NORTHWEST FISHERIES CENTER
PROCESSED REPORT
APRIL 1976

STATUS OF MAJOR DEMERSAL FISHERY RESOURCES OF THE NORTHEASTERN PACIFIC: BERING SEA AND ALEUTIAN ISLANDS

by

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INTRODUCTION

The Northeastern Pacific is defined here to include the Bering Sea and Aleutian Islands, the Gulf of Alaska, and the Pacific Northwest extending to northern California (Fig. 1). The region supports many lucrative fisheries ranging from shellfish to marine mammals. This report deals with the Bering Sea and Aleutian Island fishery resources. Those of the Gulf of Alaska and off the Pacific Northwest will be dealt with in a follow-up paper. However, the history of demersal fisheries in the entire northeastern Pacific region will be reviewed here as they are related.

Prior to World War II, waters contiguous to the Pacific Coast of North America were fished primarily by fishermen of the United States of America (U.S.) and Canada. The exception occurred in the eastern Bering Sea where Japan conducted a fish meal operation from 1929-37 and a frozen-fish operation from 1940-41. These operations were relatively small but following World War II, fisheries by Japan and the Union of Soviet Socialists Republics (USSR) for demersal fishes and other species in the eastern Bering Sea have developed rapidly.

Expansion of fishing by these foreign (other than North American) nations in waters contiguous to Alaska has brought them in direct competition with U.S. and Canadian fishermen for some species. Since 1960, their fisheries have expanded farther south into the Gulf of Alaska, off the Pacific Northwest, and eventually to northern California. In 1967, the Republic of Korea (ROK) joined in the groundfish fishery off Alaska and by 1975 had spread to the Pacific Northwest. The Polish People's Republic (Poland) and the German Democratic Republic (East Germany) also entered the fishery in 1972. The Republic of China (ROC) began a small scale fishery off Alaska and had a vessel off the Pacific Northwest in 1976.

This expansion has had tremendous impact on the fishery resources and complicated problems of managing and conserving them. All these fishing fleets are highly mobile and capable of exerting very high fishing effort on fish stocks. Consequently, the fishery scene in the northeastern Pacific has been changing rapidly. Total groundfish landings have increased almost steadily through 1972 to 2.8 million metric tons (Table 1, Figs 2 and 3). Since then, some fishing restrictions have come into effect and landings have declined slightly. Some fish stocks have been overexploited, most others are already fully utilized.

The purpose of this report, therefore, is to (1) review the history and magnitude of demersal fisheries in the entire northeastern Pacific Ocean, (2) identify the stocks to evaluate stock abundance trends, structural composition changes, sustainable yield potential, overall stock conditions, etc., in the Bering Sea-Aleutians and (3) summarize current management provisions for these resources. It is intended to provide an overview of the demersal and herring fishery resources.

NORTH AMERICAN PACIFIC COAST DEMERSAL FISHERIES

Pacific coast fisheries are defined as those carried out by U.S. and Canada based fishermen in waters contiguous to the Pacific coast of North America. The major fisheries considered in this report are those for groundfish, herring and some shellfish. Two categories of groundfish operations are defined:

(1) A long established fisheries for Pacific halibut (*Hippoglossus stenolepis*), sablebish (*Anoplopoma fimbra*), and Pacific cod (*Gadus macrocephalus*). This category of fisheries started back before the turn of the century and operates mostly offshore and farther away from the states of British Columbia, Washington and Oregon.

(2) An inshore trawl fishery for groundfish extending primarily between Oregon and Southeastern Alaska. The trawl fishery was introduced to the Pacific coast after the turn of the century and operates closer inshore. Flatfishes, rock fishes, Pacific cod and sablefish have been the important fishes harvested.

OFFSHORE HALIBUT, SABLEFISH AND COD FISHERIES

The early historic stages of development of these fisheries have been reviewed by Thompson and Freeman (1930) on Pacific halibut, Bell and Pruter (1954) on sablefish, and Cobb (1927) on Pacific cod. Alverson *et al*. (1964) also reviewed the development of these three fisheries collectively. A brief account of their development follows:

1864 First record of Pacific cod fishery in the Bering Sea.

1865 A. U.S. fishery for cod thrived in the Okhotsk Sea between 1865-1893.

1888 Commercial operations for Pacific halibut began from protected inside waters of Puget Sound.

1890 Sablefish fisheries conducted off Washington and British Columbia.

1904 Catches of halibut peaked in Puget Sound in 1904-05 after an active process of development and expansion. A process of stock depletion follows.

1910 A distinct deep sea fishery for halibut was started.

1915 The Pacific cod fishery built up to a fairly intense level in the Bering Sea by 1915, especially between 1905-15. Together with sablefish, their demand was high in World War I. The production of these two fisheries was subsequently largely controlled by socio-economic factors.

1923 The International Fisheries Commission (later named the International Pacific Halibut Commission--IPHC--in 1953) was formed to establish a research program and make recommendations for halibut fishery preservation and deployment.

1930 A second convention for halibut was held which continued the International Fisheries Commission as a research organization but with greatly increased regulatory powers. As economic depression set into North America, production of sablefish and cod declined.

1932 A specific set of regulations for halibut fishery became effective and since then many changes have been made. These included (a) dory fishing prohibitions in 1933, (b) establishment of closed nursery areas, (c) incidental catch regulation in 1937 based upon halibut-to-other fish ratios, (d) restrictions in net fishing, (e) shortening of fishing seasons, etc.

1944 Production of sablefish and cod increased as World War II demand for food fish and sablefish liver for Vitamin A increased.

1952 Foreign trawling activities began in the Bering Sea and in subsequent years became a major distuptive force in halibut conservation measures instituted by the IPHC. In the eastern Bering Sea where Japanese and Soviet trawling activities became very intensive, incidental catches of juvenile halibut proved detrimental to the North American setline fishery for halibut. The other North American fisheries for sablefish and cod would also have been affected by foreign trawl activities had they not been discontinued in the mid-1950s due to economic difficulties.

1961 USSR expanded trawling activities into the Gulf of Alaska and was immediately followed by Japan in 1962. Again as in the case of the eastern Bering Sea, they were a threat to the traditional halibut fishery. Subsequently, some regulatory measures aimed at reducing incidental catches of halibut by foreign fleets were negotiated and instituted.

1972 More and more foreign fleets including these of the ROK, Poland, East Germany and later the ROC began trawling, setline and pot-fishing operations in the Gulf of Alaska and off the Pacific Northwest. Pacific coast halibut fishery still remain offshore but sablefish and cod fisheries generally become restricted inshore.

INSHORE TRAWL FISHERIES

Exploitation of inshore groundfish resources did not get established until the mid-1930s although otter trawling was introduced in the early 1900s (Moore 1958). The development of this trawl fishery of the Pacific Northwest (Oregon, Washington and British Columbia) was summarized by Alverson et al. (1964), Browning (1974), and Hongskul (1974). The general trend of development in each state was very similar. Some of the major events associated with trawling activities follows:

1903 First otter-trawl attempt to capture halibut in Queen Charlotte area of British Columbia.

1906 The otter-trawl was first used in Puget Sound, Washington.

1911 British Columbia trawl fishery began.

1917 Demand for food fish increased during the first World War "eat more fish" campaign.

1921 First groundfish landing records by Seattle-based trawlers. The use of otter-trawls spread to other areas

1926 Coastal trawling off Washington began.

1930 Otter trawling became firmly established with extensive trawling in Puget Sound (Scofield 1948).

1934 Washington trawlers, operating out of Seattle, expanded operations northwards.

1937 Development of otter trawling along the southern coast of Washington and Oregon.

1942 Otter trawling became more important as demand for food fish increased due to war-time shortage of cod-liver oil. Efficiency of trawling was also increased with use of depth-sounders (Cleaver 1949).

1950 Post-war demand for food fish dropped but growth of mink industries in Oregon and British Columbia encouraged trawling for non-food fish as mink food.

1965 Foreign nations began trawling beyond the 12-mile U.S. contiguous zone off the Pacific Northwest.

Before World War II, the emphasis on groundfish by North Americans was for food fish. The species composition generally fell into three major groups: flatfishes, rockfishes and roundfishes. The flatfishes were the most important species group, both from weight and value standpoint. This group was followed by rockfishes and Pacific cod in importance.

During and after the war, landings of non-food fish, which include minor species used for animal food or for fish meal, also increased as did those of food fish.

Since 1956, when record of all Pacific coast fisheries are more complete, catch trends and composition by major groundfish species groups are shown in Table 2 and Fig. 4. Between 1956 and 1961, total food fish catch by trawlers (therefore excluding halibut) varied around 50 thousand mt, a large proportion of which was Pacific cod and rockfishes. After 1961, the production increased steadily to a peak of 71 thousand mt. in 1966 and declined thereafter to 54 thousand mt in 1974. Landings of non-food fish, however, do not show a consistent trend. They fluctuated from 3-21 thousand mt and averaged 5 thousand mt in the 1970s.

Compared to established species of salmon and Pacific halibut, groundfish species were generally less preferred species. Demand for groundfish fluctuated according to socio-economic factors. Therefore, the development of the fishery was strongly influenced by like factors rather than by availability and abundance of resources, except in heavily exploited localized areas and in recent years. The two World Wars stimulated the fishery but during peaceful years, fierce competition with other fishery products and more lucrative indistries lowered demand and trawling activity.

Major Species and Fishing Grounds

As mentioned, two major utility groups of groundfish are harvested by North American trawlers: food-fish and non-food fish. Although more than 55 species of groundfish are commonly caught by North American trawlers (Alverson *et al*. 1964) only seven species or groups of species are economically important. They average at about 90 percent of total trawl landings. These species are:

Flat fishes: English sole, (*Parophrys vetulus*), petrale sole (*Eopsetta jordani*), and Dover sole (*Microstomus pacificus*)

Round fishes: Pacific cod and ling cod (*Ophiodon elongatus*)

Rockfishes: Pacific ocean perch (*Sebastes alutus*) and other rockfishes

North American trawlers mainly operate in nearshore waters, often between the mainland and islands, between islands, in straits and other sheltered bodies of water.

The major fishing areas (Fig. 5) are:

Area A - Hecate Strait, Area B - Queen Charlotte Sound, Area C - West Vancouver Island, and Area D - Washington-Oregon coasts.

Prior to 1964, 30 percent of the total North American food fish production came from Area D. The percentage fell to 20 percent in the late 1960s when trawlers move northward in search of Pacific ocean perch. As a result, landings in Area B increased from 26 percent in 1964 to 43 percent in 1969 but declined to 34 percent in 1971, however, Area B was the major fishing ground by contributing an average of 31 percent of total landings. This was followed by Areas C (24%), D (24%) and A (21%).

Peak catches were achieved around 1966 in areas A and B but catch trends were relatively stable in both Areas C and D. Dominant species (in excess of 10 percent of total) in order of importance in each of the four areas were:

Area A: Pacific cod, rock sole, English sole and Dover sole

Area B: Pacific ocean perch, rockfishes, Pacific cod and ling cod

Area C: Same as Area B but include petrale sole

Area D: Rockfishes, English sole, Pacific cod and Dover sole

NORTH AMERICAN HERRING AND SHELLFISH FISHERIES

A Pacific herring (Clupea harengus pallasi) fishery by the U.S. in southeastern and southcentral Alaska had faded in importance since the early 1960s. The fishery started in the early 1900s and large year class fluctuations were encountered. Peak catches averaging up to 47 thousand mt per year were landed from 1936-40. Annual catches dropped to 12 thousand mt from 1951-55; doubled in the next 5 years but has slowly declined in importance.

The Canadian fishery for herring around Vancouver Island and the Queen Charlotte Islands has also suffered declining catches. The fishery started around 1877 in the lower east coast of Vancouver Island where it was confined until the 1910s. By 1941 most of the herring grounds around Vancouver Island were subjected to intensive fisheries. Further expansion was then moved northward to Queen Charlotte waters. As with most herring fisheries, wide fluctuations of year class strength were encountered. In 1960, Canada landed 240 thousand mt (Table 2) of herring but dropped sharply after 1966 with the passing of a strong year class. The fishery was virtually curtailed after then and was not reopened until 1971 when 40 thousand mt were landed. By 1974 catches were still low at 67 thousand mt.

Shellfish fisheries are very important to North American fishermen of the Pacific coast both from the standpoint of weight landed and revenue derived. The U.S. king and Tanner crab fisheries are in the eastern Bering Sea, along the Aleutians and the Gulf of Alaska to Southeastern Alaska (Reeves and Phinney, 1976). The fishery for king crab (mainly Paralithodes camtschatica and some P. platypus) in the eastern Bering Sea was small before 1968 but has since grown to be a major fishery--increasing from 8 thousand mt (2.4 million crabs) in 1968 to 28 thousand mt (8.6 million crabs) by 1974. In 1975, the U.S. harvested about 23 thousand mt of king crab in the eastern Bering Sea and 21 thousand mt in other areas --primarily around Kodiak Island (11 thousand mt).

Beginning in 1968, the U.S. also entered the Tanner crab (Chionoecetes bairdi and C. opilio) fishery in the eastern Bering Sea. Catches were small by comparison to those of king crab. Landings increased from 14 mt (6 thousand crabs) in 1968 to 680 mt (482 thousand crabs) in 1970, dropped to 52 mt (43 thousand crabs) in 1972 and increased sharply again to 2,530 mt (2.532 million crabs) by 1974. Therefore, the fishery too is becoming very important as others in the Gulf of Alaska, especially around Kodiak Island. In 1975, the U.S. harvested 3 thousand mt of Tanner crabs in the eastern Bering Sea as compared to 8 thousand mt in the vicinity of Kodiak Island and 9 thousand mt from other areas.

Outside the Bering Sea, there are U.S. fisheries for king and Tanner crabs and shrimps from the south side of the Aleutian Islands to southeastern Alaska; dungeness crab (Cancer magister), rock crab (C. productus), scallop, clam, and oyster fisheries along the coasts of Alaska, Washington, and Oregon. There are also, among other minor species, the shrimp and dungeness crab fisheries off British Columbia by Canadian inshore fishermen. For the major species and including catches in the Bering Sea and Aleutians, total catches of king and Tanner crabs and shrimps are listed in Table 3. Except for these three species, the status of shellfish fisheries are not reported in this paper.

FOREIGN DEMERSAL FISHERIES IN THE NORTHEASTERN PACIFIC

The historical development of large Asian fisheries for groundfish from the eastern Bering Sea to northern California have been described by Alverson et al. (1964), Kasahara (1972), and Pruter (1972). Collectively they illustrate the types of fisheries involved, gear used, principal species harvested and the state of some stocks affected by the fisheries.

Some of the events associated with the development were:

1929 Exploration of the eastern Bering Sea by Japanese trawlers.

1933 First commercial operations for flatfish in the eastern Bering sea for fish meal.

1937 Fishery discontinued due to slumps in fish meal markets. Catches so far were less than 200 thousand mt per year (Kibesaki 1965).

1940 Japan re-entered the fishery with a mothership fleet of 9 to 12 catcher vessels. Catches were mainly frozed for food.

1942 The fishery was apparently not profitable and the second World War interrupted fishing activities.

1954 Japan re-entered ground fisheries in the eastern Bering Sea Flatfishes were the target species for fish meal.

1958 Yellowfin sole (Limanda aspera) became the target species.

1959 USSR fishing fleets moved into the eastern Bering Sea after sucessful exploratory surveys of 1954 and 1958.

1961 Catch of flatfish peaked near 610 thousand mt and yellowfin sole was apparently overharvested. Exploratory vessels by Japan were sent into the Gulf of Alaska.

1962 The USSR started commercial operations in the Gulf.

1963 Japan followed the example set by USSR and moved some independent stern trawlers and longline vessels into the Gulf but stayed west of Kodiak Island.

1965 Fishing operations by Japan in the Gulf moved farther eastward and southward.

1966 Fishing vessels of Japan and USSR were operating throughout much of the North American coastline (Chitwood 1969). Principal species harvested in the Gulf were Pacific ocean perch and sablefish. Meantime in the Bering Sea, perch and yellowfin sole were being depleted rapidly and walleye pollock (Theragra chalcogramma) became the prime target species as a result of automated "mince-meat" processing operations.

1967 The ROK joined in the groundfish fisheries off the Pacific Northwest. The fisheries later developed primarily into a sablefish fishery.

1972 European flag vessels first appeared to join ground fisheries of the Pacific Northwest. Poland was the first and East Germany followed in 1974. Both these nations target on Pacific hake.

1974 A ROC stern trawler initiated a groundfish fishery in the eastern Bering Sea in December and added a longliner to fish in the Gulf of Alaska in 1975.

BERING SEA-ALEUTIAN ISLANDS

Groundfish resources of the Bering Sea and Aleutian Islands region have been heavily exploited by Japan and the USSR since the late 1950s. Their annual harvest in recent years amounts to more than 2 million mt

(Table 4, Fig. 6). In 1970 and 1971, Japan accounted for approximately 84 percent and the USSR 15 percent of the combined harvest of all nations (Pruter 1973). Three other nations, the ROK, U.S., and Canada, took the remaining 1 percent of the harvest.

Of the major species harvested in this region (Table 5), four species dominated the total catch: yellowfin sole; walleye pollock; Pacific cod; and Pacific ocean perch.

From 1954 to 1957, flatfishes (mainly yellowfin sole) were predominant. After the abundance of yellowfin sole declined, the fisheries targeted on ocean perch and pollock. Total ocean perch catch reached a maximum in 1965. As with the yellowfin sole fishery, catches dropped with time.

Catches of pollock grew from 7 thousand mt in 1958 to 1.9 million mt in 1972. However, catches have declined partially because of catch quota restrictions on Japan and the USSR. Pacfic cod are caught on the same fishing grounds as pollock and landings have also increased since 1958. The rate of increase and the magnitude of the landings were not as high as that of the present target species--pollock.

The main fishing grounds for these four principal species, and those for sablefish, herring and shrimp, have been discussed by Pruter (1973) and Low (1974). In general, yellowfin sole and other flatfishes are caught in the shallower waters of outer Bristol Bay. Pacific cod and pollock are caught along the continental slopes of the Bering Sea proper. Pacific ocean perch are found in deeper waters in the southern continental slopes of the eastern Bering Sea and on both sides of the Aleutian chain of islands. Sablefish are found along the southern part of the outer continental shelf and along both sides of the Aleutians. Herring are caught in surface waters of the central and eastern Bering Sea. Shrimps were harvested west of the Pribilof Islands and toward the Gulf of Anadyr. For the entire groundfish fishery in the Bering Sea, most of the fish are landed along the 200 m isobath, especially north of Unimak Island as shown in Fig. 7.

Catch trends of the four important groundfish species in the Bering Sea are shown in Fig. 8 (pollock), Fig. 9 (yellowfin sole), Fig. 10 (Pacific cod), and Fig. 11 (Pacific ocean perch).

GULF OF ALASKA AND OFF PACIFIC NORTHWEST

Fishing by Asian nations are not as intensive in the Gulf of Alaska and off the Pacific Northwest as campared to the Bering Sea (Tables 5 and 6, Fig. 12). The fishery was started almost 20 years later. Unlike the Bering Sea, the USSR catches more fish than Japan in this area because of its fishery for Pacific hake (Merluccius productus). Since 1967, the USSR has accounted for 60-76 percent of total groundfish landings by foreign nations. Mostof the rest were accounted for by Japan.

Of the entire catch, hake (and at one time herring) are harvested in the greatest quantity (Table 6, Fig. 12). Rockfishes, especially Pacific ocean perch follow in importance. Next comes sablefish and miscellaneous flatfishes. The fishing grounds for hake are located along the coasts of California, Oregon, and Washington where the Soviets concentrate their fishing. Japan concentrates her efforts farther north, mainly in the Gulf of Alaska for ocean perch and sablefish. The USSR also takes substantial quantity of rockfishes, but not as much as Japan.

