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THE STATUS OF PACIFIC OCEAN PERCH (SEBASTES ALUTUS) STOCKS OFF BRITISH COLUMBIA, WASHINGTON, AND OREGON IN 1974

by D. R. Gunderson[1], S. J. Westrheim[2], R. L. Demory[3]
and M. E. Fraidenburg[4]

This report was originally prepared as Appendix B for the 1976 Report of the Technical Sub-Committee to the International Groundfish Committee, and was subsequently submitted to the 1976 Annual Meeting of the International North Pacific Fisheries Commission.

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[1]National Marine Fisheries Service
[2]Fisheries and Marine Service
[3]Oregon Department of Fish and Wildlife
[4]Washington State Dept. of Fisheries

LIST OF FIGURES

LIST OF FIGURES (cont'd) Page

ABSTRACT

Gunderson, D. R., S. J. Westrheim, R. L. Demory, and M. E. Fraidenburg. 1976. The status of Pacific ocean perch (Sebastes alutus) stocks off British Columbia, Washington, and Oregon in 1974. Fish. Mar. Serv. Res. Dev. Tech. Rep. 690: 63 p.

A joint, Canada-United States stock assessment of Pacific ocean perch (Sebastes alutus) off British Columbia, Washington, and Oregon was completed for the period 1956-74. Data analyzed included catch statistics from all participating nations, size and age composition of commercial landings in Canada and the United States, and biomass estimates based on research vessel catches. In the Hecate Strait-Queen Charlotte Sound region (B.C.), three stocks were identified, one of which was relatively large and unutilized, one small and moderately utilized, and one now small and overutilized. In the Vancouver-Oregon region all stocks are now small and overutilized.

RÉSUMÉ

Gunderson, D. R., S. J. Westrheim, R. L. Demory, and M. E. Fraidenburg. 1976. The status of Pacific ocean perch (Sebastes alutus) stocks off British Columbia, Washington, and Oregon in 1974. Fish. Mar. Serv. Res. Dev. Tech. Rep. 690: 63 p.

Conjointement, le Canada et les États-Unis ont effectué une évaluation des stocks de sébastodes (Sebastes alutus) au large de la Colombie-Britannique et des États de Washington et d'Oregon pour la période de 1956-1974. Les données analysées comprenaient des statistiques sur les prises de toutes les nations participantes, sur la répartition par taille et par âge des débarquements commerciaux au Canada et aux États-Unis et des évaluations de la biomasse basées sur les prises des bateaux de recherche. Dans les détroits d'Hécate et de la Reine Charlotte (C.-B.), trois stocks ont été découverts dont l'un était assez grand et inexploité, l'autre petit et modérément exploité et le troisième présentement petit et surexploité. Dans la région de Vancouver-Oregon, tous les stocks sont actuellement petits et surexploités.

INTRODUCTION

A joint analysis of the condition of Pacific ocean perch stocks off the U.S. and Canadian coasts was carried out in 1971-72 at the request of the Technical Sub-Committee of the International Groundfish Committee. The results of this analysis were summarized in Westrheim et al. (1972), and annual updates of key tables in that report have served to keep assessment of stock conditions current.

A significant amount of information useful for stock assessment has become available since 1972, and extensive re-appraisal of stock conditions is now appropriate. Consequently, the Technical Sub-Committee requested that a working group of United States and Canadian scientists prepare a detailed report on the status of Pacific ocean perch stocks in the Oregon-British Columbia region as of 1974. This report summarizes the results obtained by that working group.

MATERIALS AND METHODS

Production Records

Canada-U.S. catch records have been obtained from the Data Record Series of the Pacific Marine Fisheries Commission, and have been allocated to the appropriate INPFC Areas. The United States fleet has continued to take considerably more Pacific ocean perch than its Canadian counterpart, accounting for 59% of landings from the Charlotte Area, 99% from the Vancouver Area, and 100% from the Columbia Area in 1974.

Japanese catch records have been obtained from INPFC Documents prepared by the Fishery Agency of Japan. "Annual" records represent the period November 1 - October 31.

Soviet catch records for 1968-74 have been obtained during scientific meetings with Soviet scientists. These data were presented by INPFC Area for 1973, but in the other years in this series Soviet catches reported from the "British Columbia" statistical area (north of 48°30'N) were allocated to the INPFC Charlotte and Vancouver Areas, while those from the "Washington-Oregon" region (42°00'-48°30'N) were allocated to the INPFC Columbia Area. Soviet catches for 1965-67 were estimated from observed fleet activity and the known monthly catch rate for each class of trawler.

Production by Polish vessels began in 1974, and their catch statistics were obtained at US-Polish scientific meetings. Polish production records were available by INPFC Area.

None of the national production records for Pacific ocean perch apply exclusively to S. alutus, and all include unknown quantities of other rockfish species.

Biological Data

All information on length and age composition of the catch is derived from Canadian and United States sources. These data were obtained by sampling the commercial landings of Pacific ocean perch or research vessel catches at sea.

Data on relative abundance was obtained from CPUE indices of the Canadian (Charlotte Area), Washington (Charlotte and Vancouver Areas), and Oregon (Columbia Area) trawl fleets. Effort data from other sources were either not available or were deemed inapplicable. In the Charlotte Area, biomass estimates were available from resource surveys made during 1967-73.

QUEEN CHARLOTTE SOUND SUB-AREA

Subsequent to publication of the initial stock assessment for Pacific ocean perch in Queen Charlotte Sound (Westrheim et al., 1972), new complexities in the stock structure have been revealed from exploratory fishing and more detailed catch statistics. Commercial concentrations of Pacific ocean perch inhabit all three major gullies located in the Queen Charlotte Sound - Southern Hecate Strait region (Figure 2). Boundaries of these gullies were defined by Westrheim (1974). Each concentration has had a different history of exploitation. Moresby Gully has undergone negligible exploitation by Canadian or United States vessels to date (February 1976). Mitchells Gully was first fished at a significant level by United States vessels in 1967 and by Canadian vessels in 1973. Goose Island Gully was the only major Canada-United States fishing ground in Queen Charlotte Sound prior to 1967.

Catch, Effort, and CPUE

During 1956-74, total catch of Pacific ocean perch in Queen Charlotte Sound rose from 758 m.t. in 1957 to a peak of 27,054 m.t. in 1966, then declined to 4,867 m.t. in 1971 (Figure 3, Table 1). The 1974 catch was 11,601 m.t. The Canada-U.S.A. trawl catch peaked at 8,254 m.t. in 1966, and subsequently declined to 3,618 in 1974.

Japanese vessels began fishing in 1966. Their catch peaked at 6,268 m.t. in 1969, then declined to 702 m.t. in 1971. The 1974 catch was 7,983 m.t., a sharp increase from the 958 m.t. in 1973 and 2,281 m.t. in 1972.

U.S.S.R. vessels began fishing in 1965. Their catch peaked at 18,800 m.t. in 1966, then declined precipitously to 55 m.t. in 1969. No U.S.S.R. vessels have fished in this sub-area since 1971, when their catch was negligible. Since 1971, only Canadian and United States vessels are permitted by the

Canadian Government (Anon., 1971) to trawl eastward of a line connecting Triangle Island and Cape St. James (Figure 2).

CPUE for United States vessels rose from 0.672 m.t./hr. in 1959 to a peak of 1.132 m.t./hr. in 1966. Subsequently, these values leveled off during 1969-73 at 0.656-0.812 m.t./hr. The 1974 value was 0.610. The Canadian CPUE values followed a similar, but more variable course. Peak value was 1.285 m.t./hr. in 1965, and the 1974 value was 0.961.

Among gullies, CPUE values for United States vessels exhibited similar trends and levels (Figure 4 and Table 2). Both trends were horizontal during 1969-74. Weighted means were 0.787 m.t./hr. for Mitchells Gully and 0.703 m.t./hr. for Goose Island Gully. United States-Canadian catch and calculated effort, however, exhibited differing trends and levels. In Mitchells Gully, catch was relatively high during 1967-69 (1,165-1,770 m.t.); relatively low during 1970-72 (741-828 m.t.); and relatively high again during 1973-74 (1,717-2,011 m.t.). North American catch in Goose Island Gully was relatively high during 1967-72 (3,391-5,336 m.t.), and relatively low during 1973-74 (1,615-1,901 m.t.). Calculated effort rose steadily during 1970-74 in Mitchells Gully (969-2,555 hrs.), and declined during the same period in Goose Island Gully (7,601-2,256 hrs.). It is apparent that the United States CPUE level in Goose Island Gully has been sustained by a reduction in fishing effort, while the overall North American catch from Queen Charlotte Sound has been sustained by increased effort in Mitchells Gully.

Within Goose Island Gully, catch statistics for United States vessels suggest that stocks in the north and south portions are reacting differently

to exploitation. For the north portion, CPUE peaked in 1966 at 1.324 m.t./hr., then leveled off during 1968-74 at 0.634-0.775, except for an anomalous peak in 1973 of 0.930--perhaps caused by a substantial reduction of effort (Figure 5, Table 3). Both catch and effort remained relatively stable during 1967-72 (1,197-2,240 m.t.; 1,765-2,445 hr.), then declined sharply during 1973-74 to 865-1,190 m.t. and 930 and 1,558 hrs., respectively. For the south portion, CPUE peaked at 1.083 m.t./hr. in 1965; stabilized at 0.626-0.721 m.t./hr. during 1967-72; then declined sharply to 0.286-0.396 m.t./hr. during 1973-74. Catch was relatively stable during 1967-70 (1,207-1,585 m.t.), then declined sharply to 237 m.t. in 1973, and 120 m.t. in 1974. Effort was relatively stable during 1965-70 (1,707-2,304 hrs.), then declined steadily to 420 hrs. in 1974.

Detailed records of Japanese vessels operating off Queen Charlotte Sound during 1967-74 indicate considerable production, during summer and winter, from the area between 50°30'N. lat. to 51°29'N. lat. (Figure 6; Tables 4 and 5), and only minor production between 51°30'N. and 51°59'N.[a/] The former area lies off Goose Island Gully, while the latter area lies off Mitchells and Moresby Gullies. During 1972-74, Japanese effort and catch increased substantially in the two areas off Goose Island Gully, particularly off south Goose Island Gully. Coincidentally, during the same period, United States catch and CPUE of Pacific ocean perch in south Goose Island Gully exhibited substantial declines.

[a/] Summarized by month, by statistical block (1° longitude x 30' latitude), at the Northwest Fisheries Center (NMFS) in Seattle, Washington, from detailed data submitted to the International North Pacific Fisheries Commission by the Fishery Agency of Japan.

Size and Age Composition

Only for Goose Island Gully is there a long-time series of size and age-composition data from commercial landings--Canadian. Length-frequency anomalies for 1961-75 display the temporal progression of two sets of dominant year classes (Figure 7, Table 7). The first set is identifiable during 1961-75, and the second set during 1969-75. Age-frequency data for 1963-75 indicate that the principal year classes are 1952 and 1961. Furthermore, the 1961 year class must be weaker than the 1952 year class, because by 1975 the 1963 year class was dominant and the 1961 year class occupied a minor position.

The relative weakness of the 1961 year class coupled with the extinction of the 1952 year class has contributed to the decrease in abundance of Pacific ocean perch in Goose Island Gully.

Size and age composition varied substantially among gullies, based on research cruises conducted in 1973 and 1974 (Table 8, Figure 8). Moresby Gully contained mostly large fish (>35 cm.) in 1974, and the age composition was tri-modal--modal ages were 5, 9, and 19. In 1973, Mitchells Gully contained mostly medium fish (30-40 cm.), and the age composition was essentially uni-modal (age groups 8-11). In 1973, Goose Island Gully contained mostly medium and large fish (>35 cm.), and the age composition was tri-modal--age groups 3, 11, and 17-19. Moresby Gully evidently contains more older fish than do the other two gullies, probably due to the absence of a fishery. Density of the older age groups (>16 years) was 37.2 fish/sq. mile in Moresby Gully, 13.0 in Mitchells Gully, and 18.4 in Goose Island Gully.

Biomass Estimates

Methods used for estimating Pacific ocean perch biomass were described by Westrheim et al. (1972). Areas, in square nautical miles by depth stratum, are listed below for the three gullies:

Depth stratum (fm.)	Gully		
	Moresby	Mitchells	Goose Island
80-99	537	46	353
100-119	472	180	314
120-139	516	103	165
140-159	328	61	161
160-179	115	72	17
180-199	131	55	11
200-219	95	-	-
220-239	38	-	-
240-259	7	-	-
Total	2,239	517	1,021

For Moresby Gully, only one biomass estimate has been made--136,000 m.t. of marketable (≥31 cm. FL) Pacific ocean perch in September 1974 (Table 6).

For Mitchells Gully, three biomass estimates have been made, but all are questionable--particularly that in June 1972 (16,400 m.t. ≥31 cm. FL). The 1971 and 1972 estimates did not include the 80-99 and 100-119 fm. depth strata. In 1973, the trawling stations may not have been arrayed adequately. There appeared to be an excess of young fish, a deficiency of older fish, or both.

