
- Hilborn, R. and M. Ledbetter. 1979. Analysis of the British Columbia salmon purse-seine fleet: dynamics of movement. J. Fish. Res. Board Can. 36: 384-391.
- Ledbetter, M. 1977. Competition and information among the British Columbia salmon purse seiners. PhD Thesis. The University of British Columbia. 145 p.
- Lettic, J. and A. Gould. 1988. The 1987 report of the Johnstone Strait commercial net verification program. Can. MS Rep. Fish. Aquat. Sci. No. 2003: 45 p.
- Nagtegaal, D. A., P. J. Starr and B. Riddell. 1988. A pilot study to estimate total chinook mortality associated with seine fishing in Johnstone Strait during 1986. Can. MS Rep. Fish. Aquat. Sci. No. 1977: 55 p.
- Nagtegaal, D. A., P. J. Starr and B. Riddell. 1990. Estimation of total chinook mortality associated with seine fishing in Johnstone Strait, Sabine Channel, and Juan de Fuca Strait during 1987. Can. MS Rep. Fish. Aquat. Sci. No. 2062: 91 p.
- 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: 72 p.

Rouse, M. L., and Marshall, S. 1989. Chinook salmon catch and mortality associated with the 1987 southeast Alaska purse seine fishery. Alaska Dept. Fish and Game. Tech. Fish. Rpt. No. 89-16: 54 p.

Rouse, M. L. 1990. Chinook salmon catch and mortality associated with the 1987 southeast Alaska purse seine fishery. Alaska Dept. Fish and Game. Tech. Fish. Rpt. No. 90-03: 43 p.

Zar, J. H. 1984. Biostatistical analysis. Prentice-Hall Inc. N.J., USA.

Table 1. Seine fishery openings by area for 1990.

Area	Dates of survey	Scheduled fishing dates
Johnstone Strait (Stat. area: 12,13)	Aug. 12-14 19-21 26-29	12-14 19-21 26-29
	Sept. 2-3	Sept. 2-3
Mainland Inlets <sup>1</sup>	Aug. 6 13-14 21	Aug. 6 13-14 21
Sabine Channel (Stat. area: 16)	Sept. 2-3	Sept. 2-3
Juan de Fuca Strait (Stat. area: 20)	Aug. 13-14 20-22 26-27	13-14 20-22 26-27

<sup>1</sup>Aug. 6: statistical area 12-35 only

Aug. 13-14: statistical areas 12-35 and 12-37 only

Table 2. Number of different vessels boarded and total boardings made (in parenthesis) by study area and date.

DATE	STUDY AREA							
	Gordon Group	North Shore	Upper Johns Strait	Lower Johns Strait	Johnstone Strait (Total)	Mainland Inlets	Sabine Channel	Juan de Fuca Strait
Aug. 6	-	-	14(15)	-	14(15)	80(98)		
12	4(4)	-	13(13)	7(7)	24(24)			
13	22(30)	14(20)	42(47)	18(18)	96(115)			31(37)
14	-	-	17(20)	2(2)	19(22)	11(11)		46(59)
19	10(10)	8(8)	13(13)	-	31(31)			
20	29(33)	13(13)	55(71)	11(11)	108(128)			28(34)
21	22(29)	11(11)	27(30)	-	60(70)	14(16)		51(60)
22								47(55)
26	5(5)	3(3)	12(12)	6(6)	26(26)			47(52)
27	22(22)	15(15)	30(33)	23(23)	90(93)			55(60)
28	20(27)	12(13)	31(37)	29(29)	92(106)			
29	13(21)	4(4)	31(31)	14(14)	62(70)			
Sep. 2	2(2)	3(3)	12(12)	2(2)	19(19)		17(21)	
3	16(16)	7(7)	25(25)	17(17)	65(65)		38(48)	

Table 3. Average catch per set by category compiled from data collected during the Johnstone Strait seine fishery.

Gordon Group	Chinook			Sockeye
	Adult	Jack	Juvenile	
Aug. 12	0.25(0.50) <sup>a</sup>	0.00(0.00)	0.00(0.00)	93.8( 42.7)
13	0.53(0.78)	0.03(0.17)	0.00(0.00)	142.1(140.1)
14		NO DATA		
19	0.10(0.32)	0.00(0.00)	0.00(0.00)	9.9( 15.6)
20	0.12(0.33)	0.06(0.35)	0.06(0.35)	67.1(122.3)
21	0.07(0.26)	0.00(0.00)	0.00(0.00)	82.5(125.5)
26	0.60(1.34)	0.00(0.00)	0.00(0.00)	46.8( 64.4)
27	0.05(0.21)	0.00(0.00)	0.00(0.00)	10.0( 17.2)
28	0.33(1.21)	0.07(0.38)	0.07(0.38)	19.4( 28.9)
29	0.05(0.22)	0.10(0.30)	0.00(0.00)	15.6( 27.4)
Sept. 2	0.00(0.00)	0.00(0.00)	0.00(0.00)	38.0( 45.3)
3	0.00(0.00)	0.00(0.00)	0.00(0.00)	7.1( 7.6)
Mean <sup>b</sup>	0.19(0.63)	0.04(0.23)	0.02(0.20)	55.4(102.6)

Table 3 (cont'd)

North Shore	Chinook			
	Adult	Jack	Juvenile	Sockeye
Aug. 12		NO DATA		
13	0.30(0.80) <sup>a</sup>	0.05(0.22)	0.15(0.49)	154.3(143.6)
14		NO DATA		
19	0.88(1.64)	0.00(0.00)	0.25(0.46)	77.5( 64.4)
20	0.00(0.00)	0.08(0.28)	0.08(0.28)	34.7( 49.5)
21	0.09(0.30)	0.55(0.69)	0.00(0.00)	14.6( 9.2)
26	0.33(0.58)	0.33(0.58)	0.00(0.00)	25.0( 10.0)
27	0.27(0.59)	0.07(0.26)	0.07(0.26)	34.1( 60.5)
28	0.46(0.88)	0.08(0.28)	0.00(0.00)	14.8( 10.8)
29	0.00(0.00)	0.50(0.58)	0.00(0.00)	10.5( 8.0)
Sept. 2	0.67(0.58)	0.00(0.00)	0.00(0.00)	16.0( 13.1)
3	0.29(0.49)	0.00(0.00)	0.00(0.00)	12.6( 6.5)
Mean <sup>b</sup>	0.30(0.75)	0.13(0.37)	0.07(0.30)	54.4( 90.4)

Table 3 (cont'd)

Upper Johnstone Strait	Chinook			Sockeye
	Adult	Jack	Juvenile	
Aug. 12	0.92(2.22) <sup>a</sup>	0.23(0.83)	0.00(0.00)	249.0(379.2)
13	0.51(0.95)	0.04(0.20)	0.04(0.20)	122.2(195.8)
14	0.25(0.44)	0.15(0.49)	0.00(0.00)	72.1(130.4)
19	0.38(0.96)	0.08(0.28)	0.00(0.00)	161.3(171.1)
20	0.39(0.16)	0.00(0.00)	0.07(0.31)	78.4(114.0)
21	0.17(0.46)	0.00(0.00)	0.00(0.00)	74.4(109.6)
26	0.67(1.50)	0.00(0.00)	0.08(0.29)	82.4(169.2)
27	0.36(0.90)	0.15(0.44)	0.09(0.52)	27.7( 55.3)
28	0.28(0.60)	0.08(0.27)	0.03(0.16)	15.6( 16.3)
29	0.13(0.43)	0.10(0.40)	0.00(0.00)	12.8( 16.5)
Sept. 2	0.08(0.29)	0.00(0.00)	0.00(0.00)	18.4( 32.9)
3	0.19(0.49)	0.12(0.43)	0.04(0.20)	31.0( 33.1)
Mean <sup>b</sup>	0.35(0.94)	0.07(0.32)	0.04(0.24)	69.9(141.2)

Table 3 (cont'd)

Lower Johnstone Strait	Chinook			Sockeye
	Adult	Jack	Juvenile	
Aug. 12	0.29(0.49) <sup>a</sup>	0.43(1.13)	0.00(0.00)	765.0(1868.6)
13	0.28(0.75)	0.06(0.24)	0.06(0.24)	51.2( 73.9)
14	0.00(0.00)	0.00(0.00)	0.00(0.00)	48.1( 59.4)
19		NO DATA		
20	0.64(1.03)	0.00(0.00)	0.00(0.00)	177.4(425.9)
21		NO DATA		
26	0.83(1.33)	0.83(1.17)	0.33(0.82)	325.8(239.8)
27	0.48(1.38)	0.17(0.49)	0.00(0.00)	171.3(317.2)
28	0.55(1.33)	0.17(0.47)	0.07(0.26)	242.7(597.5)
29	0.21(0.43)	0.07(0.27)	0.00(0.00)	24.0( 45.7)
Sept. 2	0.00(0.00)	0.00(0.00)	0.00(0.00)	30.0( 42.4)
3	0.12(0.49)	0.12(0.33)	0.00(0.00)	35.4( 42.3)
Mean <sup>b</sup>	0.40(1.02)	0.16(0.51)	0.04(0.23)	172.5(552.8)
Johnstone Strait (All areas combined)	1.41(1.02)	0.08(0.01)	0.04(0.01)	80.1(9.0)

Table 3 (cont'd)

Mainland Inlets	Chinook			Sockeye
	Adult	Jack	Juvenile	
Aug. 6	0.12(0.82) <sup>a</sup>	0.00(0.00)	0.06(0.34)	2.0(15.6)
13	0.09(0.30)	0.00(0.00)	0.09(0.30)	-
21	0.00(0.00)	0.13(0.34)	0.06(0.25)	0.4(1.3)
Sabine Channel				
Sept. 2	0.19(0.51) <sup>a</sup>	0.29(0.64)	0.19(0.51)	6.1( 7.6)
3	0.06(0.24)	0.40(0.84)	0.42(0.90)	9.5( 8.6)

<sup>a</sup>Standard deviation in parentheses.

<sup>b</sup>Weighted mean catch per set, all weeks combined.

Table 4. Two-way analysis of variance of catch per set vs area and week for the Johnstone Strait seine fishery.

	Source of Variation	DF	SS	MS	F <sub>obs</sub>	F <sub>0.05</sub>
Jacks	Total	786	94.79			
	Model	15	3.34	.22	1.88	
	Error	771	91.45	.12		
	Area	3	1.66		4.68	3.29*
	Week	3	.53		1.50	3.29
	Area and Week	9	1.14		1.07	2.59
Juveniles	Total	786	43.93			
	Model	15	.56	0.03	0.67	
	Error	771	43.36	.05		
	Area	3	0.17		1.05	3.29
	Week	3	0.09		0.54	3.29
	Area and Week	9	0.29		0.59	2.59
Adults	Total	786	645576			
	Model	15	8813.29	587.5	0.71	
	Error	771	636763	825.9		
	Area	3	1191		0.48	3.29
	Week	3	3829		1.55	3.29
	Area and Week	9	3792		0.51	2.59
Sockeye	Total	786	50305211			
	Model	15	3171339	211422	3.46	
	Error	771	47133871	61133		
	Area	3	1343883		7.33	3.29*
	Week	3	1501015		8.18	3.29*
	Area and Week	9	3264400		0.59	2.59

\*Denotes significance

Table 5. Comparison between type of set and catch per set by study area for the seine fishery.

Johnstone Strait:	N	Chinook			Sockeye
		Adults	Jacks	Juveniles	
Gordon Group					
Open	188	.17(.04) <sup>1</sup>	.03(.02)	.02(.01)	56.5(7.6)
Beach	7	.86(.70)	.14(.14)	-	35.4(20.2)
North Shore					
Open	92	.30(.08)	.13(.04)	.04(.02)	55.9(9.6)
Beach	1	-	-	-	5.0(5.0)
Upper Johnstone Strait					
Open	99	.15(.06)	.01(.01)	.03(.02)	51.6(13.1)
Beach	262	3.73(3.1)	.08(.02)	.03(.02)	73.8(8.8)
Lower Johnstone Strait					
Open	55	.11(.06)	.04(.02)	.02(.02)	130.4(90.5)
Beach	74	.61(.14)	.26(.07)	.05(.03)	203.8(52.0)
Total <sup>2</sup>					
Open	434	.19(.03)	.05(.01)	.03(.01)	64.6(12.4)
Beach	344	2.99(2.3)	.12(.02)	.04(.01)	100.8(13.3)
Mainland Inlets <sup>3</sup>					
Open	26	-	-	.04(.19)	1.6(7.8)
Beach	41	.27(1.3)	.02(.16)	.15(.53)	3.7(23.4)
Sabine Channel					
Open	43	.14(.41)	.35(.84)	.23(.72)	7.8(8.4)
Beach	20	.05(.22)	.45(.76)	.55(.94)	11.4(8.6)
Juan de Fuca Strait					
Open	357	.76(.10)	.46(.07)	1.17(.16)	360.9(42.1)
Beach	-	-	-	-	-

<sup>1</sup>Standard error of the mean.<sup>2</sup>All areas combined (Johnstone Strait).<sup>3</sup>primarily Tribune Channel

Table 6. Summary of chinook biological samples collected during the seine fishery in Johnstone Strait.

Juveniles			Jacks			Adults					
Length (cm)	M	F	U <sup>1</sup>	Length (cm)	M	F	U	Length (cm)	M	F	U
31	1	0	0	43	5	0	1	58	1	0	0
32	0	0	0	44	1	1	1	59	3	4	3
33	1	0	0	45	4	2	2	60	4	2	2
34	0	0	0	46	4	2	0	61	3	5	0
35	0	0	0	47	2	1	2	62	4	5	0
36	1	0	0	48	3	1	2	63	3	1	0
37	0	1	1	49	0	1	0	64	4	2	0
38	3	2	0	50	4	1	0	65	3	6	1
39	1	0	0	51	0	0	1	66	6	4	0
40	0	1	0	52	6	1	0	67	3	2	0
41	4	0	0	53	3	0	3	68	2	1	3
42	3	0	1	54	4	1	0	69	3	3	0
				55	7	1	0	70	3	2	0
				56	6	0	2	71	3	4	0
				57	3	2	1	72	9	1	3
								73	2	3	1
								74	5	1	0
								75	1	1	0
								76	0	4	5
								77	2	1	0
								78	4	2	1
								79	2	0	1
								80	2	0	1
								81	3	1	4
								82	3	3	2
								83	2	1	1
								84	1	1	3
								85	2	1	3
								86	0	2	3
								87	3	2	2
								88	2	1	4
								89	2	3	1
								90	1	3	2
								91	2	3	1
								92	3	1	3
								93	1	1	4
								94	2	1	1
								95	1	2	0
								96	0	0	2
								97	4	0	0
								98	1	1	2
								99	0	1	0

Table 6 (cont.)

Juveniles			Jacks			Adults					
Length (cm)	M	F	U	Length (cm)	M	F	U	Length (cm)	M	F	U
								100	0	1	0
								101	0	0	0
								102	0	2	0
								103	1	1	1
								104	0	0	1
								105	0	0	0
								106	0	0	0
								107	0	0	0
								108	0	0	0
								109	0	0	0
								110	1	1	1
								111	0	0	0
								112	0	0	0
								113	0	0	0
								114	0	0	0
								115	0	0	0
								116	0	0	0
								117	0	0	0
								118	0	0	0
								119	0	0	1
Total	14	4	2		52	14	15		107	87	63
Weighted Mean Length	38.8	38.2			50.8	49.6			64.2	76.2	
Percent Mature	43	-	-		68	-	-		-	-	-
Sex Ratio (% Males)		70				78				55	

<sup>1</sup>Fish not sampled for sex and maturity

Table 7. Summary of chinook age samples collected during the seine fishery.

Johnstone Strait <sup>1</sup>				
Age <sup>2</sup>	Males	Females	Unk <sup>3</sup>	Total
0.1	12	3	1	16
0.2	11	4	2	17
0.3	13	12	3	28
0.4	0	1	0	1
0.5	1	0	0	1
Total	40	20	6	66
Unknown <sup>4</sup> : 160				

Juan de Fuca Strait				
Age	Males	Females	Unk	Total
0.1	43	13	0	55
0.2	13	10	2	25
0.3	24	16	8	48
0.4	4	0	1	5
1.1	27	14	0	41
1.2	1	1	0	2
1.3	0	2	0	2
Total	116	58	12	186

Unknown: 116

Table 7. (cont.)

Sabine Channel				
Age <sup>1</sup>	Males	Females	Unk	Total
0.1	6	4	0	10
0.2	1	0	0	1
0.3	0	1	0	1
0.4	2	0	0	2
Total	9	5	0	14

Unknown<sup>2</sup>: 6

<sup>1</sup>Includes mainland inlets

<sup>2</sup>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.

<sup>3</sup>Unknown sex: fish not sampled because skipper did not want fish to be mutilated.

<sup>4</sup>Unknown age: scales were unreadable.

Table 8. Summary of chinook biological samples<sup>1</sup> collected at the processing plants in Vancouver during the seine fishery in Johnstone Strait<sup>2</sup>.

Length (cm)	Juveniles				Length (cm)	Jacks			
	M	F	U <sup>3</sup>	T		M	F	U	T
32	1	0	0	1	43	8	6	0	14
33	1	0	0	1	44	4	4	0	8
34	2	0	0	2	45	4	4	0	8
35	1	0	0	1	46	8	4	0	12
36	2	0	0	2	47	5	3	0	8
37	0	0	0	0	48	12	4	0	16
38	4	0	0	4	49	7	4	0	11
39	1	0	0	1	50	6	12	0	18
40	3	0	0	3	51	9	1	0	10
41	4	2	0	6	52	3	2	0	5
42	10	2	0	12	53	13	2	0	15
					54	7	0	0	7
					55	3	4	0	7
					56	1	2	0	3
					57	4	2	0	6
<hr/>									
Total:	29	4	0	33		94	54	0	148
Weighted Mean Length	39.1	41.5				49.5	48.8		
Percent Immature:	27	100				38	100		
Sex Ratio (% males)		88%					63%		

<sup>1</sup>For purposes of comparison with the survey data the cannery sample data was assigned to the jack and juvenile categories according to the criteria used for the survey data.

<sup>2</sup>includes mainland inlets

<sup>3</sup>Fish not sampled for sex and maturity.

Table 9. Average number of sets made per vessel by day for Johnstone Strait and Juan de Fuca Strait seine fishery.

Study Area	August										Sept	
	12	13	14	19	20	21	26	27	28	29	2	3
Gordon Group	4.75	19.5	-	3.0 (1.8) <sup>a</sup>	16.7 (1.3)	21.7 (1.0)	4.0 (1.2)	17.0 (1.3)	16.1 (1.7)	15.8 (1.3)	4.0 (1.8)	-
North Shore	-	16.3	-	3.5	12.8 (0.9)	12.0 (1.0)	4.3 (0.9)	17.0 (1.2)	13.7	20.5	3.3 (1.3)	14.8 (1.2)
Upper Johnstone Strait	3.6 (1.2)	16.8 (1.0)	10.5 (1.6)	4.1 (0.8)	13.3 (1.3)	13.6 (1.0)	3.8 (0.8)	12.6 (1.0)	13.2 (1.3)	10.4 (1.0)	4.0 (1.0)	9.5
Lower Johnstone Strait	2.2 (1.3)	14.8 (0.4)	10.0 (0.7)	-	10.0 (1.0)	-	2.3 (1.0)	12.6 (1.0)	14.1 (0.8)	6.9 (1.1)	2.0 (1.3)	9.2 (1.1)

Study Area	August			Study Area	Sept.	
	6	13	14		2	3
Mainland Inlets	10.5 (0.8)	5.3	8.8	Sabine Channel	3.9 (1.1)	11.3 (0.9)

Study Area	August								
	12	13	14	20	21	22	26	27	28
Juan de Fuca Strait	-	8.3 (0.8)	8.3	9.8	8.7	8.3	8.0 (0.7)	8.4 (0.7)	-

<sup>a</sup>Average number of sets per hour

Table 10. Available fishing time by fishery opening for Johnstone Strait and Juan de Fuca Strait.

Date	Statistical area <sup>a</sup>	Time of opening <sup>b</sup>	Available fishing hours
Aug. 6	12 <sup>c</sup>	0700	11.0
12	12, 13	1800	3.5
13	12, 13	0600	12.0
13	20	0700	12.0
14	12, 13	0600	12.0
14	20	0700	12.0
19	12, 13	1800	3.5
20	12, 13	0600	12.0
20	20	0700	12.0
21	12, 13	0600	12.0
21	20	0700	12.0
22	20	0700	12.0
26	12, 13	1800	3.5
26	20	0700	12.0
27	12, 13	0600	15.5
27	20	0700	12.0
28	12, 13	0600	15.5
29	12, 13	0600	12.0
Sept. 2	12, 13, 16	1800	3.5
3	12, 13, 16	0600	12.0

<sup>a</sup>Areas 12 and 13: Johnstone Strait

Area 16: Sabine Channel

Area 20: Juan de Fuca Strait

<sup>b</sup>Universal time

<sup>c</sup>statistical area 12-35 (Tribune Channel)

Table 11. Gear count<sup>1</sup> of seiners by day and study area for each seine fishery.

Study Area <sup>2</sup>	August									
	6	12	13	14	19	20	21	22	26	
Gordon Group	-	35	60	-	77	100	-	-	-	43(40)
North Shore	-	-	-	-				-		(11)
Upper Johnstone Strait	-	185	149	102	168	136		-		154(144)
Lower Johnstone Strait	-	65	41	-	22	24		-		66
Discovery Pass	-	-	-	-				-		
Mainland Inlets	114	149	149				26			
Sabine Channel										
Juan De Fuca <sup>3</sup> Strait	-	-	104	105		184(162)	184(125)	184(184)		230

Table 11. (con't)

Study Area	August			Sept.	
	27	28	29	2	3
Gordon Group	33	25	-	18(14)	-
North Shore			-	(22)	-
Upper Johnstone Strait	154	120	-	88(56)	-
Lower Johnstone Strait	70	77	-	101	115
Discovery Pass			-		-
Mainland Inlets					
Sabine Channel				120(166)	
Juan De Fuca Strait	190(231)				

<sup>1</sup>Fishery officers recorded gear count on fishing grounds, overflight gear count recorded in statistical area 12 only (in parenthesis),

<sup>2</sup>According to fishery officers, gear count for the mainland inlets and Johnstone Strait areas was difficult to record since much of the fishing fleet moved from one area to the other.