The main fishing banks for rockfishes and sablefish follow the 200 m isobath near and all along the North American coastline from Chirikof to the Queen Charlotte Islands. Figure 13 shows that the major fishing grounds for sablefish by Japan follow the continental slopes of the Gulf of Alaska. The sequential catch pattern for ocean perch is similar to that of sablefish.

FOREIGN HERRING AND SHELLFISH FISHERIES IN THE BERING SEA

Both Japan and the USSR conduct fisheries for Pacific herring near the Pribilofs and the Bering Sea coast of Alaska. The development of these fisheries was in conjunction with that of groundfish fisheries. Trawls are used by both nations for herring and Japan also uses gillnet in its fishery. However, trawlers are landing more than 90 percent of the catches since 1968. The fishery for herring reached a peak in the 1968-69 season when 132 thousand mt were landed (Table 4).

The Japanese were the first to exploit the southeastern Bering Sea crab populations in the early 1930s. This fishery was interrupted by World War II and re-started in 1952. The U.S. started taking crabs in the eastern Bering Sea in 1947 with trawls. Before 1959, when the USSR joined the king crab fishery in the eastern Bering Sea, landings were below 1.9 million crabs per year (Table 4). After that year, both Japan and the USSR stepped up their operations to a peak of 8.5 million crabs in 1963 (5.5 by Japan and 3.0 by USSR). Catches by the U.S. continued to be minor as fishing effort was concentrated closer to shore-based processing plants.

Following ratification of the Geneva Convention of 1958, the U.S. established sovereign rights over crabs as creatures of the continental shelf, thereby enabling the U.S. to exercise more control of foreign crab fisheries. Within this legal framework, bilateral agreements have been negotiated with Japan and the USSR to establish conditions under which their fisheries could operate. Other nations have refrained from crab fishing.

As the U.S. king crab fishery grew and foreign fisheries became more restricted, a larger share of the harvest has accrued to U.S. fishermen. By 1972, the USSR did not participate in the king crab fishery and Japan's catch was reduced to 874 thousand crabs as compared to the U.S. catch of 4 million crabs. In 1975 there was no foreign catch of king crab.

However, as the king crab fishery of Japan was being reduced, she was building up her Tanner crab pot fishery. Japan and the USSR first entered that fishery in 1965, and the U.S. in 1968. Catches by Japan increased rapidly from 1 million crabs in 1965 to 18 million crabs in 1970. Since then the Japanese Tanner crab fishery has been phased down to its current level of 13.5 million crabs. There has been no USSR Tanner crab fishery since 1971.

In 1972 and 1973 Japan reported 21 vessels fishing for sea snails east of 175°W. This new fishery recovered about 3,200 mt of edible meat per year, estimated to come from 250 million snails.

STATES OF DEMERSAL FISHERY RESOURCES IN THE BERING SEA AND ALEUTIAN REGION

In the Bering Sea-Aleutian Region, the species in these principal areas that will be discussed are:

Roundfishes: Walleye pollock and Pacific cod along the continental slopes. Sablefish along the continental slopes and the Aleutian Region.

Flatfishes: Yellowfin sole, Rock sole, Flathead sole, Turbot, and Pacific Halibut off the continental shelf.

Rockfishes: Pacific ocean perch along the eastern Bering Sea slope and the Aleutian Region.

Shellfish: King crab, Tanner crab, shrimp, and sea snails on the continental shelf.

Others: Herring around the Pribilof Islands. Clam, sandlance, ratfish and capelin resources which are latent commercial species.

A fishery status summary of the major species is provided first in Table 7 and followed by more detail appraisals.

WALLEYE POLLOCK

Catch History

Walleye pollock is the largest single species fishery in the North Pacific and second in the world. However, it was yellowfin sole, rather than pollock, that was the incentive for Japanese and Soviet expansion of fisheries into the eastern Bering Sea. Pollock became important as yellowfin sole became over-exploited in the early 1960s and when mechanized processing of pollock into minced-meat was successfully implemented on motherships and large factory stern trawlers.

As a result, pollock catches increased more than 10-fold between 1964 and 1972 (from 175 thousand mt to nearly 1.9 million mt). There was some decline in the catch to about 1.8 million mt in 1973 and to about 1.6 million mt in 1974 (Table 8, Fig. 14).

Japan was by far the largest harvester of pollock, accounting for over 80% of total catches since 1970. Most of the rest was accounted for by the USSR although a small ROK effort was also in the fishery.

Stock

Soviet scientists (Anon. 1974) believe that there are four discrete populations of pollock in the Bering Sea with the largest occurring in the southeastern part of the sea. There are also believed to be a northern Bering Sea stock, an Olyutorski stock, and a western Aleutian-Commander Island Stock.

The two main stocks that contribute to the eastern Bering Sea pollock fishery are located along the continental slope west of 175°W. Maeda (1972) outlined their probable migratory patterns and area of influence (Fig. 15). Catch patterns also suggest that these two stocks separate across the continental slope area southeast and northwest of 170°W. The southeastern stock is the larger of the two and the fishery depends mainly on it. The geographical boundary between these stocks probably varies from year to year with changing weather conditions, and there must be considerable mixing of fish across it.

Data is lacking to verify that these two stocks are in fact separate with different population reactions to fishing and environmental stress (Ishida 1967). Consequently, and for practical reasons, yield analyses on the eastern Bering Sea pollock fishery were carried out as though the pollock were of one stock (Chang 1974, Low 1974, Takahashi 1975a).

Catch Per Unit Effort

Procedure

Pollock is the target species of the Japanese mothership fleet and the Japanese independent stern trawl fleet. Because of the detail available in Japanese statistics, they have formed the basis for assessing the condition of the groundfish stocks in the Bering Sea. Also, because of the variety of capture gear involved and the changing proportions of each from year to year, it has been necessary to isolate the single unit of effort that best indicates the trend in the fishery success.

An examination of fisheries records showed that pair trawlers contributed increasingly to the pollock catch sine 1964. Therefore pair trawls have been selected as the most representative capture gear type to determine relative pollock abundance by Alton and Fredin (1974) and by Takahashi (1975a). In their analyses, the effects of increasing fishing power due to horsepower changes of pair trawlers were taken into account. Their assumption that q, the catchability coefficient, is related to vessel horsepower is supported by Maeda (1972) who reported that catch by pair trawlers per hour trawling increases proportionately with brake horsepower.

Following the procedure of Alton and Fredin (1974), Bakkala et al. (1975) summarized their analysis by six areas used by INPFC in recommending conservation measures for Pacific halibut (Fig. 16). In their analysis, nominal fishing effort was multiplied by mean vessel horsepower to estimate effective effort of pair trawlers. Catch per thousand pair trawl-horsepower hours were then computed and total fishing effort was estimated by dividing all nation pollock catch by catch per unit pair trawl-horsepower hour.

Takahashi (1975a) refined his analysis to areas of 1° longitude by ½° latitude blocks and using pair trawl effort, computed average density indices (ADI) for pollock following a procedure by Doi et.al. (1972) whereby

$$ADI = \sum_{i=1}^{n} \left(\frac{c_i}{f_i}\right) / n$$

c = catch

f = effort

n = number of 1° longitude by ½° latitude statistical blocks.

The annual ADI was then adjusted by an annual modulation factor related to Maeda's (1972) fishing power factor calculated from vessel brake horsepower data.

Low (1974) selected stern trawl data to assess pollock abundance since pollock was also a target species of stern trawlers. Moreover, the fishing power of stern trawls did not increase much over the years and adjustments in q need be considered only for changing fishermen skill.

Annual CPUE values for pollock in the eastern Bering Sea based on stern trawl performance were computed through five steps:

1. Data were grouped into 1° x ½° blocks and monthly periods to compute CPUEs for all gear-vessel class combinations.

2. Assuming that pollock abundance within each month-block stratum was the same, differences in CPUEs were then attributed to differences in fishing power of capture gear. Consequently, relative fishing powers of all gear-vessel class strata within month and block were computed to that of standard stern trawl class 8 vessels using a computerized version of Robson's (1966) maximum-likelihood technique of estimating relative fishing power of individual vessels.

3. Using CPUE and relative fishing power information for each gear-vessel strata within block and month, the equivalent amount of stern trawl class 8 vessel effort expended was calculated. Dividing total catch by estimated total stern trawl class 8 effort gave a CPUE value for pollock for the block-month combination.

4. From CPUE indices for pollock derived for every month of the period 1964 through 1971, the month of each year when the highest popul-tion biomass was estimated in the Bering Sea area was selected to indicate

annual relative abundance. This criterion was used because the fishery did not operate in the same areas in the same month from year to year, and because CPUEs should be compared when the stock was most available for capture during the year. It was assumed that the stock was most available for capture when the absolute biomass (calculated from CPUE data by number of statistical blocks actually fished) was highest.

5. Each computed CPUE index was later adjusted according to an assumed learning curve (Low 1974) to describe effects of increasing fishermen skill on q. Because q for a standard class 8 stern trawler has changed little due to horsepower increases (Takahashi 1974a), such an adjustment may reflect most of the increase in annual effective effort due to "human" factors. When Alton and Fredin (1974) and Takahashi (1975a) adjusted effort according to horsepower increases, improvements in trawl design, material, and fish detection gear were not considered.

All three procedures (Alton and Fredin 1974, Low 1974, Takahashi 1975a) of selecting effort attempted to pick a unit of effort that is least biased in estimating pollock abundance only. Chang (1974) on the other hand, attempted to partition nominal fishing effort into an effective fishing effort component by a correlation method. For instance $\rho y_1 f_2 (f_1,f_3,f_4)$ is the measure of interdependence between the catch of species 1 and the effort of gear 2 while the efforts of gears 1, 3, and 4 are held constant. The coefficient is interpreted as the vulnerability coefficient or gear efficiency for the y^{th} species in the f^{th} gear type in a given area and time. Effective fishing effort was then calculated by multiplying appropriate nominal fishing effort to partial correlation coefficients.

Results

Results of the CPUE analyses according to the four procedures are shown in Table 9 and Figure 17. In order to compare results on a common basis, CPUE for 1968 was taken as a base year in each case and CPUEs of other years were expressed as ratios of the base. Data by Chang and Low lack time sequence and are ,therefore, of little utility for interpretation of recent pollock abundance trends. The actual trend was more accurately shown by the other two procedures.

It is not possible to reconcile differences in the indices of abundance generated by the various methods because the catch and effort data selected differ by area-time groupings. However, in general, peak density for pollock occurred around 1968-69 and has declined 20% by 1970, 40% by 1971, 38% by 1972, 50% by 1973, and 56% by 1974.

Bakkala et al. (1975) showed a substantial reduction in abundance of pollock in every important pollock ground since 1969 (Table 10). Likewise, Takahashi (1975a) showed that ADI's for pollock since 1968 or 1969 have also dropped to the 1964-65 levels in the southeast, northeast, and the northwest regions of the Bering Sea.

Stock Size

Chang (1974) and Low (1974) both used the area-swept method of Baranov to compute pollock biomass from their derived CPUE data and estimated q for stern trawls. Their estimates of the eastern Bering Sea pollock biomass for 1969 and 1970 were between 2.5-5.4 million mt. The lower estimate represented the period of April-May when recruitment into the fishery (from which data was collected to make such an estimate) was probably not completed. Consequently, biomass may be underestimated.

On the other hand, the upper limit was based on the assumption that pollock was uniformly distributed over all areas including many where there were in fact no pollock. A more realistic range, therefore, may be in the 3-4 million mt range.

Another procedure used to estimate stock size was that of cohort analysis (Pope 1972). Using a fixed natural mortality (M = 0.65) and fishing mortality (F = 0.50 derived by Chang) at age T = 11 (the last age in the fishery), stock sizes in numbers and weight were estimated. The 1970 level of the eastern Bering Sea stock was estimated as least at 2.4 million mt corresponding to 8.394 million fish above ages 2-3. Again, these estimates may be low both from the standpoint that cohort analysis provides conservative minimum estimates (Bishop 1959) and this procedure relied on estimated spring-time biomass when recruitment was incomplete.

Catch rate and size composition data indicated that pollock abundance in 1974-75 are expected to be much lower than in the early 1970s. However, no estimates have been made.

<u>Maximum Sustainable Yield</u>

Estimates of maximum sustainable yield (MSY) for pollock have been obtained by two methods: the surplus production model method of Pella and Tomlinson (1969); and, method by Alverson and Pereyra (1969) for first approximation of MSY using $[C_{max} = a\ M\ B_o]$ where C_{max} is maximum sustainable yield (catch), M is the instantaneous natural mortality rate, B_o is unfished (virgin) biomass, and a is a constant. Alverson and Pereyra assumed that constant to be 0.5, following the logistic production function, and Gulland (1969) assumed it to be 0.4, from dynamic pool relationships. A mean of 0.45 for the constant, a, was used here.

Using the first method, Low (1974) estimated MSY for pollock east of 170°W at 1.11 million mt while Chang (1974) estimated it at 0.9-1.2 million mt. Using the second procedure with M = 0.6-0.7 and B_o = 5 million mt, MSY was estimated as 1.35-1.58 million mt.

The estimates on MSY have limited utility inasmuch that such a catch level can only be realized on a sustained basis under average conditions encountered prior to 1971. The pollock situation has changed drastically since. Nonetheless, the figure serves as a guide as to what the MSY might be under optimal conditions. Therefore it may be necessary to rely heavily on estimates of recruitment to determine total allowable catch management.

Recruitment

Based upon yield-per-recruit analysis, Chang (1974) noted that maximum yield is derived when pollock are recruited into the fishery at ages 3-4. This was derived using fixed fishing mortality rates and variable natural mortality rates (M = 1.0, 0.2, 0.3, 0.45, 0.55, 0.65, 0.65, 0.65, 0.65, 0.65, 0.65 from ages 1 to 11). The same conclusion to the age of entry was also arrived at by using Alverson and Carney's (1975) approximation of critical size (or age) when a pollock cohort maximizes its biomass. Before 1970, more than 70% of pollock caught in the eastern Bering Sea were 3-5 year old fish. Since then more and more 2-3 year old fish have been taken in the fishery.

Since pollock of about age 4 are about 40 cm in fork length, Bakkala et al. (1975) used CPUE of fish less than 40 cm as an index of annual recruitment. The results indicate no major change in recruitment between 1966 and 1972 (Table 11). However, catch rates of age 2 pollock in U.S.

groundfish surveys in the southeastern Bering Sea indicated that the strengths of the 1970 and 1972 year classes were poorer than the 1969 and 1971 year classes.

Annual recruitment by age groups in numbers and weight were estimated by Takahashi (1975a) for 1965-74 (Table 11). Numbers of fish by age groups in the population were computed each year. The numbers by age groups were then converted to weight and summed over age groups for the year. In this way, annual recruitments for pollock for 1965-75 were estimated to have ranged from 1-2 million mt.

Estimates of recruitment for 1972, 1973, and 1974 (2.15, 1.49, and 1.14 million mt, respectively) were believed to be too high by U.S. scientists for the reason that fishing effort levels used in computing recruitment for those years may be too low. Japanese scientists however pointed out that any appreciable biases would not result if the effective effort data used in their computations were consistently underestimated.

<u>Overall Stock Condition</u>

It is the view of U.S. scientists that several signs point to a serious deterioration in the condition of the eastern Bering Sea pollock resource in recent years. There is a strong possibility of further deterioration if the fishery for pollock continues at the 1972-73 levels. Some of these signs were (1) a steady decline in CPUE throughout the Bering Sea, (2) the removal of vast quantities of small pollock from the stock which would adversely affect catches in future years, and (3) CPUEs for fish under 40 cm and catch rate data from research surveys indicated that the strength of recent incoming year classes was average at best.

Japanese scientists, however, believed that the decline in CPUE and ADI may not be as serious in view of the fact that annual catches in the past 7 years did not exceed their estimates of annual recruitment except in 1971. They do believe that unrestricted fishing would lead to poor stock conditions especially now when the proportion of age 3 pollock in the catch has been increasing in recent years.

It is quite true that the knowledge of pollock stock condition is not exact enought to provide absolute values for recruitment and sustainable yield Therefore, it is necessary to fall back on indicative signs of CPUE and fish size--all of which point to a worsening stock condition. Both Japanese and U.S. scientists have agreed in general that some restraint on pollock fishing must be imposed. As a result, an annual catch quota of 1.1 million mt for pollock has been agreed to for the Japanese pollock fishery in the eastern Bering Sea for 1975 and for 1976. Based upon careful consideration of all data, U.S. scientists believe that the all-nation catch of pollock in the eastern Bering Sea should be limited to 1 million mt to preclude further deterioration of the resource, and that a further reduction to 800 thousand mt may be necessary to allow rebuilding of the resource to a more productive level.

YELLOWFIN SOLE

Catch History

The annual catch of yellowfin sole in the eastern Bering Sea by Japan and the USSR during 1954-74 is given in Table 12. Catch levels increased rapidly in the late 1950s after the USSR entered the fishery and the Japanese intensified their effort. Catches reached a peak of about 610 thousand mt in 1961 (Fig. 14). This level of catch was more that the resource could sustain and catches dropped precipitously to 113 thousand mt in 1963. Since that year, catches have fluctuated between 62 thousand mt (in 1965) and 202 thousand mt (in 1971). Following the relatively large catches of 158-202 thousand mt during 1969-71, catches in 1972 and 1973 declined to 72 and 62 thousand mt, respectively. Preliminary data indicate that the total catch in 1974 was approximately 45 thousand mt--the lowest recorded since 1958.

Stock

Yellowfin sole are distributed widely in the North Pacific from Korea to the Sea of Japan off Asia to Vancouver Island off North America (Pruter 1972). Large populations reside in the eastern Bering Sea flats as indicated by the size of commercial catches. They form four well defined concentrations in winter (Fadeev 1972). The largest group is concentrated off Unimak Island and the next largest west of the Pribilof Islands. Two smaller groups are located southeast of the Pribilof Islands and in Bristol Bay. These two groups were found to be less stable and not well defined each year (Bakkala and Hirschhorn 1974).

According to tagging studies conducted in 1970 and 1971, Wakabayashi (1974) identified two stocks in the eastern Bering Sea which contribute significantly to the fishery (Fig. 18): a southern stock wintering off Unimak Island and a northern stock wintering west of the Pribilof Islands. The studies also reveal that these two groups largely maintain their separate identities throughout the year. In spring, the larger Unimak Island group apparently moves northeasterly to shallower waters; the Pribilof Island group appears to initially move northerly or northwesterly along the continental slope and lower shelf then northeasterly into shallower waters. By summer these two groups become distributed over the central and upper shelf areas, again forming two main concentrations, one off Nunivak Island and the other off Bristol Bay.

Catch Per Unit Effort

Procedure

Catch estimates are available for the initial phase of the fishery but no effort statistics was available before 1963. Since fishing effort directed specifically for yellowfin sole is not identified in the Japanese data base, it has to be extracted for CPUE analyses. Low (1974), Takahashi (1974b), and Bakkala and Hirschhorn (1975) all selected pair trawl effort to evaluate the state of yellowfin sole resources because pair trawls continually land a major share of the catch. However, after completing CPUE analysis using pair trawl data, Low converted the results to stern trawl units. This was done to compare the resulting stern trawl CPUE values with other derived for pollock, cod, and ocean perch. Bakkala and Hirschhorn also analyzed data for two other gear types (Danish seine and stern trawl).

The analyses done by Low and Takahashi follow the same principles explained in their pollock analysis. Bakkala and Hirschhorn restricted their examination of CPUE statistics to those 1° x ½° statistical areas in which yellowfin sole made up 50% or more of the total catch of groundfish by pair trawlers. This procedure of selecting catch-effort data follow that of Ketchen (1964). The data were also separated for spring-summer and winter fishing seasons.