For Goose Island Gully, seven biomass estimates have been made--the latest in September 1973. These data suggest that the stock of marketable (≥31 cm. FL) Pacific ocean perch has declined about 60% from 1965-69 (89,900-125,600 m.t.) to 1973 (44,700 m.t.).

Biological Statistics

Exploitation rate (μ) was computed for Goose Island Gully for 1967, 1969, 1970, 1971, and 1973 (Table 9). The all-nation catch includes the Japanese catch from the area 50°30'N. - 51°29'N. The Japanese catches reported for 1972-74 were adjusted upward, assuming that Pacific ocean perch comprised 92% (the proportion reported for 1967-69) of the "other rockfish" catch during this period. Estimates of exploitation rates ranged from 0.058 (1971) to 0.244 (1967).

Computations of a, Z, F, and M based on the 1951-54 year classes in commercial landings were not attempted for the 1973 data because CPUE values for that year were aberrantly high. Mortality rates were based on the abundance of the 1951-54 year classes (CPUE in Canada-U.S.A. landings and absolute numbers in Canadian biomass estimates) and Canadian biomass estimates for the entire stock. Values for all rates varied considerably, e.g., .10-.20 for F and .03-.30 for M (Table 9). Best estimate of M was considered to be .10, based on CPUE for the 1951-54 year classes in the Canada-U.S.A. landings during 1967-71. For the same period, F = .15 and Z = .25. Subsequent to 1971, F has undoubtedly increased substantially, but none of the estimates detected this.

Stock Condition

Overall, the Pacific ocean perch resource occupying the Queen Charlotte Sound sub-area remains in reasonably satisfactory condition. Total biomass in 1973-74 of marketable fish (≥31 cm. FL) was estimated to be 215,600 m.t.,

and the all-nation catch in 1974 was 11,601 m.t. If both of these values are correct, the overall exploitation rate is only .054, substantially lower than the estimated value of M of 0.10. However, overall abundance is expected to decline independently of fishing because no new year classes have appeared which even begin to approach the strength of the 1952 year class.

Among gullies, however, conditions vary substantially. Moresby Gully (2,200 sq. miles) contains a relatively large, old stock (136,000 m.t. of marketable fish) which is virtually unexploited, but is probably declining in size because gains (recruits + growth) are exceeded by losses due to natural mortality. Mitchells Gully (500 sq. miles) apparently contains a modest stock (34,800 m.t. of marketable fish in 1973) of uncertain status. Goose Island Gully (1,100 sq. miles) contains a now-modest stock (44,700 m.t. of marketable fish in 1973) which has declined sharply since 1971. This decline is greater than could be expected from the joint effects of the Canada-United States fishery and natural mortality. The Japanese vessels operating in the vicinity of Triangle Island are probably responsible for much of the decline in abundance of Pacific ocean perch--particularly in the south portion of Goose Island Gully.

VANCOUVER AREA

Catch and CPUE

From 1956 through 1974, total Pacific ocean perch catches in the Vancouver Area have ranged from 675 to 16,358 m.t. per year (Table 10). Production from this area has followed the general trends described by Westrheim et al. (1972). Pre-1960 was characterized by moderate production, 1961-1966 by increasing production and 1966-70 by drastically decreasing production.

Since 1970, production has remained low and continued to decrease, although at a slower rate (Figure 9).

Through 1964, all catches from this area were made by the Canadian-U.S.A. fleets. The U.S.S.R. began fishing in this area in 1965, Japan in 1966, and Poland in 1974, so that a total of five countries harvested perch from the Vancouver area in 1974.

The largest Canadian-U.S.A. catches occurred in 1962-63 at 3,857 and 3,867 m.t. respectively with an overall decline thereafter and a drastic decline after 1966. The U.S.S.R. catch peaked in 1966 at 14,000 m.t. and fell drastically thereafter, and the Japanese catch peaked in 1967 at 6,678 m.t. and has fallen steadily since. Polish production was 32 m.t. during their first year in the fishery.

U.S.A. CPUE (m.t./hr.) ranged from 0.718 in 1965 (immediately before large removals) to 0.242 in 1969 (immediately after large removals). In 1974, CPUE was 0.202 after six years of lowered production, indicating a 72% decline in perch abundance from 1965 to 1974 (Figure 9, Table 10).

Size and Age Composition

Size and age composition data (Table 11, Figure 10) reflect the progression of strong year classes through the fishery from 1966-1974 and the effect that large removals have had.

As in Queen Charlotte Sound, length frequency anomalies (Figure 10) were used to depict the temporal progression of strong year classes through the fishery. One set appears definable from 1969-74. The extistence and relative magnitude of this dominant year class set is well documented by age composition data (Figure 10) from fishery sampling during these same years. These data demonstrate this set was from a strong year class series centered around brood year 1961.

While these data, presented in this manner, do not show any dominant year class series prior to the 1961 brood, evidence presented by Westrheim (1970) and Gunderson (1976) indicate a prominent year class series centered around 1952 did exist. This year class is conspicuously absent from the age composition samples taken from 1966-69.[1/]

Extensive fishery removals during 1966-68 resulted in a pronounced skewing toward a younger age structure during 1970-74. Because the biomass of older fish had been drastically reduced by the 1966-68 removals, the 1961 year class series dominated the catches in the first year they appeared in significant numbers and in each subsequent year through 1974.

Recruitment of the 1961 year class series to the fishery began to restore abundance (as indicated by the number caught per hour, Table 11) to former levels, and as of 1970 this stock began to recover. Exploitation rates remained at high levels during 1970-74, however, and the 1961 year class series was cropped off as it recruited to the fishing grounds. Abundance consequently declined during 1970-74.

Biological Statistics

Total 1973-1974 survival rate (S) and instantaneous mortality rate (Z) of 14-18 year old perch was estimated with age composition data from 1973-74 United States landings (Table 11) using the Jackson method where:

$$S = \frac{Y_{15}+Y_{16}+Y_{17}+Y_{18}}{Y_{14}+Y_{15}+Y_{16}+Y_{17}}$$

where Y_n is the number of fish per unit effort of age n. Estimates of total instantaneous mortality (Table 12) ranged from 0.08 to 0.56 during 1967-1974, and have remained high despite a general decrease in total international removals.

[1/] 1966 age samples were collected only in October, November and December.

Estimates of instantaneous rates of fishing mortality (F) and natural mortality (M) have been calculated by Gunderson (1976). Although his estimate of M was 0.232 he cautioned that this estimate should be considered tentative and that his work should serve mainly to show that natural mortality lies in the range between 0.1-0.2. For purposes of this report, the mid-point (0.15) of this natural mortality range is probably the most realistic value to use, and we have applied this value to the Vancouver Area. Subtracting M from Z yields estimates of F from 0.18 to 0.41 in the Vancouver Area from 1967 to 1974.

Biomass Estimates

In the Vancouver Area, the most extensive removals were made during 1966-1968 when annual total international catches were 16,358, 13,483, and 10,417 m.t., respectively (Table 10). For the same period, Westrheim et al. (1972) obtained a mean biomass of marketable fish (>31 cm.) of 34,000 m.t. by dividing the mean annual catch (13,419 m.t.) by their calculated exploitation rate (0.39). The International Trawl Fishery Committee (Technical Subcommittee, 1972) subsequently calculated a mean 1969-1971 biomass of 18,703 m.t. in the Vancouver Area by observing the decline in the mean, weighted Washington CPUE from the 1966-1968, to the 1969-1971 time periods and applying this decline to the original biomass of 34,000 m.t. Using this same technique, we have calculated a mean 1972-1974 biomass as follows:

Mean 1966-1968 biomass of marketable fish in the Vancouver Area = 34,000 m.t.
Mean weighted 1966-1968 Washington CPUE = 0.538
Mean weighted 1972-1974 Washington CPUE = 0.264
Mean 1972-1974 biomass in the Vancouver Area = $\frac{0.264}{0.538}$ (34,000) = 16,700 m.t.

Stock Condition

The Pacific ocean perch stock in the Vancouver Area is in poor condition. Total catch (Table 10) has declined approximately 91% from 1966-1974. Relative abundance, as indicated by CPUE (Table 10, Figure 9) has declined approximately 72% from 1965 to 1974, and mortality rates (Table 12) have remained high. Biomass has remained low despite the appearance of a reasonably strong 1961-1962 year class series (Table 11, Figure 10). These factors coupled with the absence of any subsequent strong year classes since the 1961-1962 series (Figure 10) portends a somewhat gloomy future for the Pacific ocean perch stock in the Vancouver Area should heavy fishing pressure be allowed to continue.

After considering the effects of reduced population size on future recruitment, Gunderson (1976) recommended that fishing for Pacific ocean perch in the Vancouver-Charlotte region be regulated in such a manner that F not exceed 0.1. Taking M = 0.15, this implies that Z shouldn't be higher than 0.25, a value that has been exceeded almost every year since 1967.

COLUMBIA AREA

Catch and CPUE

Landings of Pacific ocean perch caught in the Columbia Area are not entirely Sebastes alutus.. There is considerable contamination from other perch-like Sebastid species. Quantitative measures of species composition

in ocean perch landings from the Columbia Area are consistent only since 1963 (Table 13, Figure 11). There has been a steady decline since 1963 in the proportion of S. alutus in Pacific ocean perch landings; from nearly 96% to about 37% in 1967; an increase to 78% in 1969; and a decline to 32% by 1974. United States catch and CPUE were therefore corrected to show the actual amount of S. alutus in reported ocean perch landings. No adjustments were made for catches reported by nations other than the United States.

During 1956-74, the total catch of Pacific ocean perch in the Columbia Area increased slowly to 3,643 m.t. in 1964; peaked at 23,976 m.t. in 1967; then declined sharply to 305 m.t. in 1974 (Figure 12, Table 14). Catch by United States vessels was reasonably stable ($\bar{x}$ = 869 m.t.) during 1956-60; increased steadily from 2,060 m.t. in 1961 to 5,375 m.t. in 1965; then declined sharply to 281 m.t. in 1967. Since 1967, catch has ranged from 95 to 281 m.t. and averaged 168 m.t.

U.S.S.R. production began in 1965; reached a peak of 19,845 m.t. in 1967; then declined to 7,110 m.t. in 1968. Soviet production since 1969 has ranged from 100 to 2,621 m.t.

Japanese production began in 1966, reached a peak of 4,274 m.t. in 1968, then dropped to 0 in 1969. It increased to 880 m.t. in 1972. Since 1973, Japan has not fished for Pacific ocean perch in the Columbia Area.

In 1974, Polish production started, and a catch of 94 m.t. was reported.

Catch per unit of effort for United States vessels was 0.379 m.t./hr. in 1956, peaked at 0.467 m.t./hr. in 1965, then declined rapidly to 0.113 m.t./hr. in 1967. Since 1967, CPUE has ranged from 0.042 m.t./hr. in 1972 to 0.129 m.t./hr. in 1969. These data suggest an 83% decline in abundance of Pacific ocean perch in the Columbia Area during 1965-74.

Size and Age Composition

United States landings of Pacific ocean perch from the Columbia Area were sampled for size composition from 1963-74 and for age composition from 1966-74. Length frequency anomalies, in percent deviation from the long-term mean, are shown in Figure 13. During 1963-66 there appeared to be a significant number of large fish present in the Columbia Area, but these fish were noticeably absent in 1967-68 when removals by U.S.S.R. and Japan were greatest. There was no suggestion of strong year classes entering the fishery during this period. In 1970-74, a prominent series of year classes was entering the fishery as shown by the dome of positive anomalies for fish smaller than 40 cm.

Age composition of Pacific ocean perch landed by United States vessels from the Columbia Area shows the presence of relatively strong 1950-54 year classes in 1966. These year classes no longer predominated in 1968, following the large removals in 1967-68. Age composition data from 1970-74 show another series of relatively strong year classes, especially those spawned in 1961-62.

Biological Statistics

Total annual mortality rate (a) was estimated with age composition data, ages 14-18 (Table 16) from the 1966-74 United States landings. Among year classes, values of a ranged from 0.16 for the 1955 year class to 0.78 for the 1950 year class. During the period of heavy exploitation (1966-68) an average value of a of 0.76 was obtained using the 1948-52 year classes. Following the period of heavy exploitation between 1969 and 1972, the estimate of a was 0.48 for the 1951-55 year classes. During the period of 1973-74 when catches were lowest, the value of a was 0.24 for the 1955-59 year classes. These mortality rates varied directly with the catch.

Values of Z, using grouped year classes as above and the same time periods, were 1.41, 0.65, and 0.27 respectively.

There are no estimates of M available for the Columbia Area. However Gunderson (1976) found M to be between 0.10 and 0.20 in the Vancouver Area. As in the Vancouver Area, M was assumed to be 0.15.