<sup>3</sup>For August 20-22 radar gear counts are given in parenthesis. According to fishery officers it was often difficult to distinguish between seine and gillnet vessels on the radar screen.

Table 12. Number of vessels that reported catch by week from sales slip data compared with overflight and fishery officers gear counts for Johnstone Strait and Juan de Fuca Strait seine fishery.

Area	Date	Sales slip count <sup>a</sup>	DF0 overflight <sup>b</sup>	Ground count <sup>c</sup>	PSC count <sup>d</sup>
Johnstone Strait	Aug. 12	277	249		
	13		203		
	14				
	19	252	267		
	20		286		
	21				
	26	180	263		
	27		257		
	28		222		
	29				
	Sept. 2	125	207		
	3				
Mainland Inlets <sup>e</sup>	Aug. 6	221		114	
	13			149	
	14				
Sabine Channel	Sept. 2	166		120	
	3				
Juan De Fuca Strait	Aug. 13	169		104	104
	14			105	105
	20	249		191	184
	21			190	184
	22			190	184
	26	257		231	230
	27			231	190

<sup>a</sup>Unique CFV licences delivering catch by stat. area, weekly totals only.

<sup>b</sup>Regular Dept. of Fisheries and Oceans overflights were taken for stat. area 13 only, so this number represents a combination of overflight data for stat. area 13 and a fishery officer ground count for stat. area 12.

<sup>c</sup>Gear count taken by fishery officers on fishing grounds.

<sup>d</sup>Gear count from the Pacific Salmon Commission, combination of fishery officer ground count and overflight counts.

<sup>e</sup>Fishery officers reported that it was difficult to get accurate estimates of effort since there was considerable movement of gear between Johnstone Strait and the mainland inlets.

Table 13. Comparison of bootstrap estimates and sales slip data (Numbers caught) by week for Johnstone Strait and Sabine Channel.

Johnstone Strait:

WEEK	CHINOOK			
	ADULT	JACK	JUVENILE	SOCKEYE
Aug. 6 <sup>e</sup>	218 <sup>a</sup> (0-815) <sup>b</sup> 93 <sup>c</sup>	29 (0-99) 63	157 (0-494) d	2,555 (1,912-12,470) 5,007
Aug. 12-14 <sup>f</sup>	2646 (1387-4345) 4718	578 (95-1266) 655	181 (0-614) d	905,076 (507,437-1,451,770) 586,700
Aug. 19-21 <sup>f</sup>	1436 (714-2771) 3436	368 (41-1018) 315	240 (17-670) d	487,763 (295,555-748,519) 637,774
Aug. 26-29	3074 (1675-4970) 3442	1133 (539-2069) 474	373 (30-1167) d	568,186 (292,419-1,083,916) 652,265
Sept 2-3	430 (43-1100) 1120	242 (0-694) 210	31 (0-164) d	79,311 (42,545-137,715) 60,865
TOTAL	7,804 (5,486-10,726) 12,154	2,347 (1,432-3,712) 1,717	983 (320-1,601) d	2,042,892 (1,479,447-2,765,571) 1,942,611

Table 13 (cont.)

## Sabine Channel:

WEEK	CHINOOK			SOCKEYE
	ADULT	JACK	JUVENILE	
Sept 2-3	165 (18-457) 469	642 (239-1,757) 283	646 (126-1,389) d	15,265 (6,631-26,532) 14,519

<sup>a</sup>Bootstrap estimates.

<sup>b</sup>Upper and lower 95% confidence limits.

<sup>c</sup>Sales slip data collected by the Dept. of Fisheries and Oceans (Annual Summary, 1990).

<sup>d</sup>No data recorded for juveniles in sales slip data.

<sup>e</sup>Estimates for Mainland Inlets only

<sup>f</sup>Week of Aug. 12-14 and Aug. 19-21 include estimates for mainland Inlets.

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

Statistical Area	Adult	Jack	Juvenile	Sockeye
12 <sup>a</sup>	6,161 <sup>a</sup>	1613	835	1,329,651
	(4,154-8,201) <sup>b</sup>	(822-2674)	(171-1435)	(953,972-1,755,954)
	8,870 <sup>c</sup>	1069	d	1,238,379
13	1,643	734	148	713,241
	(668-3180)	(260-1664)	(0-394)	(291,695-1,325,049)
	3,284	648	d	704,232
Total	7,804	2347	983	2,042,892
	(5,486-10,726)	(1,432-3,712)	(320-1,601)	(1,479,447-2,765,571)
	12,154	1,717	d	1,942,611

<sup>a</sup>Bootstrap estimates.

<sup>b</sup>Upper and lower 95% confidence limits.

<sup>c</sup>Sales slip data collected by the Dept. of Fisheries and Oceans (Annual Summary, 1990).

<sup>d</sup>No data recorded for juveniles in sales slip data.

<sup>e</sup>Includes estimates for Mainland Inlets.

Table 15. Average catch per set by category compiled from data collected during the Juan de Fuca Strait seine fishery.

	CHINOOK			SOCKEYE
	ADULT	JACK	JUVENILE	
Aug. 13	0.76(1.86) <sup>a</sup>	0.27(1.02)	1.81(3.63)	469.9(805.3)
14	0.69(1.56)	0.54(1.03)	2.31(5.16)	597.6(1348.8)
20	1.29(4.41)	0.85(2.11)	0.97(1.93)	276.3(428.3)
21	0.35(0.58)	0.17(0.59)	0.57(1.13)	434.9(626.4)
22	0.62(0.95)	0.16(0.42)	0.33(0.86)	465.3(737.5)
26	1.21(2.20)	0.65(1.79)	0.54(0.98)	71.3(92.9)
27	0.67(1.56)	0.68(2.08)	1.68(3.34)	52.7(78.8)
Mean <sup>b</sup>	0.76(1.98)	0.46(1.42)	1.17(2.98)	360.9(796.0)

<sup>a</sup>Standard deviation in parenthesis

<sup>b</sup>Weighted mean catch per set, all weeks combined

Table 16. Summary of catch per set by fishing line for Juan de Fuca Strait<sup>a</sup>.

FISHING LINE	N	CHINOOK			SOCKEYE
		ADULT	JACK	JUVENILE	
1	79	1.4(2.9) <sup>b</sup>	0.5(1.4)	2.5(4.9)	516.7(1011)
2	60	0.8(1.4)	0.6(1.9)	0.9(2.4)	342.8(496.4)
3	32	1.5(3.3)	1.0(2.5)	0.5(1.3)	381.5(1084)
4	32	0.2(0.5)	0.2(0.5)	0.1(0.5)	293.3(320.8)
5	26	0.6(1.5)	0.2(0.8)	1.1(1.9)	311.0(422.7)
6	26	0.2(0.4)	0.4(0.8)	0.4(0.7)	281.6(369.0)
7	27	0.3(0.5)	0.4(0.9)	1.4(2.9)	220.5(171.3)
8	31	0.7(1.9)	0.2(0.8)	0.9(1.7)	234.2(303.4)
9	22	0.2(0.5)	0.2(0.6)	1.2(2.4)	275.3(632.1)
10	8	-	0.8(1.4)	0.4(0.7)	52.1(68.2)
11	4	-	1.5(3.0)	0.7(1.5)	189.2(277.6)
14	3	0.7(1.1)	0.3(0.6)	0.6(1.1)	144.0(188.2)

<sup>a</sup>Mean catch per set, all weeks combined<sup>b</sup>Standard deviation in parenthesis

Table 17. Catch per set by fishing line and time of day in Juan de Fuca Strait.

MORNING <sup>a</sup>		CHINOOK				SOCKEYE
FISHING LINE	N	ADULT	JACK	JUVENILE		
1	22	0.5(0.7) <sup>b</sup>	0.4(0.6)	1.6(2.1)	610.7(887.0)	
2	13	0.3(0.6)	0.2(0.4)	0.4(0.6)	296.8(291.5)	
3	10	1.8(2.4)	2.1(3.7)	0.3(0.7)	80.9( 85.0)	
4	14	0.4(0.6)	0.2(0.6)	0.1(0.5)	227.5(224.6)	
5	12	1.1(2.1)	0.4(1.2)	1.7(2.3)	399.7(565.8)	
6	13	0.1(0.4)	0.4(0.7)	0.3(0.5)	266.6(402.2)	
7	17	0.2(0.4)	0.4(0.9)	1.9(3.6)	212.8(173.1)	
8	23	0.9(2.2)	0.3(0.9)	0.8(1.5)	212.2(268.9)	
9	14	0.2(0.4)	0.3(0.8)	0.7(2.2)	413.6(766.6)	
10	7	-	1.0(1.5)	0.4(0.8)	45.3(70.6)	
11	3	-	-	-	215.0(333.4)	
14	3	0.7(1.1)	0.3(0.6)	0.7(1.2)	144.0(188.2)	
AFTERNOON						
1	57	1.7(3.4)	0.5(1.5)	2.8(5.6)	480.5(1060.4)	
2	47	0.9(1.4)	0.7(2.2)	1.1(2.9)	355.5(541.4)	
3	22	1.3(3.7)	0.5(1.6)	0.6(1.5)	518.1(1292.9)	
4	18	0.1(0.2)	0.2(0.3)	0.1(0.4)	344.6(377.9)	
5	14	0.2(0.5)	0.1(0.3)	0.6(1.4)	234.9(243.5)	
6	13	0.3(0.5)	0.4(0.9)	0.5(0.8)	296.7(348.4)	
7	10	0.4(0.5)	0.4(0.9)	0.6(0.8)	233.8(176.6)	
8	8	0.3(0.7)	-	1.5(2.3)	297.7(401.4)	
9	8	0.2(0.7)	-	2.1(2.8)	33.4(45.9)	
10	1	-	-	-	100.0	
11	1	-	6.0	3.0	112.0	

<sup>a</sup>Catch per set was compiled before and after 12:00 noon, all weeks combined.

<sup>b</sup>Standard deviation

Table 18. Analysis of variance of catch per set vs week and fishing line for Juan de Fuca Strait seine fishery.

	Source of Variation	DF	SS	MS	F <sub>obs</sub>	F <sub>0.05</sub>
Jacks	Total	353	716			
	Model	36	81	2.2	1.12	
	Error	317	635	2.0		
	Week	2	7.7		1.93	3.73
	Line	14	24		0.85	1.90
	Week/Line	20	49		1.24	1.88
Juveniles	Total	353	3156			
	Model	36	532	14.8	1.79	
	Error	317	2624	8.3		
	Week	2	145		8.76	3.27*
	Line	14	186		1.61	1.90
	Week/Line	20	200		1.21	1.88
Adults	Total	353	1395			
	Model	36	128	3.6	0.90	
	Error	317	1266	3.9		
	Week	2	4		0.53	3.27
	Line	14	86		1.54	1.90
	Week/Line	20	38		0.48	1.88
Sockeye	Total	353	225502084			
	Model	36	35855908	995997	1.66	
	Error	317	189646175	598252		
	Week	2	15236830		12.73	3.27*
	Line	14	6331059		0.76	1.90
	Week/Line	20	14288018		1.19	1.88

\*Denotes significance

Table 19. Comparison of catch per set and bottom depth for Juan de Fuca Strait<sup>1</sup>.

DEPTH <sup>2</sup> (fm)	N	CHINOOK			SOCKEYE
		ADULT	JACK	JUVENILE	
30-35	24	2.0	1.4	2.1	452.9
36-45	76	0.7	0.5	1.8	545.1
46-55	75	1.2	0.5	1.6	297.9
56-65	45	0.5	0.2	0.7	360.2
66-75	48	0.5	0.6	0.9	233.9
76-85	24	0.3	0.4	0.3	314.3
86-95	24	0.4	0.1	0.6	311.3
96-105	23	0.1	0.3	0.3	271.9
106-115	15	0.5	0.0	0.1	351.8
116-125	3	0.3	-	-	73.0
30-65	220	1.0	0.6	1.6	412.9
66-125	137	0.4	0.3	0.6	277.3

<sup>1</sup>A 30 fm compliance boundary is in effect for the commercial seine fleet in Juan de Fuca Strait.

<sup>2</sup>mean catch per set, all weeks combined

Table 20. Summary of chinook biological samples collected during the seine fishery in Juan de Fuca Strait.

Length (cm)	Juveniles			Length (cm)	Jacks			Length (cm)	Adults		
	M	F	U <sup>1</sup>		M	F	U		M	F	U
35	1	0	0	43	6	2	0	58	11	13	0
36	3	0	0	44	6	4	0	59	14	17	3
37	0	0	0	45	8	6	0	60	21	15	2
38	4	1	0	46	16	4	1	61	12	14	0
39	2	0	0	47	9	3	1	62	9	17	0
40	6	1	0	48	10	2	0	63	8	6	2
41	4	2	0	49	13	6	0	64	10	10	5
42	6	7	1	50	19	8	1	65	7	10	1
				51	18	8	2	66	8	6	4
				52	15	7	1	67	9	2	1
				53	17	10	3	68	6	7	2
				54	25	12	1	69	8	4	0
				55	10	14	3	70	3	2	2
				56	16	16	4	71	2	0	0
				57	13	18	1	72	0	0	0
								73	3	0	1
								74	1	1	1
								75	6	1	0
								76	2	4	1
								77	3	0	0
								78	0	2	1
								79	3	1	1
								80	2	5	3
								81	1	2	2
								82	4	2	0
								83	0	2	1
								84	2	4	1
								85	5	2	0
								86	4	4	0
								87	1	8	0
								88	4	4	0
								89	2	4	1
								90	1	5	0
								91	1	5	0
								92	3	3	3
								93	1	2	2
								94	2	1	0
								95	2	0	0
								96	4	1	0
								97	1	1	0
								98	3	0	0
								99	1	0	1
								100	2	0	0
								101	0	1	0
								102	1	0	0

Table 20 (cont.)

Length (cm)	Juveniles			Length (cm)	Jacks			Length (cm)	Adults		
	M	F	U <sup>1</sup>		M	F	U		M	F	U
								103	1	0	0
								104	1	0	1
								105	1	0	0
								106	0	0	1
								107	0	0	0
								108	1	0	0
								109	0	0	0
								110	1	0	0
								111	0	0	1
Total:	26	11	1		201	120	18		198	188	44
Weighted Mean Length	39.6	41.3			50.9	52.4			71.6	70.4	
Percent Mature	69	100	-		28	-	-		-	-	-
Sex Ratio (% males)		70%				63%				51%	

<sup>1</sup>Fish could not be sampled for sex and maturity.

Table 21. Summary of chinook biological samples<sup>1</sup> collected at the processing plants in Vancouver during the seine fishery in Juan de Fuca Strait.

Length (cm)	Juveniles				Length (cm)	Jacks			
	M	F	U <sup>2</sup>	T		M	F	U	T
33	1	0	0	1	43	20	3	0	23
34	0	0	0	0	44	10	3	0	13
35	1	0	0	1	45	17	8	0	25
36	1	0	0	1	46	17	4	0	21
37	8	1	0	9	47	11	3	0	14
38	4	2	0	6	48	10	5	0	15
39	8	1	0	9	49	13	8	0	21
40	11	3	0	14	50	11	4	0	15
41	12	2	0	14	51	11	2	0	13
42	18	3	0	21	52	10	2	0	12
					53	7	5	0	12
					54	10	2	0	12
					55	3	2	0	5
					56	3	0	0	3
					57	5	3	0	8
TOTAL:	64	12	0	76		158	54	0	212
Weighted Mean Length	39.8	40.0				48.3	48.8		
Percent Immature:	42	100				29	100		
Sex Ratio (% males)	84%					74%			

<sup>1</sup>For purposes of comparison with the survey data the cannery sample data was assigned to the jack and juvenile categories according to the criteria used for the survey data.

<sup>2</sup>Fish not sampled for sex and maturity.

Table 22. Available fishing time by fishery opening for Juan de Fuca Strait<sup>1</sup>.

Date	Time of opening <sup>2</sup>	Available fishing hours
Aug. 13	0700	12.0
14	0700	12.0
20	0700	12.0
21	0700	12.0
22	0700	12.0
26	0700	12.0
27	0700	12.0

<sup>1</sup>Statistical areas 20-1, 20-3, and 20-4.

<sup>2</sup>Universal time

Table 23. Average number of sets made per day per vessel by fishery line in Juan de Fuca Strait<sup>1</sup>.

FISHING LINE	N	SETS/DAY <sup>2</sup>
1	76	5.6(2.4)
2	59	8.4(2.6)
3	32	8.9(3.6)
4	30	9.5(2.3)
5	26	9.3(2.7)
6	26	9.6(2.7)
7	26	8.7(2.8)
8	29	10.3(2.6)
9	21	9.7(2.5)
10	7	9.3(2.7)
11	4	12.7(2.9)
14	3	14.0(3.5)

<sup>1</sup>mean number of sets made, all weeks combined.

<sup>2</sup>Standard deviation in parenthesis.

Table 24. Fleet dynamics in Juan de Fuca Strait fishery.

GEAR COUNT<sup>a</sup>

DATE	TIME	BONILLA PT. (LINE 1,2)	OWEN PT. (LINE 3-9)	SOMBRIO PT. <sup>c</sup> (LINE 10-12)	SHERINGHAM PT. (LINE 13-20)
Aug. 20 <sup>b</sup>	0900	129	18	15	-
21	0900	108	8	9	-
22	0900	135	40	9	-

<sup>a</sup>Radar gear counts recorded by Fishery officers in Patrol Vessels

<sup>b</sup>Gillnet fleet was present among seine fleet from 10:30 onwards.

<sup>c</sup>Past Owen Pt. vessels do not align along fishing lines as rigidly as in the first lines.

Table 25. Comparison of bootstrap estimates and sales slip data (numbers caught) by week for Juan de Fuca Strait.

WEEK	CHINOOK			SOCKEYE
	ADULT	JACK	JUVENILE	
Aug 13-14	1,119 <sup>a</sup>	886	2,548	944,790
	(220-3,010) <sup>b</sup>	(261-1,931)	(1,048-4,470)	(402,204-2,010,617)
	1,650 <sup>c</sup>	2,697	d	746,063
Aug 20-22	3,311	2,362	3,039	1,918,811
	(922-7,800)	(1,303-4,008)	(1,536-5,389)	(1,173,817-2,812,015)
	2,759	932	d	2,056,937
Aug 26-27	2,362	1,338	3,533	297,791
	(1,303-4,008)	(322-3,043)	(1,072-6,112)	(141,921-508,498)
	1,342	1,096	d	382,406
TOTAL	6,792	4,175	9,120	3,161,392
	(3,552-11,364)	(1,953-7,047)	(5,362-12,691)	(2,000,000-4,447,463)
	5,753	4,743	d	3,186,516

<sup>a</sup>Bootstrap estimates.

<sup>b</sup>Upper and lower 95% confidence limits.

<sup>c</sup>Sales slip data collected by the Dept. of Fisheries and Oceans (Annual Summary, 1990).

<sup>d</sup>No data recorded for juveniles in sales slip data.