In view of the probable existence of two spawning stocks of yellowfin sole in the eastern Bering Sea, Bakkala and Hirschhorn partitioned the data to analyze for each of these stocks separately. The two stock areas (Fig. 18) were separated by a line connecting St. George Island (about 56°39'N and 169°30'W) and Cape Avinof (about 59°58'N and 164°14'W). However, catch and effort data were insufficient for the northern stock area, hence the analysis was restricted to the southern stock area, where, with the exception of two years, over 80% of the catch was taken each year by the fisheries. Analyses conducted by Takahashi and Low apply to the combined data of both stocks.

<u>Trends</u>

CPUE values derived by the various authors are listed in Table 13. The overall interpretation of stock densities was that there has been no major change in the abundance of yellowfin sole in the eastern Bering Sea since the mid-1960s. There was an indication that the condition became somewhat better after 1969 due to lower intensity of fishing in the mid-1960s but that situation has not prevailed. Consequently, the stock has remained in the depressed condition caused by intensive fishing in the early 1960s. Since detailed data prior to 1963 are not available, the early history of the fishery cannot be documented.

<u>Size and Age Composition</u>

Length frequency information for yellowfin sole are generally available for the months of September-December over most of the history of the fishery, including the peak period of the fishery in the early 1960s. Bakkala and Hirschhorn (1975) analysed such data collected by the Japanese trawl fishery for the months of September (1957-67) and October-December (1969-74). The areas from which the 1957-62 samples were taken are unknown, but since 1964 they were taken from the southern stock area.

Changes in mean size of yellowfin sole harvested since 1957 are illustrated in Figure 19. Catches in the early phase of the fishery (1957-58) were made up largely of fish in the 30-40 cm length range. Mean size dropped from 33 cm to about 26 cm from 1957 to 1962. Much of the initial decline in size composition of the catch was probably due to the fishery converting its production from frozen fish to fish meal which allowed the fishery to use smaller fish.

Since 1962 and continuing up to the present time, catches have been mainly made up of 20-30 cm fish. In most years from 1964-71 mean lengths were relatively stable, varying around 26 and 27 cm. In the most recent years, there was a further decline in mean size to 24 or 25 cm. Since the fishery reverted back to the frozen fish operation in 1970, the continued decline of average size undoubtedly indicates a real reduction in size composition of the stock.

The continued removal of young fish can adversely affect the spawning potential of the stock. Bakkala and Hirschhorn (1975) showed that size at first spawning is 10.5 cm for males and 18.5 cm for females. The size at which 50% of the fish become mature is 13 cm for males and 26 cm for females. For females, 18-19 cm fish are mainly 5-6 year olds while 26 cm fish are mainly 7-9 year olds. These fish become first recruited to the fishery at age 4 and are fully recruited to the fishery at age 6 or slightly before achieving 50% maturity.

Stock Size

Yellowfin sole biomass has generally not been adequately estimated. Absolute numbers estimated by Low (1974) and Wakabayashi (1975) do not agree except for stock abundance trends. Low used the Baranov area-swept procedure of biomass estimation while Wakabayashi conducted a more detailed virtual population analysis to arrive at estimates of the catchable population.

In general, five phases of biomass abundance for the eastern Bering Sea yellowfin sole resource (both the northern and southern stocks combined) may be identified. In connection with these five phases, best estimates of yellowfin sole biomass are:

(a) a near virgin state of 1954-61 when annual biomass was probably 600 thousand - 1 million mt,

(b) a rapid stock depletion phase of 1961-64 when biomass probably dropped from a peak in 1961 to about 390 thousand mt in 1964,

(c) a depressed stock abundance phase of 1964-69 when biomass varied from 250-390 thousand mt,

(d) a moderate stock rebuilding phase of 1969-71 when biomass probably built up to 470 thousand mt and finally,

(e) a declining and stabilization phase from 1971 to the present when yellowfin sole biomass probably averaged less than 300 thousand mt.

All of these phases were related to the history of the fishery. Fluctuations due to natural factors were generally small and probably completely obliterated by the intensive fishery.

Maximum Sustainable Yield

Using the general production models, MSY for yellowfin sole was estimated at 131 thousand mt. Using Alverson and Pereyra's (1969) procedure with M = 0.25 - 0.30, a = 0.45, and B = 1 million mt; MSY was estimated at 113-135 thousand mt. A figure for 130 thousand mt was also estimated by Neiman (1963). Wakabayashi (1975) estimated that the total allowable harvest for yellowfin sole to be 120 thousand mt. Except for Neiman's estimate, these figures of MSY apply to average yellowfin stock conditions since 1964. The maximum level of production before the heavy phase of exploitation of 1959-62 cannot be properly determined but is not expected to be very much higher.

Overall Stock Conditions

The aggregate body of evidence indicates that for more than a decade, the yellowfin sole resource in the eastern Bering Sea has remained in a depressed condition caused by the extremely large catches in the early 1960s. Because of lower catches for many years after over-fishing, Japanese scientists consider that the yellowfin sole stock has been improving in recent years and can now sustain catches of 120 thousand mt annually.

It should be emphasized that sustained catches of the 113-135 thousand mt range can only be realized under steady state conditions and prudent sustained harvesting practice at appropriate levels. However, any improvements in stock abundance in the late 1960s were obliterated by unsustainable large annual catches of 158-202 thousand mt during 1969-71. Consequently, U.S. scientists consider the eastern Bering Sea yellowfin resource to be in a depressed state with no evidence of improvement; accordingly they recommended that the annual all-nation catch be held at the 1972-73 level (65 thousand mt) until the stock shows signs of recovery, and perhaps produce at maximum potential of about 120 thousand mt.

PACIFIC OCEAN PERCH

Catch History

The fishery for Pacific ocean perch started in the mid-1950s and gradually built up to a peak of 127 thousand mt by 1965. Catches declined almost continuously thereafter until 1973 (Table 14). Recent catches have been no more than 30% of mid-1960 catches. From 1973 to 1974, however, total catches more than doubled, from 15 to 36 thousand mt, mainly as a result of increased Japanese catches.

The species has been harvested entirely by Japan and USSR. Prior to 1973, Soviet catches generally exceeded those by Japan. However, in 1973 and 1974, the USSR ocean perch component was less than 25% of total catches.

The ocean perch fishery is mainly concentrated along both sides of the Aleutian Island chain and along the continental slope of the eastern Bering Sea. Catch records show that the former region supports a larger population.

Stock

Pacific ocean perch is the most abundant rockfish species in the North Pacific. Chikuni (1975a) identified two main stocks in the Bering Sea: an Eastern Slope Region stock along the southern half of the eastern Bering Sea continental solpe and an Aleutian Region stock along both sides of the Aleutian Islands. These stocks mix at various stages of life history but variations in growth rate, length-weight, age-length, and length-fecundity relationships suggest distinct stocks. From length-weight studies (Chikuni 1974), further stock separation appears appropriate for the Eastern Slope Region, but identification of precise stock units has not yet been accomplished.

Catch Per Unit Effort

Procedure

CPUE for ocean perch has been extensively studied by Chikuni. In his latest work (Chikuni 1975b), he selected catch-effort statistics when ocean perch made up at least 10% of total catches in 1° x ½° statistical blocks by month and by stern trawlers of four vessel classes. These were stern trawlers of the Japanese North Pacific trawl fishery (class 4, 7, 8) and the Japanese Land-based Dragnet Fishery (equivalent of class 4 trawler) engaged principally in ocean perch fishing.

Pruter (1973) and Low (1974) also selected stern trawl data to gauge ocean perch abundance. Pruter derived CPUE values for all classes of stern trawlers combined and for two separate classes (3+4 and 8) of stern trawlers. Low standardized all vessel class data to that of class 8 stern trawlers. Data were also examined by smaller statistical blocks and by month and screened for exclusion when ocean perch did not appear in the catch. The procedure for estimating annual CPUE rates was similar to that used for pollock when CPUE associated with highest monthly population biomass within year was selected as annual CPUE. Furthermore, CPUE estimates were also adjusted for increasing fishing power associated with changing fishermen skill.

Trend

Pacific ocean perch stock abundances in the Bering Sea were best indicated by Chikuni (1975b) for the Eastern Slope and the Aleutian Regions (Table 15). It is apparent tht stock abundances in both regions have been drastically reduced since the early 1960s. Since then they have remained at a relatively low level of abundance. CPUE trends determined by both Pruter and Low showed a faster rate of decline in the 1970s than that shown by Chikuni. CPUE levels of the 1970s were about 25% of more productive years. Again the trends point toward a deteriorated state of the resource.

Length and Age Composition

Size and age composition of ocean perch catches in the Bering Sea indicated that the majority of catches in recent years consisted of fish less than 30 cm, or ages 8-9. Based upon the Beverton and Holt (1957) yield per recruit (Y/R) analysis, the age at first capture for maximum Y/R is close to 10 years. Consequently, Chikuni concluded that both the Eastern Slope and Aleutian stocks should be harvested at 1-2 years older than that of recent years.

It was also noted that ocean perch begin to mature at age 5, reach 50% maturity at age 7, and full maturity at age 9. The continued decline of fish older than age 10 is a threat to the reproductive potential of the stocks.

Stock Size

Of the two main stocks in the Bering Sea, the Aleutian stock is perhaps four times larger than that of the Eastern Slope Region. In the mid-1960s and before the rapid decline of stock biomass, the Aleutian stock was at least two and one-half times larger than in recent years. Chikuni estimated that the 1972 stock biomass was close to 150 thousand mt. By comparison, the Eastern Slope stock size has not changed much since 1963 and seemed to have stabilized at a low level of less than 35 thousand mt.

Biomass estimates have not been made for more recent years but based upon CPUE analyses, such numbers are expected to be below levels of 1972.

Maximum Sustainable Yield

As for other species in the Bering Sea which have undergone considerable changes in population structure and abundance as a result of intensive "pulse" fishing, the interpretaion of MSY must be viewed in its proper perspective. Under ideal resource conditions, the Pacific ocean perch stock in the Eastern Slope Region may be as high as 32 thousand mt while that in the Aleutian may be as high as 75 thousand mt (Chikuni 1975a).

However, considerable changes have taken place for these stocks as well as other ecosystem components. An examination of catch-effort records (Table 14) show that sustained catches of 32 or 75 thousand mt are definitely not possible. Instead, based upon recent catch history and the surplus production model, Low (1974) estimated MSY for both stocks of ocean perch combined at 12-17 thousand mt.

Since 1960 the Eastern Slope Region has produced catches in excess of 32 thousand mt only twice (1961 and 1968). Following high catches, CPUE and catch decreased substantially. In the second case, a catch of 32 thousand mt in 1968 has since been followed by annual catches of less than 15 thousand mt. Judging from declining catch rates, the ocean perch stock in the Eastern Slope Region must not have been able to support a fishery of 10-15 thousand mt annually without detrimental effects to the already low level of stock abundance. An appropriate harvest level has not been properly determined but should be set low (perhaps 6-8 thousand mt) to prevent further depletion of the resource.

In the Aleutian Region, there were clear cases of over-exploitation in the early stages of the fishery when amounts in excess of 90 thousand mt were taken consecutively from 1964 through 1966. Since then, catches have dropped to 12 thousand mt in 1973 and 22 thousand mt in 1974. It is evident that the sustained annual catch of 75 thousand mt estimated by Chikuni cannot be realized because of the deteriorated stock conditions of ocean perch in the Region. Consequently, U.S. scientists recommended that the total annual all nation catch not exceed 15 thousand mt until the resource shows signs of substantial recovery.

Overall Stock Condition

It is the concensus of Japanese, U.S., and Canadian scientists that Pacific ocean perch stocks are at a depressed level of abundance and generally not in good condition. The opinion is derived from various state of stock indicators including (i) a continuous decline in CPUE after 1968; (ii) drastic reductions in the availability of all sizes of POP through the period 1969-72; (iii) a heavy dependence in the fishery after 1968 on young-small fish; and (iv) the rapid depletion of the strong 1961 and 1962 year classes without any evidence of future strong year classes.

What cannot be agreed upon is the level of allowable harvest. Because of current low stock abundances, total allowable catch should not exceed 8 and 15 thousand mt in the Eastern Slope and Aleutian Regions respectively. In addition, the age of recruitment into the fishery should be increased 1-2 years to about age 10 or fish above 32 cm in fork length.

Because ocean perch is a long-lived, slow-growing species with full maturity not occurring until age 9 and a life span of 25 years, stock conditions are not expected to improve for many years even if recruitment improves and removals remain at modest levels.

SABLEFISH

Catch History

The sablefish resource of the North Pacific ranges from northern Mexico northward in the eastern Pacific to Alaska, along the Aleutians and in the Bering Sea to the coast of Siberia. In the Bering Sea, fishing areas are generally similar to those for Pacific ocean perch, except in deeper waters. Major fishing areas are along the continental slope of the eastern Bering Sea and along both sides of the Aleutian chain of islands.

The species has been a target of USSR trawlers since 1961 and of Japanese longliners and trawlers since 1958. Since 1966, longliners have been phased out of the fishery in the Bering Sea because extensive trawling activities for pollock have pre-empted the grounds.

In recent years, Japan accounted for about 85% of the all-nation sablefish catch in the Bering Sea. The rest were taken by the USSR and the very limited ROK longline fishery initiated in 1975.

The fishery by Japan built up rapidly from 32 mt in 1958 to a peak of 29 thousand mt by 1962 (Table 16). Since then total catches by all nations have not exceeded 20 thousand mt (1968-69) and have been declining. In 1974, catches were slightly higher than 7,500 mt.

In the Bering Sea catches showed a bimodal pattern with peaks in 1962 and 1968, and with considerably reduced catches in recent years. Those in the Aleutian Region gradually built up to a peak of 3,300 mt in 1972 with a modest decline in the last two years.

Stocks

The number and delineation of sablefish stocks in the North Pacific has not been satisfactorily defined (Sasaki et al. 1975).

It is evident from tagging studies conducted by Japan, U.S., and ROK that sablefish conduct extensive migrations. Interchange of fish between inshore and offshore regions of the Gulf of Alaska and off the Pacific Northwest have been demonstrated. Also, interchange of fish between the Bering Sea, the Gulf of Alaska, and off the Pacific Northwest apparently takes place. In essence, the resource from the State of Washington to the Bering Sea seems to be interrelated.

The degree to which extensive migrations maintain local biomass strengths has not been determined but is not expected to be high. Catch records and tag recovery data imply that local concentrations of fish with common reaction to fishing pressure occur throughout its range. This, however, could very well be an artifact of localized fishing and its history of exploitation.

On the basis of CPUE trends, there appear to be three areas where separate management stocks exist: (i) western Bering Sea, west of 180° longitude, (ii) eastern Bering Sea along the continental slope east of 180° longitude, and (iii) south of 55°N latitude on both sides of the Aleutian Island chain.

Catch Per Unit Effort

Procedure

Since most of the sablefish have been caught by Japanese stern trawlers and longliners, data from these two fisheries have been used to assess stock abundance. Of the stern trawl data, only those of the

Japanese land-based dragnet fishery whose vessels are limited to 349 gross tons were used because their fishing power was less likely to have changed over the years.

Because stock delineation is not certain, CPUE values were computed for five INPFC areas of the Bering Sea (Fig. 20). Areas 1 to 4 are in the Bering Sea proper and Area 5 is the Aleutians. Three management units seem appropriate for the Bering Sea: Areas 1 and 2 (eastern Bering Sea), Areas 3 and 4 (western Bering Sea), and Area 5 (Aleutian Region).

<u>Trend</u>

Longline activities have been substantially reduced since the early 1960s in Areas 1 and 2; therefore, longline CPUE data do not provide a complete trend for eastern Bering Sea sablefish. In spite of this limitation, the decline of longline CPUE trends in Area 1 and 2 (Fig. 20) since 1970 point to declining sablefish abundance.

For the western Bering Sea unit (Areas 3 and 4), longline CPUEs are also incomplete since the gear was phased out in 1971. Therefore, only data of the land-based stern trawlers were used. The trends show that sablefish abundance has been declining in Areas 3 and 4 since 1967.

Both the longline and the stern trawl CPUE data show that since 1967, abundance may be down by as much as 41-90% in the eastern Bering Sea (Areas 1 and 2) and 76-84% for western Bering Sea (Areas 4 and 5).

Longline catch-effort data are probably more appropriate to evaluate sablefish resources in the Aleutian Region inasmuch as stern trawling is limited by rough bottom topography. Catch and effort levels in the longline fishery have been relatively stable from year to year and CPUE values have remained at high levels from 1966-73 (Fig. 20). These levels, averaging 210 kg per 10 hachi longline units for 1972-73, indicate relative sablefish abundance is higher than in any of the four areas of the Bering Sea proper. In 1974, however, catch rates dropped 15% to less than 180 kg per 10 hachi longline units.

Size and age composition

Length and age composition data from the sablefish fisheries are not sufficiently complete in specific time and area sequences to accurately follow the changes in size and age composition of the stock. Since the distribution of sablefish of different size is influenced by depth (Kulikov 1965, Phillips 1954) and season, the data must also be grouped by season, depth strata and gear-type for comparison. Of the available data, that for longlines comes from a more consistent depth range (500-800 m). Hence, longline data summarized over a period of one year and over large geographical areas may be used as a rough indicator of stock composition.

Combining data for all depths between 500 and 800 m the length and age composition of longline catches for the Bering Sea as a whole are as follows. Most of the fish taken during 1963-68, except for 1965 fall within the 58-62 cm fork length range. The 1965 fishes taken were somewhat larger. In 1971 and 1973 the size ranges were narrow, being 66-68 cm for 1971 and 62-64 cm for 1973. Generally speaking, commercial catches have not changed much in length composition.

The conversion of length composition to age composition data with a length-age key indicate that 52-64 percent of the Japanese longline catch from the Bering Sea was between ages 5-7. In the Bering Sea, the catch of fish older than age 6 was rather high in 1965 and 1971. No major change in age composition of the catch has been detected, even though trends in catch rate indicate that stock abundance in the Bering Sea has decreased severely since 1967. The longline fishery could have operated in depths where the larger fishes predominate.

Maximum Sustainable Yield

Stock biomass and MSY were not estimated separately for the Bering Sea and the Aleutian Region. Instead a first approximation of MSY for the entire sablefish resource from northern Califronia to the Bering Sea was made by Sasaki et al. (1975). Using the surplus production model, an MSY figure of 45,400 mt was derived.

As the level of stock abundance is different among regions, and it is not certain that only a single sablefish stock exists, it is appropriate to allocate catch in proportion to stock abundance and historical fishing pattern by region. Based upon such considerations, regional catch quotas were estimated to be 7,700 mt in the Bering Sea, 3,600 mt in the Aleutians, and 34,100 mt in the northeastern Pacific Ocean (Table 17). These figures need to be refined further as stock size and fishing grounds change.

Overall Stock Conditions

CPUE trends suggest declining fish densities in certain areas and the need for management if optimum production is to be achieved. All four areas of the Bering Sea show indications of drastic reductions in stock abundance, ranging from 41-90% below the 1967 base year. Furthermore, since the Bering Sea resource was heavily fished in the early 1960s stock abundance may already have been reduced somewhat by 1967.

Because of reduced stock abundance, catch quotas suggested for the Bering Sea and the Aleutian Region may not be taken without detrimental effects on the resources. For this reason any substantial increase in fishing effort over present levels could have an adverse impact on the resource. Thus, for the Bering Sea as a whole, even though Japanese catches of sablefish have declined from 13 thousand mt in 1972 to less than 5 thousand mt in 1974, further reduction in catch would help to improve stock conditions.

The high incidental catch of sablefish in the trawl fishery directed toward pollock on the outer continental shelf and slope of the Bering Sea must be considered as part of the recommended quota.

PACIFIC COD

Catch History

Fishing for Pacific cod in the Bering Sea was initiated by the U.S. aś early as 1864. This fishery was fairly intensive throughout the period 1905-15 and continued until the early 1950s when, mainly due to economic conditions it was discontinued. Since then, this resource has been harvested mainly by Japan. The USSR and ROK take Pacific cod as an incidental species in their operations for flatfish and pollock.