Estimates of instantaneous fishing mortality by catch period were 1966-68, 1.26; 1969-72, 0.50; and 1973-74, 0.12.

Biomass Estimates

Biomass estimates were obtained by dividing the mean catch by exploitation rate μ where $\mu = \frac{a\ F}{Z}$. Again using the same time periods, estimates of μ were: 1966-68, 0.68; 1969-72, 0.37; and 1973-74, 0.11. Mean landings for the same time periods (Table 14) divided by the exploitation rate gives the following estimates of biomass: 23,000 m.t., 7,300 m.t., and 4,300 m.t. for the 1966-68, 1969-72, and 1973-74 periods, respectively.

SUMMARY

The intensive exploitation of stocks off British Columbia, Washington, and Oregon during 1965-68 resulted in drastic reductions in the biomass of Pacific ocean perch off Washington-Oregon and Vancouver Island, and substantia reductions in Queen Charlotte Sound. Production in the INPFC Vancouver-Columb region plummeted from 39,000 metric tons in 1967 to 6,000 m.t. in 1969 (a 85% decline), and CPUE declined 45% during the same period.

Pacific ocean perch stocks in Queen Charlotte Sound were affected less drastically by fishing than those in the Oregon-Vancouver region. Biomass estimates and CPUE data indicate that S. alutus were initially more abundant in the former area, and that they did not undergo such intensive exploitation. During 1966-68, production declined 50% and CPUE of U.S. trawlers declined 36%

Evidence from research surveys (Westrheim, 1970) and biological composition of commercial landings (Westrheim et al., 1972; Gunderson, 1976) suggest that two strong series of year classes have dominated throughout the Oregon-Queen Charlotte Sound region, the first of these centered around the 1952 year class and the second around the 1961 year class. Although stronger than the year classes around them, the 1960-62 year classes didn't begin to approach the strength of the 1952 year class series.

The 1965-68 period of high production coincided with the time when the 1952 year class series was almost completely recruited to the fishery (ages 13-15). Intensive exploitation in the Vancouver - Columbia region soon reduced the relative importance of the 1952 series, and by 1971 the landings were dominated by the 1961 year class series.

Exploitation rates were highest in the Columbia Area and were estimated at 68% annually during 1966-68, 37% during 1969-72, and 11% during 1973-74. Only during the last year of this series was exploitation ever at the level recommended by the International Groundfish Committee (1972). Estimates of annual exploitation rate in the Vancouver Area ranged from 25% to 37% during 1966-71 and from 15% to 22% during 1971-74. Exploitation rate has consistently exceeded the 11% level recommended by the International Groundfish Committee.

Because exploitation rates in the Vancouver and Columbia Areas remained high subsequent to the drastic stock reductions of 1966-68, the 1961 year class series has been cropped off as soon as it was recruited to the fishing grounds, and biomass continued to decline. Estimated biomass in the Columbia Area was 23,000 m.t. during 1966-68, 7,300 m.t. during 1969-72, and 4,300 m.t. during 1973-74. Estimated biomass in the Vancouver Area was 34,000 m.t. during 1966-68 and 16,700 m.t. during 1972-74.

The 1952 year class series was exploited less intensively in the Charlotte Area than in the Vancouver-Columbia Region. The Pacific ocean perch stock in Moresby Gully has been virtually unexploited, and is still dominated by this group of year classes.

In Goose Island Gully, annual exploitation rate ranged from 6% to 24% during 1967-73, and the 1952 year class series still dominated the catches as late as 1969. Exploitation rates were moderate (6% - 10%) during 1969-71, and the number of Pacific ocean perch (Tables 7 and 8) in Goose Island Gully increased somewhat as the 1961 year class series recruited to the fishery. Large catches during 1972-74 cancelled out any gains made during the period, however, and the population in Goose Island Gully declined. Estimated biomass was 107,000 m.t. during 1967-69, 77,500 m.t. during 1971, and 44,700 m during 1973. The Japanese catch off Goose Island Gully increased substantiall in 1974, the reported catch of Pacific ocean perch increasing from 958 m.t. in 1973 to 7,983 m.t. in 1974. Further declines in biomass consequently occurred in 1974, particularly in south Goose Island Gully.

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Table 1.--Pacific ocean perch catch (m.t.) by nation and CPUE (m.t./hr.) for Canadian and U.S. vessels in Queen Charlotte Sound, 1956-74.

Year	Catch (m.t.)				CPUE (m.t./hr.)	
	Canada-U.S.A.	Japan	U.S.S.R.	Total	Canada	U.S.A.
1956	1,236	--	--	1,236	--	--
1957	758	--	--	758	--	--
1958	933	--	--	933	--	--
1959	1,915	--	--	1,915	--	0.672
1960	1,680	--	--	1,680	1.139	0.577
1961	1,201	--	--	1,201	1.116	0.645
1962	1,838	--	--	1,838	1.034	0.661
1963	3,712	--	--	3,712	1.297	0.841
1964	3,507	--	--	3,507	0.939	0.731
1965	4,889	--	7,000	11,889	1.285	1.040
1966	8,254	few	18,800	27,054+	1.270	1.132
1967	5,745	3,196	17,800	26,741	0.884	0.800
1968	6,051	5,614	1,827	13,492	0.963	0.722
1969	6,628	6,268	55	12,951	0.743	0.656
1970	6,077	3,775	2	9,854	0.674	0.710
1971	4,165	702	few	4,867+	0.567	0.670
1972	5,561	2,281[1/]	0	7,842	0.941	0.710
1973	3,626	958	0	4,584	1.234	0.812
1974	3,618	7,983	0	11,601	0.961	0.610

[1/] January-October.

Table 2.--North American catch (m.t.) and effort (hr.), and United States CPUE (m.t./hr.) in Mitchells and Goose Island Gullies, 1965-74.

Year	Mitchells Gully			Goose Island Gully		
	Catch (m.t.)	Effort (hr.)	CPUE (m.t./hr.)	Catch (m.t.)	Effort (hr.)	CPUE (m.t./hr.)
1965	20	39	.514	4,869	4,513	1.079
1966	11	20	.552	8,243	6,980	1.181
1967	1,770	1,914	.925	3,975	5,038	.789
1968	1,165	1,290	.903	4,886	6,805	.718
1969	1,770	2,366	.748	4,858	7,650	.635
1970	741	969	.765	5,336	7,601	.702
1971	773	1,098	.704	3,391	4,922	.689
1972	828	1,160	.714	4,734	5,962	.794
1973	2,011	1,808	1.112	1,615	2,256	.716
1974	1,717	2,555	.672	1,901	2,855	.666

Table 3.--Catch (m.t.), effort (hr.), and CPUE (m.t./hr.) for United States vessels operating in the north and south portions of Goose Island Gully, 1965-74.

	North			South		
Year	Catch (m.t.)	Effort (hr.)	CPUE (m.t./hr.)	Catch (m.t.)	Effort (hr.)	CPUE (m.t./hr.)
1965	1,610	1,500	1.073	1,849	1,707	1.083
1966	3,450	2,606	1.324	2,142	2,131	1.005
1967	2,240	2,445	0.916	1,207	1,928	0.626
1968	2,056	2,763	0.744	1,585	2,304	0.688
1969	2,110	3,328	0.634	1,167	1,829	0.638
1970	2,130	2,910	0.732	1,300	1,979	0.657
1971	1,197	1,765	0.678	898	1,277	0.703
1972	1,459	1,883	0.775	510	707	0.721
1973	865	930	0.930	237	598	0.396
1974	1,190	1,558	0.764	120	420	0.286

Table 4.--All-species catch (m.t.), effort (hr.), and CPUE (m.t./hr.) for Japanese trawlers operating off Queen Charlotte Sound (50°30'N.-51°59'N.) by season, by area, 1967-74.[a/]

Year	Apr.-Sep. m.t.	Apr.-Sep. hr.	Apr.-Sep. m.t./hr.	Year	Oct.-Mar. m.t.	Oct.-Mar. hr.	Oct.-Mar. m.t./hr.
			50°30'N.-50°59'N.				
1967	381	33	11.546	1967-68	461	103	4.476
1968	616	185	3.330	1968-69	578	90	6.422
1969	1,696	368	4.609	1969-70	443	123	3.602
1970	--	0	--	1970-71	--	0	--
1971	114	9	12.667	1971-72	371	51	7.275
1972	1,186	150	7.907	1972-73	2,659	543	4.897
1973	2,334	104	22.442	1973-74	5,071	728	6.966
1974	6,757	1,398	4.833				
			51°00'N.-51°29'N.				
1967	602	50	12.040	1967-68	2,782	916	3.037
1968	1,393	344	4.049	1968-69	1,917	546	3.511
1969	1,151	444	2.592	1969-70	1,891	545	3.470
1970	1,120	219	5.114	1970-71	1,164	193	6.031
1971	6	5	1.200	1971-72	793	146	5.432
1972	423	60	7.050	1972-73	1,875	379	4.947
1973	1,077	166	6.488	1973-74	1,571	307	5.117
1974	546	120	4.550				
			51°31'N.-51°59'N.				
1967	177	22	8.046	1967-68	458	53	8.642
1968	730	137	5.329	1968-69	1,589	399	3.983
1969	401	99	4.051	1969-70	591	111	5.324
1970	5	8	0.625	1970-71	--	0	--
1971	--	0	--	1971-72	62	5	12.400
1972	10	2	5.000	1972-73	28	11	2.546
1973	102	19	5.368	1973-74	88	28	3.143
1974	19	9	2.111				

[a/] Among areas, percent rockfish (including Pacific ocean perch) was 90, 89, and 86, respectively, from south to north.

Table 5.--Pacific ocean perch catch (m.t.), effort (hr.), and CPUE (m.t./hr.) for Japanese trawlers operating off Queen Charlotte Sound (50°30'N.-51°59'N.) by season, by area, 1967-74.

Year	Apr.-Sep. m.t.	hr.	m.t./hr.	Year	Oct.-Mar. m.t.	hr.	m.t./hr.
			50°30'N.-50°59'N.				
1967	260	33	7.879	1967-68	248	103	2.408
1968	559	185	3.022	1968-69	505	90	5.611
1969	1,274	368	3.462	1969-70	275	123	2.236
1970	--	0	--	1970-71	--	0	--
1971	110	9	12.222	1971-72	336	51	6.588
1972	861	150	5.740	1972-73	503	543	0.926
1973	133	104	1.279	1973-74	2,730	728	3.750
1974	3,773	1,398	2.699				
			51°00'N.-51°29'N.				
1967	421	53	8.420	1967-68	2,118	916	2.312
1968	1,174	344	3.413	1968-69	1,554	546	2.846
1969	869	444	1.957	1969-70	1,428	545	2.620
1970	939	219	4.288	1970-71	875	193	4.534
1971	5	5	1.000	1971-72	693	146	4.747
1972	375	60	6.250	1972-73	190	379	0.501
1973	290	166	1.747	1973-74	912	307	2.971
1974	250	120	2.083				
			51°30'N.-51°59'N.				
1967	101	22	4.591	1967-68	183	53	3.453
1968	607	137	4.431	1968-69	1,282	399	3.213
1969	373	99	3.768	1969-70	545	111	4.910
1970	4	8	0.500	1970-71	--	0	--
1971	--	0	--	1971-72	60	5	12.000
1972	10	2	5.000	1972-73	26	11	2.364
1973	18	19	0.947	1973-74	53	28	1.893
1974	10	9	1.111				

Table 6.--Pacific ocean perch biomass estimates (m.t.) for marketable fish (>31 cm. FL) by gully, in Queen Charlotte Sound, 1965-74.

Year	Month	Gully		
		Moresby	Mitchells	Goose Island
1965	Aug.	--	--	125,600
1966	Aug.	--	--	89,900
1967	Sep.	--	--	107,100
1969	Sep.	--	--	106,900
1970	Jun.	--	--	72,700
1971	Aug.	--	40,600	--
1971	Oct.	--	--	77,500
1972	Jun.	--	16,400	--
1973	Sep.	--	34,800	44,700
1974	Sep.	136,100	--	--

Table 7.--Pacific ocean perch age composition (no./hr.) of Canada-U.S. landings during 1963-73, based on Canadian samples, Queen Charlotte Sound.

Age (yr.)	Goose Island Gully						Mitchells Gully
	1963	1965	1967	1969	1971	1973	1973
4	--	--	--	--	--	1	--
5	3	1	--	5	1	0	1
6	0	4	4	3	9	0	1
7	13	3	0	20	36	3	17
8	18	6	1	45	24	13	25
9	39	32	12	68	80	46	45
10	79	66	37	47	206	66	69
11	236	85	60	41	83	151	155
12	198	217	92	38	30	142	127
13	190	351	131	96	17	46	56
14	90	176	159	77	44	26	69
15	52	94	164	97	32	14	78
16	48	46	81	87	78	29	85
17	43	48	54	70	60	25	108
18	41	33	58	57	47	30	92
19	36	40	30	33	75	32	84
20	21	23	24	29	21	29	85
>20	34	61	39[a/]	80[b/]	71	75[c/]	170[d/]
Total	1,141	1,286	946	893	914	728	1,267

a/ 21 = 16; 22 = 7.

b/ 21 = 19; 22 = 19; 23 = 20; 24 = 10.

c/ 21 = 35; 22 = 13.

d/ 21 = 55; 22 = 45; 23 = 29.