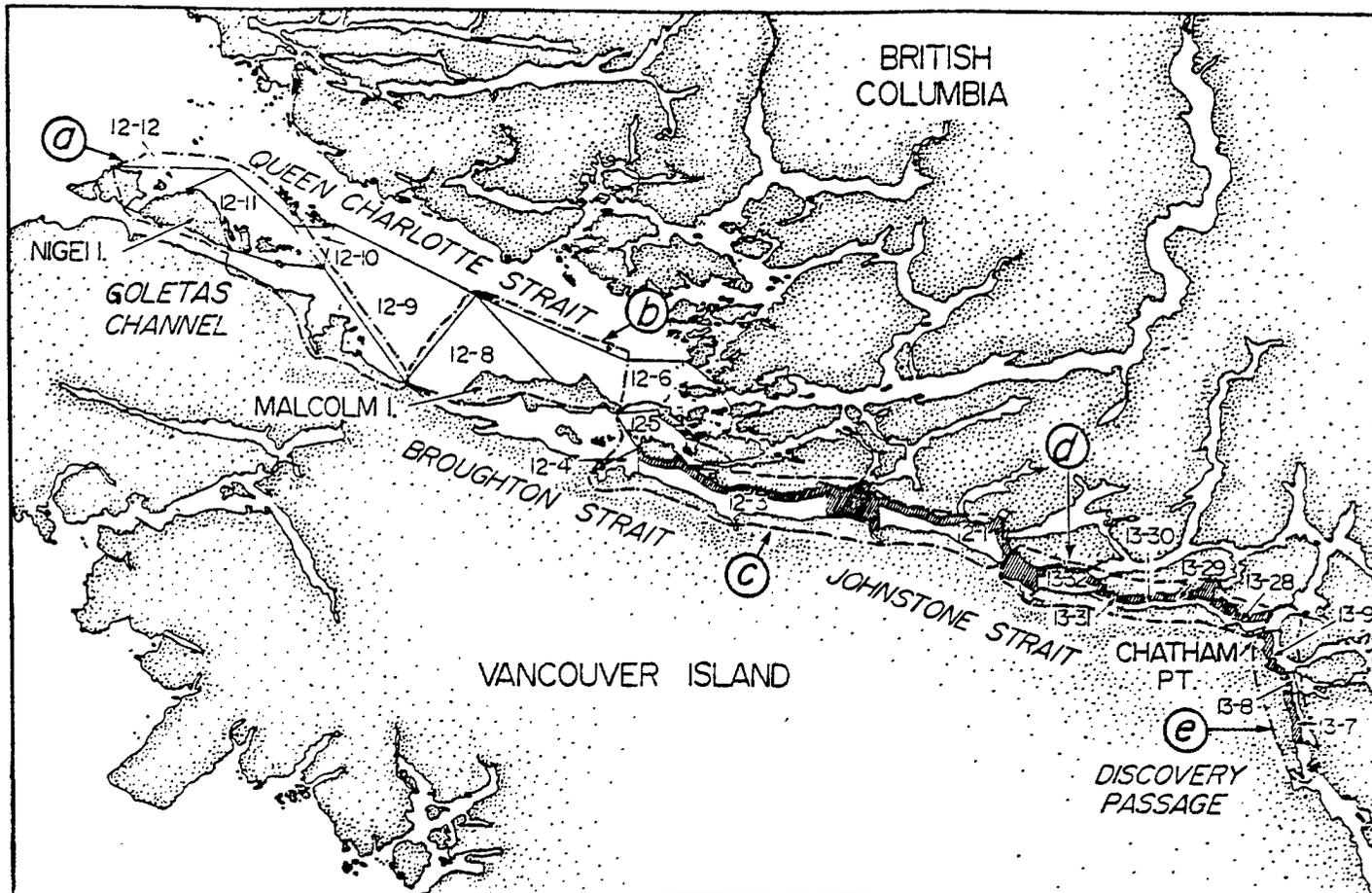
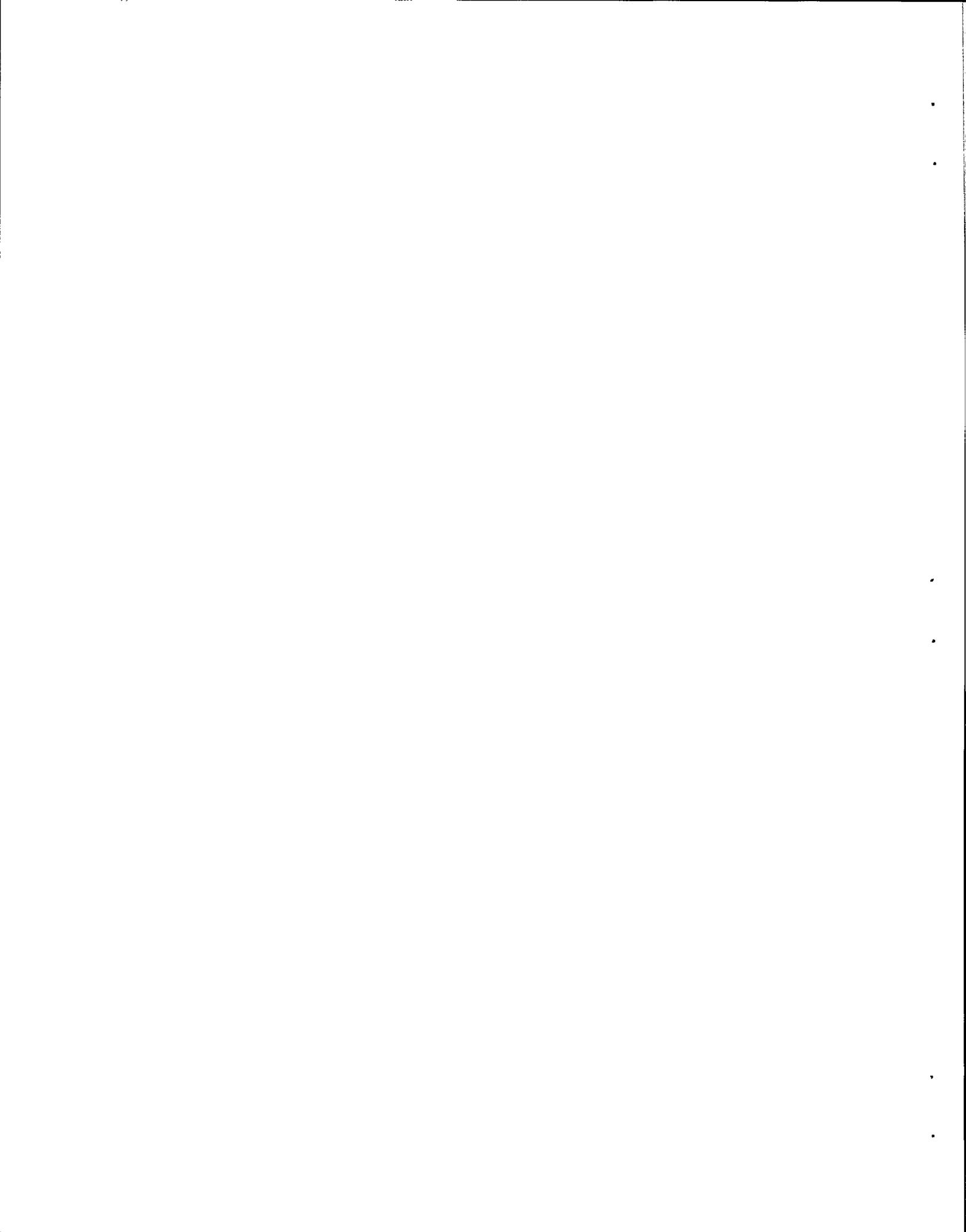


Fig. 1. Locations of management areas and study areas (a - Gordon Group, b - North Shore, c - Upper Johnstone Strait, d - Lower Johnstone Strait, e - Discovery Passage). Hatched sections represent areas closed to commercial fishing.



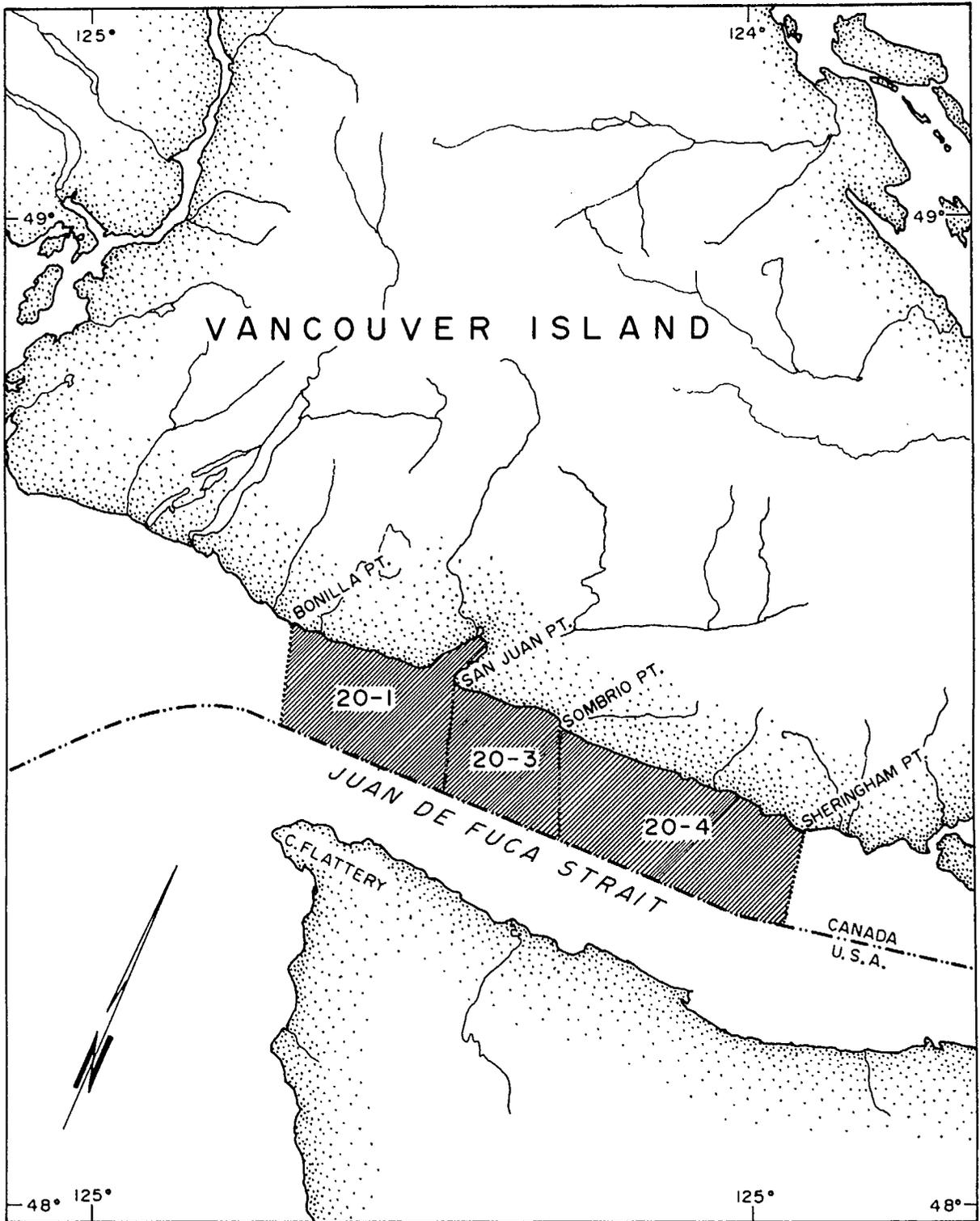
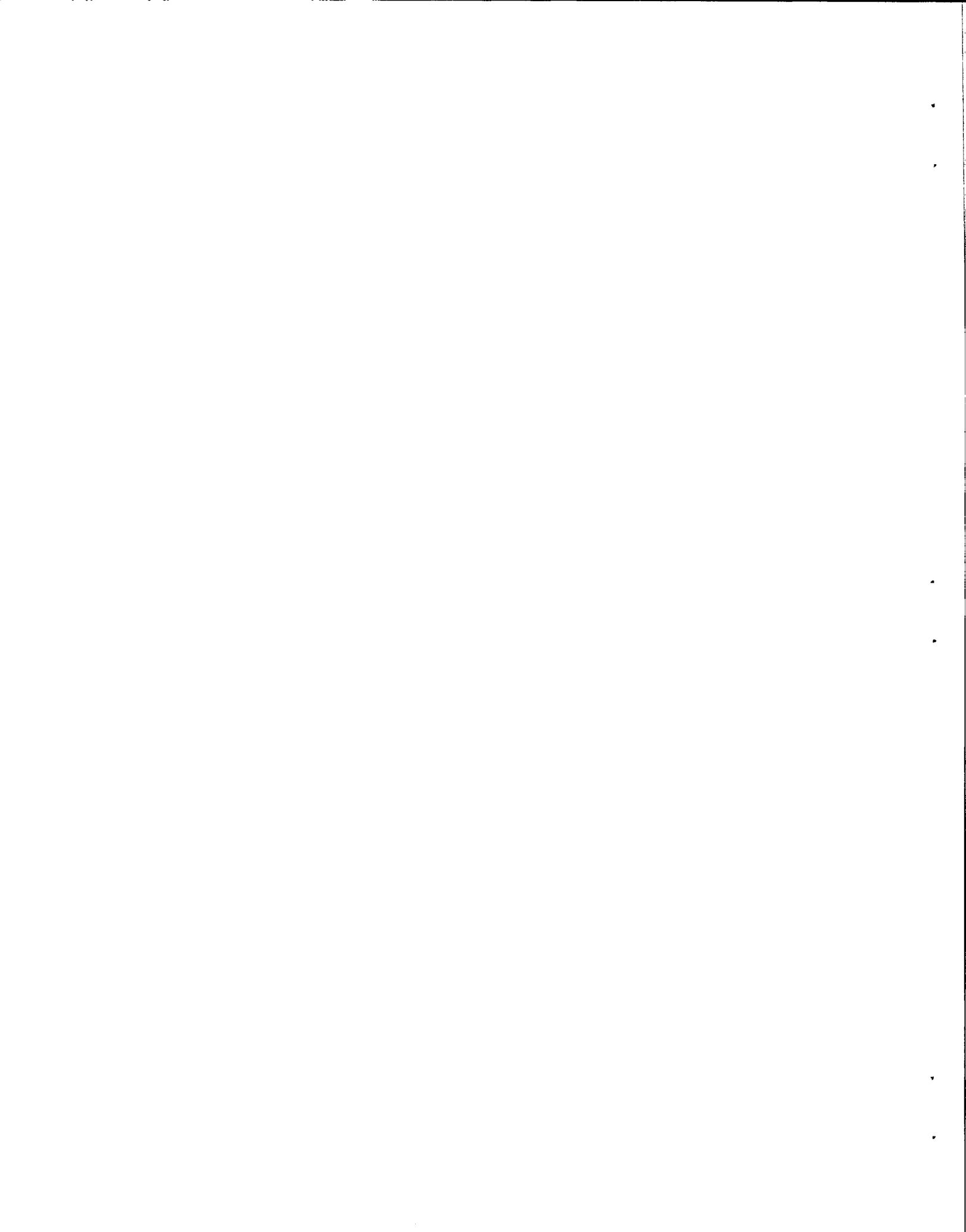


Fig. 2 Study areas in Juan de Fuca Strait sockeye seine fishery.



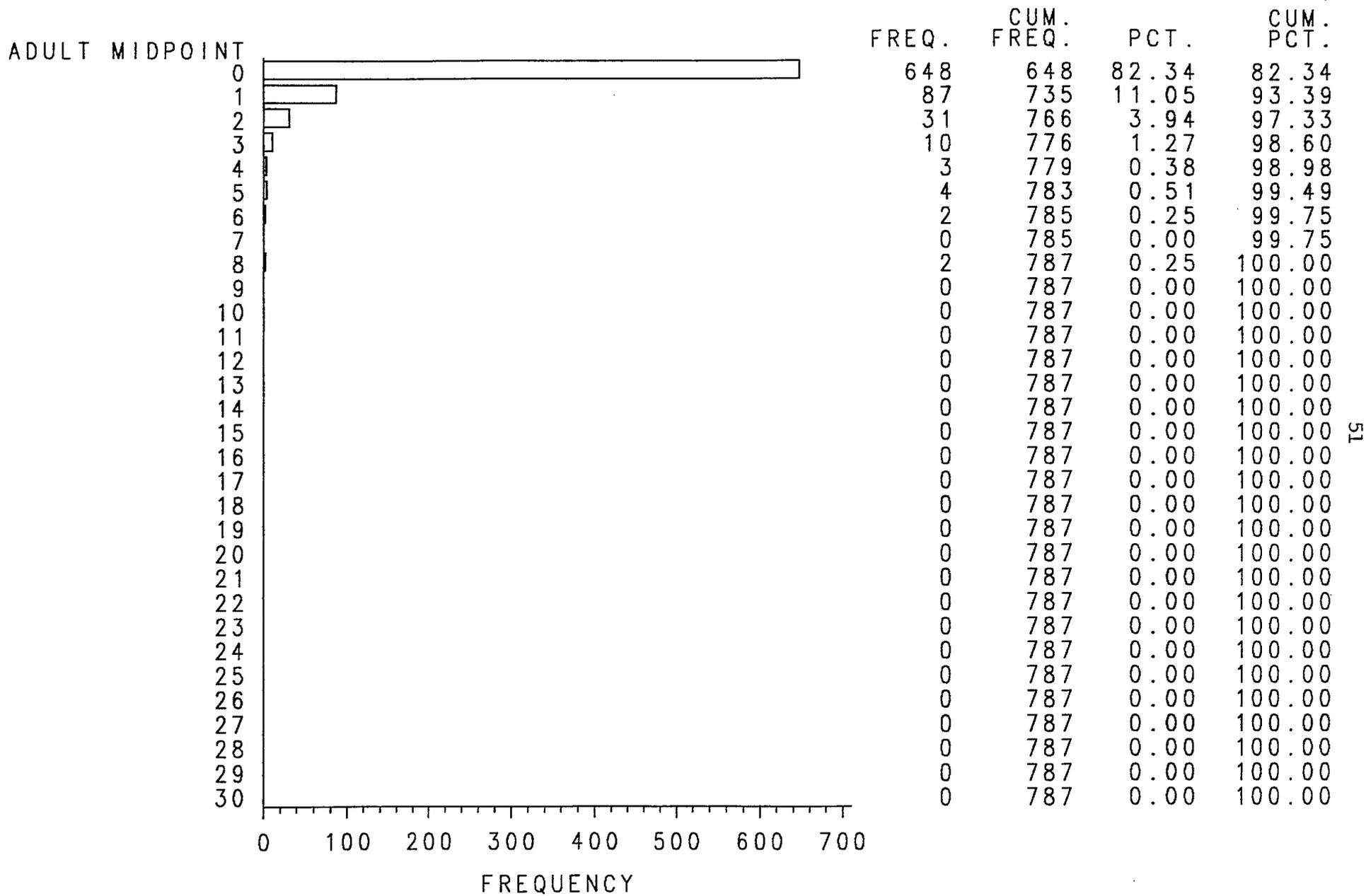
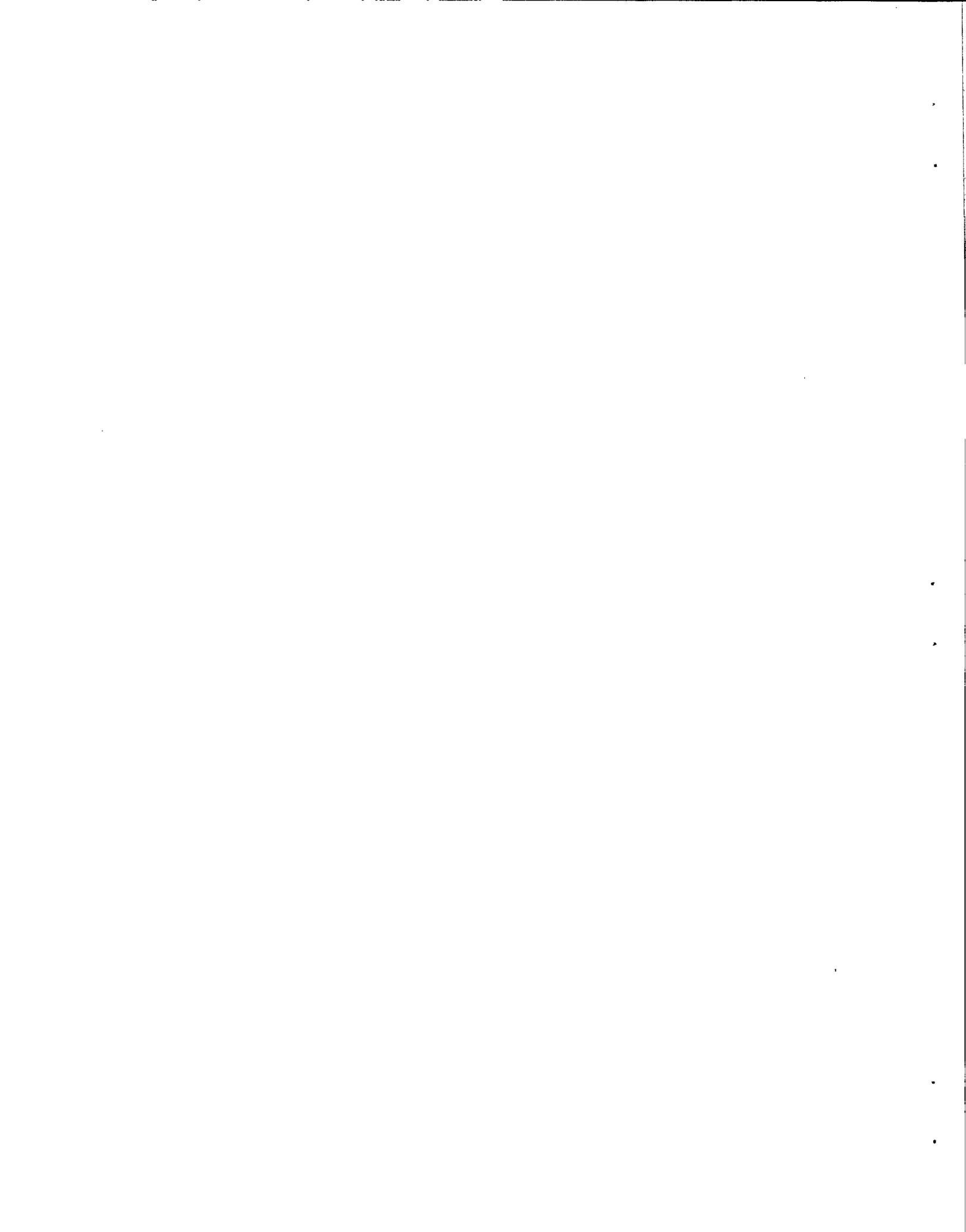