The annual catch of Pacific cod by Japan rose from 19 thousand mt in 1964 to a peak of 74 thousand mt in 1970 (Table 18). The geographical distribution of commercial catches is quite similar to that of pollock but Pacific cod is generally not a target species. Therefore, the increase in cod catch largely reflects the expansion of the pollock fishery. Although fishing effort was much higher after 1970, catches dropped markedly in subsequent years--ranging from 41 to 51 thousand mt during 1971-74.

Catches by the USSR are not available before 1971 but since then, records show that cod has been taken in increasing amounts--rising from less than 2 - 17 thousand mt. Catches by ROK are believed to be small.

Stock

The biology and behavior of Pacific cod and the Bering Sea have not been studied adequately to delineate stocks. From catch records, it is reasonable to assume that Pacific cod form a single stock in the eastern Bering Sea and data analyses have been conducted accordingly. Pruter (1972) showed the main area of concentration to be between depths of 50-1,000 m.

Catch Per Unit Effort

Low (1974) using the same procedure of determining CPUE for Pacific cod as for pollock showed that relative abundance of cod stayed relatively stable from 1965-70 but dropped drastically from 1970-71. CPUE (measured in kg per hr trawled by a standard class 8 Japanese stern trawler) declined from a rather stable level of 790 in 1965-70 to 340 in 1971, reflecting the effects of large catches in 1968-70 (corresponding to catches of 63, 52, and 74 thousand mt respectively). Pruter (1972), however, pointed out that CPUE determined for cod may not be a good indicator of stock abundance because of its secondary importance in the fishery.

Size Composition and MSY

After early removals of accumulated large fish in the virgin stock, cod catches from 1969 through 1971 were heavily dependent upon smaller fish. In 1973, however, the population of fish less than 40 cm was considerably less than in any of the four previous years. Consequently, Wolotira (1975) believed that incoming year classes are much weaker than in the recent past.

Based upon the general production model, Low (1974) estimated that MSY for Pacific cod can be as high as 58 thousand mt.

Overall Stock Condition

It is difficult to evaluate the state of Pacific cod resources in the eastern Bering Sea because the species is generally not a target of the fisheries. It was estimated that MSY could be as high as 58 thousand mt and since 1971 this level was not exceeded except in 1974. However, using size composition information, it was suggested that incoming year classes many not be as strong as those of 1969-71 when the largest catches were made. Therefore, it is uncertain if the resource can continue to sustain catches of 58 thousand mt.

OTHER FLATFISHES

Flatfishes, primarily yellowfin sole, were the incentive for both Japanese and Soviet fishing in the eastern Bering Sea. Flatfishes other than yellowfin sole caught incidentally to the expanded groundfish fishery in order of relative abundance are turbot (Atheresthes stomias) flathead sole (Hippoglossoides elasodon), rock sole (Lepidopsetta bilineata), and Pacific halibut.

A species by species account of each resource follows, but in a less detailed format than earlier species described. In general, the state of these resources is difficult to evaluate because of their secondary importance in the fishery.

Turbot

Turbot are most abundant along the edge of the eastern Bering Sea continental shelf but are also found in smaller concentrations on the shelf. Unlike yellowfin sole and rock sole, they do not inhabit shallow areas.

The utility of turbot by Japan is solely for fish meal. In the early stages of Japanese fishing in the eastern Bering Sea, which were mainly for fish meal, turbot were harvested in annual amounts of 30-50 thousand mt from 1960-64 (Takahashi 1974b, 1975b). Because of the depletion of yellowfin sole stocks and the subsequent conversion of many vessels to minced pollock production, turbot became an incidentally caught species. Therefore, Japanese catches of turbot has declined, except for 1972 (Table 18) when the Japanese land-based dragnet fishery reported high catches of turbot.

In addition to the usual complications of determining appropriate CPUE indices of stock abundance for seconday species, the difficulties are further compounded because one other flatfish spceies, Greenland turbot (Reinhardtius hippoglossoides), is sometimes reported as "turbot" in catch statistics.

In the absence of better information, Takahashi (1975b) noted that catch rates for turbot since 1966 show drastic declining trends in INPFC Area 2 (170°W-180°) while those in Area 1 (east of 170°W) are relatively stable. Again, these trends are related to catches and stock abundances are difficult to discern.

Flathead Sole

Flathead sole are found on the eastern Bering Sea flats in the same general geographical region as yellowfin sole and rock sole, but in deeper waters. Their abundance is slightly greater than that of rock sole but not enough so to be a target species.

Between 1965 and 1971, catches increased to a peak of 50 thousand mt (Table 18) but have declined. In general, Japan takes roughly the same amount of flathead sole as the USSR.

Length-frequency data from Japanese trawl fisheries indicated no substantial change in the size composition of catches in recent years and perhaps relatively even levels of recruitment. Takahashi (1975b) showed the minor role of this species in the fishery and concluded that catch rates are not satisfactory indicators of stock abundance.

Rock Sole

The geographical distribution of rock sole is very similar to that of yellowfin sole, being in the eastern Bering Sea flats. Of the two species, rock sole is very much lower in abundance than yellowfin sole, in spite of the latter resource being depleted to a low level. Therefore, rock sole by itself cannot support an economical fishery and consequently is not a target species.

Annual all-nation catch of rock sole did not exceed 20 thousand mt until 1970. In the following 2 years (1971 and 1972) they increased substantially to 50 and 68 thousand mt (Table 18). This increase was immediately followed by a rapid decline to 34 thousand mt in 1973.

Based upon length composition data, the large catches of 1971-72 were supported by the relatively strong year classes of 1965 and 1966 (Wolotira 1975). By 1973, however, these cohorts were diminished by several years of exploitation and no signs of subsequent strong year classes has appeared. Age composition data from U.S. trawl surveys in the eastern Bering Sea further indicated that year classes after 1966 are not strong and the 1968 year class in particular appears weak.

Takahashi (1975b) also noted that catch rates for rock sole increased through 1972 with catches but has since observed a declining trend through 1974. This observation substantiates Wolotira's deductions of weakening year class strengths.

It is possible that the relatively strong year classes of 1965 and 1966 could have been the result of decreased yellowfin sole abundance on the same grounds due to over-exploitation in the early 1960s. Also, any increase in the relative abundance of rock sole could be the result of bias in the data. In recent years, there was more selection of larger rock sole for freezing and accounting as a separate species when previously they were classified in the "other fish" category for fish meal.

Pacific Halibut

Pacific halibut is the species of groundfish in which the U.S. and Canada traditionally have had a great vested interest in the Bering Sea. A North American setline fishery once thrived economically on this species but since extensive trawling operations were initiated by Japan and USSR, the fishery has been limited to a few adventurous boats for very short fishing seasons.

The main area of concentration is in a triangular area north of Unimak Island. This area is also rich in other groundfish species including pollock, the fisheries for which have posed a problem in managing halibut. Juvenile halibut are also found in the eastern Bering Sea flats and because of intensive trawling activities there by Japan and USSR, incidental catches of halibut can be very high and is a topic of concern to IPHC.

Total catch of halibut in the Bering Sea peaked at 15 thousand mt in 1963 and immediately thereafter, the catch dropped to 5 thousand mt in 1964 (Table 19). Since then, catches fluctuated between 4 and 8 thousand mt through 1973. The 1974 catch was 2 thousand mt.

West of 175°W, the annual catch was 11 thousand mt in 1961 and dropped to between 3 and 6 thousand mt through 1973. Subsequently, the annual catch declined to 2 thousand mt in 1974. West of 175°W, the fish were mainly landed by Japan.

East of 175°W, the North American setline fishery has since 1971 accounted for most of the retained catch of halibut because of restrictions imposed on purposeful fishing for halibut by other fleets. However, the North American fishery has been very small, catching less than 200 mt since 1971. Before then the peak was 8 thousand mt in 1963.

Stock delineation in the Bering Sea is not certain but for practical reasons, stock assessments have been made for areas east and west of 175°W. The halibut resource west of 175°W is difficult to assess for lack of data. Total catch remained relatively stable through 1971, then steadily declined through 1974. The principal fishery since 1964 has been the Japanese land-based dragnet fishery, and its catch has declined since 1970. CPUE of the land-based dragnet fishery has also declined steadily, but is difficult to evaluate because halibut is not usually a target species.

East of 175°W, the halibut stock remains in a very unsatisfactory condition. The North American setline fishery continues at a very low level of effort, and the Japanese longline fishery has not operated since 1970. Annual trawl surveys conducted by IPHC to estimate the relative abundance of juvenile halibut inhabiting the eastern Bering Sea show that during 1966-75, the relative abundance index (number per hour trawled) declined from 31.8 in 1966 to 3.1 in 1972, then increased to 11.9 in 1975. The sharp increase in 1975 was reflected in abundance indices for all juvenile age groups (2-7) and was probably attributable in part to the trawl closures imposed in the area in 1974 and 1975 (Skud 1976).

IPHC surmised that the effects of the increased relative abundance of juvenile halibut should begin to appear in the North American setline catch about 1980. The Canadian and U.S. scientists believe that, in the meantime, area-time trawl closures should continue in order to protect the halibut resource, and the annual trawl surveys by IPHC should be conducted to provide continuing assessment of the effects of these closures. Certain of the trawl closures were modified to allow limited off-bottom trawling during early 1976 on an experimental basis.

Tagging experiments have shown that Bering Sea halibut are related to those farther south into the Gulf of Alaska. The high incidence of juvenile halibut caught by trawl gear is detrimental to recruitment. Consequently, agreements have been made between all nations except USSR that all trawl-caught halibut cannot be retained east of 175°W longitude and halibut of less than 66 cm caught west of 175°W cannot be kept by Japan. These restrictions are in addition to area-time trawl closures.

HERRING

Catch History

The herring fishery in the eastern Bering Sea was started by Soviet trawlers in the winter of 1961 northwest of the Pribilof Islands. Japan entered the fishery for the first time east of 180° longitude in the winter of 1964 with trawl gear. Prior to that year, a fishery for herring had existed west of 175°W longitude toward the USSR coast.

Table 20 shows that this western Bering Sea resource was soon depleted and by agreement between the USSR and Japan, closed to fishing. The eastern resource was mainly harvested by trawlers of Japan and the USSR. The USSR has been taking the larger share of the resource which for 4 years (1968-72) supported annual catches in excess of 85 thousand mt. The peak catch of 128 thousand mt was obtained in the fishing year of 1968-69. Since then catches have declined steadily to less than 23 thousand mt for 1973-74.

Stocks

Stock delineation has not been well studied. It appears that three main stocks exist: a western stock west of 175°W longitude towards the Soviet coast, a stock around and south of the Pribilof Islands which undoubtedly is the largest, and finally a stock found northeast of the Pribilof Islands towards the Alaskan coast.

Catch Per Unit Effort

Procedure

In CPUE analysis for herring, stock delineation has not been taken into consideration. Instead data east of 180°W or 175°W longitude have been grouped to evaluate resource conditions in the eastern Bering Sea.

These areas undoubtedly include the largest stock around the Pribilof Islands and the other northeast of these Islands.

Fredin (1974) determined CPUE for herring east of 180° for Japanese stern trawl classes 4-5 and 6-9. He used catch-effort data only when herring constituted at least 30% of total catches by months and $1° x \frac{1}{2}°$ statistical blocks. He also computed CPUE for herring east and west of 175°W longitude for Japanese gillnet vessels. Takahashi (1975b) also determined CPUEs for Japanese stern trawlers and gillnetters. Such values were then converted to average density indices (ADIs) by the same procedure he used for pollock.

<u>Trend</u>

West of 175°W, the stock showed a continued decline in abundance from 1964-69 (Table 20). Since then, the fishery has been phased out.

In the eastern Bering Sea, the resource initially showed an increasing trend through 1969-70 followed by a general decline to the present. The gillnet CPUE index however showed a slight increase from 1972 to 1973 and 1974. However, overall abundance of herring was still low.

<u>Overall Stock Conditions</u>

There are signs of deterioration in the herring resource which point to a need to take steps to conserve the resource as Japan and the USSR did in the western Bering Sea. However, derivation of harvestable catch levels for herring cannot be derived adequately from CPUE and catch trends alone. The eastern Bering Sea resource is in poor condition but further analyses on year class strength and recruitment are necessary to manage the resource.

As in most herring populations, recruitment can be highly variable and a strong year class can support a lucrative fishery for many years. However, size composition data which can provide useful information to year class strength are inadequate for evaluation. Consequently, recruitment and stock size estimates were not made.

KING CRAB

Catch History

King crab was one of the basis for Japanese fisheries in the eastern Bering Sea in 1952. Before 1959, when the USSR also joined the fishery, landings were below 1.3 million crabs per year. After that year, both countries stepped up their operations to a peak catch of 8.5 million crabs in 1963 (5.5 by Japan and 3.0 by USSR, Table 21 and Fig. 21). Proclamation of the 1958 Geneva Convention that king crab is a creature of the continental shelf and, therefore, of proprietory rights to the coastal state led to more control of king crab fishing by foreign fishermen.

By 1972, the USSR did not participate in the fishery and Japan's operations were severely reduced and are presently under quota management to allow room for the expanding U.S. fishery. As a result, Japan landed 874 thousand crabs in 1972 as compared to the U.S. catch of 4 million. Since then total catches increased to 5.3 million crabs in 1973 (5 million by the U.S.) and an all-time peak of 9.1 million crabs in 1974. The U.S., which only conducts a pot fishery, accounted for 8.6 million of the crabs that year.

In 1975, Japan did not fish for king crab although she had a small quota. Although purposeful fishing for king crab by Japan and the USSR have been scaled down or phased out, incidental catches in their regular trawl fisheries continued. In 1973, and 1974, such incidental catches by Japan have been estimated at around 330 thousand crabs respectively.

Stock

The red king crab (Paralithodes camtschatica) is the major species harvested. It is southerly in range in the Bering Sea, with one area of concentration south of the Pribilof Islands and another in the eastern flats. The other species, the blue king crab (P. platypus), is concentrated in the immediate vicinity of the Pribilof Islands.

Not much is known about the delineation of king crab stocks. Also, catch records generally do not distinguish between king crab species in the eastern Bering Sea. Therefore data analysis is conducted as if king crab is of one unit stock. Further distinction will be necessary for more accurate analyses.

Catch Per Unit Effort and Size Composition

Changes in CPUE of king crab in commercial catches of Japan, U.S. and USSR show declining trends from 1957-62 (Table 22). From 1963-70, trends were rather stable although slight declining trends were observed from 1966-70 in all indices of abundance. Since 1970, U.S. catch rates show that abundance has been increasing--preliminary data of September 1975 indicate one of the highest CPUE rates on record for U.S. fishery.

Data on average size of king crabs taken in the 1975 fishery in September also indicate that the size is generally slightly larger than those in previous years--carapace lengths averaging 146 mm.

Overall Stock Conditions

The concept of constant MSY is not applicable to king crab because of widely fluctuating recruitment.

From biological and fishing data, it is evident that the king crab stock in the eastern Bering Sea was reduced by fishing from 1966-70. This apparent decline stopped in 1970 and abundance of king crab has been increasing. These increases have also been accompanied by small increases in average size and annual catches in recent years. Independent of commercial data, U.S. trawl surveys also indicate an increase in abundance since 1970 (Reeves and Phinney 1976).

Based upon observations presented, it is surmised that the king crab stock has continued to show signs of recovery from the lower level of abundance in 1969. The resource is regulated by season quota and by area for the Soviet and Japanese fisheries for 1975-76. Although both the foreign fisheries maintain small quotas, neither nation is fishing for king crab.

TANNER CRAB

Catch History

The fishery for Tanner crab started much later (in 1965) than that for king crab (in 1952). It is less preferred because of its smaller size and thinner legs which makes processing less profitable. However, as the king crab fishery for Japan was being reduced she was building up her Tanner crab pot fishery. Both Japan and USSR entered the fishery in 1965 and the U.S. entered in 1968.

Catches by Japan increased from 1 million crab in 1965 to 18 million crabs in 1970 and dropped to 15.6 million crabs in 1972 (Table 23, Fig. 23). The peak catch by USSR was 6.2 million crabs in 1969, but since 1971, the USSR has not conducted a fishery for Tanner crab. A peak U.S. catch of 2.7 million crabs was realized in 1975.

The types of fishing gear used by each nation are the same as in the king crab fishery: tangle nets and then pots by Japan, tangle nets by the USSR, and pots by the U.S.

Stocks

The Tanner crab fishery is mainly supported by two species--the *C. biardi* and *C. opilio*. "Biardi" is found in the southern part of the eastern Bering Sea whereas the smaller-sized "opilio" is farther north in range. A hybrid of the two species is found in between and is also caught commercially.

Catch Per Unit Effort and Size Composition

In general, CPUE values of Japanese, USSR, and U.S. fisheries show an increasing or stable trend since the inception of the fishery (Table 22).

Data of the Japanese pot fishery which has a complete data sequence from 1967-75 show that CPUE increased from 1967-68, remained stable from 1968-73, and increased from 1973-75.

In 1975, catch rates averaged 17.1 crabs per pot as a whole for the eastern Bering Sea. By quota areas, catch rates were lowest at 14.1 in the southerly part, and 18.4 in the northerly part of the eastern Bering Sea. The CPUE in the U.S. fishery in 1975 was 72 compared to 115 in 1974. This decrease was primarily due to the 1975 fishery being more selective for larger crabs.

No discernible trend in average size of crabs was detected for either species in the two quota areas. In 1975, average size of crabs in the U.S. fishery increased because of selectivity.

Overall Stock Conditions

As for king crab, MSY is not applicable and not estimated. Based upon commercial CPUE data, size composition, and U.S. annual trawl surveys, U.S. scientists concluded that the biomass of Tanner crabs remains high. Stock condition appears to be very good and the resource probably can sustain higher catches than the 12-17 million crabs of recent years.

As in the case of king crab, the U.S. Tanner crab fishery is regulated by season and the Soviet and Japanese fishery by quota and area.

OTHER SHELLFISH

Shrimp

Pink shrimp, mainly Pandalus borealis, once thrived in waters northwest of the Pribilof Islands but not for long after Japan initiated a fishery for it. Fishing started in 1960 by a mothership equipped with automated shrimp peelers. The total catch in 1961 was about 14 thousand mt and quickly reached a peak of 30 thousand mt in 1963. Most of these catches were taken from a small shelf area west of 170°W and south of 58°30'N. After 1963, catches dropped rapidly and by 1966, amounted only to 3 thousand mt. Since 1967, the fishery has not operated for lack of commercial concentrations.

Sea Snails and Clams

The latest commercial fishery initiated in the Bering Sea is for sea snails in the eastern Bering Sea flats, east of 175°W. Fishing is mainly conducted along the 100 m depth to the northwest and southeast of the Pribilof Islands. Japan reported 21 vessels fishing for sea snails in 1972 and 1973. This new fishery recovers about 3,200 mt of edible meat per year from 1972-74. Meat recovery rate is about 25% and came roughly from 250 million sea snails. The capture gear used are pots. The two principal genera taken are Neputunea and Buccinum. Neputunea make up 50% of total catches in number and 70% in weight with shell on.

Neiman (1960) noted that a complex of numerous low-Arctic benthos predominated by clamm (Macoma calcera) was widely distributed in the colder regions of the Bering Sea shelf. Areas of concentration are from the Gulf of Anadyr southeastwards to the latitude of St. Matthew Island.

South of St. Matthew Island the depth distribution for the Macoma calcera complex narrow to 50-70 m and remain confined to regions of cold bottom waters in the southeastern shelf region.

Neiman (1963) also found that the density and biomass of clam and other benthos were highest in the western and northern parts of the shelf. They decrease southeastwards towards the broad shelf region of the southeastern Bering Sea, the site of major commercial catches.

Alton (1974) noted that almost all of the macrobenthos in the Bering Sea could provide as a nutritional base for fish, crustaeceans, and mammal of commercial importance. The clam population is apparently large and primarily preyed directly by walruses (Obodenus rosmatus). It is unlikely that clam population can be exploited commercially although the population is large.