Table 8.--Pacific ocean perch age composition (absolute numbers in thousands) in biomass estimates for Goose Island, Mitchells Gully, and Moresby Gully, 1967-74.

Age (yr.)	Moresby Gully	Mitchells Gully	Goose Island Gully		
	1974	1973	1967	1969	1973
0	--	--	25	30	--
1	--	--	1,949	334	123
2	--	--	7,670	690	1,590
3	491	133	16,216	1,995	6,449
4	5,803	322	1,988	4,367	1,044
5	7,495	1,076	22,805	18,098	777
6	5,789	1,266	15,005	10,640	262
7	7,103	5,166	6,668	20,083	1,413
8	11,838	12,012	3,577	29,156	2,272
9	13,008	11,474	2,975	21,621	3,860
10	12,159	9,966	5,925	12,524	5,293
11	10,772	13,336	14,467	7,737	9,054
12	12,182	5,662	11,476	6,995	4,897
13	9,045	1,842	18,311	10,211	2,361
14	4,118	651	16,896	8,643	1,508
15	6,299	793	29,691	13,365	1,864
16	8,457	1,068	10,091	15,873	2,299
17	10,134	1,052	9,536	10,733	3,401
18	12,921	1,007	6,310	8,296	3,033
19	13,980	981	5,209	5,782	3,401
20	12,515	752	5,243	3,796	1,937
>20	25,346	1,838	6,700	11,976	4,696
Total	189,454	70,397	218,732	222,945	61,534

Table 9.--Biological statistics for Pacific ocean perch in Goose Island Gully

A. Rate of exploitation (for fish ≥31 cm. FL)

Year	Biomass (m.t.)	All-nation catch[a/] (m.t.)	Rate of exploitation (μ)
1967	107,100	26,100	0.244
1969	106,900	11,300	0.106
1970	72,700	8,900	0.122
1971	77,500	4,500	0.058
1973	44,700	8,800	0.197

B. Mortality rates for 1951-54 year classes

Year	N_o	N_n	μ	a	Z	F	M
1. Canada-U.S. landings from Goose Island Gully:							
1967-69	535	311	.175	.24	.27	.20	.07
1967-71	535	203	.132	.22	.25	.15	.10
2. Biomass estimates for Goose Island Gully:							
1967-69	74,989	48,267	.175	.20	.22	.19	.03
1969-73	48,267	8,229	.121	.36	.45	.15	.30
1967-73	74,989	8,229	.145	.31	.37	.17	.20
C. Mortality rates from biomass estimates of the total stock							
1969-70	--	--	.114	.32	.39	.14	.25
1969-71	--	--	.095	.15	.16	.10	.06
1969-73	--	--	.121	.20	.22	.13	.09

a/ Japanese catch adjusted, assuming that Pacific ocean perch comprised 92% of all-rockfish catch.

Table 10.--Pacific ocean perch catch (m.t.), by nation and CPUE (m.t./hr.) for United States vessels in the Vancouver area, 1956-74.

Year	Catch (m.t.) Canada-U.S.A.	Japan	USSR	Poland	Total	CPUE (m.t./hr.) U.S.A.
1956	1,084	--	--	--	1,084	?
1957	1,154	--	--	--	1,154	?
1958	675	--	--	--	675	?
1959	968	--	--	--	968	0.341
1960	1,575	--	--	--	1,575	0.254
1961	2,485	--	--	--	2,485	0.327
1962	3,857	--	--	--	3,857	0.350
1963	3,867	--	--	--	3,867	0.435
1964	2,499	--	--	--	2,499	0.404
1965	3,046	--	500	--	3,546	0.718
1966	2,358	few	14,000	--	16,358+	0.640
1967	805	6,678	6,000	--	13,483	0.434
1968	552	4,751	5,114	--	10,417	0.247
1969	583	1,787	1,040	--	3,410	0.242
1970	1,955	2,186	182	--	4,323	0.298
1971	1,155	1,838	900	--	3,893	0.317
1972	624	1,580	401	--	2,605	0.312
1973	344	2,989	490	--	3,823	0.228
1974	287	1,084	70	32	1,473	0.202

Table 11.--Age composition (no./hr.) of Pacific ocean perch in U.S. commercial landings from the Vancouver area, 1966-74.

Age (yrs.)	1966	1967	1968	1969	1970	1971	1972	1973	19
5	--	1	--	--	1	--	1	2	1
6	--	1	1	--	2	--	2	3	1
7	--	8	2	3	8	5	7	6	2
8	--	8	3	6	32	16	20	8	5
9	10	17	7	3	104	69	44	26	16
10	33	36	15	17	72	124	93	63	41
11	111	61	27	44	54	69	141	106	72
12	152	73	50	87	46	50	56	117	89
13	211	96	51	87	41	37	32	48	66
14	128	80	48	59	46	37	29	23	25
15	103	52	44	63	40	35	25	20	18
16	75	49	36	27	48	31	25	17	13
17	37	45	27	7	32	25	16	18	12
18	23	25	21	10	22	12	19	14	11
19	26	19	16	4	12	11	10	13	1
20	0	9	13	--	6	6	4	9	7
21	19	3	7	--	2	3	4	6	1
22	--	4	4	--	--	1	3	2	5
23	--	1	1	--	--	--	1	1	1
24	--	1	--	--	--	--	--	--	1
Total	928	589	373	417	568	531	532	502	402
No. of otoliths	216	707	502	296	1,124	1,460	1,036	1,335	1,598

Table 12.--Biological statistics for 14-18 year old Pacific ocean perch in the Vancouver area.

Year	Survival (S) estimator	S	a	Z	F
1966-67	$\frac{52+49+45+25+19}{128+103+75+37+23}$	0.52	0.48	0.66	0.51
1967-68	$\frac{44+36+27+21+16}{80+52+49+45+25}$	0.57	0.43	0.56	0.41
1968-69	$\frac{63+27+7+10+4}{48+44+36+27+21}$	0.63	0.37	0.46	0.31
1969-70	$\frac{40+48+32+22+12}{59+63+27+7+10}$	0.93	0.07	0.08	1/
1970-71	$\frac{35+31+25+12+11}{46+40+48+32+22}$	0.61	0.39	0.50	0.35
1971-72	$\frac{25+25+16+19+10}{37+35+31+25+12}$	0.68	0.32	0.39	0.24
1972-73	$\frac{20+17+18+14+13}{29+25+25+16+19}$	0.72	0.28	0.33	0.18
1973-74	$\frac{18+13+12+11+7}{23+20+17+18+14}$	0.66	0.34	0.42	0.27

1/ The estimation procedure produced unrealistically low values of Z and F.

Table 13.--United States Pacific ocean perch catch (m.t.) and CPUE (m.t./hr.) corrected for contamination by other Sebastes species, Columbia Area, 1956-74.

Year	Reported landings	% S.alutus	Landings of S.alutus	S.alutus in other rockfish landings	Total S.alutus landings	CPUE m.t./hr. 1/	CPUE m.t./hr.
1956	1,306	--	--	--	--	0.379	--
1957	1,454	--	--	--	--	0.311	--
1958	1,002	--	--	--	--	0.327	--
1959	1,134	--	--	--	--	0.285	--
1960	1,065	--	--	--	--	0.274	--
1961	2,060	--	--	--	--	0.322	--
1962	2,610	--	--	--	--	0.283	--
1963	3,542	95.8	3,393	156	3,549	0.337	0.323
1964	3,887	93.7	3,642	1	3,643	0.360	0.337
1965	6,116	85.7	5,241	134	5,375	0.545	0.467
1966	1,690	74.5	1,259	11	1,270	0.452	0.337
1967	727	37.3	271	10	281	0.302	0.113
1968	353	49.1	173	5	178	0.156	0.077
1969	272	77.5	211	44	255	0.167	0.129
1970	279	64.5	180	3	183	0.157	0.101
1971	405	31.6	128	3	131	0.149	0.047
1972	340	31.6	107	3	110	0.132	0.042
1973	243	38.6	94	1	95	0.163	0.063
1974	341	31.7	108	3	111	0.248	0.079

1/ Based on reported landings, column 1.

2/ Based on corrected landings, column 4.

Table 14.--Pacific ocean perch catch (m.t.) by nation and CPUE (m.t./hr.) for United States vessels in the Columbia area, 1956-74.

Year	U.S.A.	Japan	U.S.S.R.	Poland	Total	CPUE (m.t./hr.) U.S.A.
1956	1,306	--	--	--	1,306	0.379
1957	1,454	--	--	--	1,454	0.311
1958	1,002	--	--	--	1,002	0.327
1959	1,134	--	--	--	1,134	0.285
1960	1,065	--	--	--	1,065	0.274
1961	2,060	--	--	--	2,060	0.322
1962	2,610	--	--	--	2,610	0.283
1963	3,549	--	--	--	3,549	0.323
1964	3,643	--	--	--	3,643	0.337
1965	5,375	--	few	--	5,375	0.467
1966	1,270	few	10,000	--	11,270	0.337
1967	281	3,850	19,845	--	23,976	0.113
1968	178	4,274	7,110	--	11,562	0.077
1969	255	0	2,241	--	2,496	0.129
1970	183	38	2,621	--	2,842	0.101
1971	131	276	2,462	--	2,869	0.047
1972	110	880	1,629	--	2,619	0.042
1973	95	0	539	--	634	0.063
1974	111	0	100	94	305	0.079

Table 15.--Age composition (no./hr.) of Pacific ocean perch landed by United States vessels from the Columbia area, by year, 1966-74.

Age (yrs.)	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	--	--	--	--	T	--	--	T	--
4	--	--	T	--	--	--	T	1	--
5	T	T	T	1	T	--	T	1	T
6	1	T	3	1	7	T	1	1	2
7	2	1	7	1	7	1	2	1	1
8	8	3	10	2	12	2	2	3	1
9	10	5	6	3	12	5	4	4	4
10	23	8	7	3	11	7	6	6	11
11	41	15	10	7	11	7	10	8	15
12	79	28	15	24	14	5	4	13	20
13	47	17	13	27	17	5	3	7	14
14	34	15	9	29	12	5	4	4	6
15	41	14	7	19	15	5	4	4	5
16	39	10	5	12	10	4	4	4	4
17	24	6	2	6	6	5	5	5	2
18	17	3	1	3	4	2	2	4	3
19	8	2	1	T	2	2	1	1	2
20	3	1	T	--	1	1	1	1	1
21	1	T	T	--	1	1	1	1	T
22	T	T	T	T	T	T	T	T	T
23	T	T	--	--	--	--	T	1	T
Total	379	130	98	137	142	58	56	72	93
Otoliths read	1,117	1,658	1,629	552	768	319	845	664	295

Table 16.--Biological statistics for Pacific ocean perch in the Columbia Area.