Fig.3 Catch/set for adult chinook in Johnstone Strait, 1990



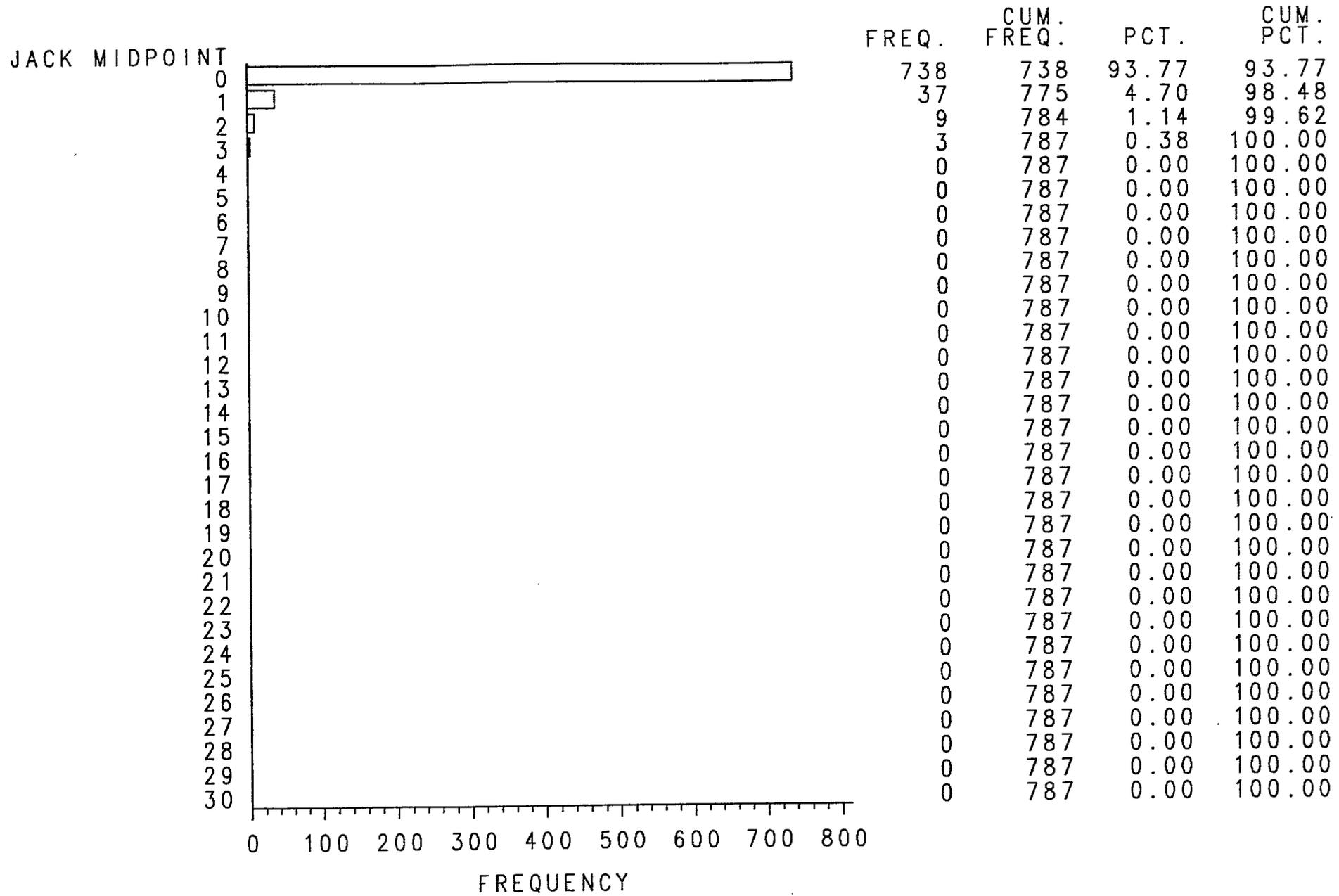
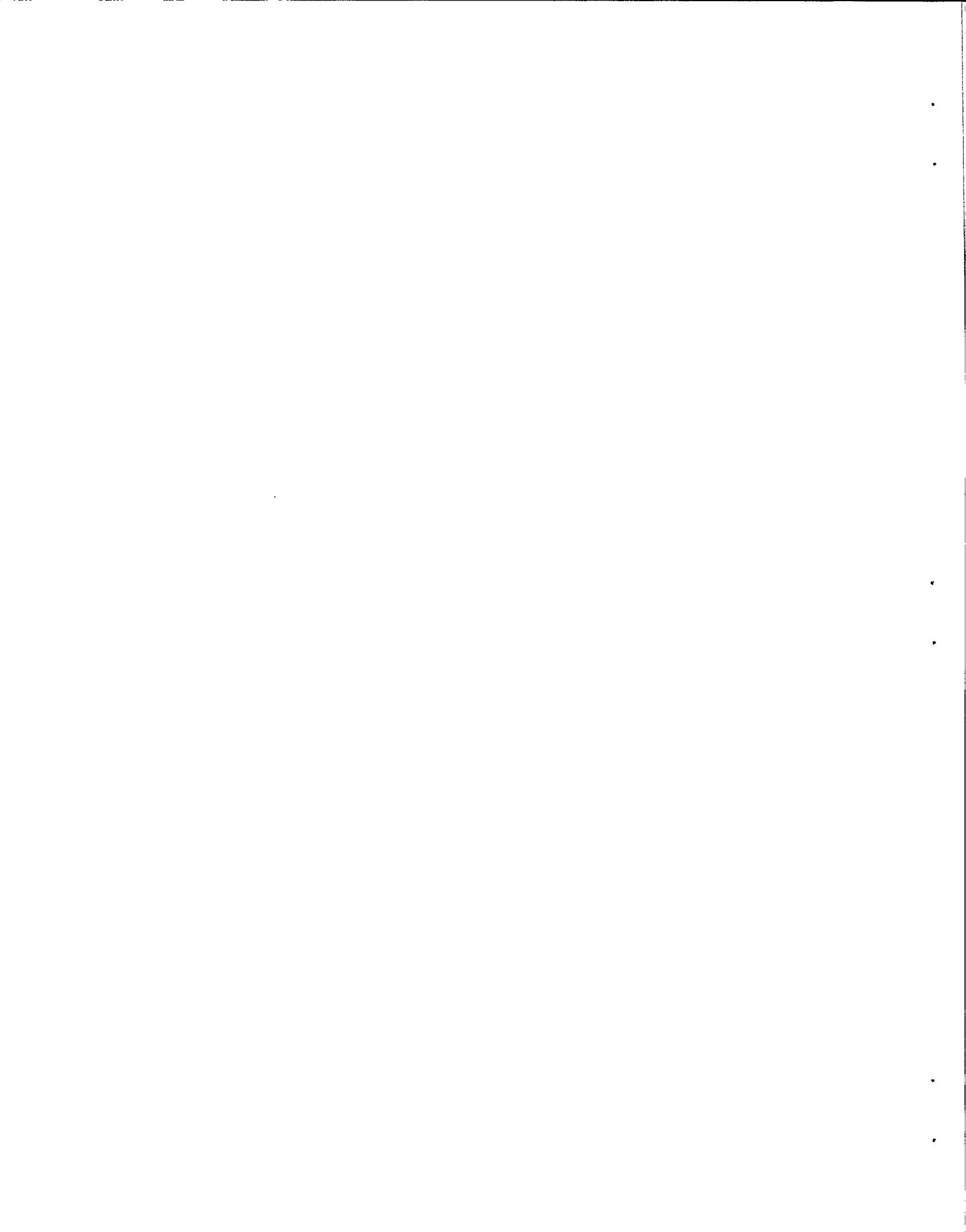


Fig.4 Catch/set for jack chinook in Johnstone Strait, 1990



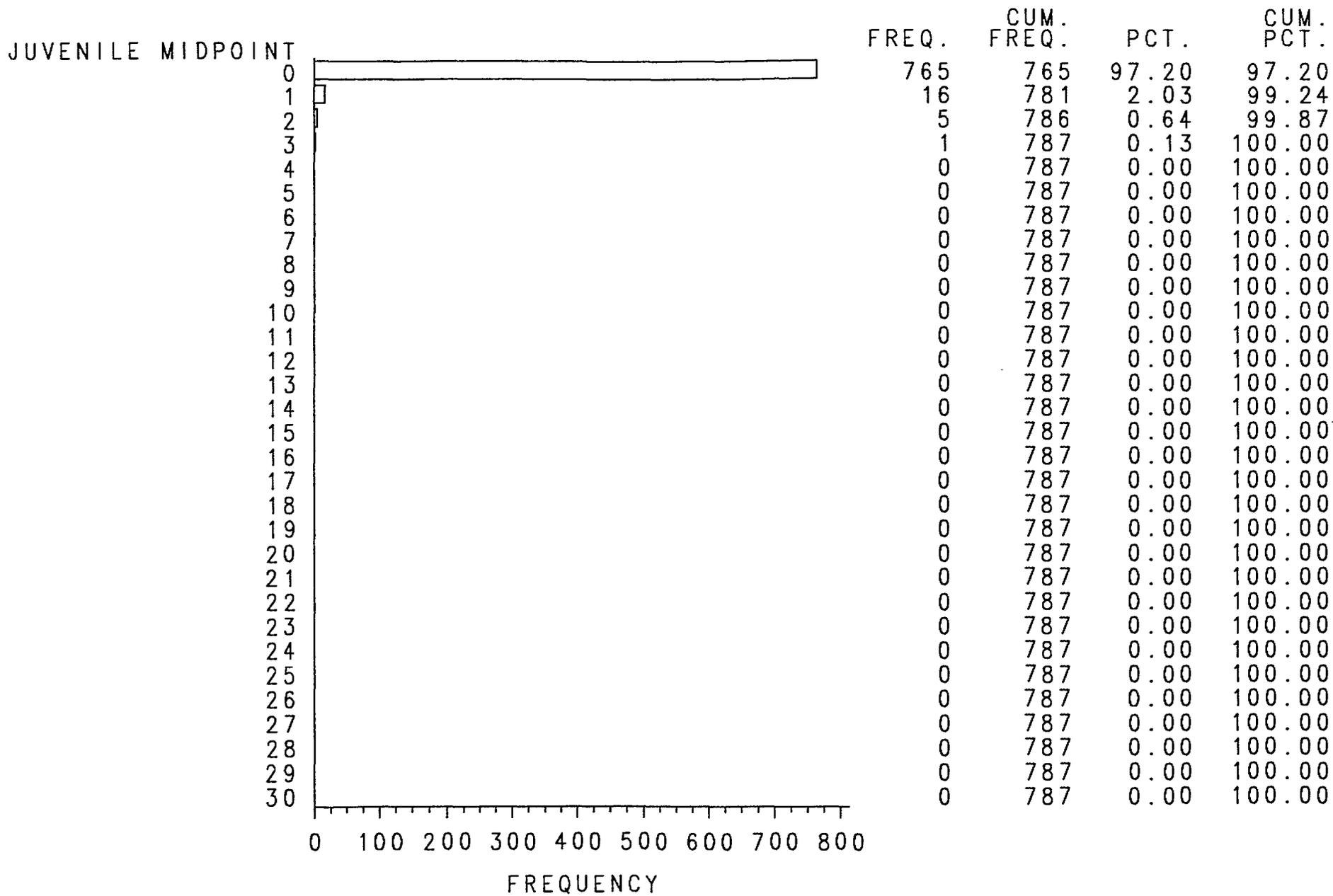
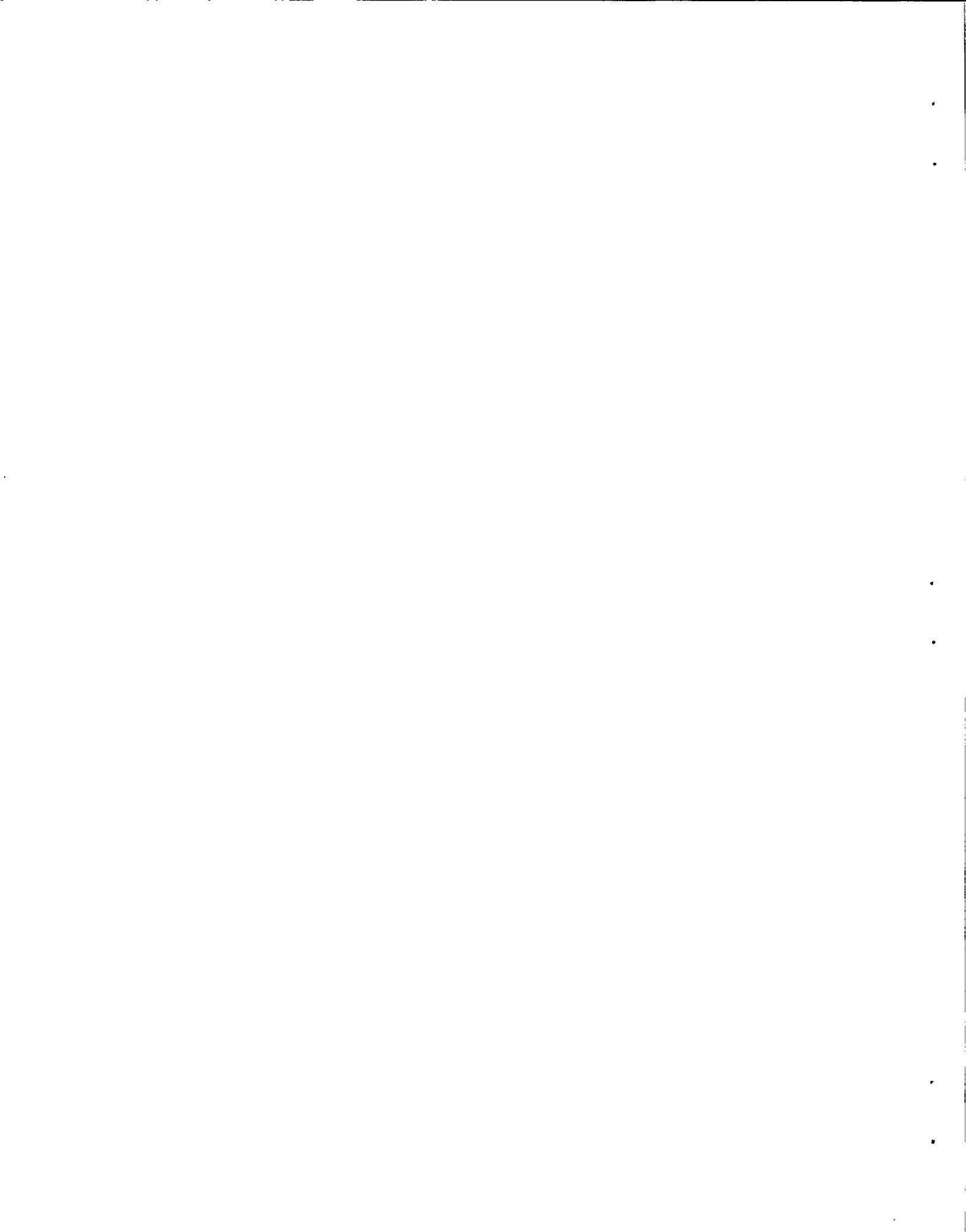
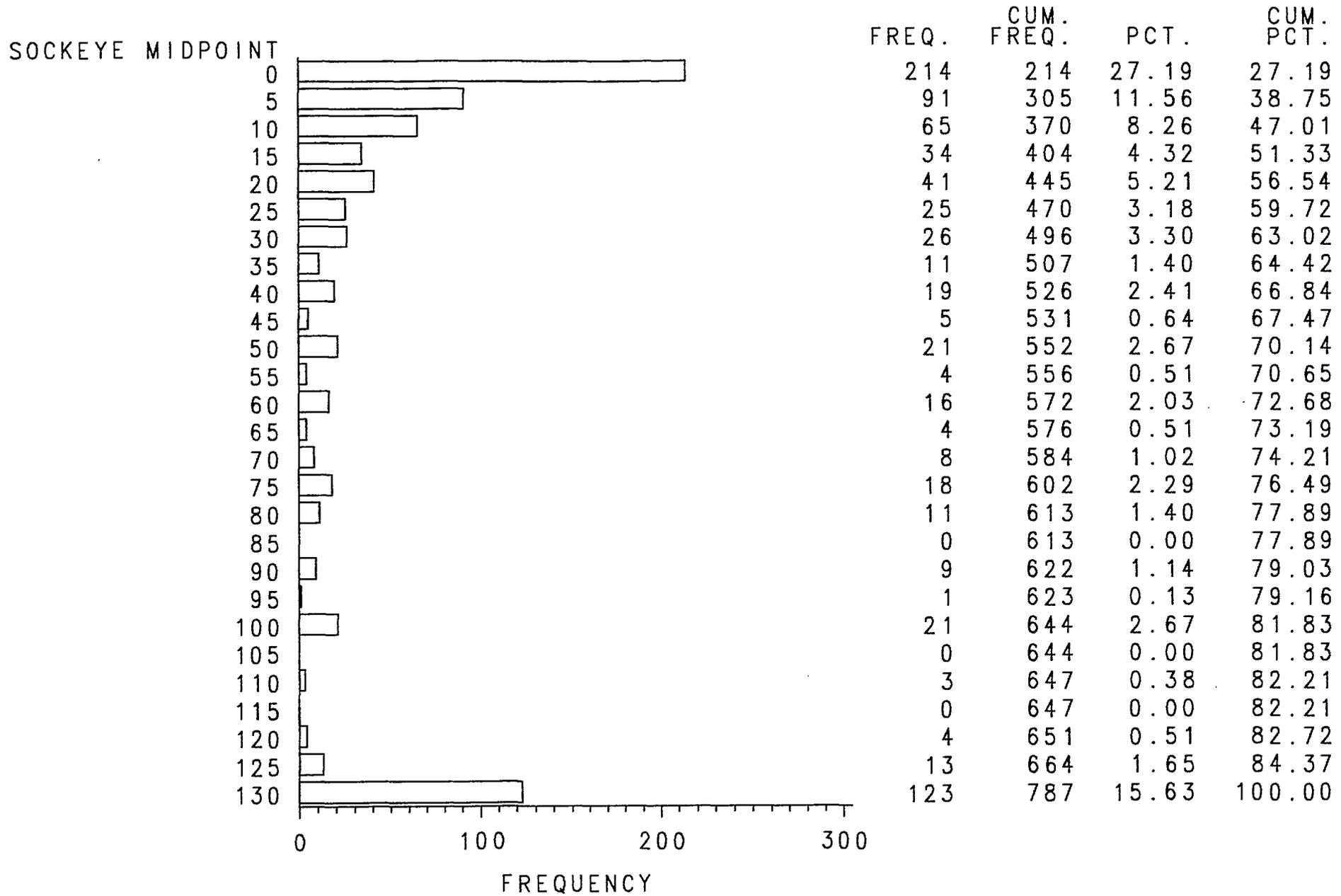


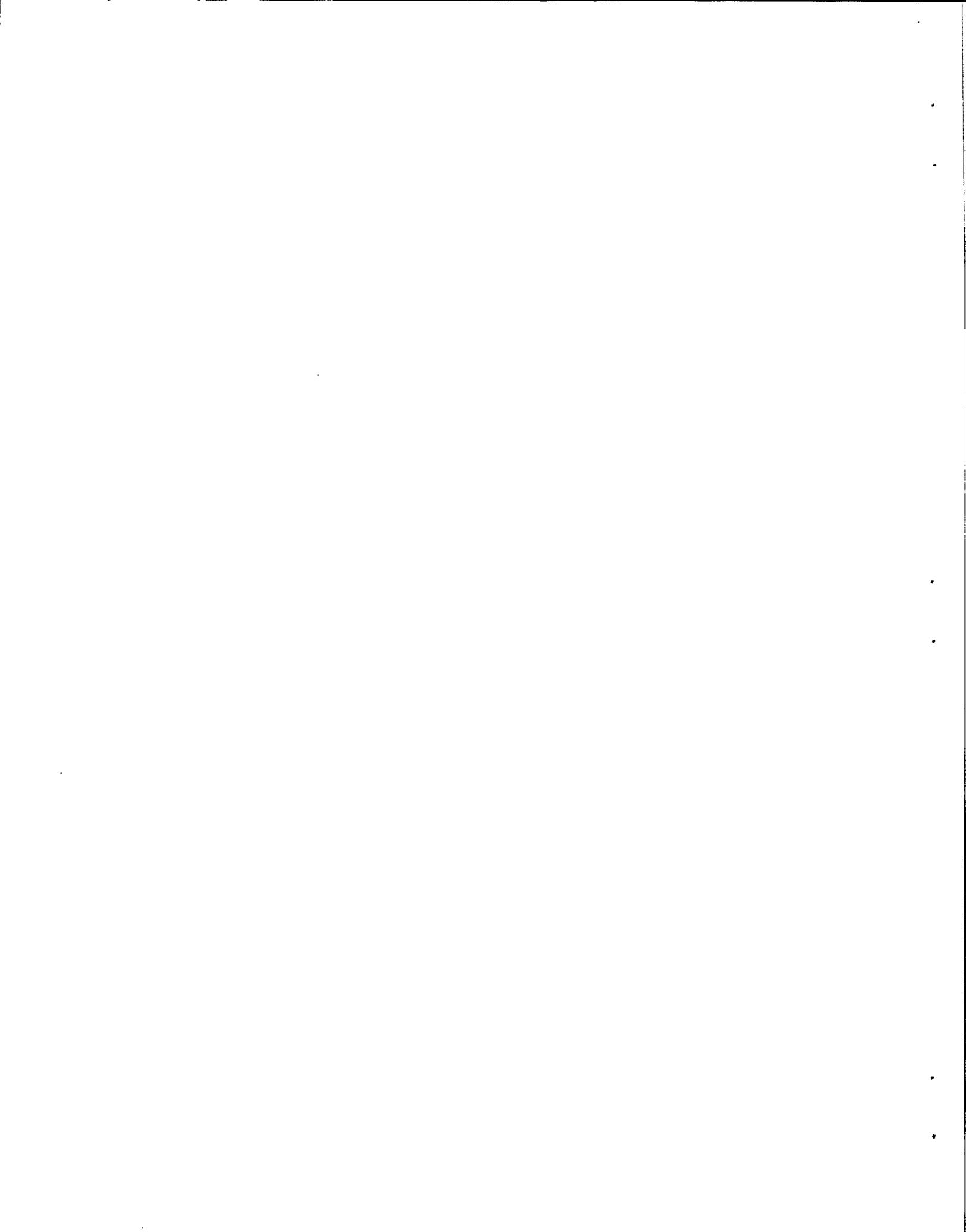
Fig.5 Catch/set for juvenile chinook in Johnstone Strait, 1990





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Fig.6 Catch/set for sockeye in Johnstone Strait, 1990