OTHER FINFISH

Resources of most demersal fisheries in the Bering Sea and Aleutian Islands are already under heavy exploitation. It is unlikely that any other demersal resources such as sandlances (Ammodytes sp.) which may be as abundant as pollock and those in the deeper parts of the continental slope such as ratfish can be of commercial importance. Ratfish have been frequently caught at the rate of 15-20 mt per trawl haul but presently have no commercial value.

Other than demersal fishes, the pelagic resources except for herring have not been exploited. The abundance of such fishes as capelin (Mallotus sp.) is believed to be high, perhaps as high as that of pollock. They are found mainly in the central portion of the eastern Bering Sea flats. The capelin could be of future commercial importance because they bear large roe and hence would bring good prices in Japan. Finally, bathypelagic species are unlikely to be of commercial importance.

ACKNOWLEDGEMENT

I wish to thank Dr. John A. Gulland of the Food and Agriculture Organization of the United Nations and Dr. Dayton L. Alverson of the National Marine Fisheries Service (NMFS), Seattle, Washington, for their assistance during the preparation of this report. Special services rendered by Jean Marler and Beth Handorff of the NMFS, Seattle, are also greatly appreciated. A review made by Herbert A. Larkins of the NMFS, Seattle, has resulted in a much improved version of this report.

LITERATURE CITED

Alton, M.S. 1974. Bering Sea benthos as a food resource for demersal fish populations. In D. W. Hood and E. J. Kelley (ed.). Oceanography of the Bering Sea with emphasis on renewable resources. Inst. Mar. Sciences, Univ. Alaska, Fairbanks, U.S.A.: 257-278.

Alton, M. S. and R. A. Fredin. 1974. Status of Alaska pollock in the eastern Bering Sea. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center. Unpubl.

Alverson, D. L. and M. J. Carney. 1975. A graphic review of the growth and decay of population cohorts. J. Cons. Int. Explor. Mer., 36(2) 133-143.

Alverson, D. L. and W. T. Pereyra. 1969. Demersal fish populations in the northeastern Pacific Ocean. An evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecast. J. Fish. Res. Bd. Canada 26: 1985-2001.

Alverson, D. L., A. T. Pruter, and L. L. Ronholt. 1964. A study of demersal fishes and fisheries of the northeastern Pacific Ocean. H. R. MacMillan Lect. Series. Inst. of Fisheries, Univ. British Columbia, Vancouver, Canada.

Anon. 1974. Report on the eighth meeting of U.S. and Soviet scientists on questions concerning the condition of the stocks of fish and crustaceans in the northeastern Pacific Ocean and on the coordination of fisheries research. Seattle, Washington. Jan. 8-16, 1974. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Bakkala, R. and G. Hirschhorn. 1974. Preliminary investigation of the condition of yellowfin sole (Limanda aspera) resource in the eastern Bering Sea in recent years. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Bakkala, R. and G. Hirschhorn. 1975. Status of yellowfin sole (Limanda aspera) in the eastern Bering Sea. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Bakkala, R., M. Alton, and G. Hirschhorn. 1975. Status of Alaska pollock in the eastern Bering Sea. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Bell, F. H. and A. T. Pruter. 1954. The Washington and Oregon sablefish fishery. Pacific Marine Fish. Comm., Bull. 3.

Beverton, R. J. H. and S. J. Holt. 1957. On the dynamics of exploited fish populations. U.K. Min. Agric. Fish., Fish. Invest. (Ser. 2) 19.

Bishop, U. M. M. 1959. Errors in estimates of mortality obtained from virtual ppoulations. J. Fish. Res. Board Can. 16: 73-90.

Browning, R. J. 1974. Fisheries of the North Pacific: History, species, gear and processes. Alaska Northwest Publ. Co., Anchorage, U.S.A.

Chang, S. 1974. An evaluation of eastern Bering Sea fisheries for Alaska pollock (Theragra chalcogramma, Pallas): population dynamics. Ph.D. dissertation. Univ. Washington, Seattle, U.S.A.

Chikuni, S. 1974. Biological characteristics of Pacific ocean perch in the North Pacific. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Chikuni, S. 1975a. Biological study on the population of the Pacific ocean perch in the North Pacific. Bull. Far Seas Fish. Res. Lab. 12: 1-119.

Chikuni, S. 1975b. Information on Pacific ocean perch stocks in the North Pacific, 1974. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Chitwood, P. E. 1969. Japanese, Soviet, and South Korean Fisheries off Alaska: Development and history through 1966. U.S. Fish. Wildl. Serv. Circ. 310.

Cleaver, F. C. 1949. The Washington otter-trawl fishery with reference to the petrale sole (Eopsetta jordani). Washington State Dept. Fisheries Biol. Rep. 49A: 3-45.

Cobb, J. N. 1927. Pacific cod fisheries. Report U.S. Comm. of Fisheries for 1926, Appendix VII (Doc. No. 1014).

Doi, T., K. Y. Mun, K. Takao, K. Ishioka, and K. Okada. 1972. Stock assessment of the Kuruna-prawn Penaeus japonicus Bate in Hiuti-Nada Area of the Seto Inland Sea. Bull. Tokai Reg. Fish. Res. Lab. 69(3): 45-54.

Fadeev, N. S. 1972. The fishery and biological characteristics of yellowfin soles in the eastern Bering Sea. In P. A. Moiseev (ed.). Soviet fisheries investigations in the northeast Pacific. Part V: 332-396.

Fredin, R. A. 1974. Herring fisheries and resource of eastern Bering Sea. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Gulland, J. A. 1969. Manual of methods for fish stock assessment. Part 1. Fish population analysis. United Nations Food and Agric. Organ. Manual. Fish. Sci. 4.

Hongskul, V. 1975. Fishery dynamics of the northeastern Pacific groundfish resources. Ph.D. dissertation. Univ. Washington, Seattle, U.S.A.

Ishida, T. 1967. Age and growth of Alaska pollock in the eastern Bering Sea. Bull. Hokkaido Reg. Fish. Res. Lab. 32: 1-7.

Kasahara, H. 1972. Japanese distant-water fisheries: A review. Fishery Bull. 70(2).

Ketchen, K. S. 1964. Measures of abundance from fisheries for more than one species. Rapp. P.V. Reun. Cons. Pern. Int. Explor. Mer. 155: 113-116.

Kibesaki, O. 1965. Demersal fish resources in northern Pacific. (Transl. from Japanese). U.S. Bur. Comm. Fish. Unpubl.

Kulikov, M. Y. 1965. Vertical distribution of sablefish, Anoplopoma fimbria (Pallas) on the Bering Sea continental slope. In P. A. Moiseev (ed.). Soviet Fisheries Investigations in the northeast Pacific. Part IV: 157-161.

Low, L. L. 1974. A study of four major groundfish fisheries of the Bering Sea. Ph.D. dissertation. Univ. Washington, Seattle, U.S.A.

Maeda, T. 1972. On the fishing conditions of Alaska pollock in the Eastern Bering Sea in 1969 and 1970. Bull. Jap. Soc. Scien. Fish. 38(7): 685-691.

Moore, M. 1958. Fisheries management. In K. McLeod (ed.). Fisheries, fish farming, fisheries management. Washington State Dept. Fisheries, Olympia, U.S.A.: 135-146.

Neiman, A. A. 1960. Quantitative distribution of benthos in the eastern Bering Sea (in Russian). Zoologicheskiy Zhurn. 39(9): 1281-1291. (Transl. 402, U.S. Naval Oceanogr. Office, 1968).

Neiman, A. A. 1963. Quantative distribution of benthos on the shelf and upper continental slope in the eastern Bering Sea. In P. A. Moiseev (ed.) Soviet fisheries investigations in the northeast Pacific. Part I: 143-217.

Pella, J. J. and P. K. Tomlinson. 1969. A generalized stock production model. Inter-Amer.Trop. Tuna Comm. Bull. 13(3): 421-496.

Phillips, J. B. 1954. The sablefish fishery of California. (1) History and research. Bull. Pac. Mar. Fish. Comm. 3: 5-22.

Pope, J. G. 1972. An investigation of the accuracy of virtual population analysis using cohort analysis. Int. Comm. Northwest. Atl. Fish. Res. Bull. 9: 65-74.

Pruter, A. T. 1972. Development and present status of bottomfish resources in the Bering Sea. J. Fish. Res. Board Can. 30: 2273-2385.

Reeves, R. A. and D. E. Phinney. 1976. Bering Sea Crab Abundance Promising. Pacific Fisheries Review 32(2): 61-72.

Robson, D. S. 1966. Estimation of the relative fishing power of individual ships. Int. Comm. Northwest Atl. Fish. Res. Bull. 3: 5-14.

Sasaki, T., L. L. Low, and K. N. Thorson. 1975. Sablefish (Anoplopoma fimbria) resources of the Bering Sea and northeastern Pacific Ocean. U.S. Dept. of Commerce, Natl. Mar. Fish. Serv., Northwest Fisheries Center, Seattle, Unpubl.

Scofield, W. L. 1948. Trawling gear in California. Calif. Fish and Game. Fish. Bull. 72.

Skud, B.E. 1976. Halibut still critical. Pacific Fisheries Review 32(2): 55-59.

Takahashi, Y. 1974a. The annual change of the relative catchability of the vessels in the mothership pollock fishery in the eastern Bering Sea. Bull. Far Seas Fish. Res. Lab., 10(4).

Takahashi, Y. 1974b. Resources of yellowfin sole, rock sole, flathead sole, Pacific halibut, shrimps, Pacific herring, Pacific cod and turbot in the Bering Sea. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Takahashi, Y. 1975a. The resource of pollock in the eastern Bering Sea. Fishery Agency of Japan. Far Seas. Fish. Res. Lab., Shimizu. Unpubl.

Takahashi, Y. 1975b. Resources of rock sole, flathead sole, Pacific cod, turbot, and Pacific herring in the Bering Sea. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Thompson, W. F. and N. L. Freeman. 1930. History of the Pacific halibut fishery. Report of the International Fisheries Comm. No. 5.

Wakabayashi, K. 1974. Studies on resources of the yellowfin sole in the eastern Bering Sea--I. Biological characteristics. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Wakabayashi, K. 1975. Studies on resources of yellowfin sole in the eastern Bering Sea.--II. Stock size and its changes estimated by the method of virtual population analysis. Fishery Agency of Japan. Far Seas Fish. Res. Lab., Shimizu. Unpubl.

Wolotira, R. J., Jr. 1975. Status of Pacific ocean perch, Pacific cod, and several flatfish stocks in the Bering Sea. U.S. Dept. Commerce, Natl. Mar. Fish. Serv., Northwest Fish. Center, Seattle. Unpubl.

Table 1.--Total catches of groundfish in the northeastern Pacific (Bering Sea to northern California) by nation and area in thousand metric tons, 1956-74.

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Japan	25	24	48	159	445	623	477	248	374	407
USSR	--	--	5	65	100	104	142	125	155	116
U.S.A.	(101	96	102	102	108	102)	73	72	63	73
Canada	(					)	35	35	37	41
Others	0	0	0	0	0	0	0	0	0	0
TOTAL	126	120	155	326	653	829	727	480	629	637
Bering Sea - Aleutians	25	24	54	226	548	729	625	368	513	470
Gulf of Alaska - off Pacific Northwest	101	96	101	100	95	100	104	112	116	167

	1966	1967	1968	1969	1970	1971	1972	1973	1974
Japan	510	1,035	1,029	1,193	1,582	1,904	2,056	1,916	1,697
USSR	131	513	362	489	596	609	663	609	702
U.S.A.	77	80	62	68	67	66	69	68	62
Canada	46	35	38	40	33	32	27	27	20
Others[2/]	0	--	--	--	--	--	4	4	-2
TOTAL	764	1,663	1,491	1,790	2,278	2,611	2,819	2,624	2,481
Bering Sea - Aleutians	551	930	1,075	1,360	1,835	2,236	2,404	2,152	1,998
Gulf of Alaska - off Pacific Northwest	213	553	416	432	448	385	425	475	483

Table 2.--Total catches of principal demersal species and herring in the Gulf of Alaska and off Pacific Northwest combined by Canada and the United States in thousand metric tons round weight, 1956-74.

Species group	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
English sole	5	5	6	6	6	5	5	5	5	6	6	6	6	5	4	3	4	4	4
Rock sole	2	2	2	1	2	2	2	2	2	2	4	3	3	4	2	2	1	1	1
Petrale sole	3	5	3	4	4	4	4	4	4	4	4	3	3	3	3	4	4	4	5
Dover sole	7	6	6	7	8	7	7	8	8	7	7	5	7	10	12	11	14	14	13
Rex sole	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	2	2
Starry flounder	1	1	1	1	1	1	1	1	1	1	1	1	2	1	+	1	1	1	1
Pacific halibut	39	36	38	42	42	38	41	38	35	37	37	32	29	35	32	28	25	19	13
Other flatfish	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
Pacific cod	7	9	10	10	6	3	4	7	10	16	17	11	9	6	4	8	13	11	13
Lingcod	3	3	3	4	4	4	3	2	3	4	5	5	7	4	4	4	4	4	5
Sablefish	3	1	1	1	2	5	2	1	1	1	1	1	1	1	2	2	3	4	3
Pacific ocean perch	4	4	3	4	4	6	8	11	10	14	12	7	7	8	9	6	7	4	4
Other rockfish	10	10	11	10	10	9	11	10	8	9	11	9	10	14	12	11	14	16	13
Misc. species	3	3	3	3	2	1	1	1	2	2	+	+	+	+	+	+	1	1	1
Dogfish	+	1	1	2	1	2	+	+	+	1	+	+	+	+	+	+	+	2	+
Non-food fish	13	7	6	6	6	10	8	6	6	6	13	21	11	10	8	7	3	3	4
Total Groundfish[a/]	102	95	96	103	100	99	101	100	97	112	120	106	97	105	95	89	97	92	84
Shrimp	?	4	9	10	6	10	11	12	9	10	17	26	28	29	43	49	50	68	65
Herring	246	148	203	222	94	224	240	236	219	165	123	18	1	3	5	40	48	74	67

Sources: Pacific Marine Fisheries Commission data series.

a/ Discrepancies due to rounding errors.
Includes catches of all captive gear.

Table 3.--North American catches of king and Tanner crabs and shrimp in the Northeastern Pacific (Bering Sea to northern California) in ten metric tons, 1957-74.

	King Crab a/	Tanner Crab a/	Shrimp		
			U.S.A.	Canada	Total
1957	5.94	--			
1958	5.08	--			
1959	8.53	--	9.32	.47	9.79
1960	12.97	--	5.62	.76	6.38
1961	19.69	+	9.47	.55	10.02
1962	23.95	.01	10.37	.75	11.12
1963	35.70	+	9.66	.81	10.47
1964	39.33	.01	6.57	.48	7.05
1965	59.74	+	9.08	.80	9.88
1966	72.21	+	15.63	.76	16.39
1967	57.92	.01	24.78	.77	25.55
1968	37.10	1.45	25.60	.71	26.31
1969	26.17	5.08	28.44	.96	21.40
1970	23.63	6.58	42.21	.70	42.91
1971	32.07	5.85	48.37	.33	48.70
1972	33.75	13.65	49.35	.36	49.71
1973	34.84	27.99	65.45	.78	66.23
1974	43.18	28.99	63.28	1.22	64.50

a/ Catch by U.S. only

Table 4.--Total catches of principal demersal species and herring in the Bering Sea and Aleutian region combined in thousand metric tons round weight, 1954-74.

Species group	1958	1959	1960	1961	1962	1963	1964	1965	1966
Sablefish	+	+	2	26	29	18	9	9	13
Flatfishes[a/]	44	185	493	610	486	156	184	78	140
Pacific halibut	3	5	10	14	14	15	5	4	4
Pacific cod	+	3	1	7	10	15	19	17	20
Pacific ocean perch	+	+	6	47	20	46	118	127	110
Pollock	7	33	26	24	59	114	175	231	262
Other fishes	--	--	10	1	7	4	3	4	2
Total Groundfish	54	226	548	729	625	368	513	470	551
Japan	48	159	445	623	478	238	357	353	419
USSR	5	65	100	104	143	125	154	116	131
Canada	+	1	1	1	2	3	1	+	+
USA	1	1	2	1	2	2	1	+	+
Others	0	0	0	0	0	0	0	0	0
Shrimp	--	--	1	10	18	27	21	9	3
Herring	--	--	--	--	--	--	42	35	24
King crab[b/]	1.1	1.9	4.0	6.5	8.0	8.6	8.8	6.7	6.9
Tanner crab[b/]	--	--	--	--	--	--	--	1.7	2.2

Species group	1967	1968	1969	1970	1971	1972	1973	1974
Sablefish	15	21	21	14	18	19	11	8
Flatfishes	216	127	228	221	302	248	210	196
Pacific halibut	8	6	5	7	8	6	4	2
Pacific cod	35	63	52	74	49	48	58	68
Pacific ocean perch	81	83	54	77	32	40	15	36
Pollock	550	702	863	1,256	1,744	1,874	1,785	1,599
Other fishes	25	82	132	181	73	160	66	89
Total Groundfish	930	1,075	1,360	1,835	2,236	2,404	2,152	1,998
Japan	750	918	1,073	1,480	1,806	1,927	1,767	1,543
USSR	178	156	281	349	420	467	382	455
Canada	1	+	+	1	+	+	+	+
USA	1	+	+	+	+	+	+	+
Others	0	1	5	5	10	9	3	
Shrimp	4	13	9	6	3	--	+	2
Herring	49	132	119	86	85	41	22	3
King crab[b/]	5.8	5.7	4.2	4.1	3.6	4.9	5.2	9.1
Tanner crab[b/]	12.0	15.5	24.2	24.4	20.0	15.6	14.1	16.5

a/ Catches for 1954-57 are 13, 15, 25, and 24 thousand mt, respectively.
b/ In millions of crabs.

Table 5.--Percent composition of species group in total demersal fish landings in the northeastern Pacific (Bering Sea to northern California), 1958-74.

Bering Sea and Aleutians

Species	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Sablefish	--	--	--	4	5	5	2	2	2	2	2	2	1	1	1	1	--
Flatfishes a/	82	82	90	84	78	43	36	17	25	23	12	17	12	14	10	10	10
Pacific cod	--	1	--	1	2	4	4	4	4	4	6	4	4	2	2	2	3
Pacific ocean perch	--	--	1	6	3	12	23	27	20	9	7	4	4	1	2	1	2
Pollock	13	15	5	3	9	31	34	49	48	59	65	63	69	78	78	83	80
Other fishes	5	2	4	2	3	5	1	1	1	3	8	10	10	4	7	3	5

Gulf of Alaska and off Pacific Northwest

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Sablefish	1	1	2	5	4	4	4	4	4	2	5	6	7	9	10	8	7
Flatfishes b/	27	17	23	22	21	20	19	15	14	5	7	6	7	8	8	9	8
Pacific halibut	36	43	42	38	39	34	29	22	17	6	7	8	7	7	6	4	3
Pacific cod	10	10	6	3	4	6	8	9	8	2	2	2	1	2	3	2	3
Pacific hake	--	--	--	--	--	--	--	1	2	40	26	39	53	41	26	32	33
Pacific ocean perch	3	4	4	6	7	15	19	33	38	14	19	17	14	15	16	1	1
Other rockfish	11	10	10	9	11	9	7	5	5	22	20	9	4	12	9	8	7
Pollock	--	--	--	--	--	1	1	2	4	1	1	4	2	2	9	9	12
Other fishes	12	15	13	17	14	11	13	9	8	7	13	9	5	4	13	26	26

a/ Mainly yellowfin sole, including Pacific halibut

b/ Excluding Pacific halibut

Table 6.--Total catches of principal demersal species and herring in the Gulf of Alaska and off Pacific Northwest combined in thousand metric tons round weight, 1962-74.