Individual year classes in commercial landings, 1966-74	s	a	Z	F
Year class				
1957 $\frac{5+4+4+2}{17+5+4+4}$	0.50	0.50	0.69	-
1956 $\frac{12+5+4+5+3}{27+12+5+4+5}$	0.55	0.45	0.60	-
1955 $\frac{29+15+4+5+4+2}{13+29+15+4+5+4}$	0.84	0.16	0.17	-
1954 $\frac{9+19+10+5+2+1+1}{17+9+19+10+5+2+1}$	0.75	0.25	0.29	-
1953 $\frac{15+7+12+6+2+1+1}{47+15+7+12+6+2+1}$	0.49	0.51	0.71	-
1952 $\frac{14+5+6+4+2+1+0.1}{34+14+5+6+4+2+1}$	0.50	0.50	0.69	-
1951 $\frac{10+2+3+2+1+1+0.4}{41+10+2+3+2+1+1}$	0.32	0.68	1.14	-
1950 $\frac{6+1+0.3+1+1+0.2+1}{39+6+1+0.3+1+1+0.2}$	0.22	0.78	1.51	
Grouped year classes (14 to 18 year olds)				
Time period				
1966-68 (1948-52 year classes) $\sqrt{\frac{5+2+1+1+0.5}{34+41+39+24+17}}$	0.24	0.76	1.41	1.26
1969-72 (1951-55 year classes) $\sqrt[3]{\frac{5+2+1+1+1}{29+19+12+6+3}}$	0.52	0.48	0.65	0.50
1973-74 (1955-59 year classes) $\frac{5+4+2+3+2}{4+4+4+5+4}$	0.76	0.24	0.27	0.12

FIGURES

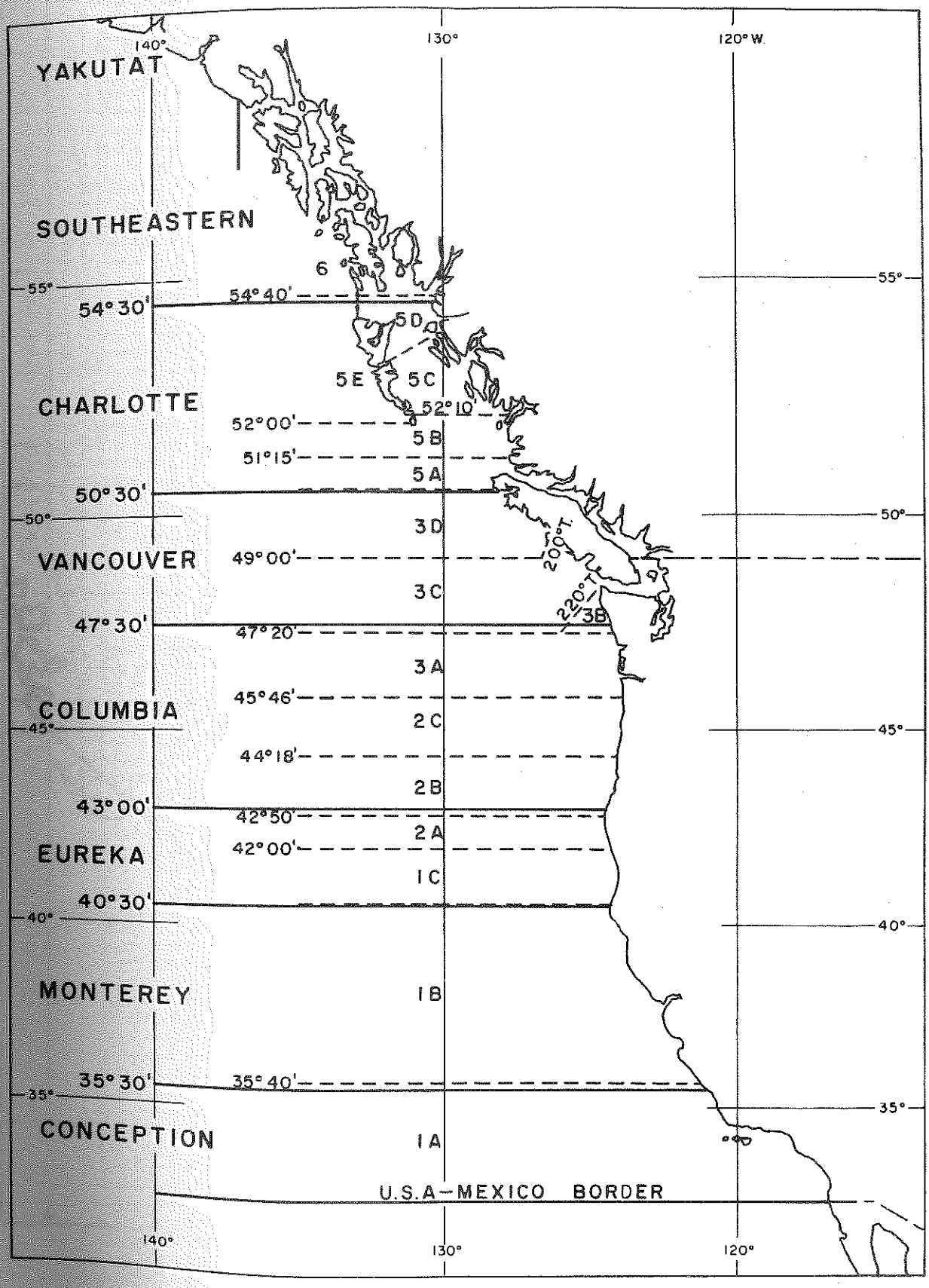

Fig. 1. Chart of northeastern Pacific Ocean showing the INPFC and PMFC groundfish statistical areas.

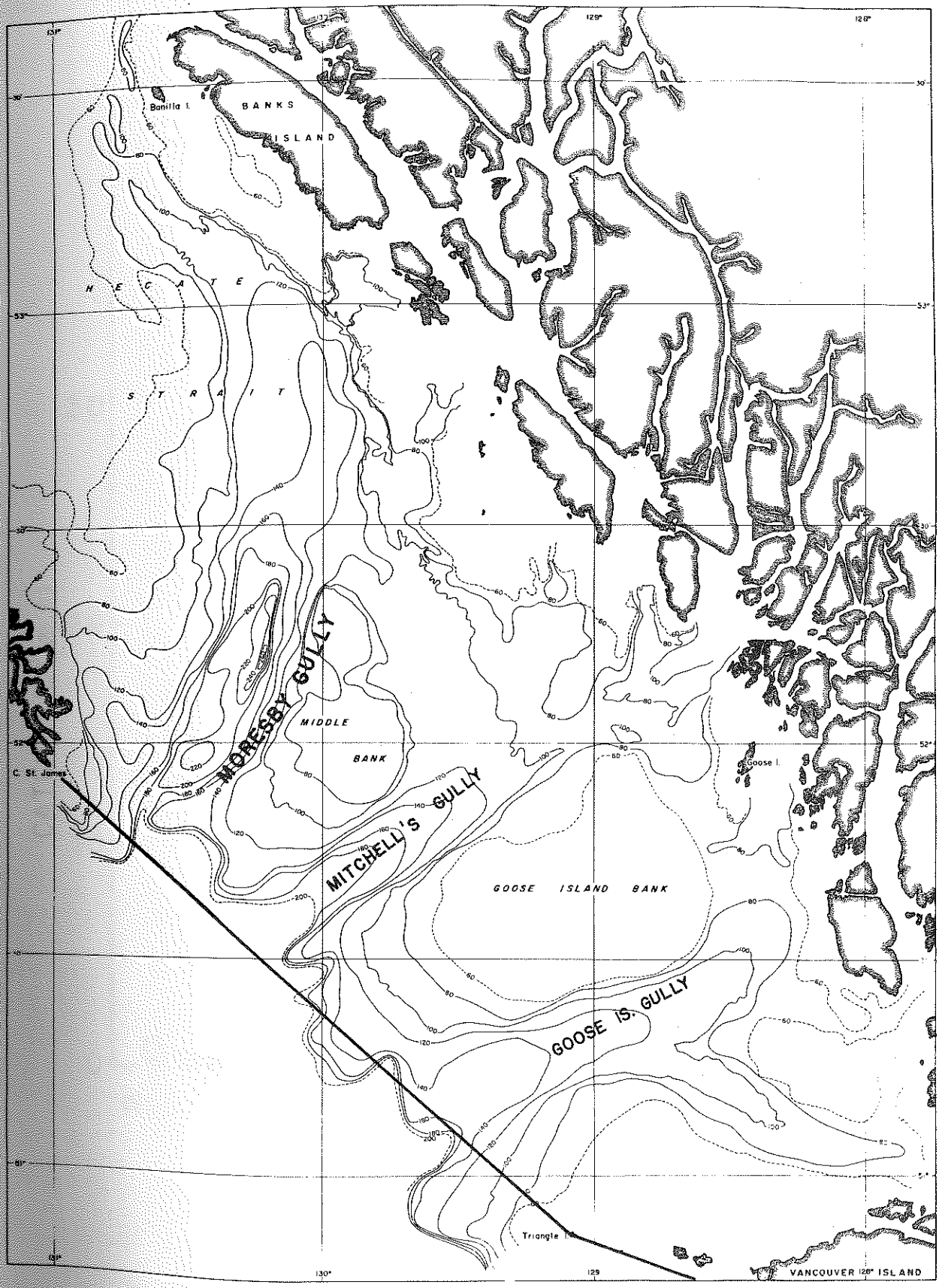

Fig. 2. Bathymetry of Queen Charlotte Sound, showing the major undersea gullies and the line enclosing the Canadian exclusive fishing zone.

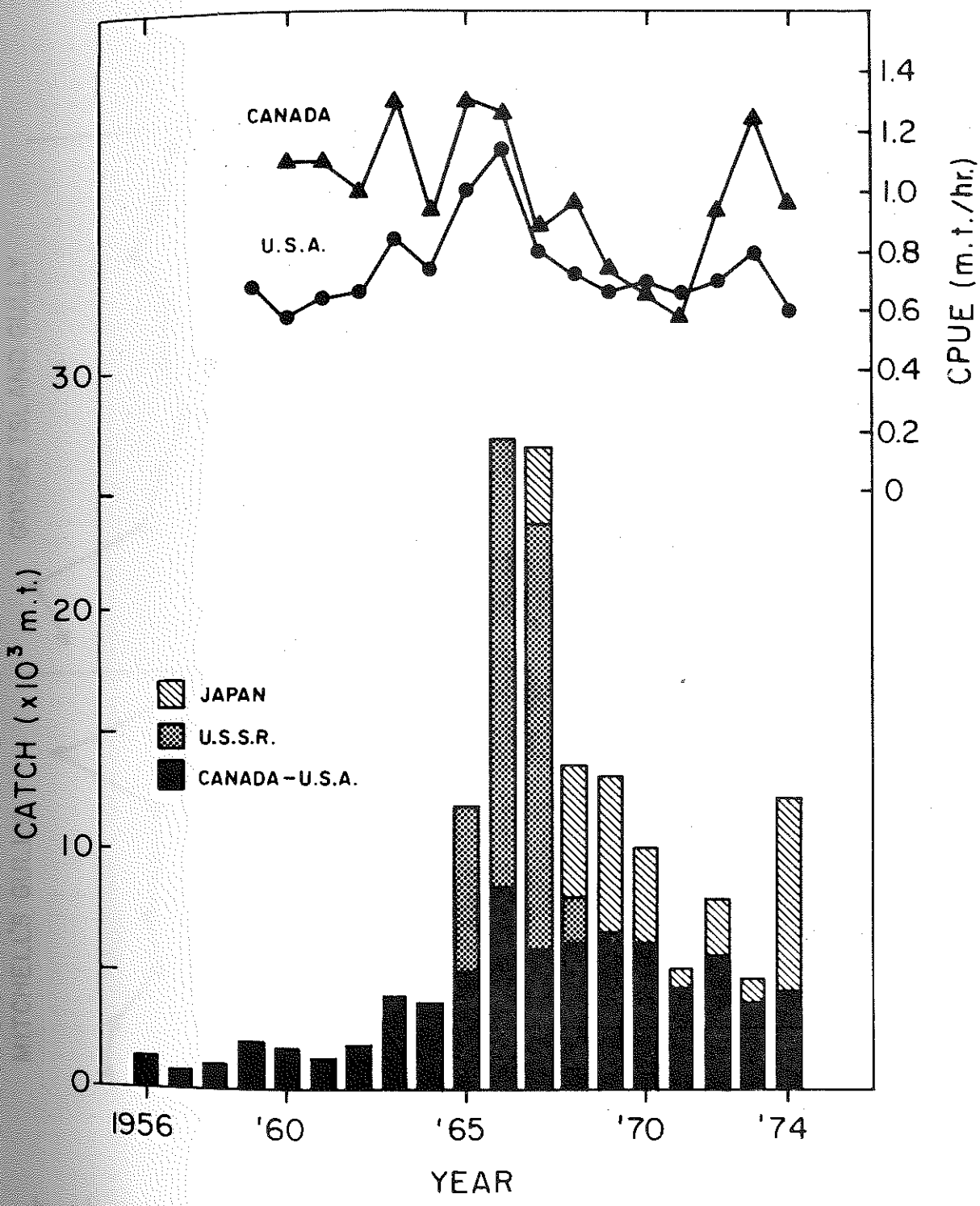

Fig. 3. Pacific ocean perch catch (m.t.) by nation, and CPUE (m.t./hr) for Canadian and United States vessels, in Queen Charlotte Sound, 1956-74.