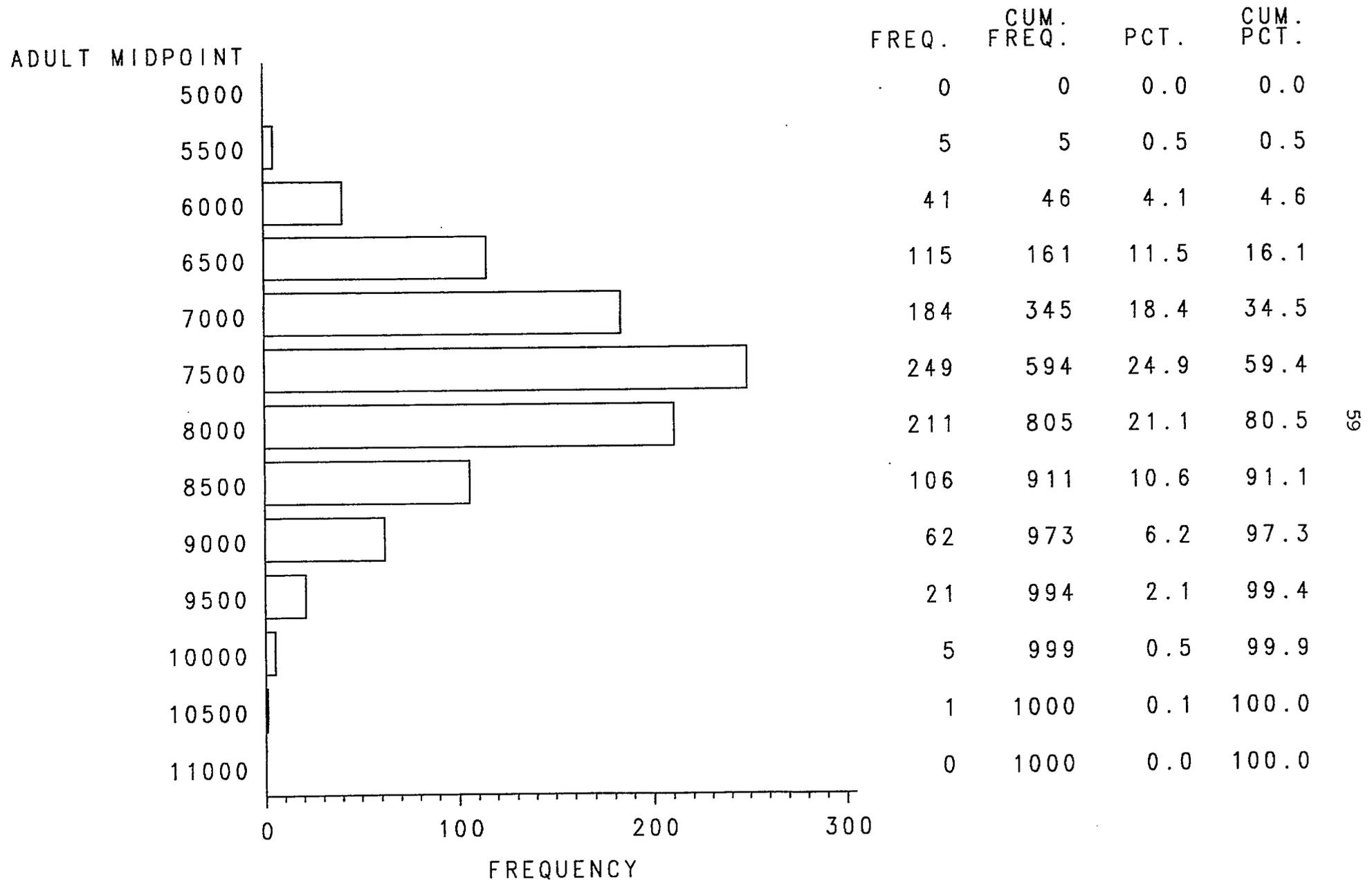
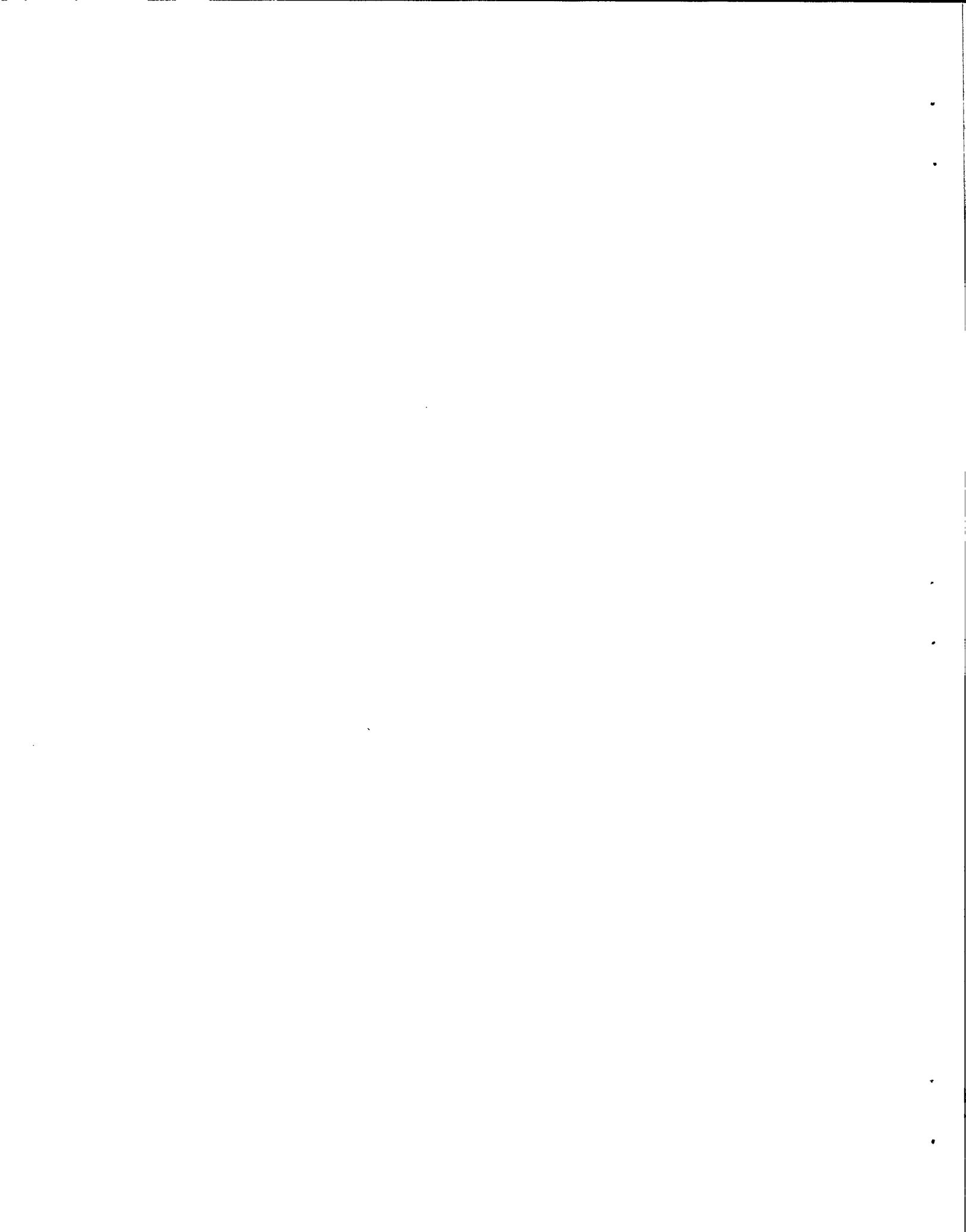


Fig.7 Bootstrap estimates for adult chinook in Johnstone Strait, 1990



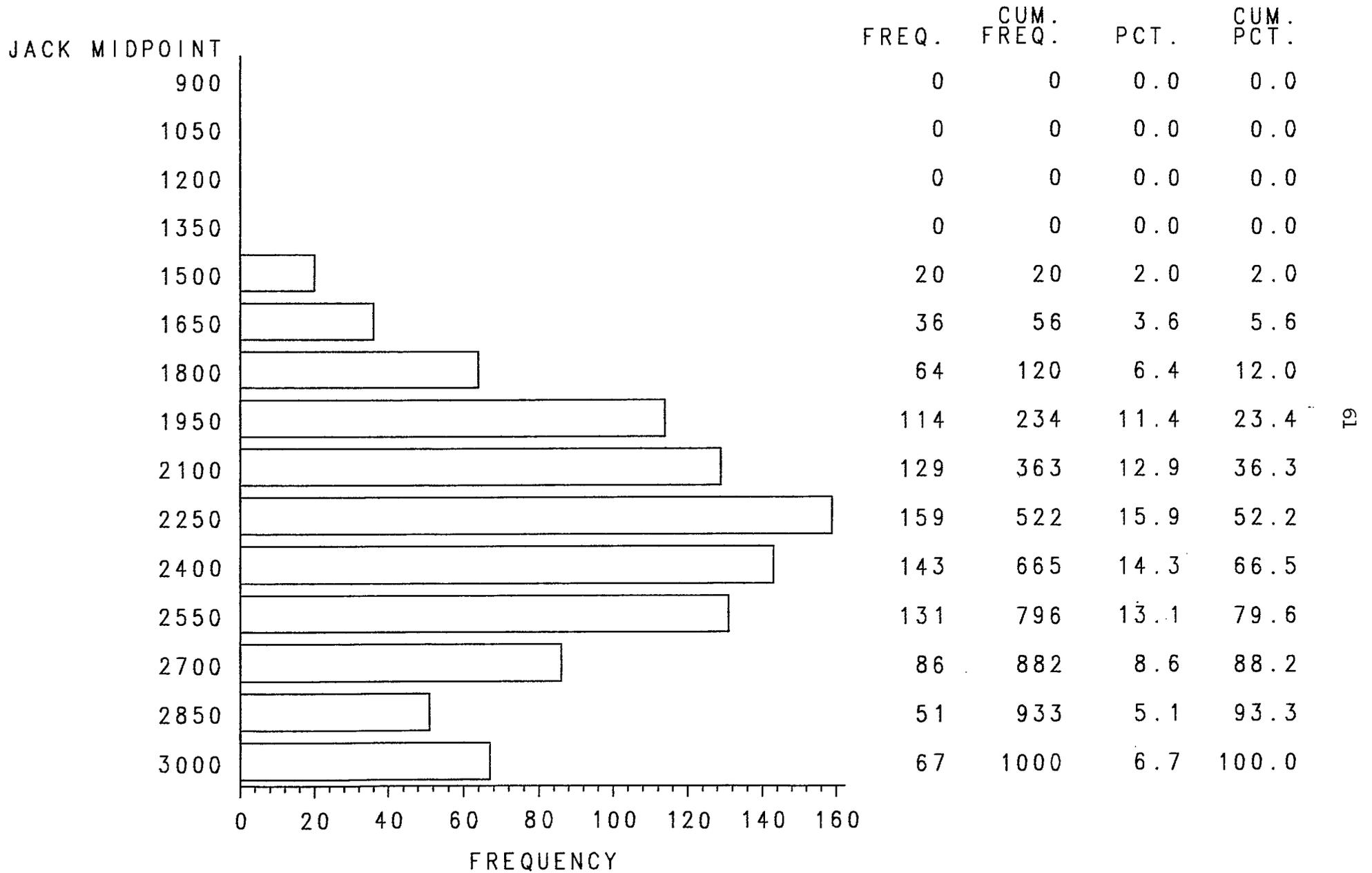
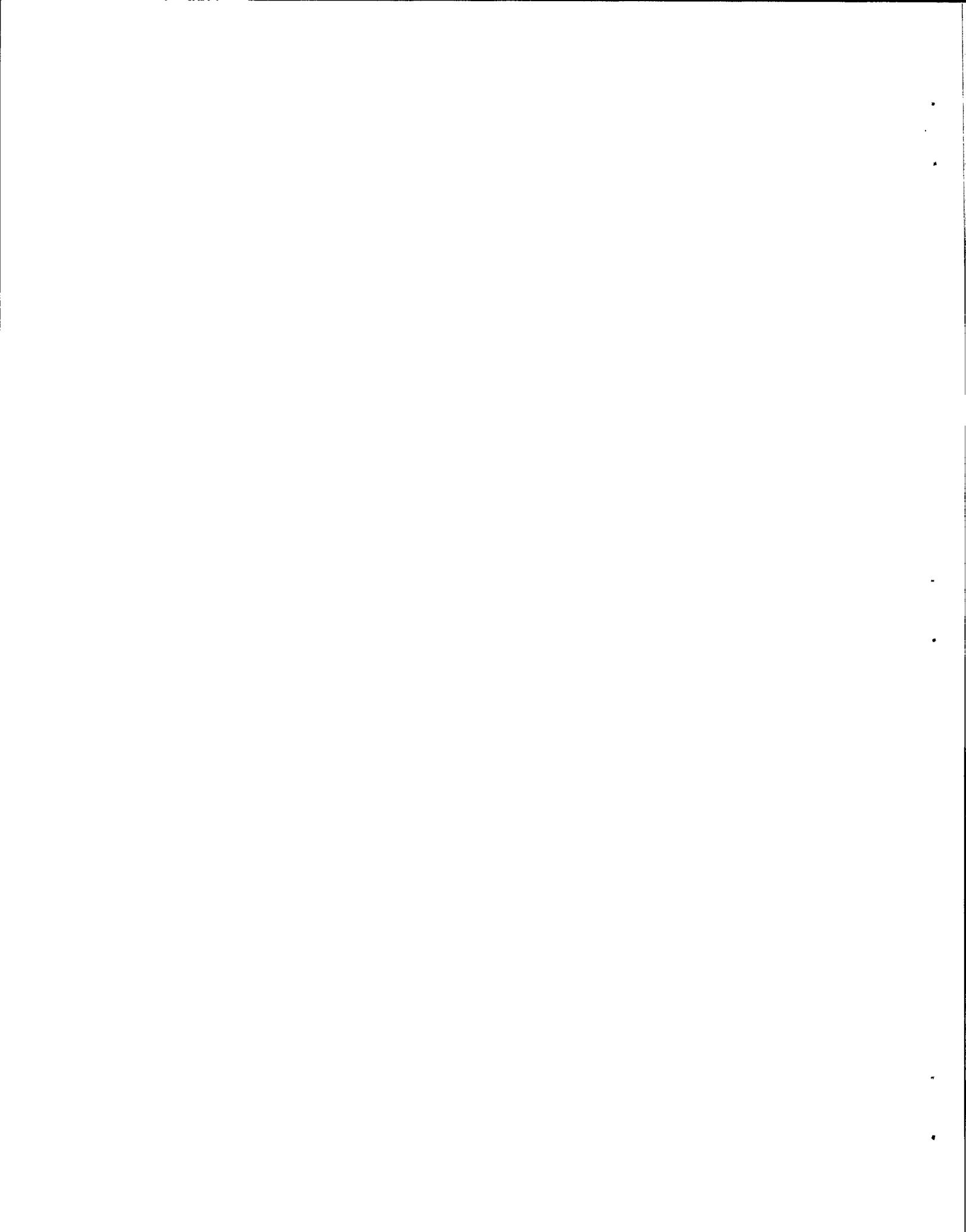


Fig.8 Bootstrap estimates for jack chinook in Johnstone Strait, 1990



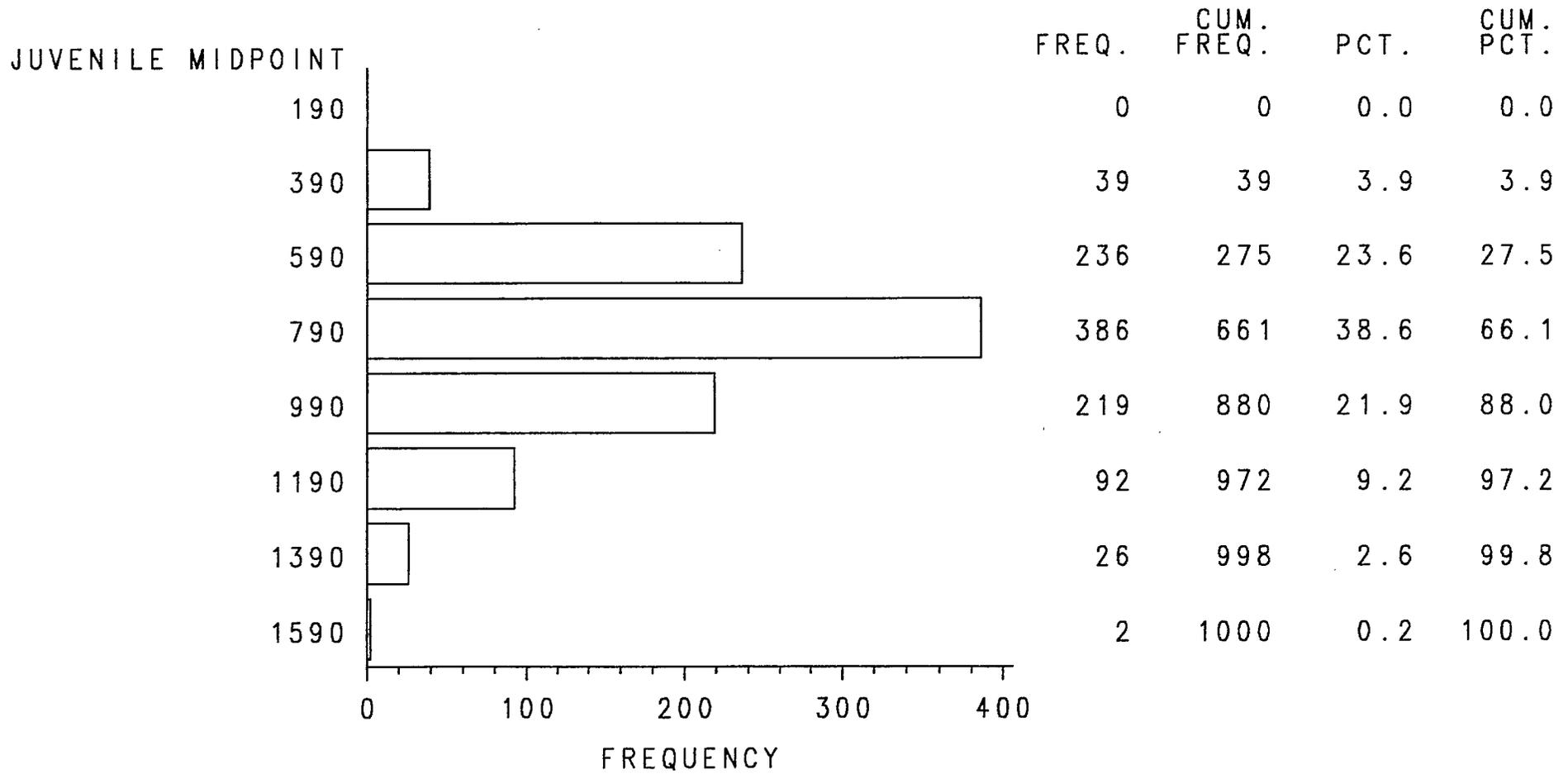
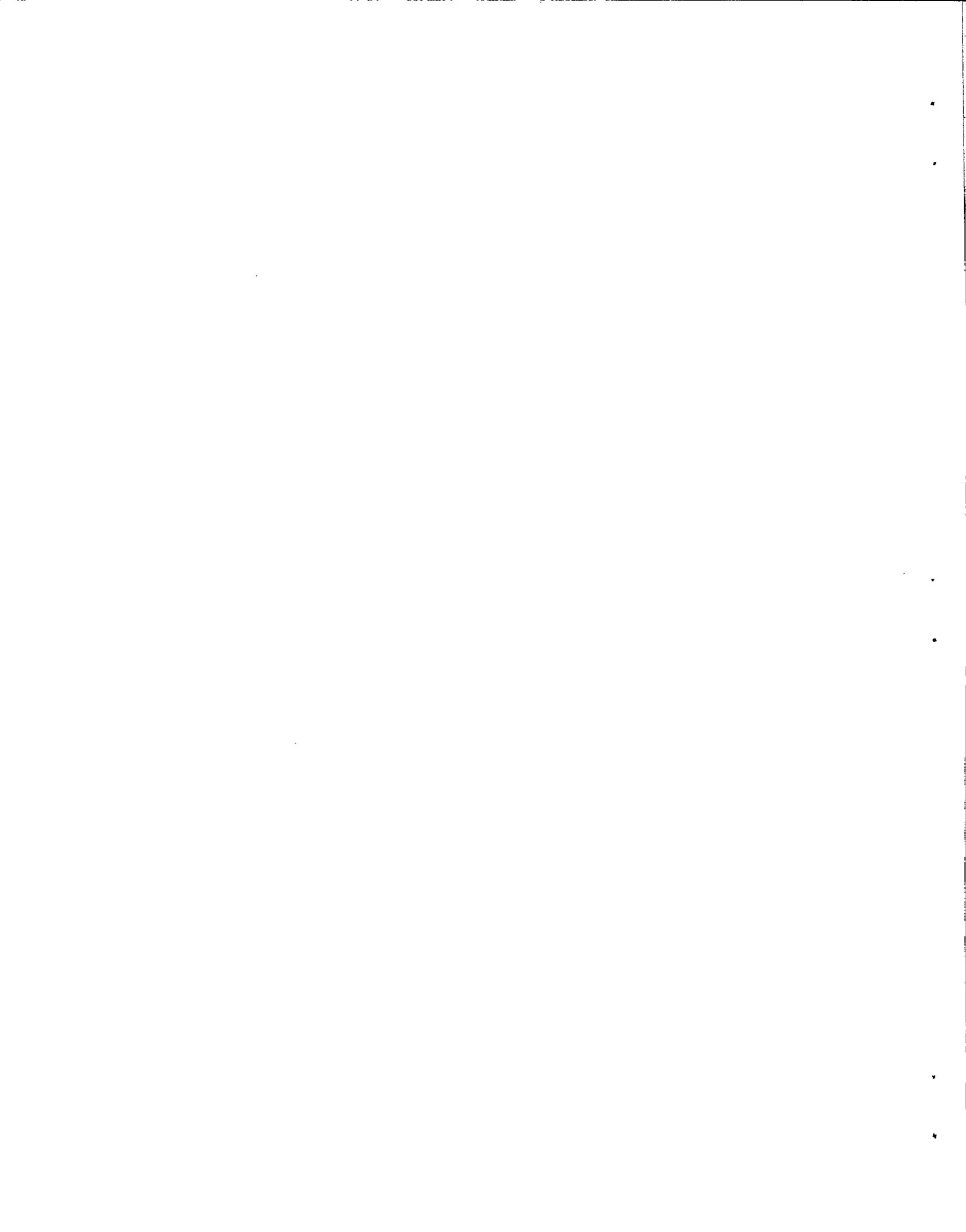