Species group	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Sablefish	4	5	5	6	8	10	20	26	33	33	43	37	33
Flatfish (excluding Pacific halibut)	22	23	22	26	29	28	27	27	29	28	32	45	41
Pacific halibut	41	38	34	37	36	32	29	35	33	28	25	19	13
Pacific cod	4	7	10	16	18	13	10	7	6	8	14	11	15
Pacific hake	--	--	--	1	5	220	109	166	233	158	111	153	159
Pacific ocean perch	8	17	23	56	81	81	80	74	61	58	67	4	4
Other rockfish	12	10	8	9	11	121	82	40	16	47	40	40	33
Pollock	--	1	1	3	9	7	6	18	10	9	38	44	58
Other fishes	15	12	15	15	17	41	52	39	27	16	55	122	127
Total Groundfish	106	113	118	169	214	553	415	432	448	385	425	475	483
Canada	33	32	36	41	46	34	38	39	32	32	27	27	20
U.S.A.	71	70	63	73	77	79	62	67	67	66	69	68	62
Japan	0	11	17	53	91	105	110	119	102	98	129	149	154
USSR	?	?	?	?	?	335	206	207	247	189	196	227	247
Others a/	0	0	0	0	0	0	0	0	0	0	4	4	?
Shrimp	11	12	9	10	17	26	28	29	43	49	50	68	65
Herring	259	254	243	181	134	26	7	10	15	46	49	74	67

a/ Incomplete, unknown catches.

Table 7.--State of exploitation of major fisheries in the Bering Sea.

Species	Principal fishing countries	Estimated potential	Catch in thousand metric tons							State of exploitation
			1961	1965	1970	1971	1972	1973	1974	
Walleye pollock	Japan, USSR, ROK	850-1,200	24	231	1,256	1,744	1,874	1,785	1,599	Over-exploited
Pacific cod	Japan, USSR	58	7	17	74	49	48	58	68	Fully-exploited
Yellowfin sole	Japan, USSR	110-120	610	62	158	201	72	62	45	Over-exploited, recovering slightly
Flathead sole	Japan, USSR	?	+	6	41	50	15	26	28	Becoming fully exploited
Rock sole	Japan, USSR	?	+	3	21	50	68	34	36	Becoming fully exploited
Turbot	Japan, USSR	?	57	14	20	15	57	3	9	Becoming fully exploited
Other flatfish	Japan, USSR	?	?	1	64	61	50	—	—	Fully-exploited
Pacific ocean perch	Japan, USSR	12-17	47	127	77	32	40	15	36	Over-exploited
Other rockfish	Japan, USSR	?	—	10	—	—	—	—	—	Fully-exploited
Sablefish	Japan, USSR	12	26	9	14	18	19	11	8	Over-exploited
Herring	Japan, USSR	a/	—	38	146	89	81	40	20	Over-exploited
King crab b/	Japan, USSR, USA	?	65	67	41	36	49	52	91	Fully-exploited
Tanner crab b/	Japan, USSR, USA	120-170	—	170	244	200	156	141	165	Becoming fully exploited
Shrimps	Japan, USSR	?	14	10	6	3	+	+	+	Over-exploited
Pacific halibut	Japan, USSR, USA, Canada	5	14	4	7	8	6	4	2	Fully-exploited

\+ Small catches.

? Unknown or uncertain.

a/ Unpredictable, dependent on highly variable recruitment.

b/ Catch in hundred thousand crabs.

Table 8.--Pollock catches in the eastern Bering Sea, in thousand metric tons, 1964-74.

Year	Nation			Total
	Japan	USSR	ROK	
1964	175			175
1965	231			231
1966	262			262
1967	550			550
1968	701		1	702
1969	831	27	5	863
1970	1,231	20	5	1,256
1971	1,514	220	10	1,744
1972	1,651	214	9	1,874
1973	1,492	290	3	1,785
1974	1,268	331		1,599

Table 9.--Indices of pollock abundance in the Bering Sea, 1964-74.

Year	By Chang (1974)[a]	By Low (1974)[b]	By Bakkala, et al. (1975)[c]	By Takahashi (1975a)[d]
1964	2.7	6.5	9.5	8.5
1965	4.8	8.5	18.3	9.3
1966	4.4	4.7	23.6	6.8
1967	7.1	6.7	21.3	8.2
1968	7.7	6.5	23.8	11.8
1969	7.8	7.3	31.5	10.4
1970	13.1	5.7	18.7	9.0
1971	--	6.0	14.2	5.6
1972	--	--	14.2	9.3
1973	--	--	11.9	6.3
1974	--	--	11.2	5.4

a/ Metric tons per effective pair trawl hour.
b/ Metric tons per adjusted stern trawl hour.
c/ Metric tons per 1,000 pair trawl horsepower-hour.
d/ Metric tons per modulated pair trawl hour.

Table 10.--Catch per unit effort[a/] trends for pollock by INPFC halibut conservation areas, 1964-73.

Year	INPFC Halibut Conservation Areas[b/]					
	A	B	C	D_E	D_W	E
1964	2	3	16	14	9	7
1965	—	—	21	21	16	17
1966	26	—	33	12	28	17
1967	17	—	19	21	27	16
1968	25	15	27	26	24	21
1969	31	15	36	35	38	18
1970	27	21	20	22	19	10
1971	25	—	13	13	17	7
1972	16	25	15	14	19	2
1973	12	16	14	6	17	6

a/ Metric tons per 1,000 pair trawl horsepower-hour adapted from Bakkala, et al. (1975).

b/ See Figure 16.

Table 11.--Estimate and index of recruitment of pollock in the eastern Bering Sea, 1965-74.

Year	Index of recruitment[a] in metric tons per 1,000 pair trawl hour: Fish smaller than 40 cm	Index of recruitment[a] in metric tons per 1,000 pair trawl hour: Fish larger than 40 cm	Estimated recruitment[b] in thousand metric tons, Age in years: 1	2	3	4	5	6-12	Total
1965	--	--	0	--	78	687	0	0	765
1966	3.9	20.1	0	3	131	291	0	0	425
1967	3.0	18.7	0	--	134	715	85	0	934
1968	3.8	20.2	0	5	218	944	180	0	1,347
1969	4.5	27.3	0	1	167	952	0	0	1,120
1970	4.5	14.3	--	3	427	1,003	0	0	1,433
1971	3.6	11.6	--	21	307	733	34	0	1,095
1972	3.6	10.9	--	40	499	855	617	135	2,146
1973	--	--	--	34	537	724	198	0	1,493
1974	--	--	--	123	438	449	132	0	1,142

Sources: a/ Alton and Fredin (1974).
b/ Takahashi (1975a).

Table 12.--Yellowfin sole catches in the eastern Bering Sea in thousand metric tons, 1954-74.

Year	Japan	USSR	Total	
1954	13		13	
1955	15		15	
1956	25		25	
1957	24		24	
1958	39	5	44	
1959	123	62	185	
1960	397	96	493	
1961	456	154	610	
1962	253	139	392	
1963	21	93	114	
1964	49	82	131	
1965	26	36	62	
1966	45	71	116	
1967	58	120	178	
1968	30	57	87	
1969	81	104	185	
1970	60	98	158	
1971	82	119	201	
1972	35	37	72	
1973	56	4	62	
1974	36 a/	9 b/	45	(approx.)

a/ November 1973-October 1974.
b/ Preliminary data.

Table 13.--Indices of yellowfin sole abundance in the eastern Bering Sea, 1964-72.

Year	By Low (1974)[a]	By Takahashi (1974b)[b]	By Bakkala and Hirschhorn (1974)[c]			
			Spring-summer season		Winter season	
			Pair trawl	Danish seine	Pair trawl	Stern trawl
1964	0.9	2.6	20.9	13.2	--	--
1965	0.4	5.3	23.6	7.4	--	--
1966	0.6	1.2	11.7	7.4	--	--
1967	0.4	1.1	11.2	6.4	--	--
1968	0.2	0.8	--	7.5	--	--
1969	1.1	2.3	13.9	4.7	--	--
1970	1.0	2.3	--	--	11.5	3.3
1971	0.9	2.9	--	--	19.3	4.2
1972	--	1.7	--	--	9.9	3.9

a/ Metric tons per standard stern trawl hour.
b/ Metric tons per pair trawl hour.
c/ Pair Trawl: Metric tons per 1,000 horsepower-hour.
Danish Seine: Metric tons per 1,000 horsepower-hour.
Stern Trawl: Metric tons per hour.

Table 14.--Pacific ocean perch catches in the eastern Bering Sea and Aleutian, by regions in thousand metric tons, 1960-74.

Year	Eastern Slope	Aleutian	Total
1960	6	—	6
1961	47	—	47
1962	20	+	20
1963	25	21	46
1964	26	92	118
1965	17	110	127
1966	20	90	110
1967	20	61	81
1968	32	51	83
1969	15	39	54
1970	10	67	77
1971	10	22	32
1972	6	34	40
1973	3	12	15
1974 a/	14	22	36

a/ Data is preliminary.
+ Less than 1 thousand mt.

Table 15.--Catch per unit effort[a/] trends for Pacific ocean perch in the eastern Bering Sea and the Aleutian Regions, 1964-74.

Year	Class 4	Class 7	Class 8	Land-based[b/]
		Eastern Slope Stock		
1964	--		3.09	--
1965	--		3.42	--
1966	--		2.67	--
1967	1.17	Insufficient	4.04	0.24
1968	0.27		3.39	0.25
1969	0.26	Data	1.13	0.21
1970	0.27		1.25	0.19
1971	0.13		0.89	0.20
1972	0.14		0.72	0.16
1973	0.14		--	0.26
1974	0.23		--	0.15
		Aleutian Stock		
1964	--	--	7.42	--
1965	--	--	6.09	--
1966	--	--	6.13	--
1967	2.48	--	4.57	0.57
1968	1.43	12.55	9.27	0.66
1969	3.75	5.24	6.17	0.53
1970	1.38	8.54	1.44	0.62
1971	0.78	7.64	3.74	0.46
1972	0.61	5.08	2.09	0.38
1973	1.44	4.38	--	0.43
1974	0.90	5.08	--	0.52

Source: Chikuni (1975b).
a/ Metric tons per stern trawl hour.
b/ Landbased dragnet fishery stern trawlers are approximately of Class 4 stern trawlers.

Table 16.--Sablefish catches in the Bering Sea and Aleutian Region in metric tons, 1958-74.

Year	USSR	Japan			All nation total
	Bering Sea and Aleutians sub-total	Bering Sea	Aleutian	Bering Sea and Aleutians sub-total	
1958	--	32	--	32	32
1959	--	393	--	393	393
1960	--	1,861	--	1,861	1,861
1961	--	26,182	--	26,182	26,182
1962	--	28,521	--	28,521	28,521
1963	--	17,626	778	18,404	18,404
1964	--	8,262	975	9,237	9,237
1965	--	8,240	360	8,600	8,600
1966	--	11,981	1,107	13,088	13,088
1967	274	13,457	1,383	14,840	15,114
1968	4,256	14,597	1,661	16,258	20,514
1969	1,579	17,009	1,804	18,813	20,392
1970	2,874	9,627	1,277	10,904	13,778
1971	3,000	12,410	2,571	14,981	17,981
1972	2,406	13,231	3,307	16,538	18,944
1973	1,254	6,395	2,875	9,270	10,524
1974	71	4,904	2,505	7,409	7,500[a]

a/ Preliminary data.

Table 17.—Computation of catch allocation for sablefish in the North Pacific, in metric tons.

Region	Area of fishing ground[a/]	Longline CPUE[b/]	Index of biomass	Proportion of total biomass	Proportion of historical catch[c/]	Catch allocation[d/]
Area 1	357	147	52,479			
Area 2	522	71	37,062			
Area 3	231	25	5,775			
Area 4	236	25	5,900			
Bering Sea	1,346	—	101,216	.14	.20	7,700
Aleutian[e/]	350	192	67,200	.10	.06	3,600
Gulf of Alaska and off Pacific Northwest	2,585	202	522,170	.76	.74	34,100
Total	4,281	—	690,586	1.00	1.00	45,400

a/ In 100 km^2, calculated by Sasaki, Fishery Agency of Japan (pers. comm.).

b/ CPUE in kg per 10 hachi longline units of 1973-74. CPUE of areas 3 and 4 are assumed.

c/ Regional catch divided by all-region catch for 1970-74.

d/ Mean biomass and historical catch proportion multiplied by 45,400 metric tons.

e/ Estimated to be 350.

Table 18.--Bering Sea catches of Pacific cod and flatfishes in thousand metric tons, 1964-74.

Year	Pacific cod			Flathead sole			Rock sole			Turbot		
	Japan	USSR	Total	Japan	USSR	Total	Japan	USSR	Total	Japan	USSR	Total
1964	19	—	19	12	10	22	3	2	5	34	29	63
1965	17	—	17	3	3	6	2	1	3	8	6	14
1966	20	—	20	5	5	10	4	5	9	10	11	21
1967	35	—	35	11	14	25	2	3	5	20	26	46
1968	63	—	63	13	13	26	3	3	6	18	19	37
1969	52	—	52	10	11	21	5	5	10	15	16	31
1970	74	—	74	21	20	41	10	11	21	10	10	20
1971	47	2	49	26	24	50	21	19	40	19	6	25
1972	41	7	48	11	5	16	46	22	68	56	1	57
1973	45	13	58	17	9 a/	26	24	11 a/	35	33	1 a/	34
1974	51	17	68	13	15 b/	28	18	19 b/	37	41	5 b/	46

a/ Combined catch of 21,178 mt, apportioned according to species catch ratio of Japan.
b/ Combined catch of 38,709 mt, apportioned according to species catch ratio of Japan.

Table 19.--Japanese and North American[a] Pacific halibut catches in the Bering Sea in metric tons round weight, 1956-74.

Year	West of 175°W			East of 175°W			Total
	N.A.	Japan	Total	N.A.	Japan	Total	
1956	-	-	-	158	-	158	158
1957	-	-	-	24	-	24	24
1958	-	1,247	1,247	1,316	-	1,316	2,563
1959	-	2,240	2,240	2,514	-	2,514	4,754
1960	-	6,931	6,931	3,416	-	3,416	10,347
1961	1	11,142	11,143	2,398	-	2,398	13,541
1962	86	10,010	10,096	4,343	-	4,343	14,439
1963	54	7,125	7,179	4,866	3,095	7,961	15,140
1964	17	3,269	3,286	1,392	291	1,683	4,969
1965	205	2,850	3,055	601	77	678	3,733
1966	52	3,269	3,321	672	11	683	4,004
1967	18	6,231	6,249	1,431	88	1,519	7,768
1968	2	4,606	4,608	797	363	1,160	5,768
1969	127	3,954	4,081	619	565	1,184	5,265
1970	161	5,930	6,091	524	297	821	6,912
1971	115	5,931	6,046	410	1,747	2,157	8,203
1972	325	4,951	5,476	199	-	199	5,475
1973	72	3,835	3,907	71	-	71	3,978
1974	154	1,919	2,073	110	-	110	2,183

[a] United States and Canada

Table 20.--Herring catch, fishing effort, and CPUE for Japanese gillnet vessels west and east of 175°W in the Bering Sea, excluding the Aleutian Region, 1964-74.

Calendar year	West of 175°W			East of 175°W		
	Catch (mt)	Effort (10-tan units)	CPUE (mt per 10 tans)	Catch (mt)	Effort (10-tan units)	CPUE (mt per 10 tans)
1964	41,597	45,239	0.92	--	--	--
1965	34,659	80,724	0.43	--	--	--
1966	24,118	48,520	0.50	--	--	--
1967	30,167	54,753	0.55	--	--	--
1968	5,183	35,898	0.14	818	2,949	0.28
1969	680	12,210	0.06	1,949	4,992	0.39
1970	--	--	--	1,585	6,645	0.24
1971	--	--	--	4,603	13,064	0.35
1972	--	--	--	472	10,420	0.05
1973	--	--	--	1,876	12,679	0.15
1974	--	--	--	3,336	9,594	0.35

Source: Fredin (1974)

Table 21.--King crab catches in the eastern Bering Sea in thousands of crabs, 1953-75.[a]

Year	Japan	USA	USSR	Total
1953	1,276	361	-	1,637
1954	1,061	328	-	1,389
1955	1,129	313	-	1,442
1956	1,079	294	-	1,373
1957	1,171	107	-	1,278
1958	1,130	1	-	1,131
1959	1,292	-	620	1,912
1960	1,949	88	1,995	4,032
1961	3,031	62	3,441	6,534
1962	4,951	10	3,019	7,980
1963	5,476	101	3,019	8,596
1964	5,895	123	2,800	8,818
1965	4,216	223	2,226	6,665
1966	4,206	140	2,560	6,906
1967	3,764	397	1,592	5,753
1968	3,853	1,278	549	5,680
1969	2,073	1,749	369	4,191
1970	2,080	1,683	320	4,083
1971	886	2,045	265	3,196
1972	874	3,994	-[b]	4,868
1973	228	5,000	-[b]	5,228
1974	476	8,618	-[b]	9,904
1975	-[c]	2,107d	-[b]	2,107[d]

[a] Includes Paralithodes camtschatica and P. platypus.

[b] No USSR fishery from 1972-75.

[c] No Japanese fishery in 1975.

[d] Catch through September only; fishery still in progress.

Table 22.--Catch per unit effort data for king and Tanner crab fisheries in the eastern Bering Sea.

Year	King crab[a/]				Tanner[a/]			
	Japan		U.S.	U.S.S.R.	Japan		U.S.	U.S.S.R.
	Tangle net	Pot	Pot	Tangle net	Tangle net	Pot	Pot	Tangle net
1953	8.9	-	-	-	-	-	-	-
1954	11.9	-	-	-	-	-	-	-
1955	11.4	-	-	-	-	-	-	-
1956	7.3	-	-	-	-	-	-	-
1957	14.0	-	-	-	-	-	-	-
1958	11.4	-	-	-	-	-	-	-
1959	16.5	-	-	9.7	-	-	-	-
1960	15.2	-	-	10.4	-	-	-	-
1961	11.8	-	-	8.9	-	-	-	-
1962	11.3	-	-	7.2	-	-	-	-
1963	8.5	-	-	5.6	-	-	-	-
1964	9.2	-	-	4.6	-	-	-	-
1965	9.3	-	-	3.6	2.3	-	1.1	-
1966	9.4	-	51.7	4.1	3.3	-	1.1	-
1967	8.3	2.7	37.4	2.4	18.9	8.2	5.2	-
1968	7.5	1.4	26.9	2.3	20.8	12.4	14.4	4.5
1969	7.2	0.2	17.8	1.5	35.8	12.8	25.2	11.8
1970	7.3	0.3	17.1	1.4	30.4	13.2	25.0	29.5
1971	6.7	0.6	20.3	1.3	30.9	13.4	20.5	8.4
1972	6.7	0.7	20.5	b/	31.9	13.8	b/	6.3
1973	b/	o.2	24.9	b/	-	13.6	b/	8.0
1974	b/	0.6	33.3	b/	-	16.4	b/	115.0

a/ CPUE units: Number of crabs per tan of tangle net
Number of crabs per pot

b/ No fishery

Table 23.--Tanner crab catches in the eastern Bering Sea in millions of crabs, 1965-75[a/].

Year	Japan	USA	USSR	Total
1965	1.03	--	.67	1.70
1966	1.49	--	.67	2.16
1967	8.61	--	3.39	12.00
1968	11.98	.01	3.49	15.48
1969	17.59	.35	6.24	24.19
1970	18.19	.48	5.72	24.39
1971	15.74	.06	4.20	20.00
1972	15.59	.04	b/	15.64
1973	13.94	.13	b/	14.08
1974	13.99	2.53	b/	16.52
1975	9.23	2.76[c/]	b/	11.99[c/]

a/ Includes *Chionoecetes bairdi* and *C. opilio*

b/ No USSR fishery from 1972-75.

c/ U.S. catch through September only.