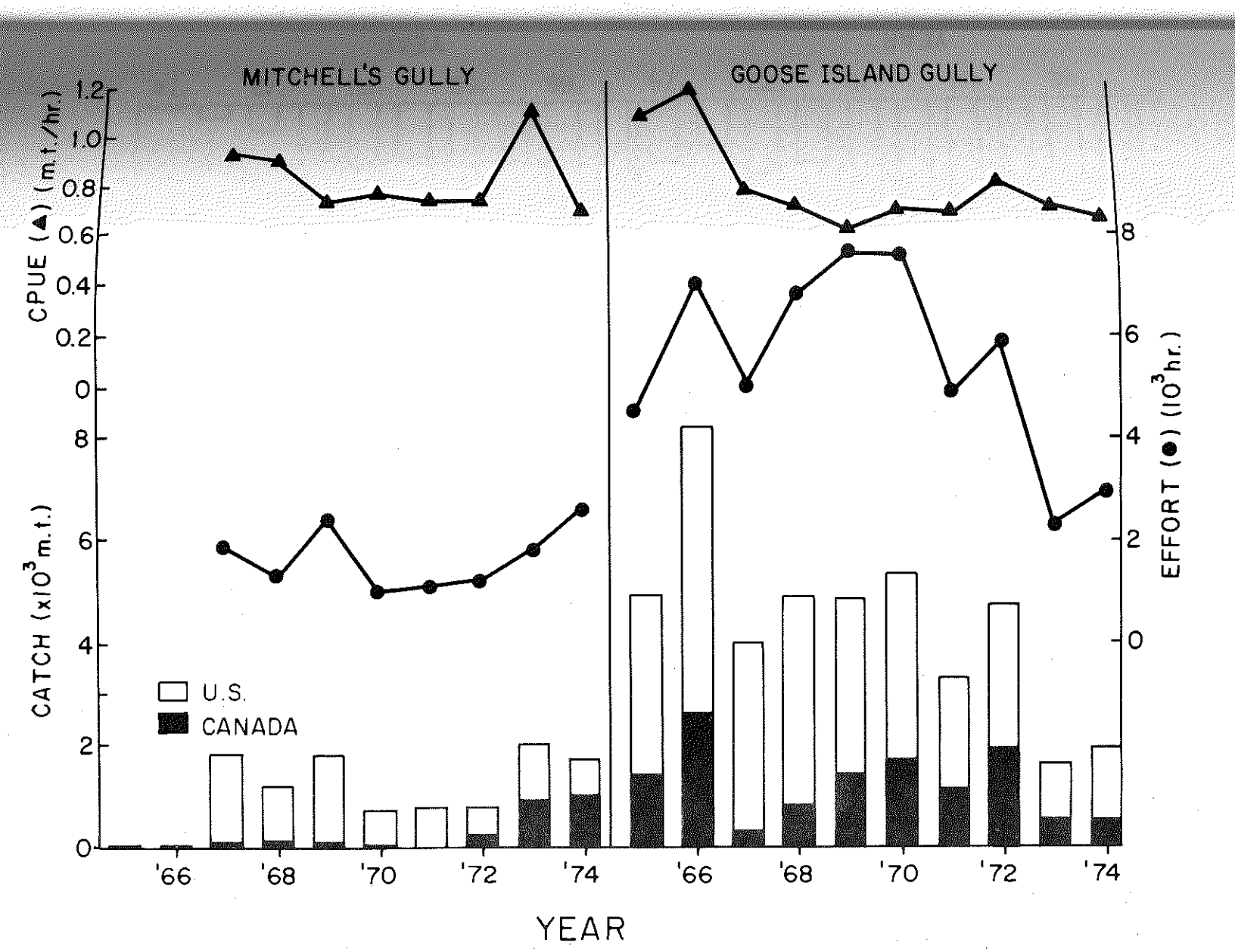

Fig. 4. North American catch of Pacific ocean perch (m.t.) and United States CPUE (m.t./hr) in Mitchells and Goose Island gullies. Shaded portion of histograms represents the Canadian catch.

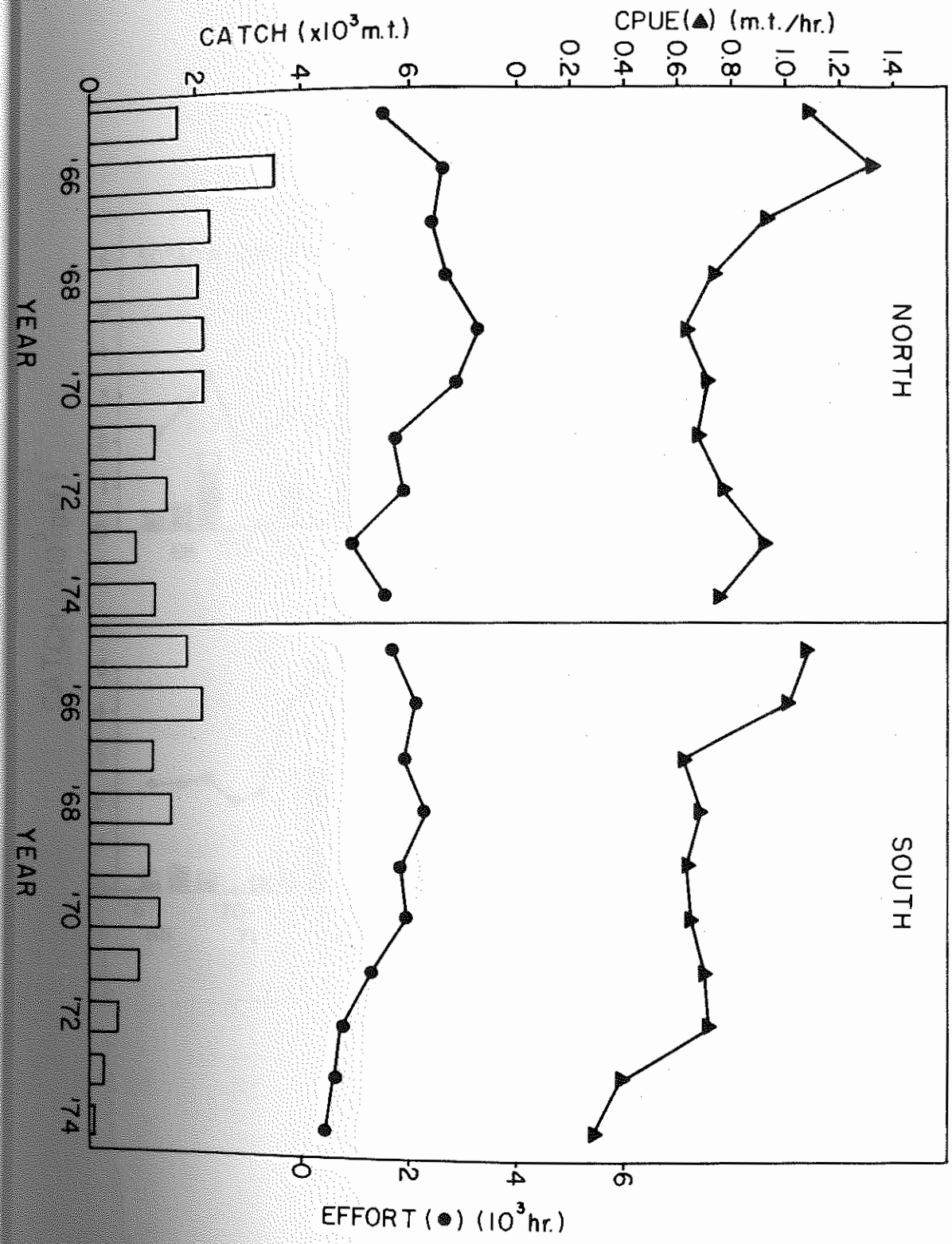

Fig. 5. Catch statistics from United States vessels operating in North and South Goose Island Gully, 1965-74.

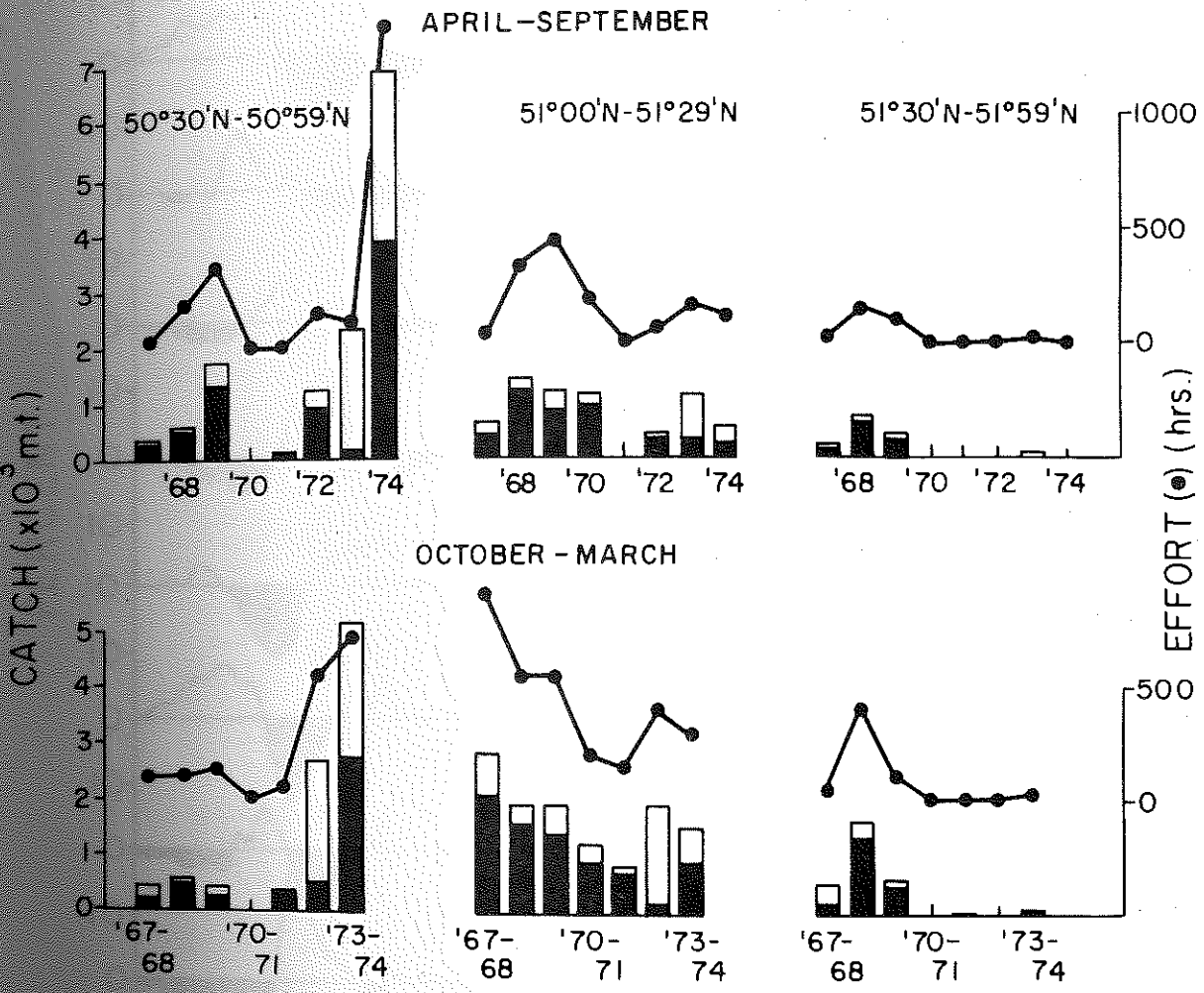

Fig. 6. Total catch, Pacific ocean perch catch (shaded portion of histograms) and effort for Japanese trawlers operating off Queen Charlotte Sound, by season and area, 1967-74.

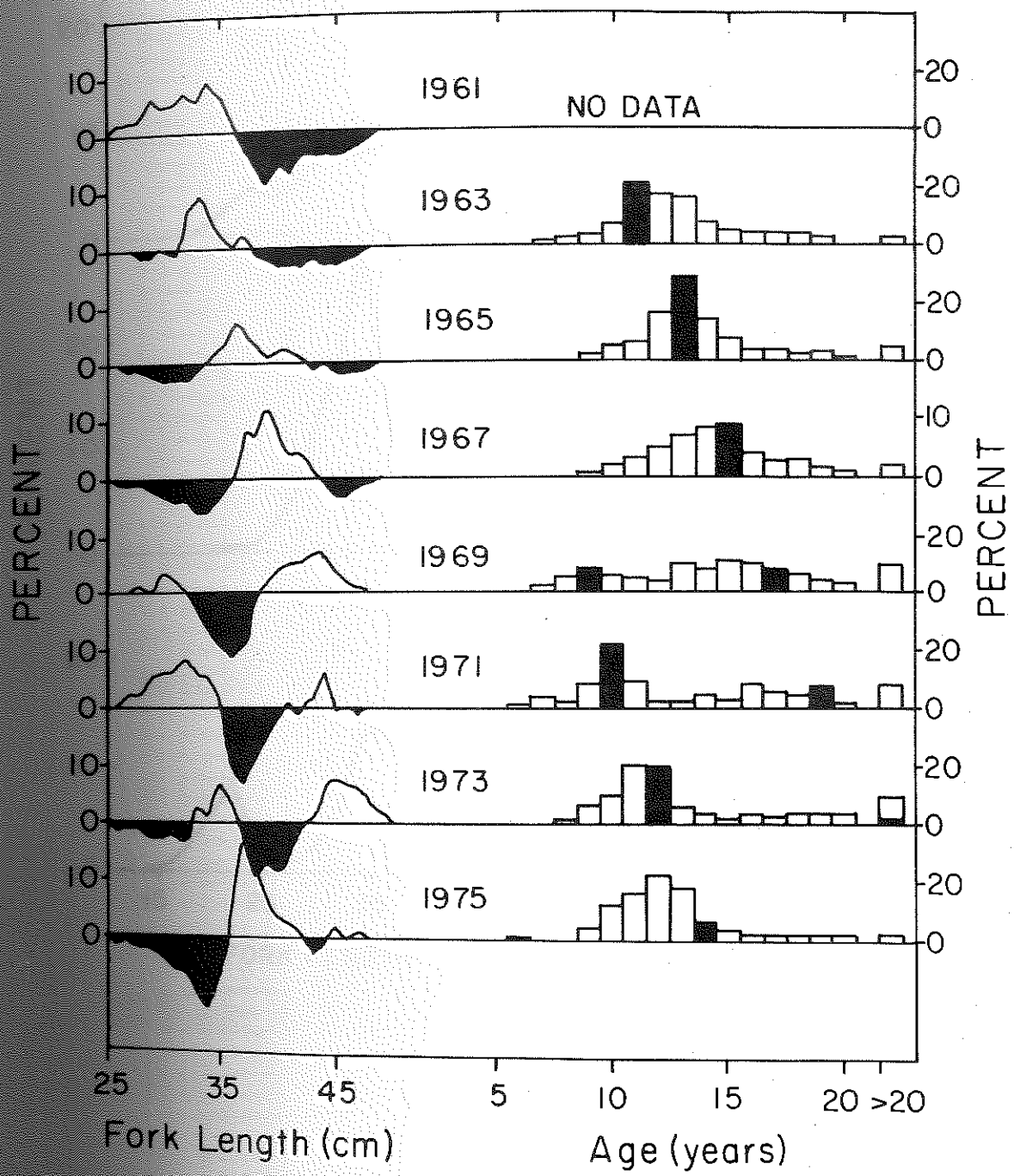

Fig. 7. Length-frequency anomalies (as percent deviations from the long-term mean) and age composition of Canadian landings from Goose Island Gully, 1961-75.