Fig.9 Bootstrap estimates for juvenile chinook in Johnstone Strait, 1990



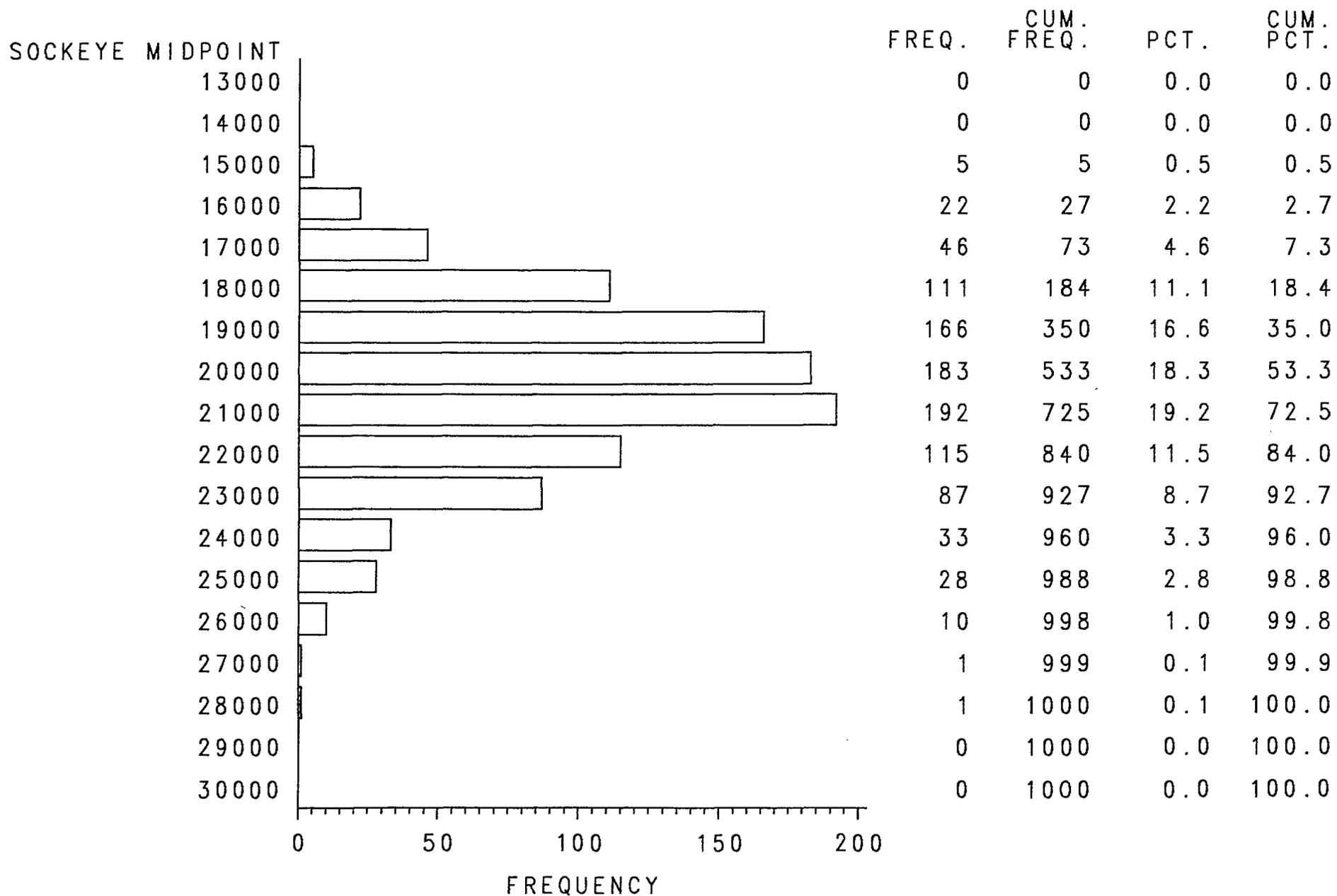
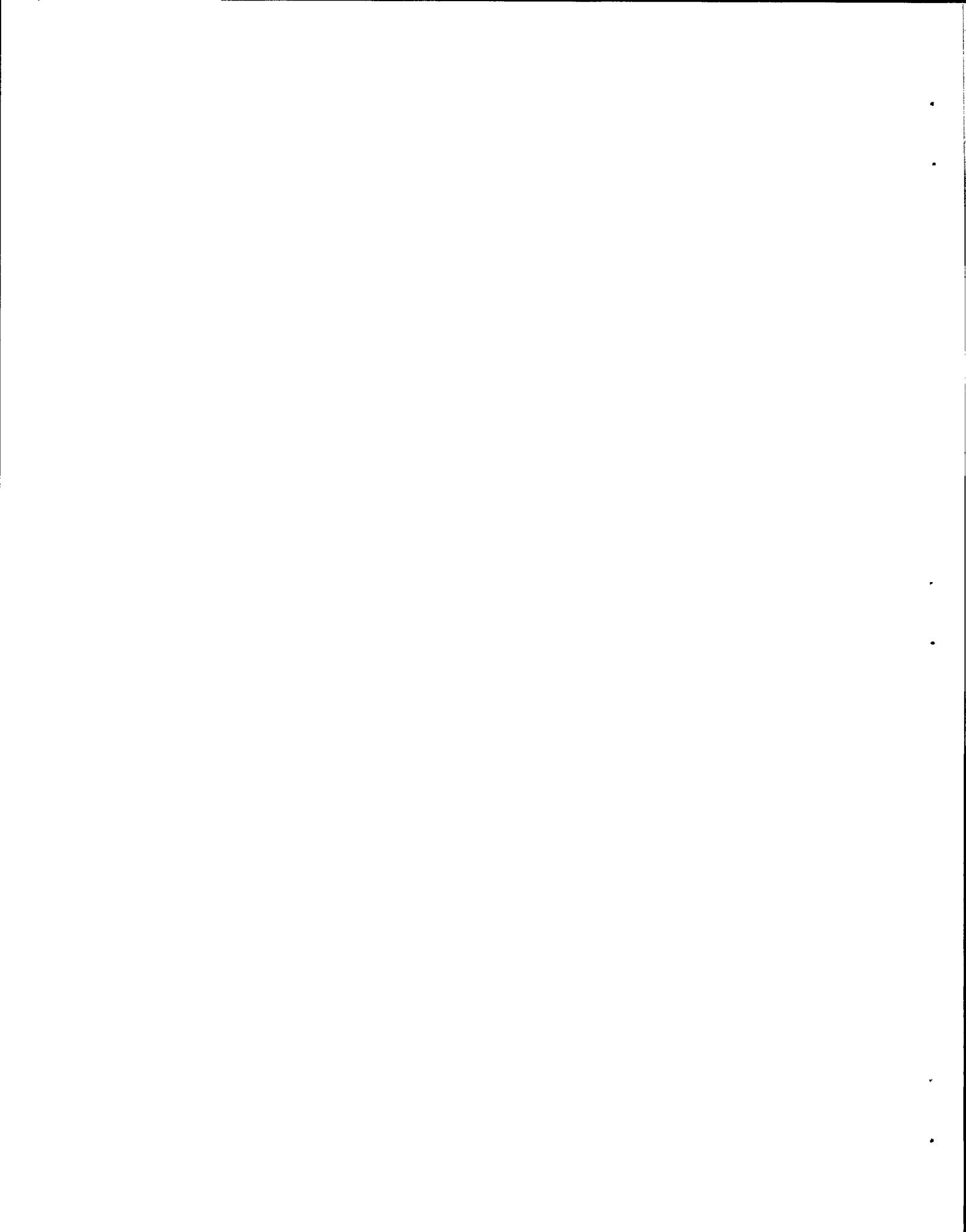


Fig.10 Bootstrap estimates for sockeye in Johnstone Strait, 1990



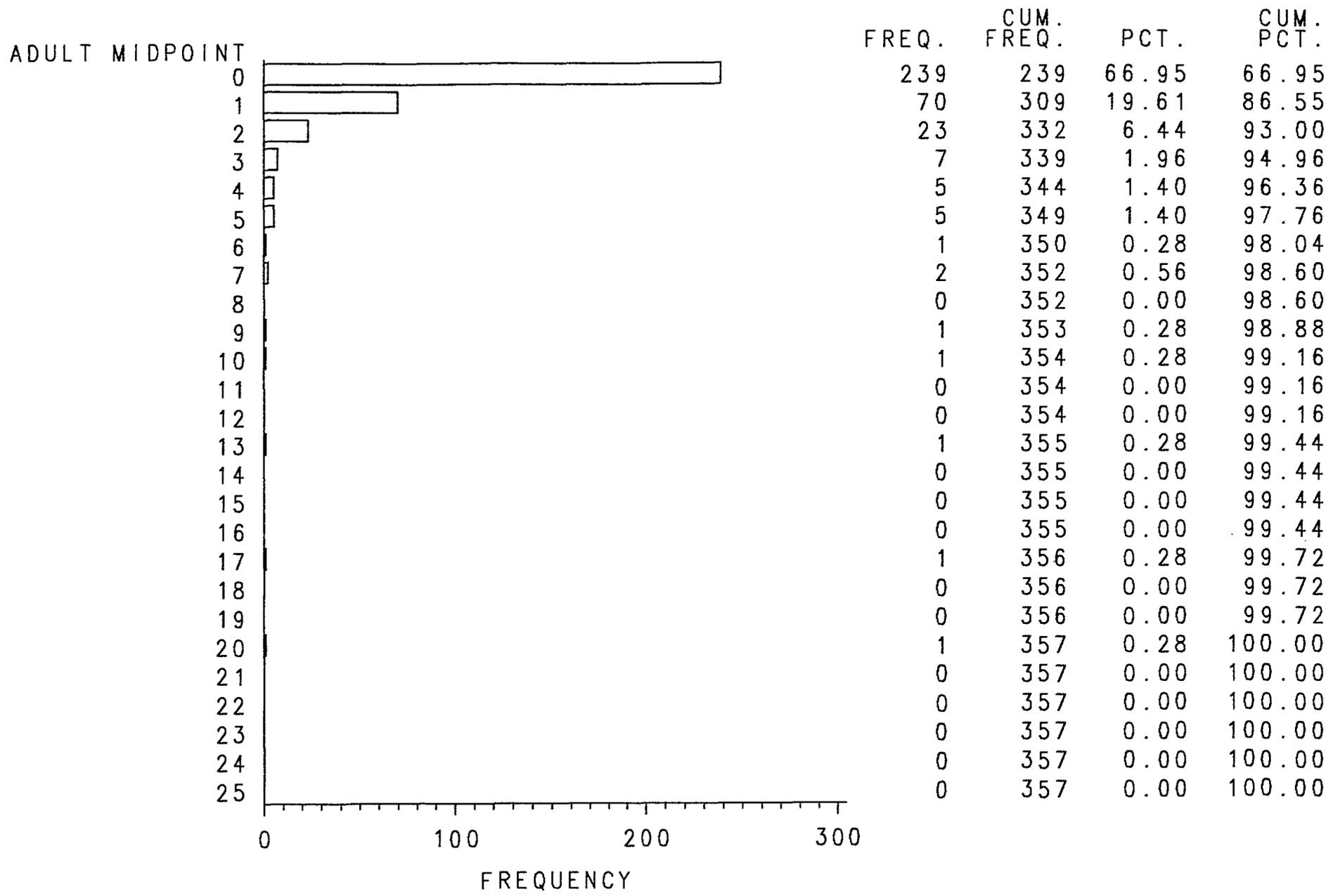
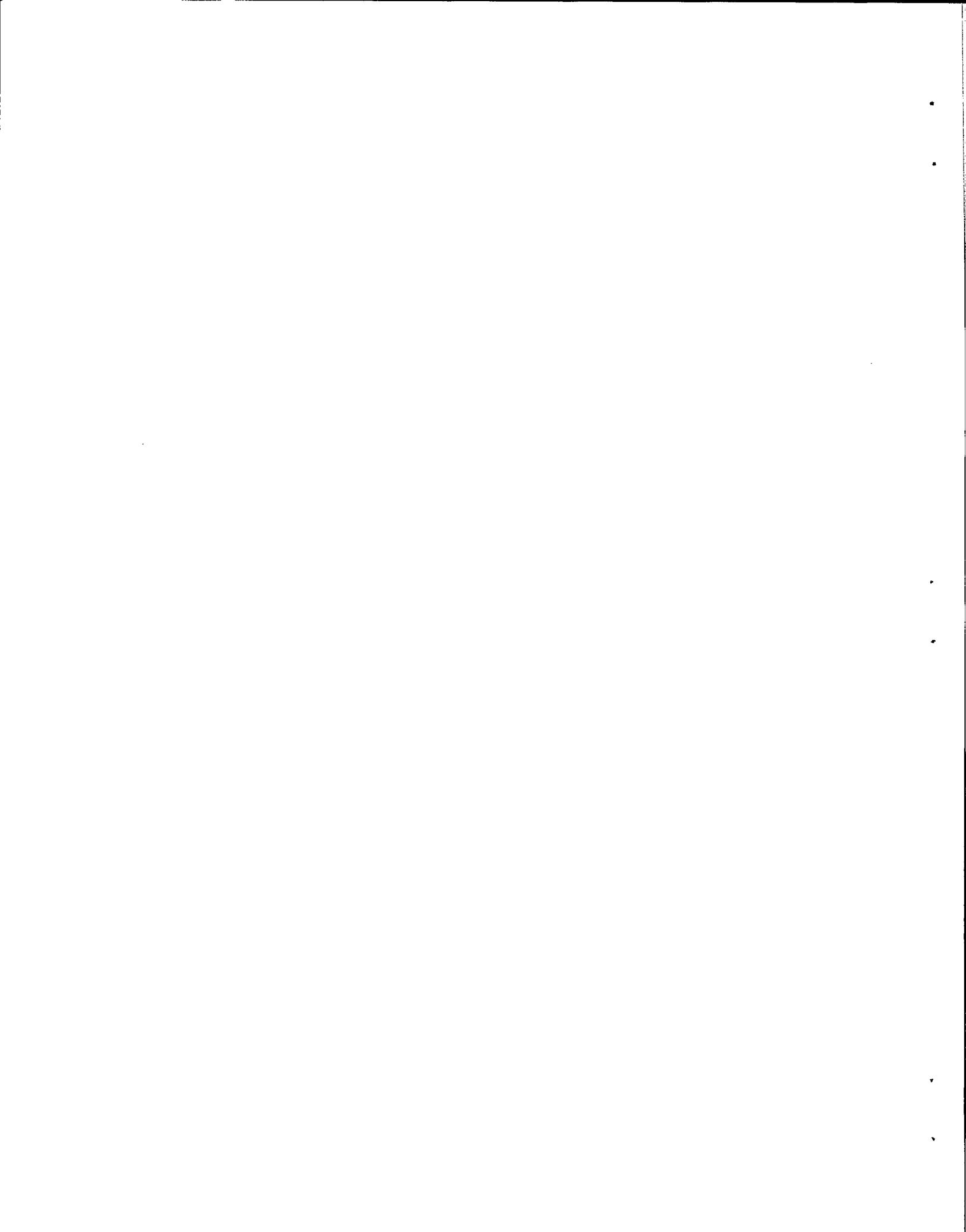


Fig.11 Catch/set for adult chinook in Juan de Fuca, 1990



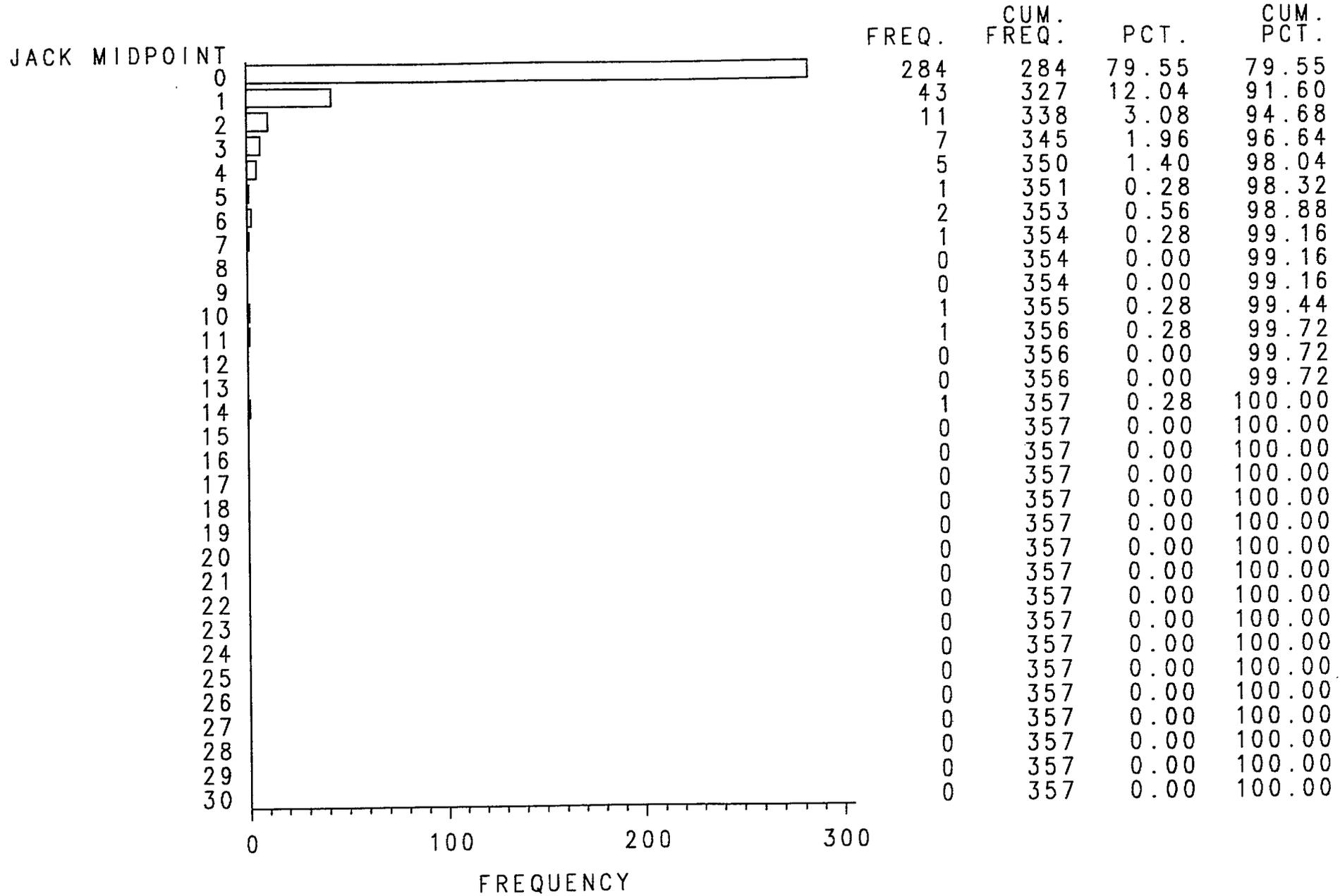
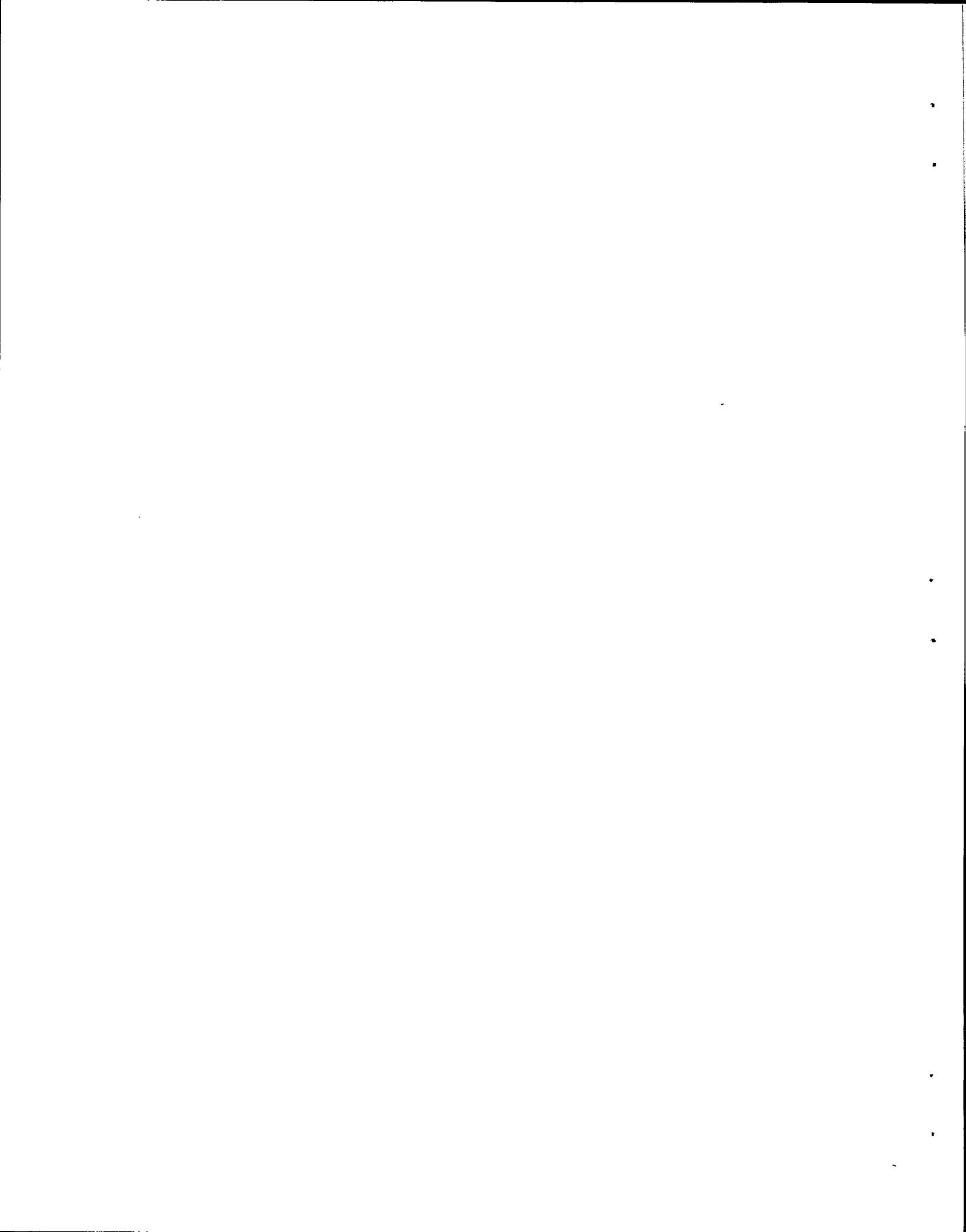