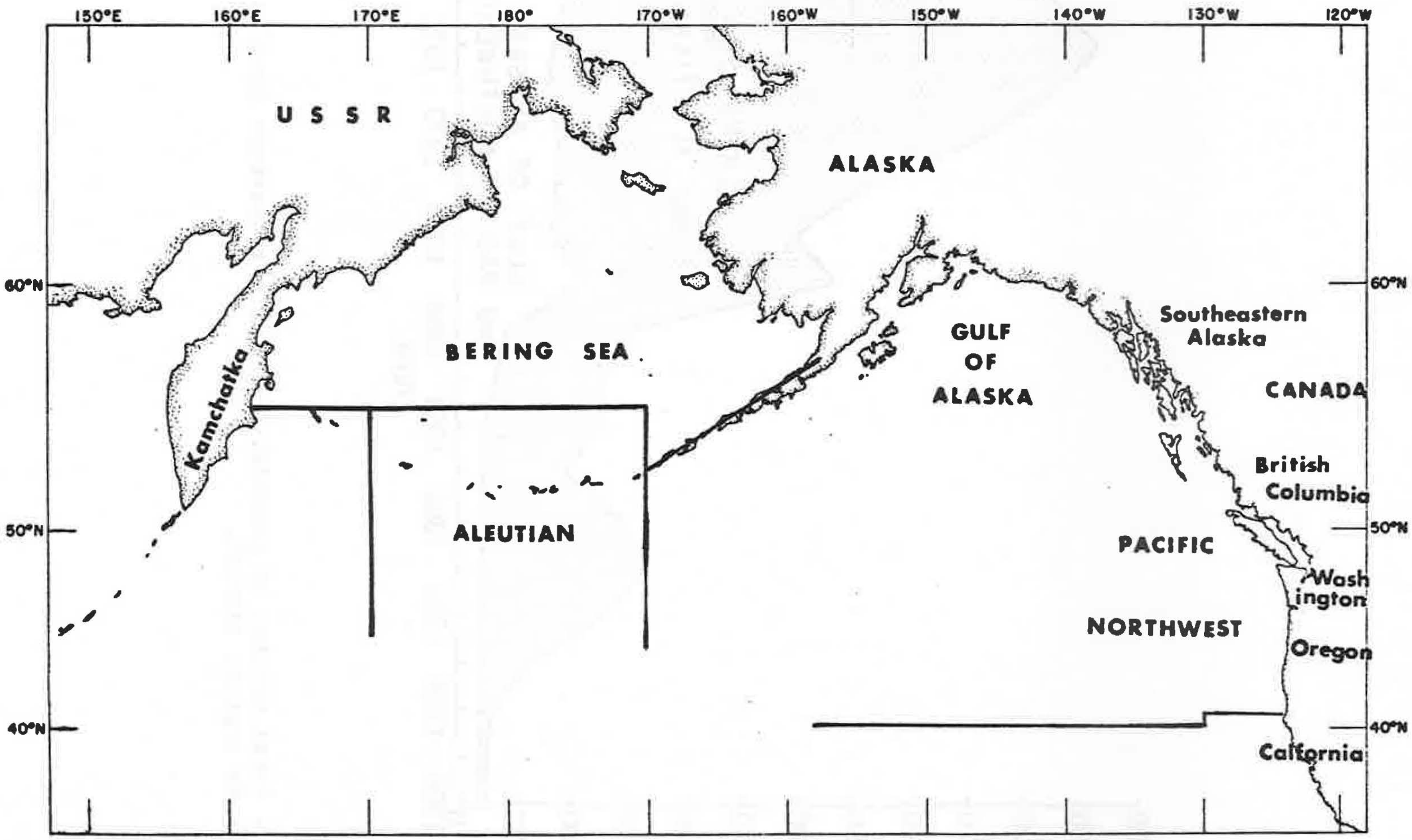

Fig. 1. Map of the northeastern Pacific Ocean showing the Bering Sea, Aleutian Islands, Gulf of Alaska and Pacific Northwest regions.

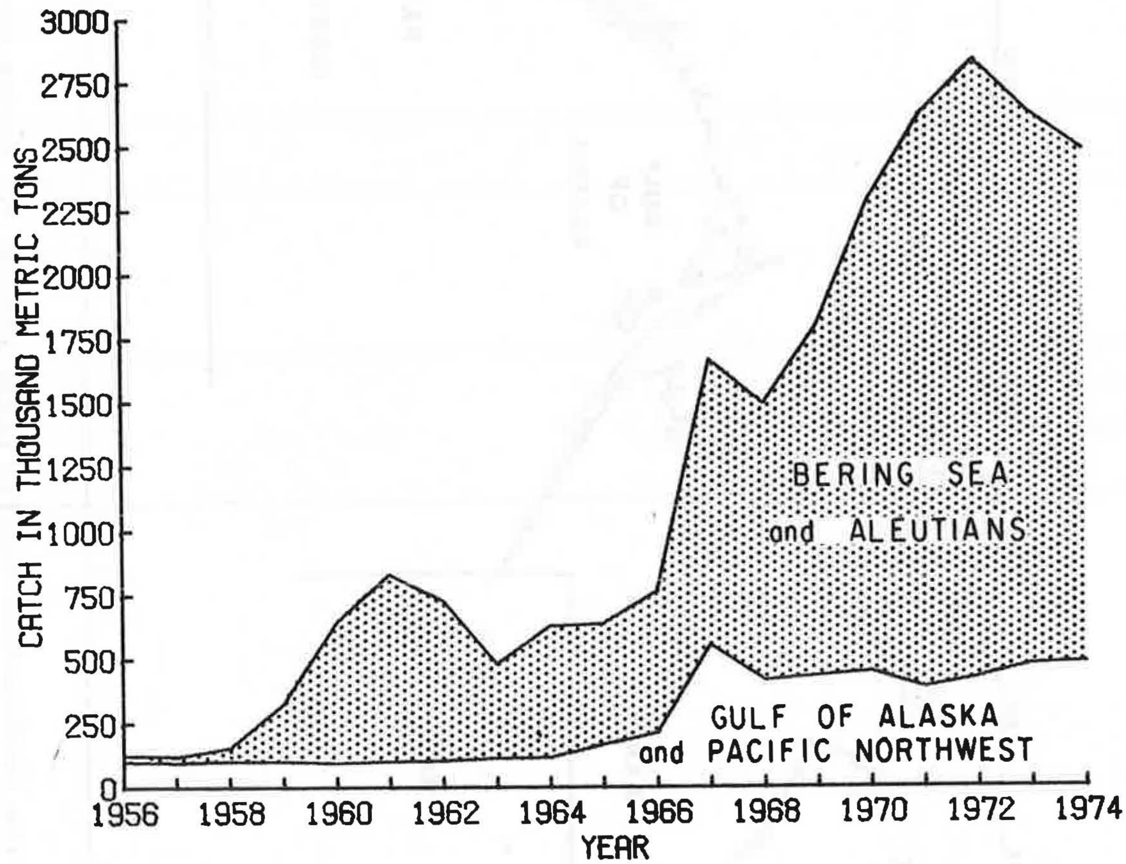

Fig. 2. Total catches of groundfish in the northeastern Pacific Ocean by region, 1956-74.

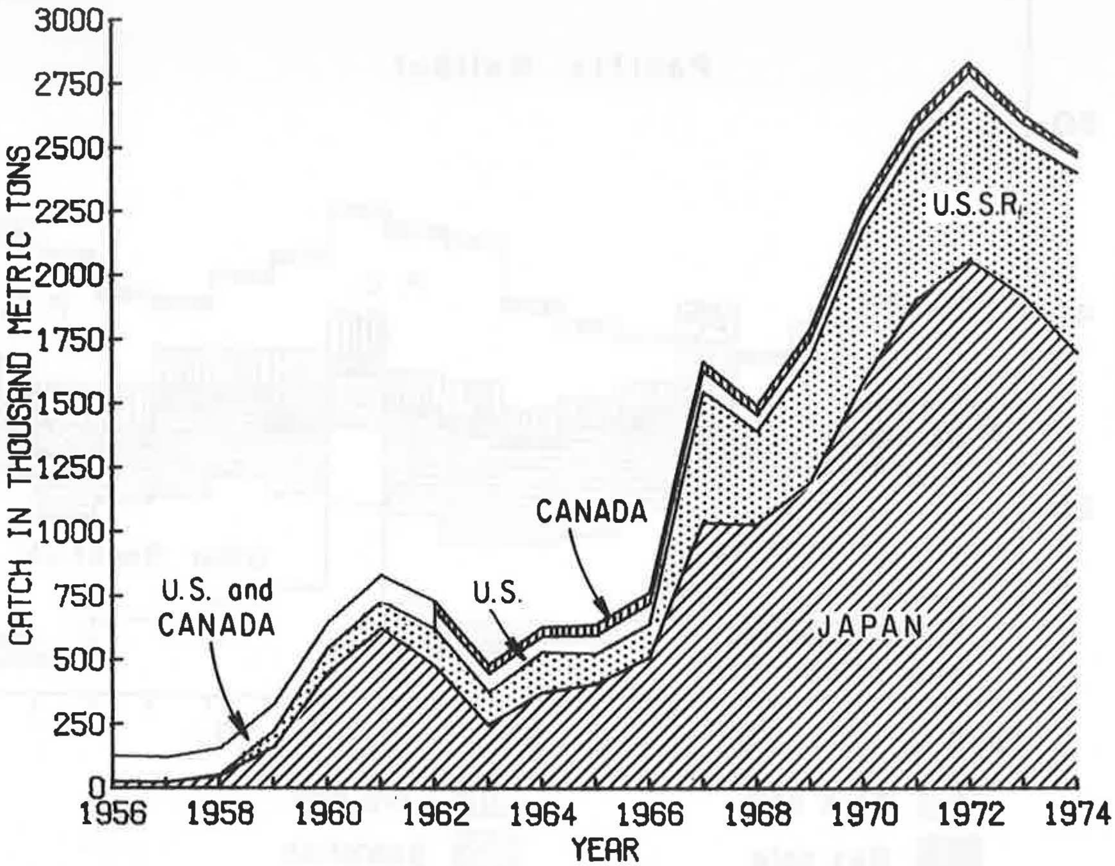

Fig. 3. Total catches of groundfish in the northeastern Pacific Ocean (from the Bering Sea to northern California) by nation, 1956-74.

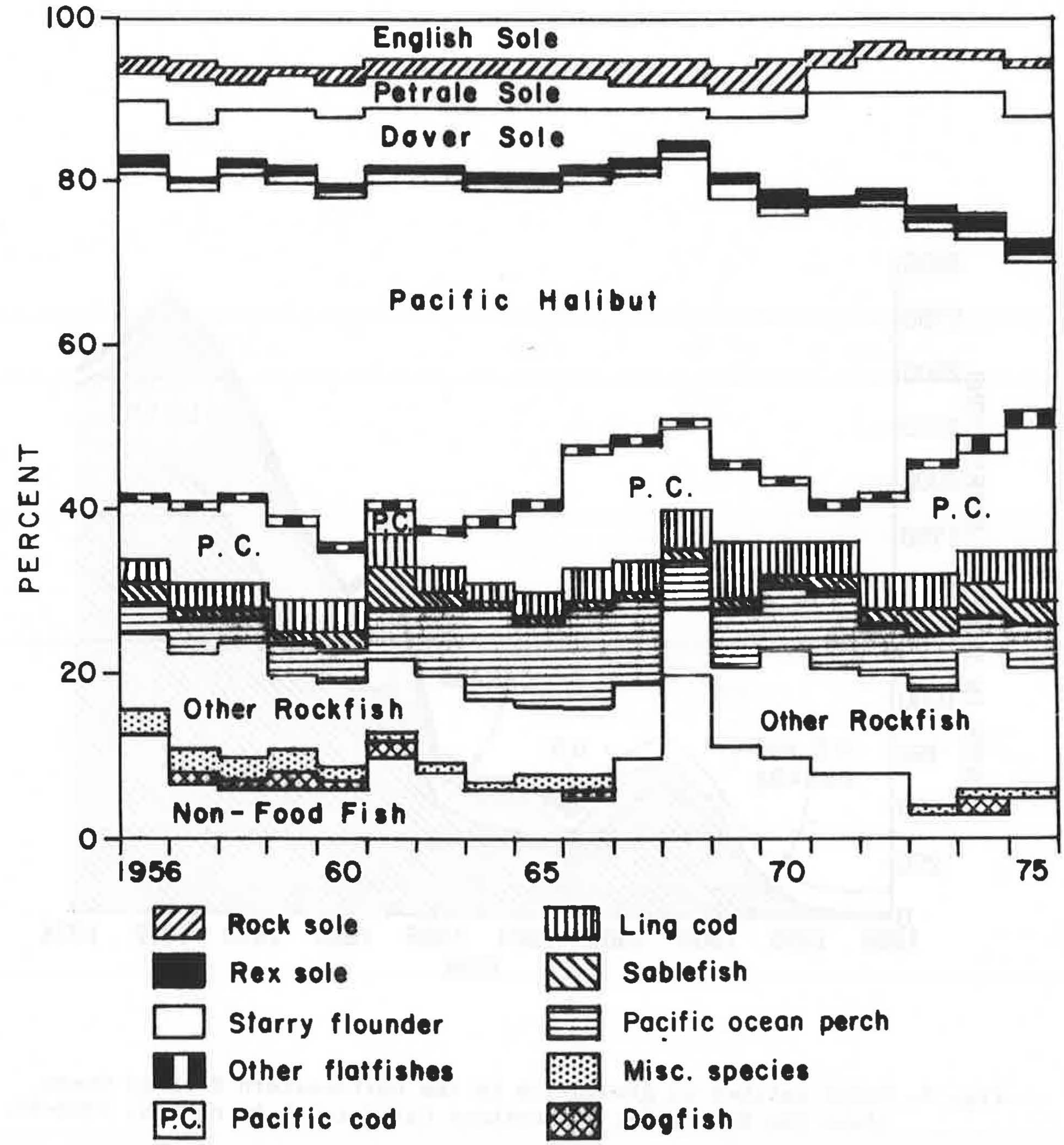

Fig. 4. Species composition of United States and Canadian groundfish catches, 1957-74.

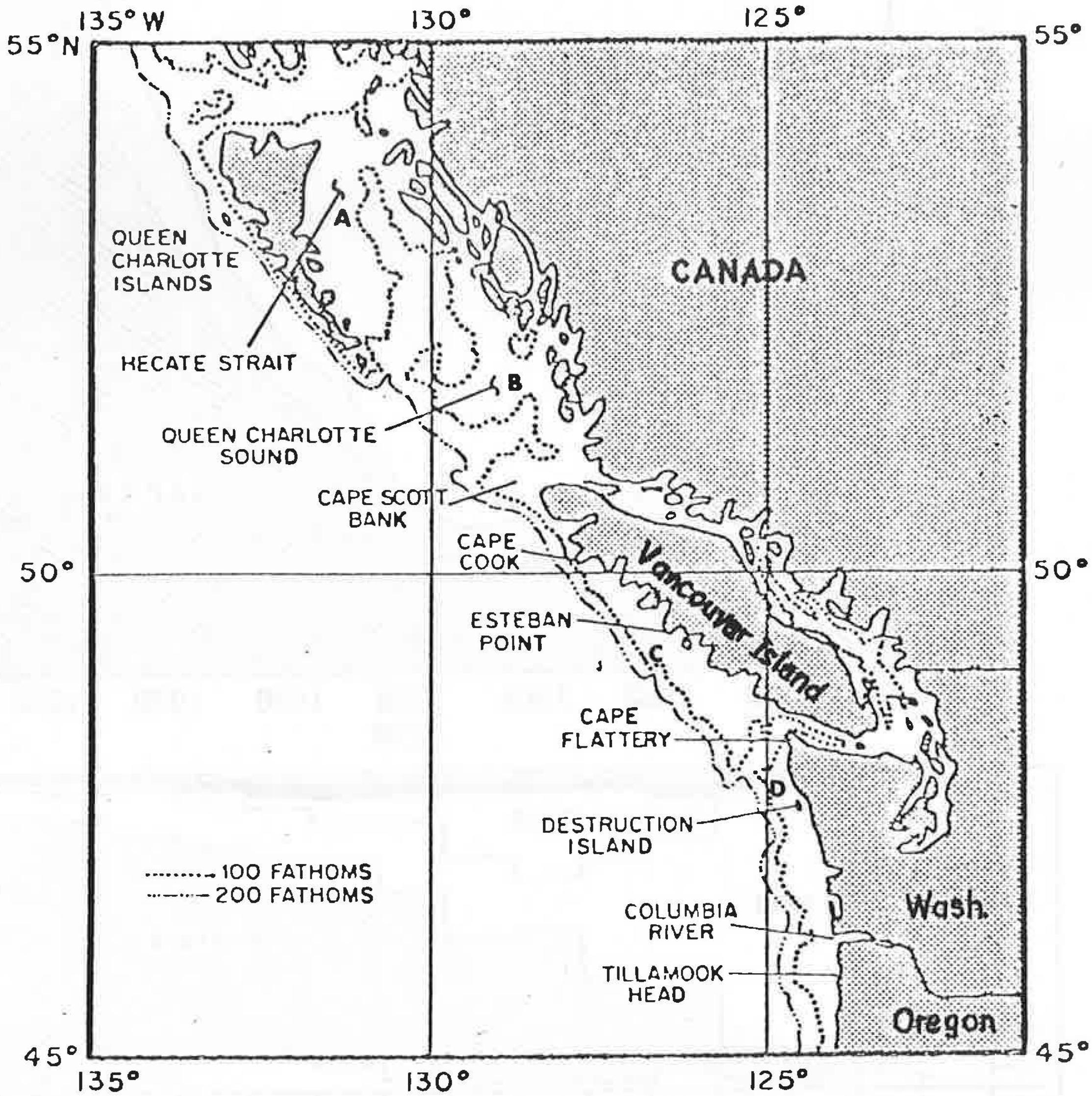

Fig. 5. Major fishing areas for United States and Canadian trawlers.