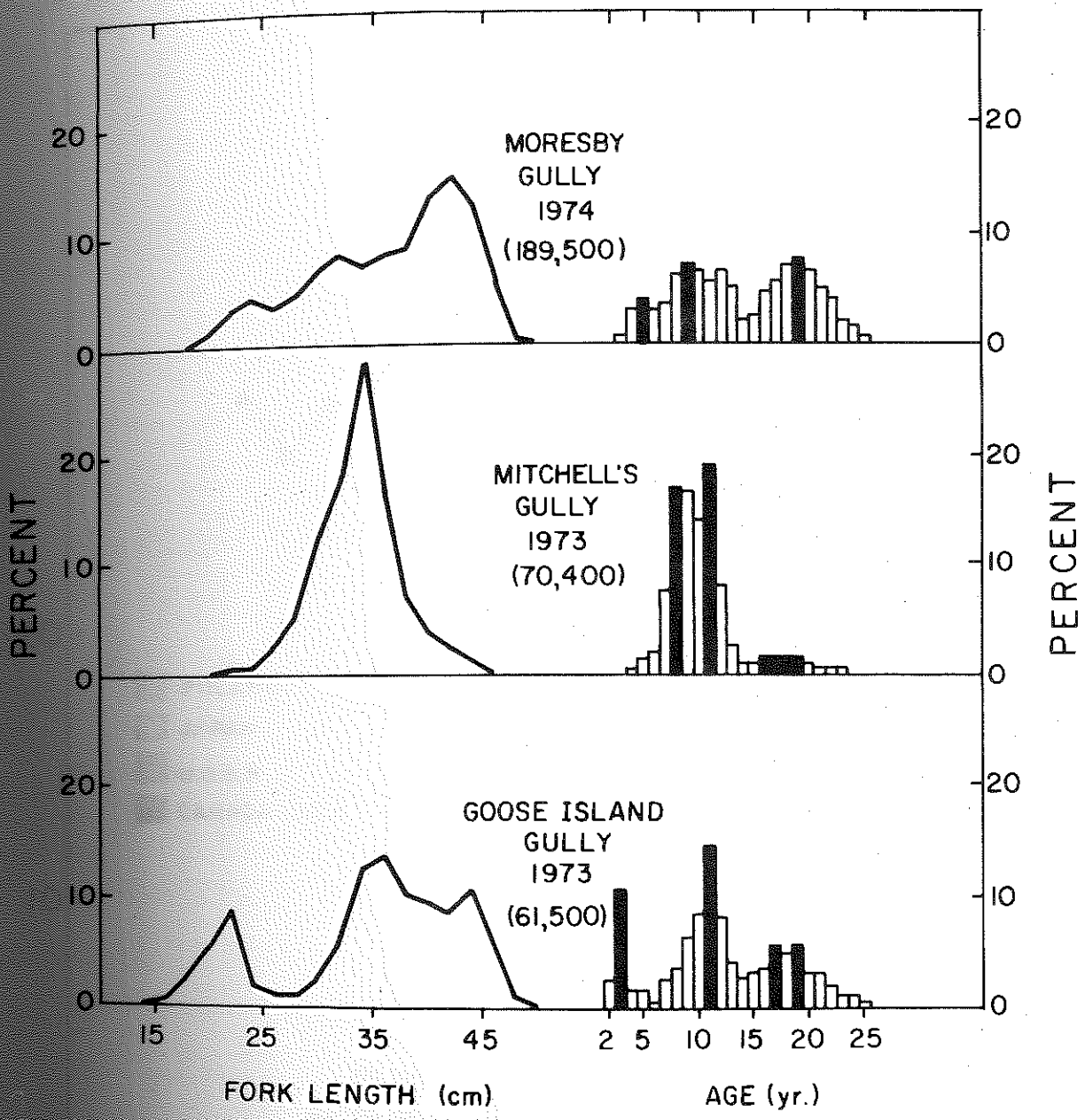

Fig. 8. Size and age composition of Pacific ocean perch in Moresby, Mitchells, and Goose Island gullies, as determined during research surveys. Estimated population size (numbers of fish) is shown in parentheses.

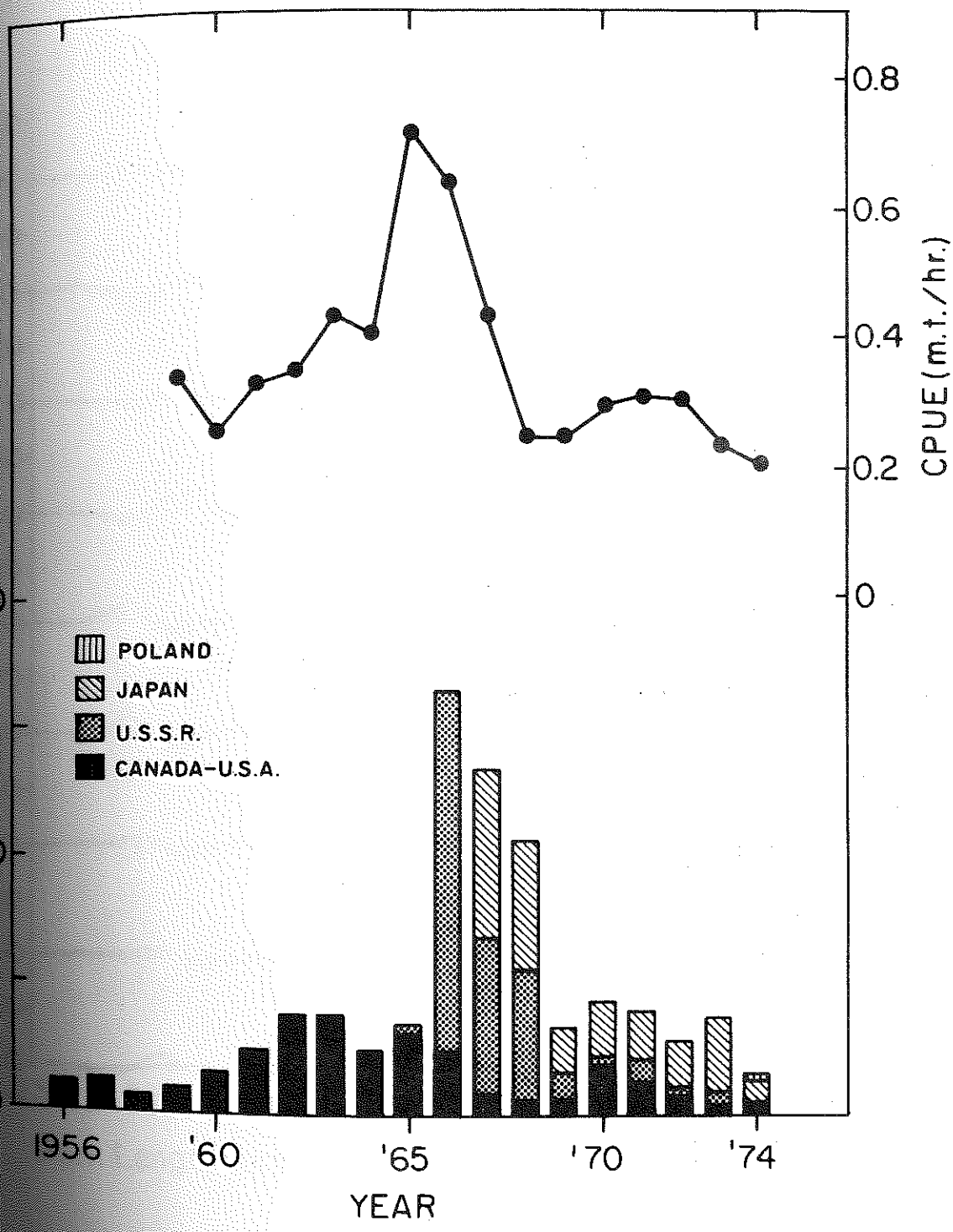

Fig. 9. Pacific ocean perch catch (m.t.) by nation, and CPUE (m.t./hr) for United States vessels, in the Vancouver Area, 1956-74.

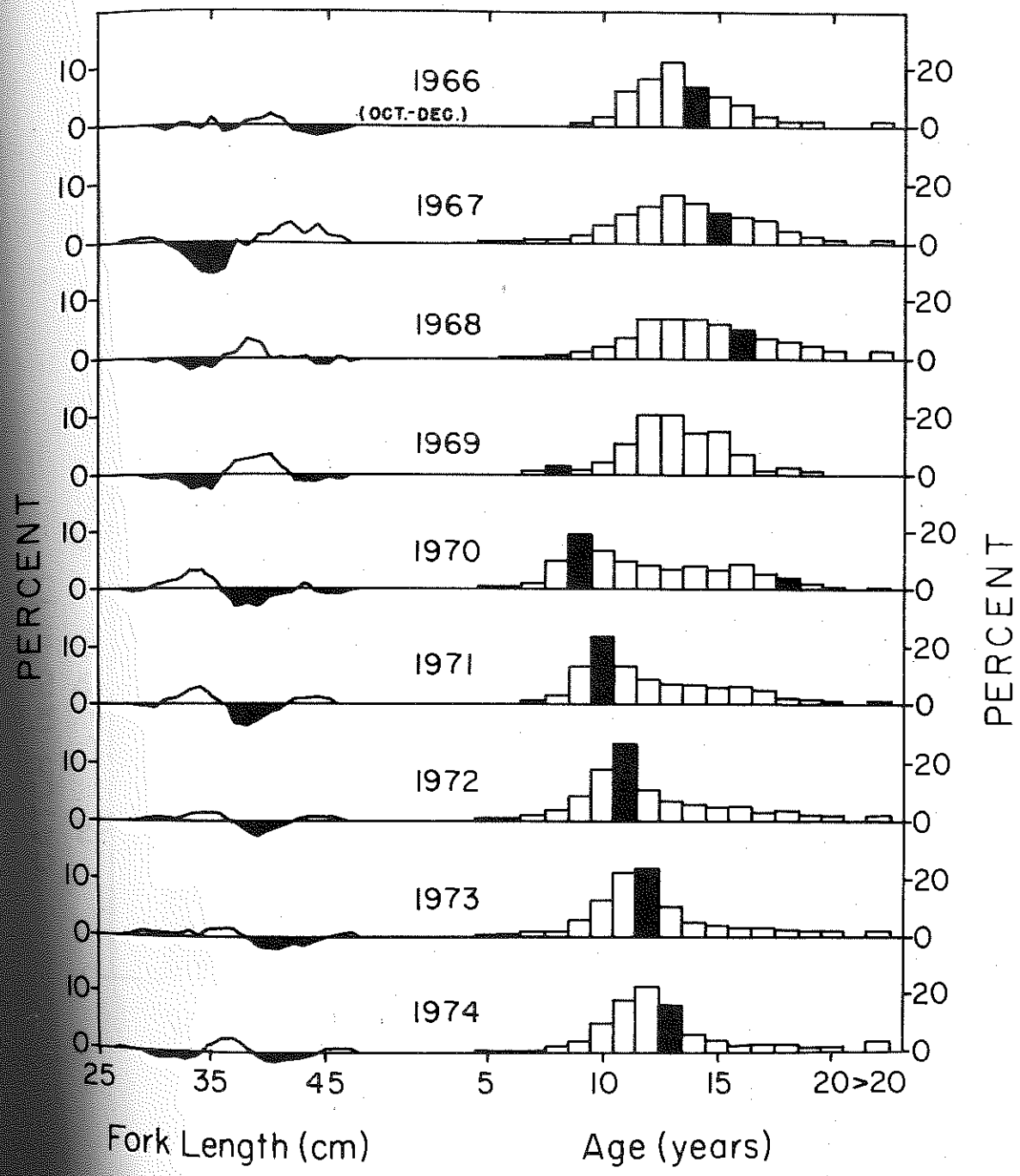

Fig. 10. Length-frequency anomalies (as percent deviation from the long-term mean) and age composition of United States landings from the Vancouver Area, 1966-74.