Fig.12 Catch/set for jack chinook in Juan de Fuca, 1990



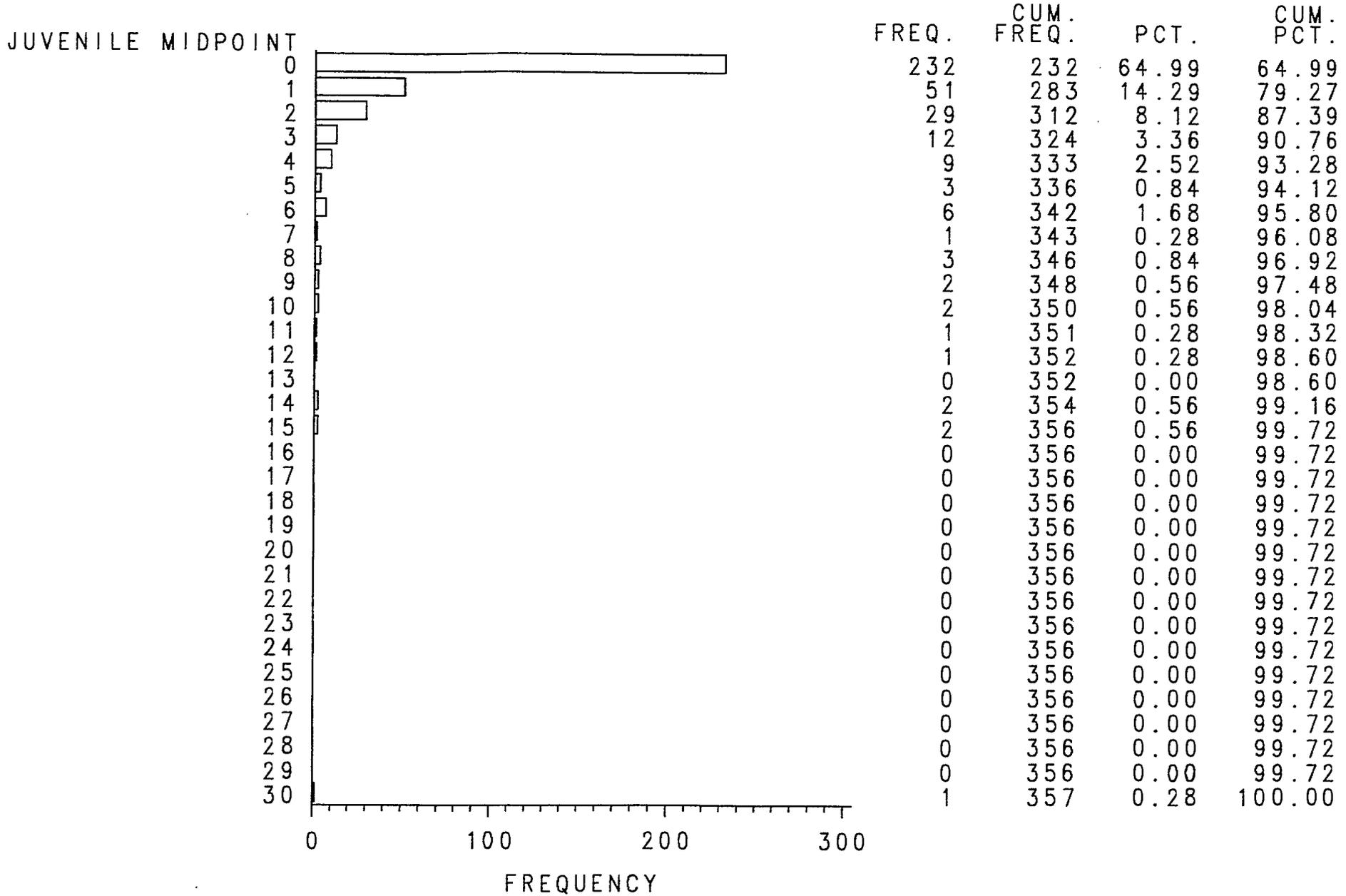
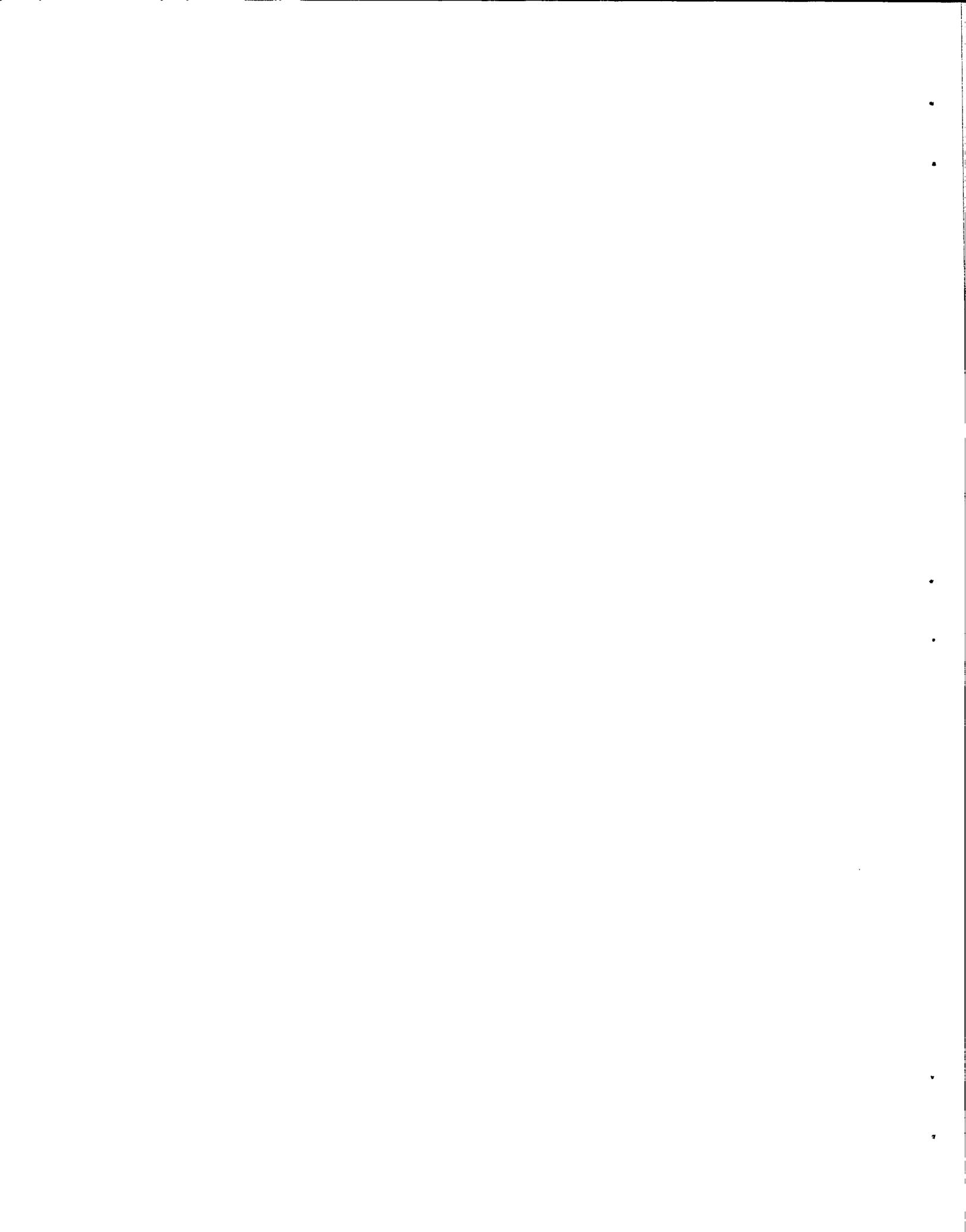


Fig.13 Catch/set for juvenile chinook in Juan de Fuca, 1990



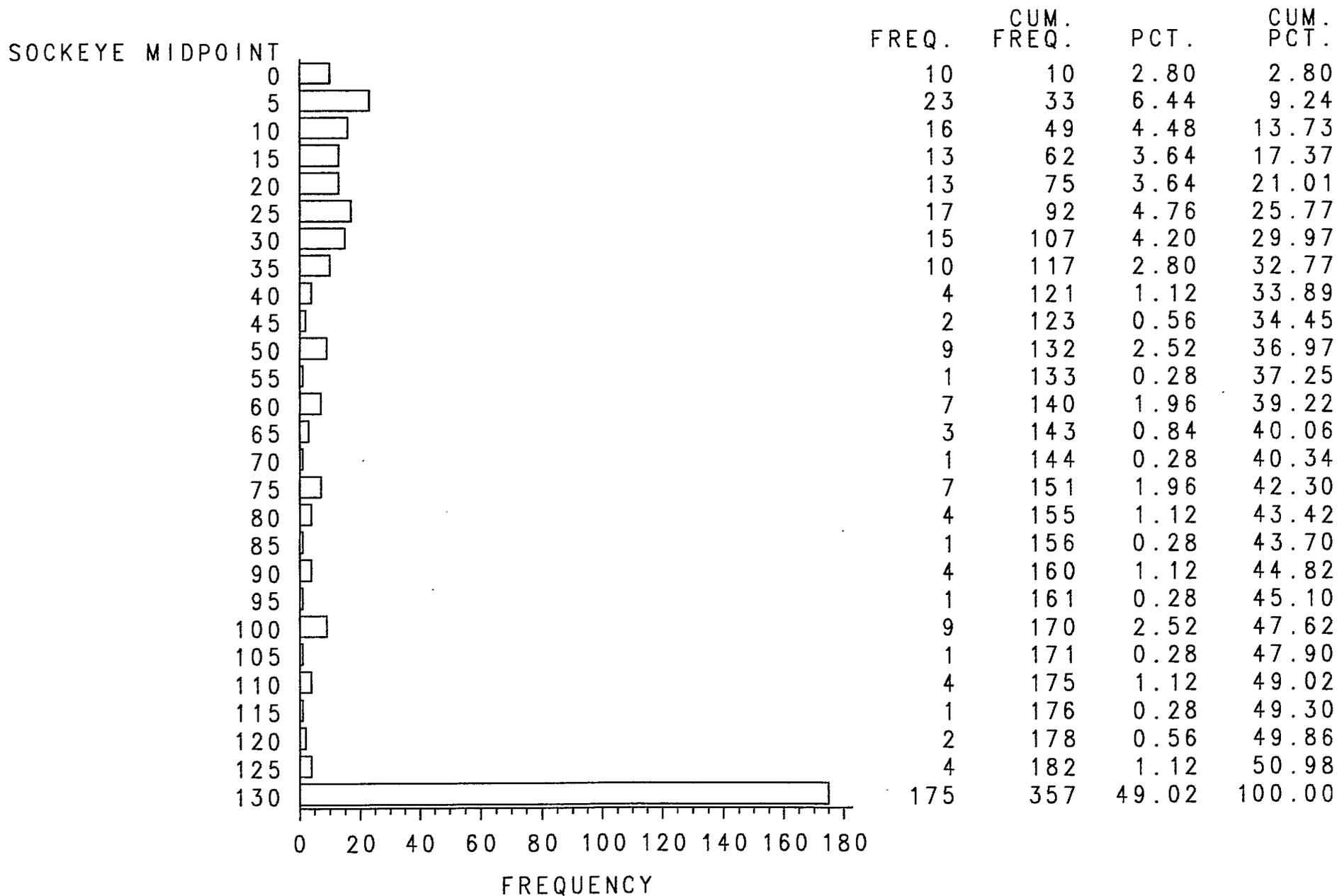
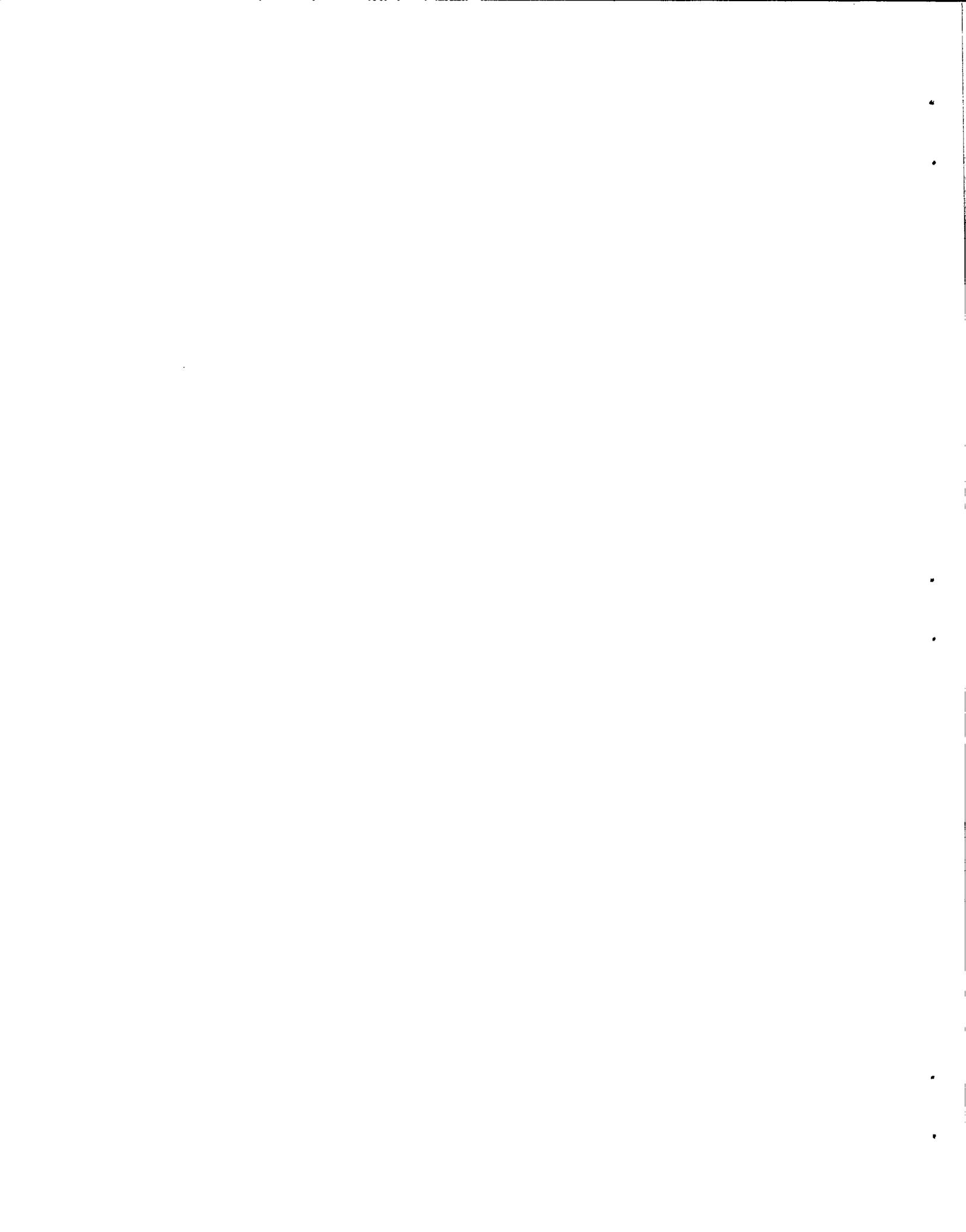