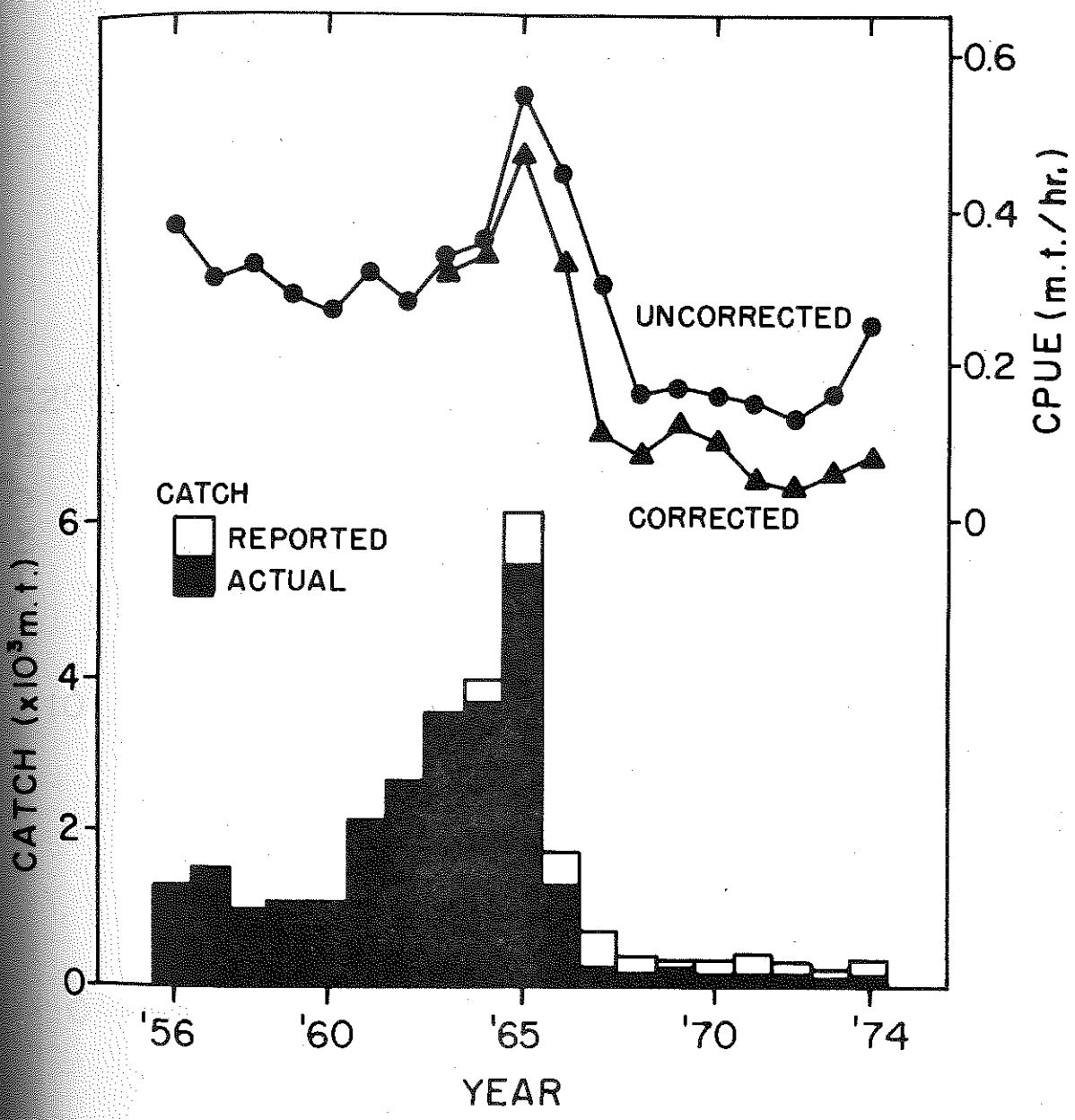

Fig. 11. Reported catch and actual catch (m.t.) of Pacific ocean perch, with uncorrected and corrected CPUE (m.t./hr) for United States data, in the Columbia Area, 1956-74.

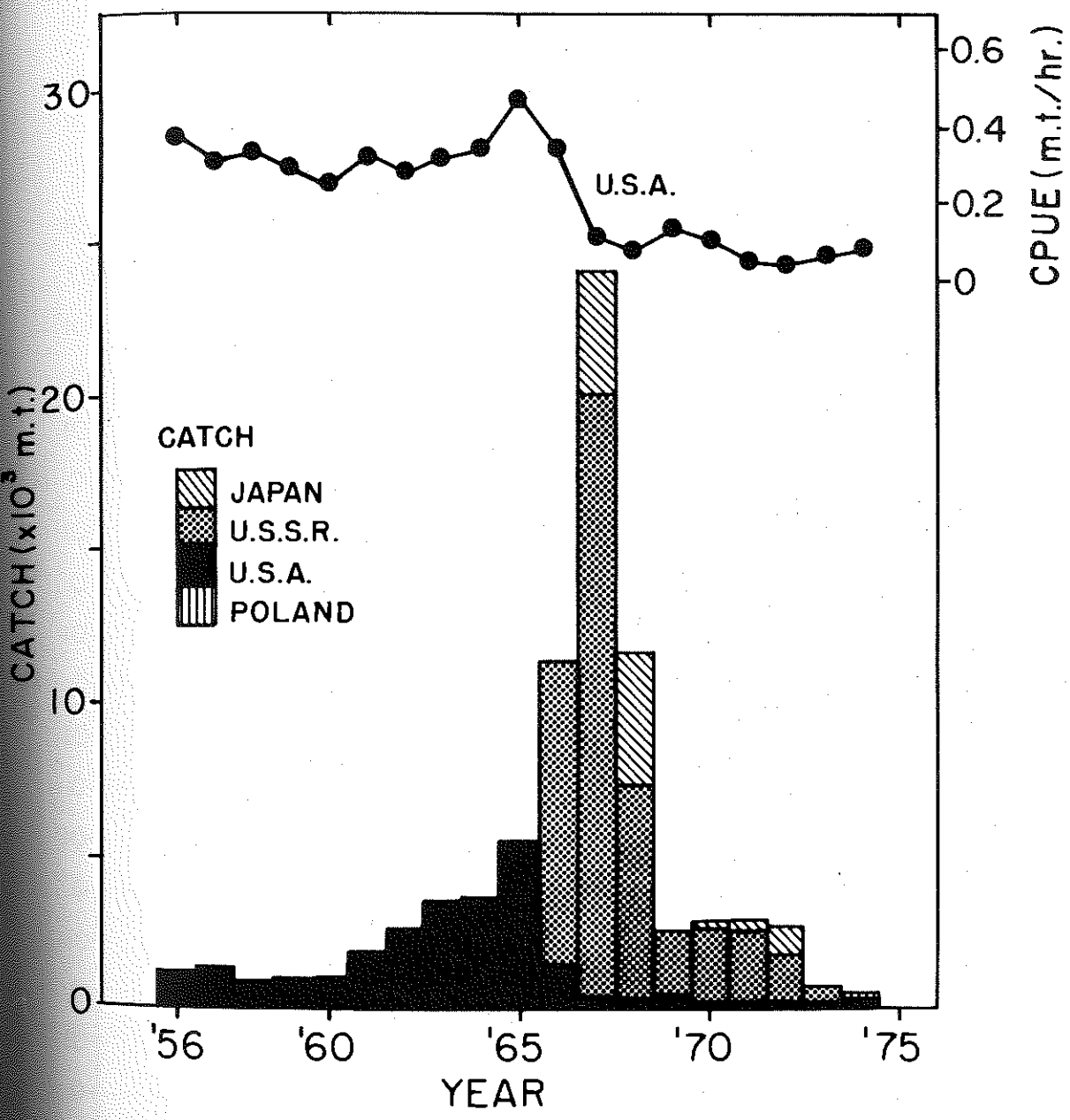

Fig. 12. Pacific ocean perch catch (m.t.) by nation, and CPUE (m.t./hr) for United States vessels, in the Columbia Area, 1956-74.

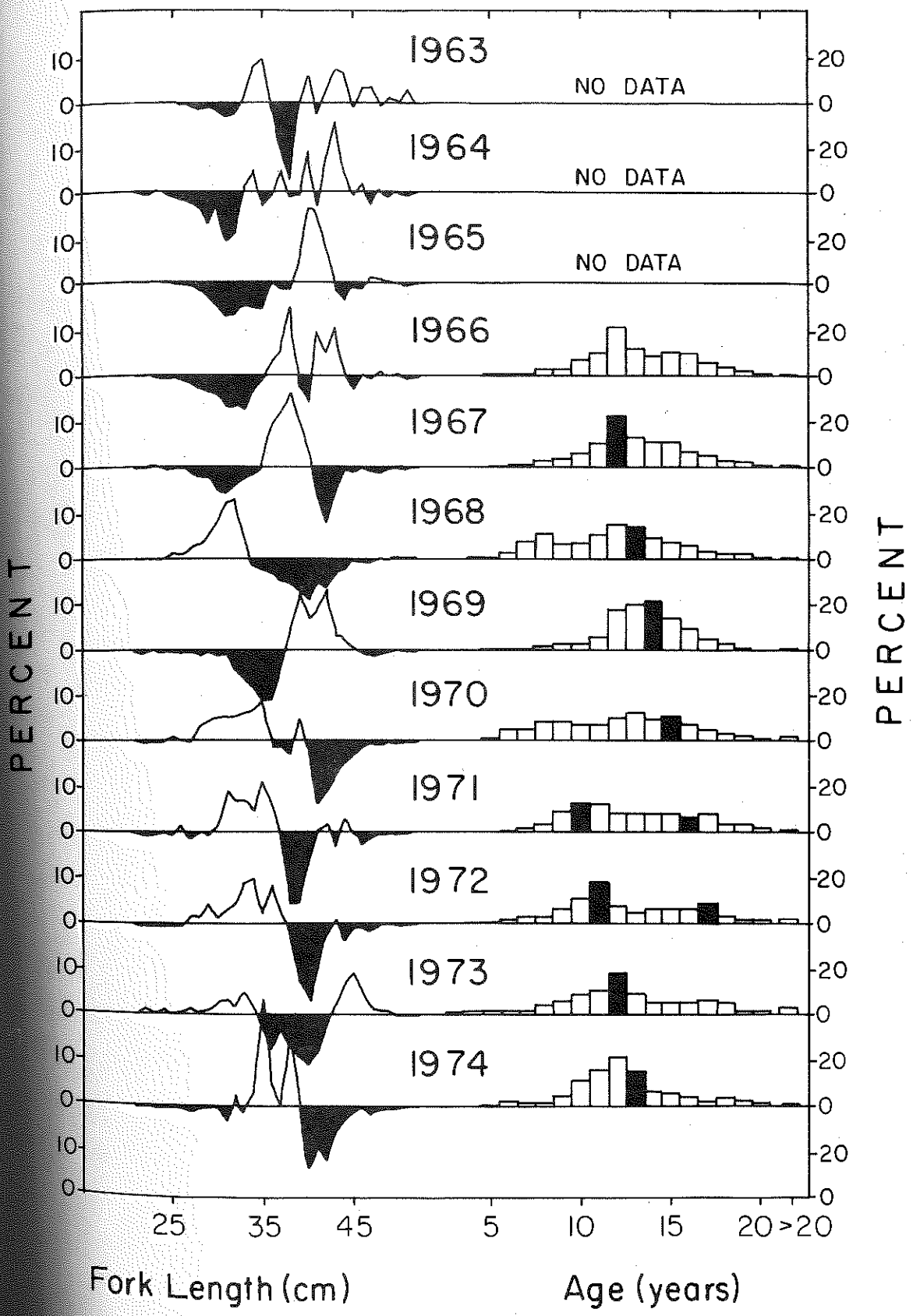

Fig. 13. Length-frequency anomalies (as percent deviation from the long-term mean, 1963-74) and 1966-74 age composition of United States landings in the Columbia Area.