Fig.14 Catch/set for sockeye in Juan de Fuca, 1990



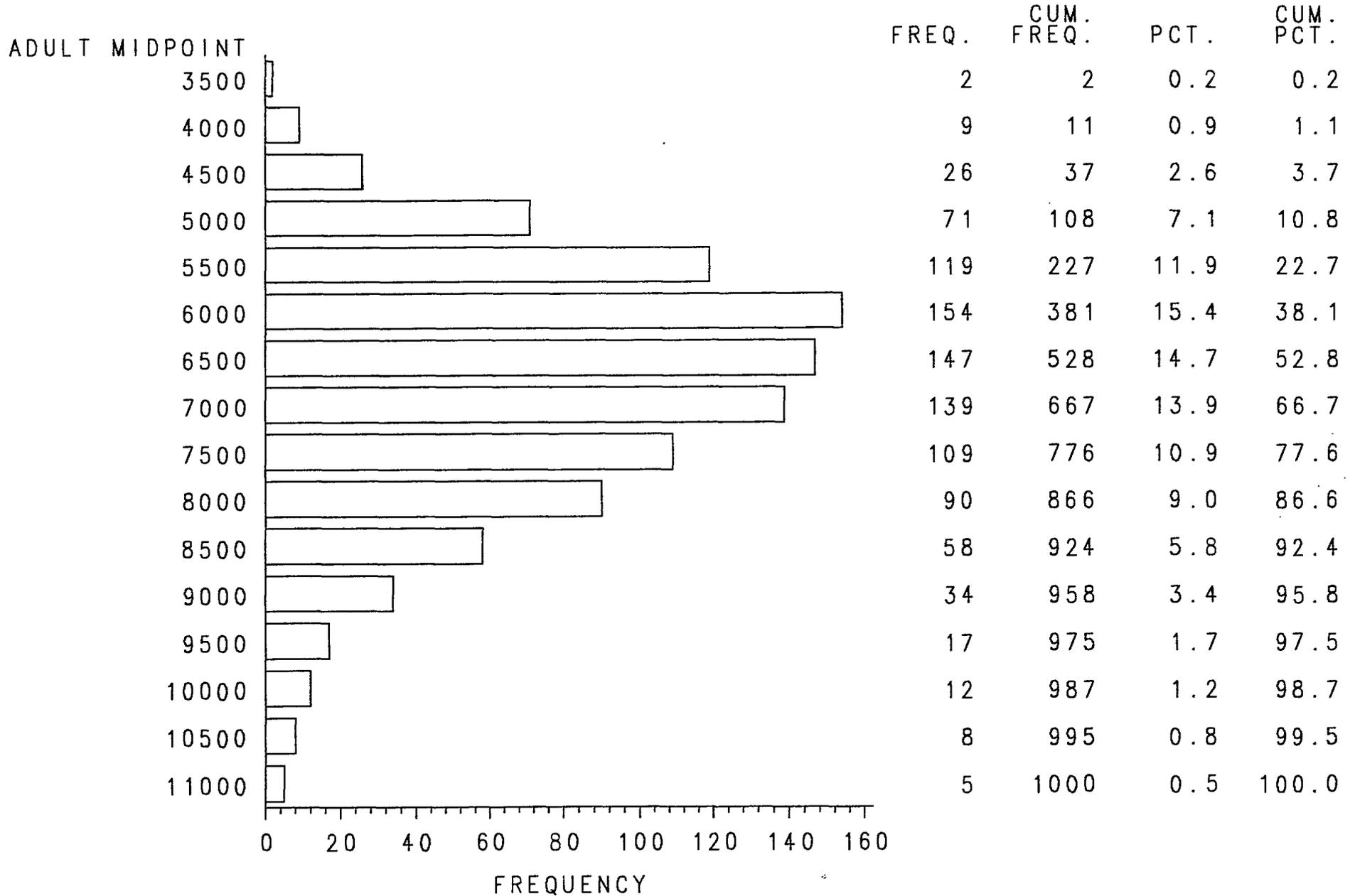
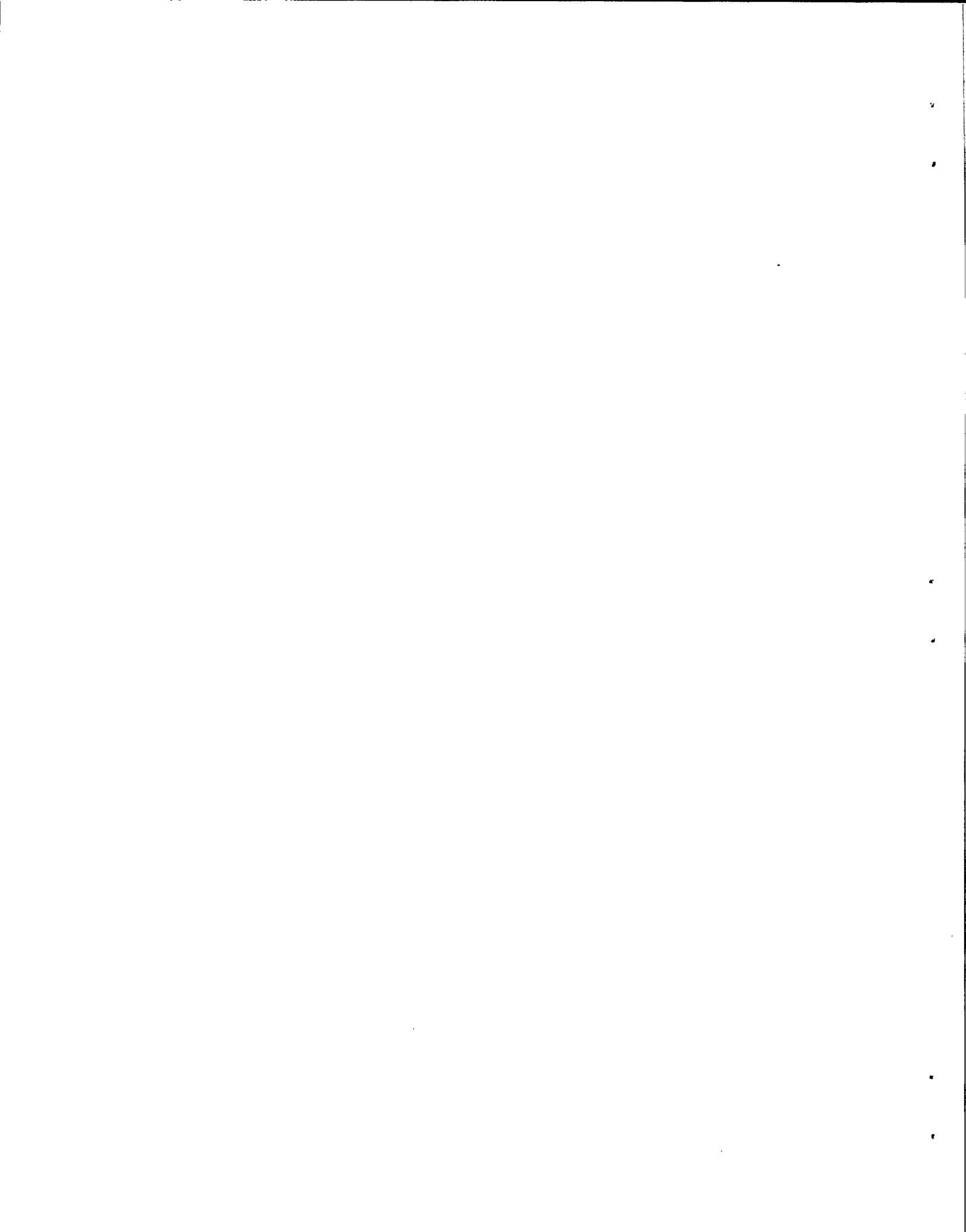
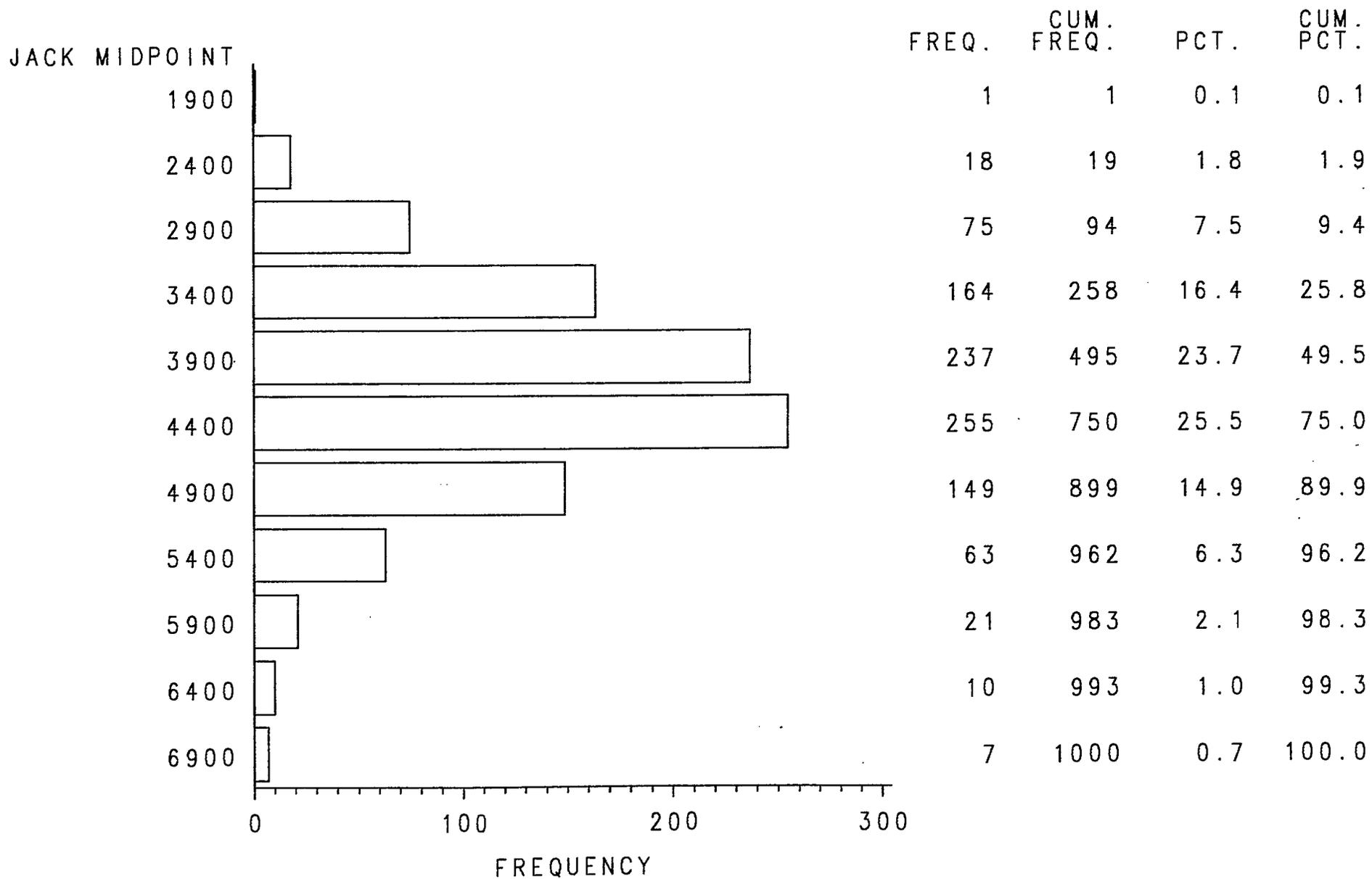


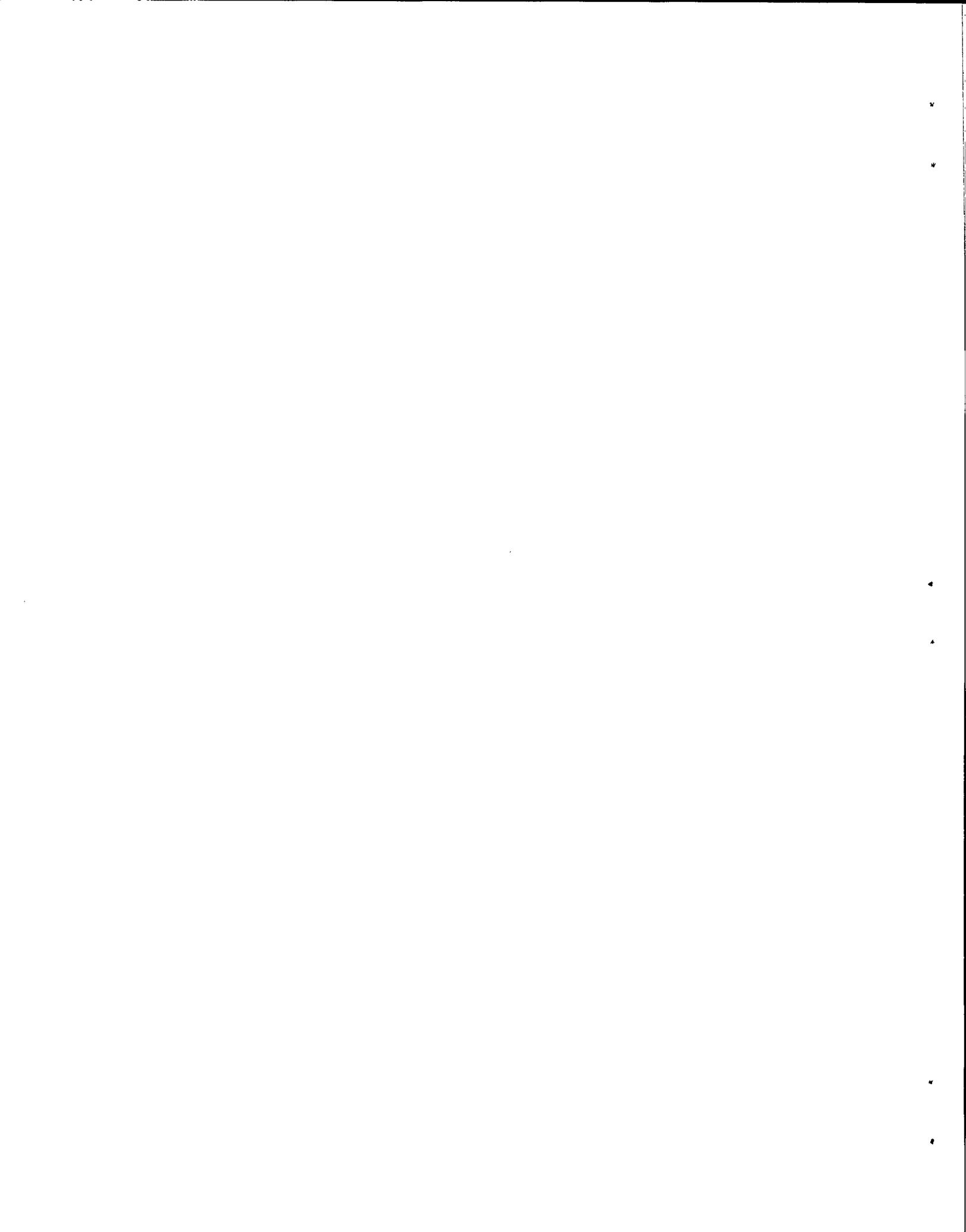
Fig.15 Bootstrap estimates for adult chinook in Juan de Fuca, 1990





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Fig.16 Bootstrap estimates for jack chinook in Juan de Fuca, 1990



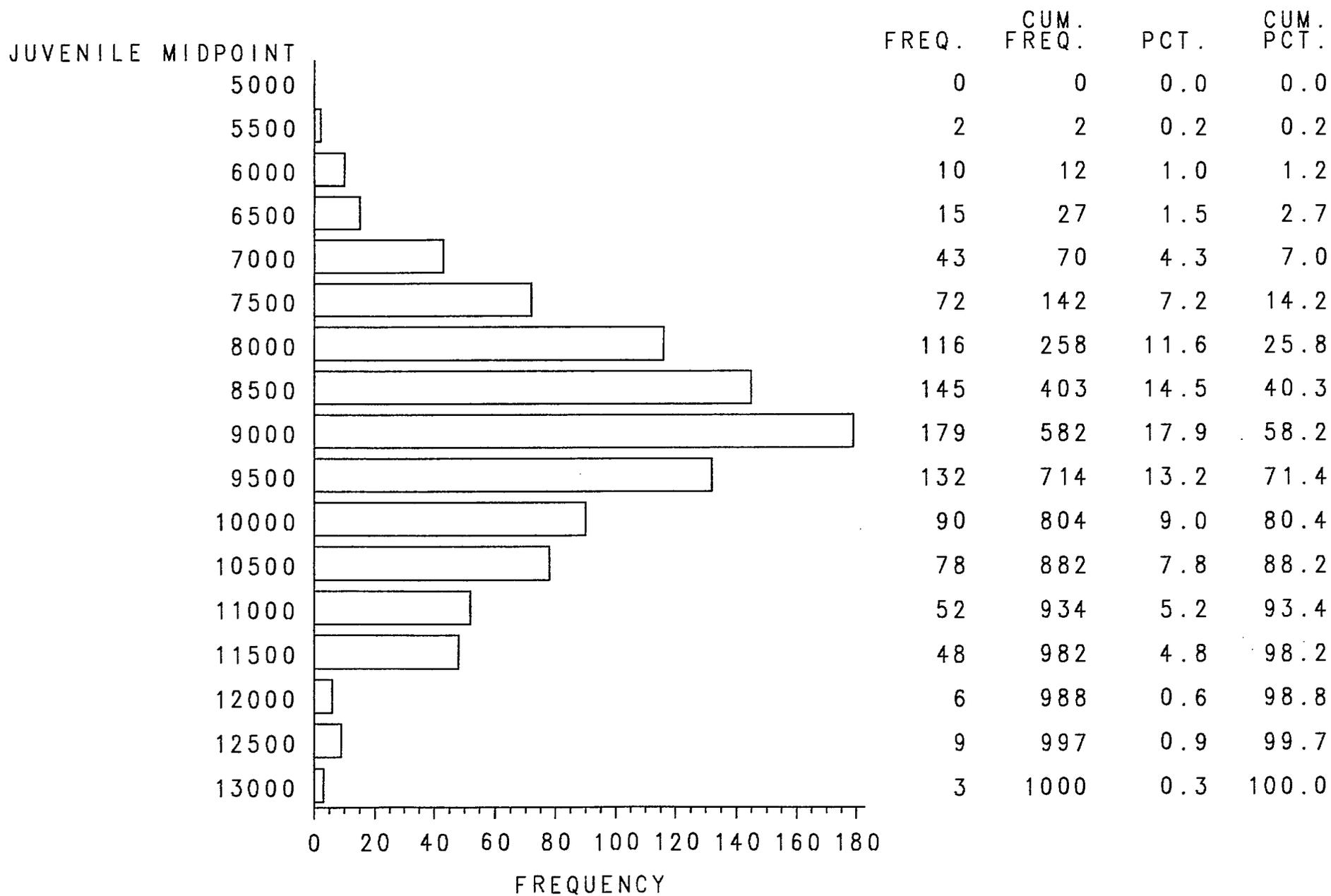
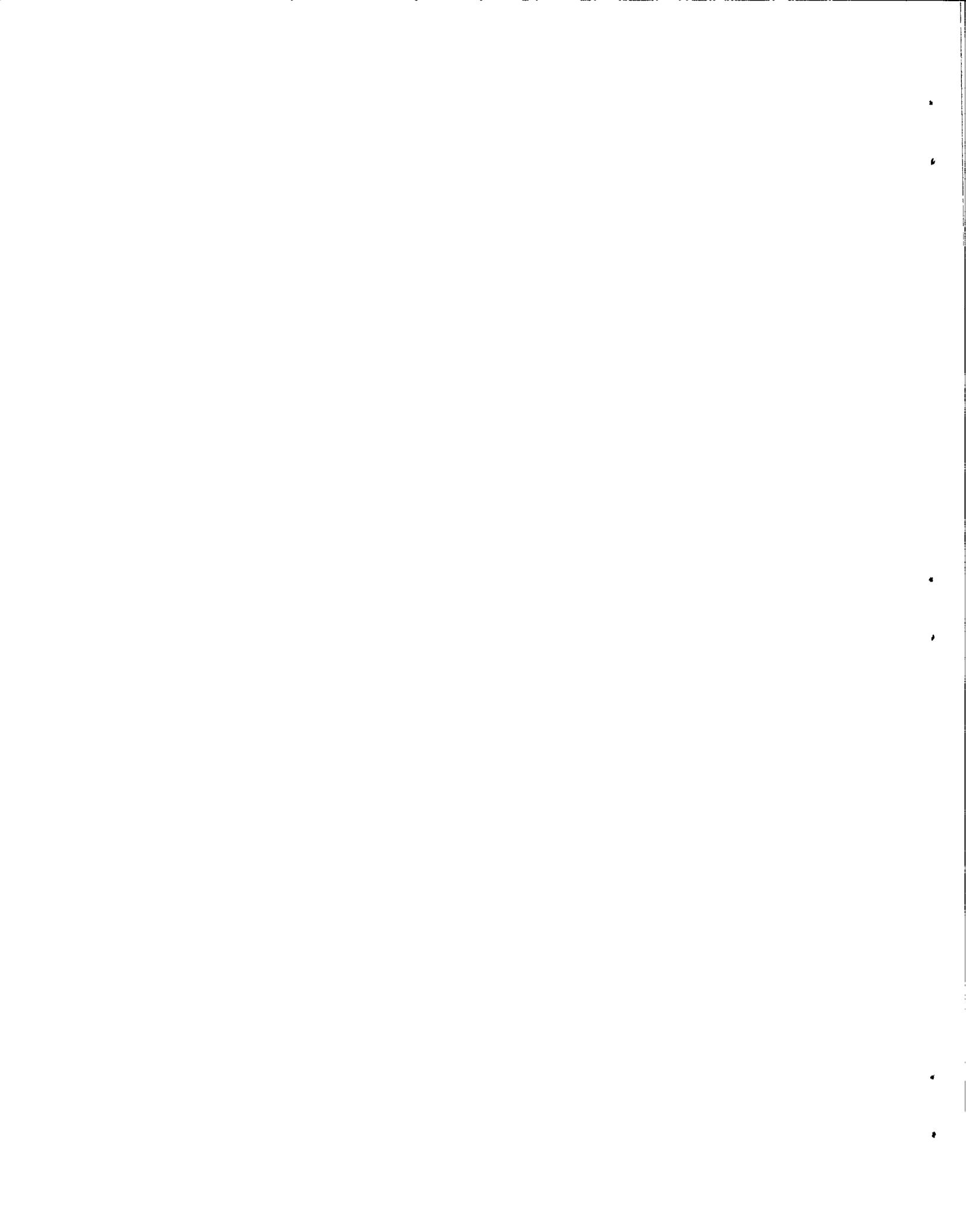


Fig.17 Bootstrap estimates for juvenile chinook in Juan de Fuca, 1990



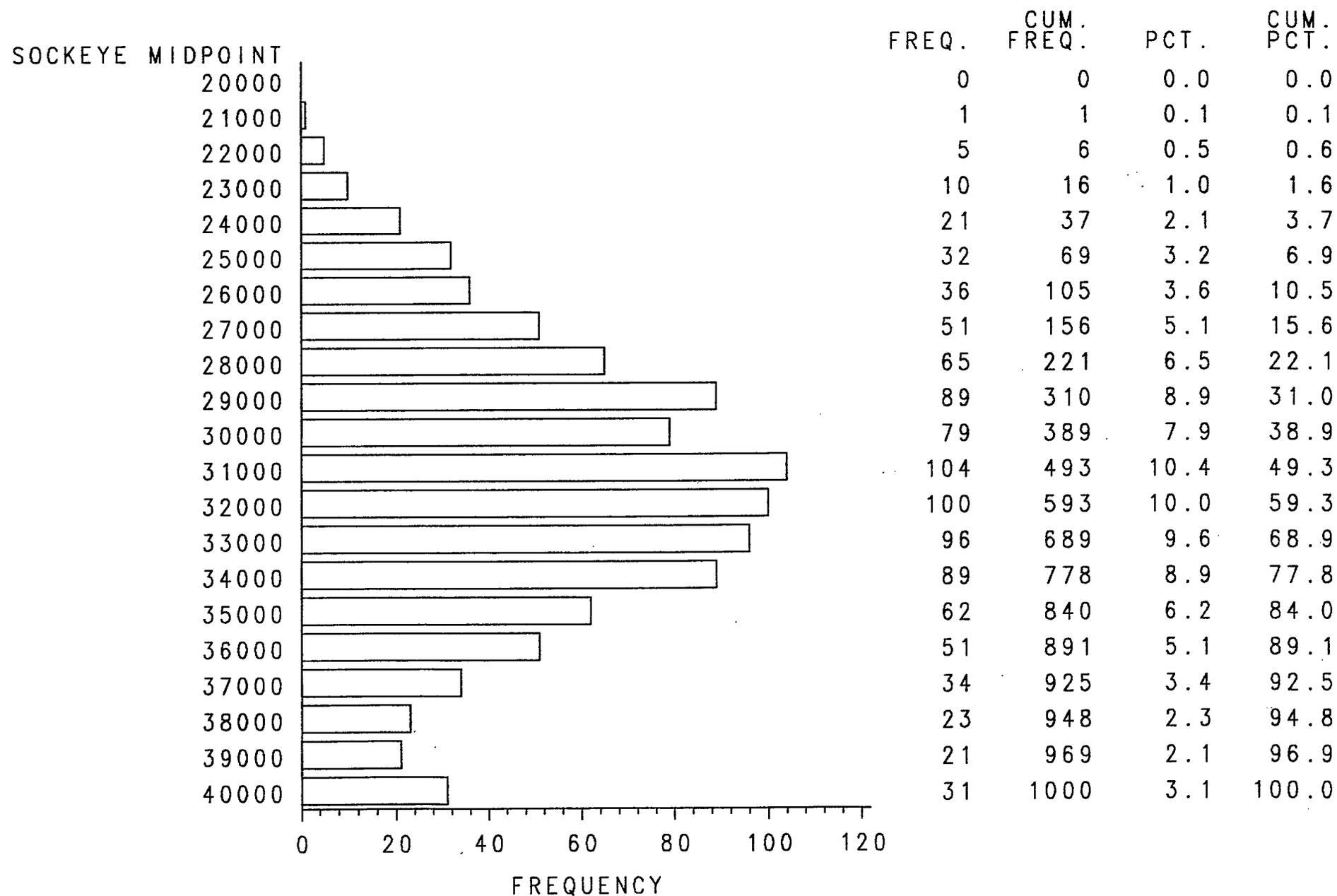


Fig.18 Bootstrap estimates for sockeye in Juan de Fuca, 1990