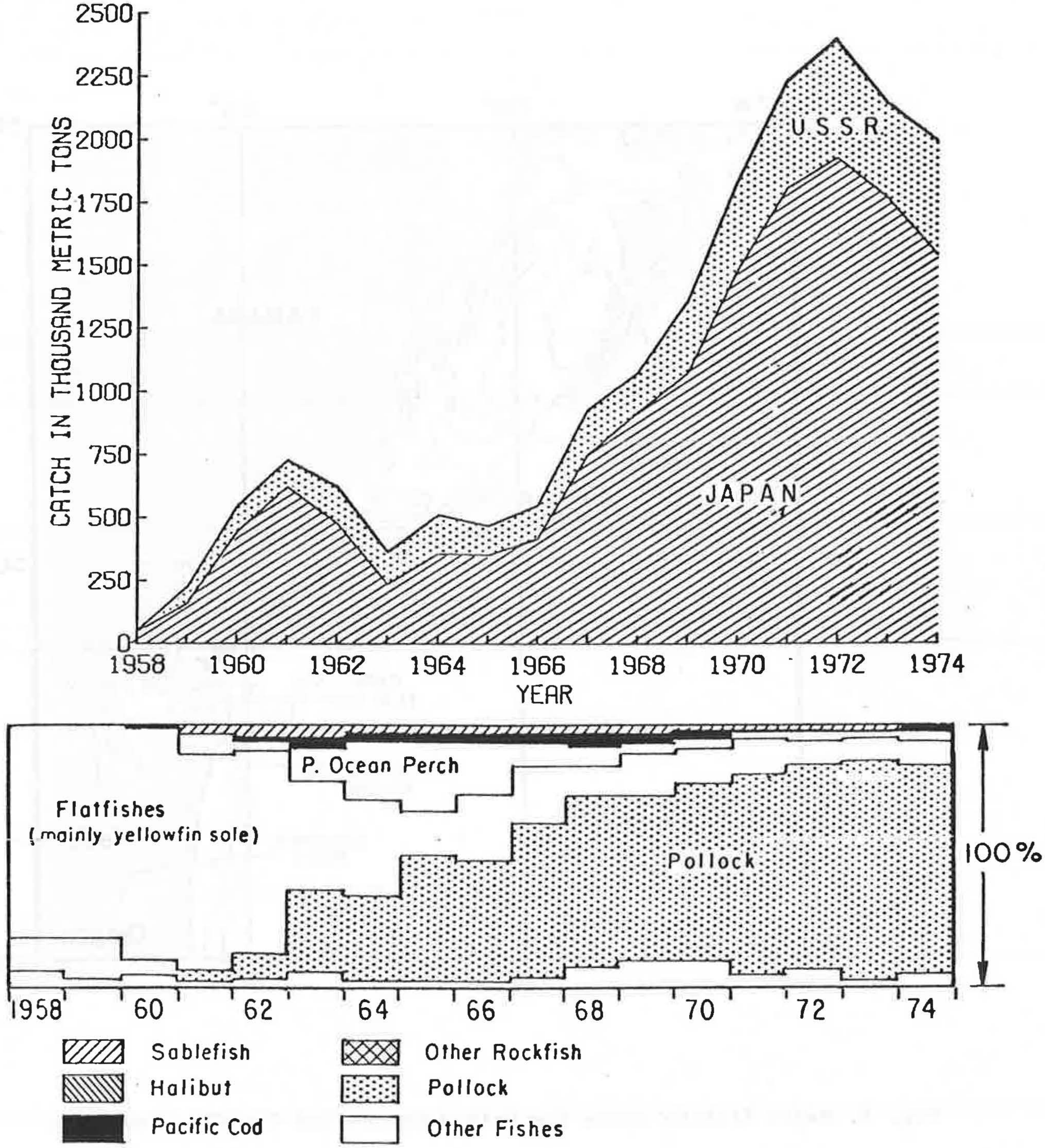

Fig. 6. Total catches of groundfish and their species composition in the Bering Sea and Aleutian Region, 1958-74.

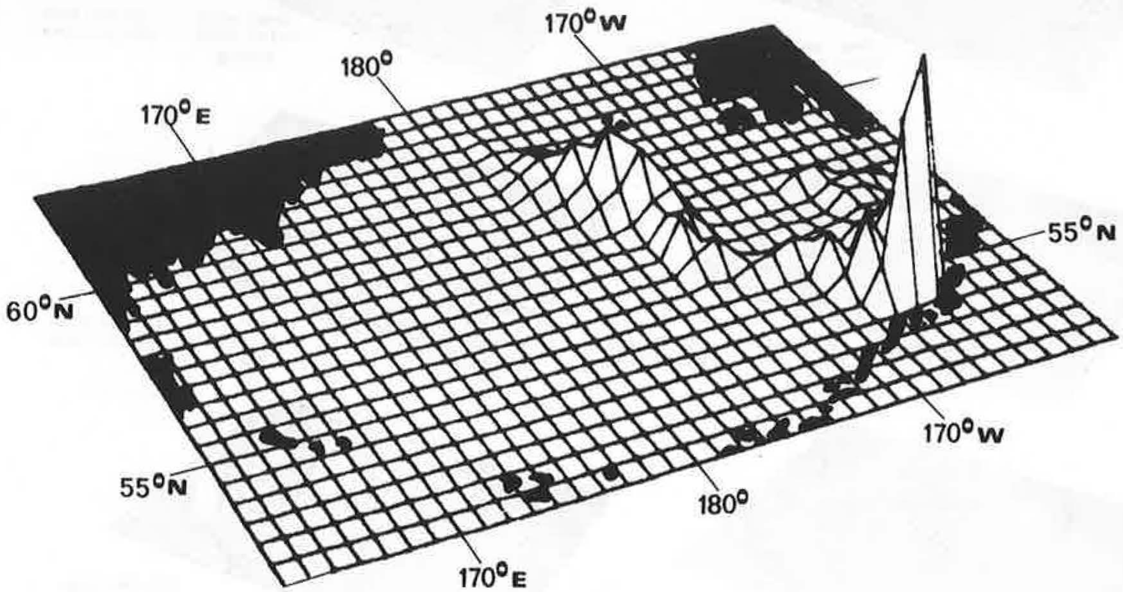

Fig. 7. General catch distribution of groundfish in the Bering Sea.

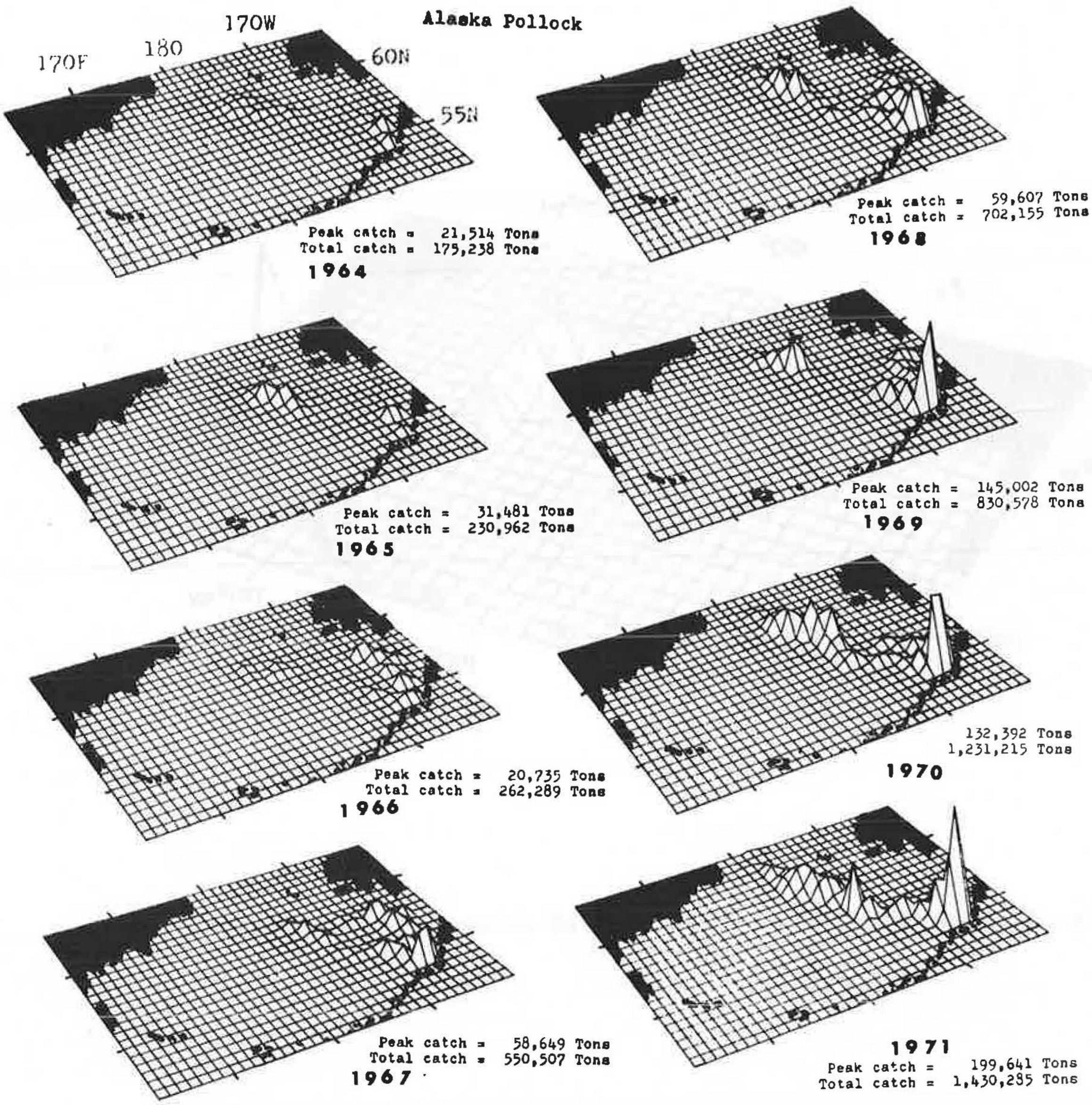

Fig. 8. Catch distribution of pollock by Japan in the Bering Sea, 1964-71.

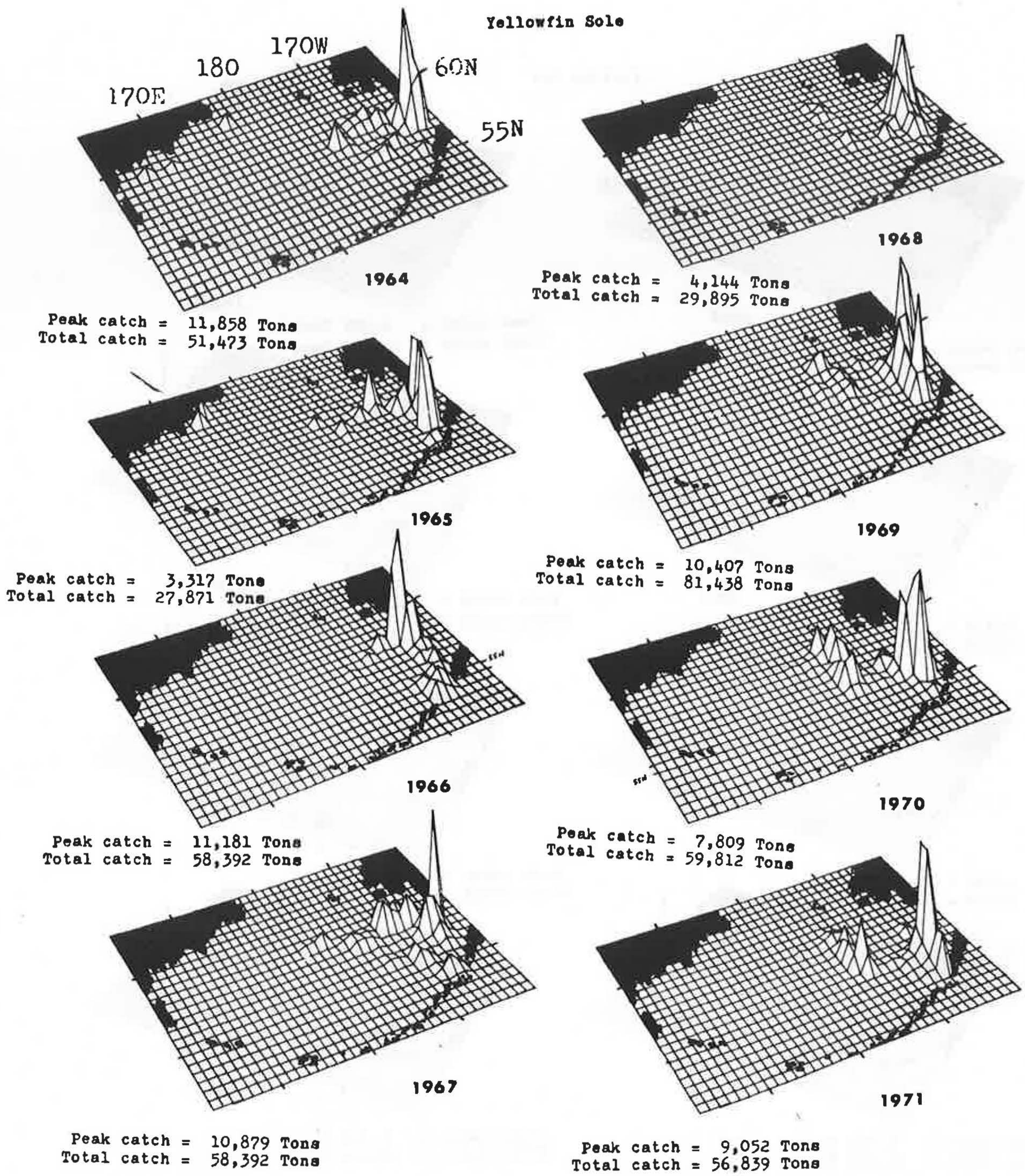

Fig. 9. Catch distribution of yellowfin sole by Japan in the Bering Sea, 1964-71.

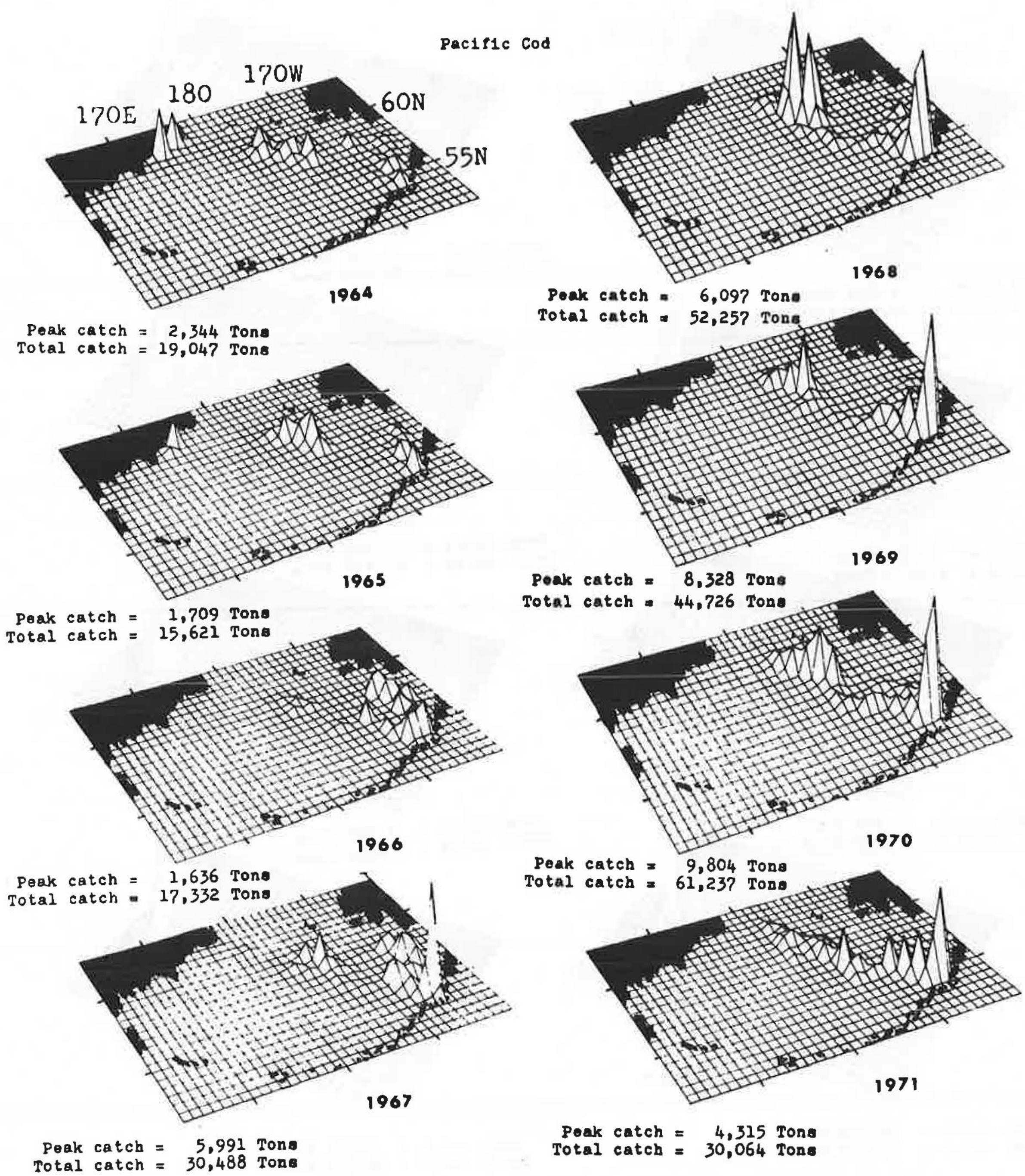

Fig. 10. Catch distribution of Pacific cod by Japan in the Bering Sea, 1964–71.

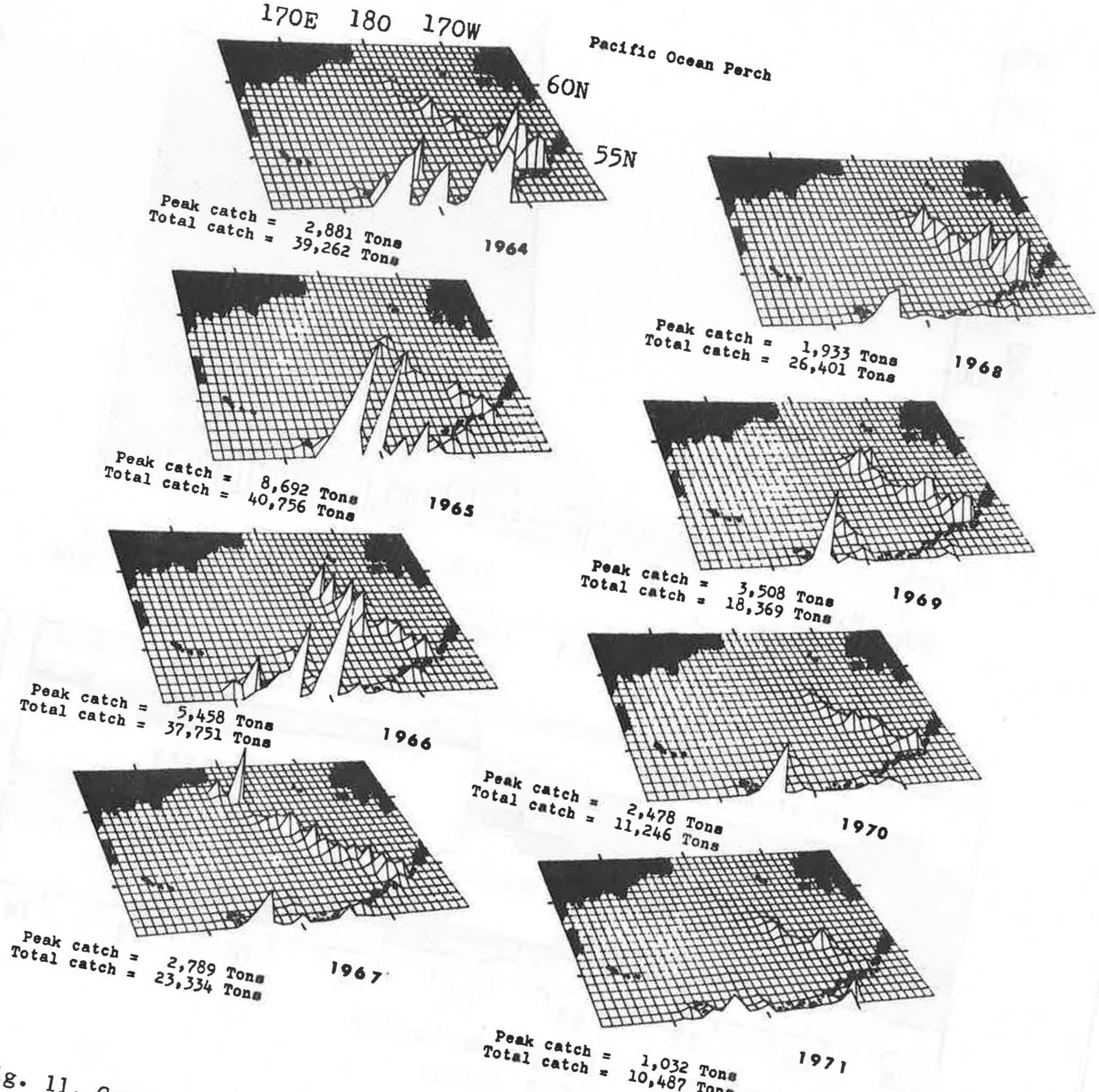

Fig. 11. Catch distribution of Pacific ocean perch by Japan in the Bering Sea, 1964–71.

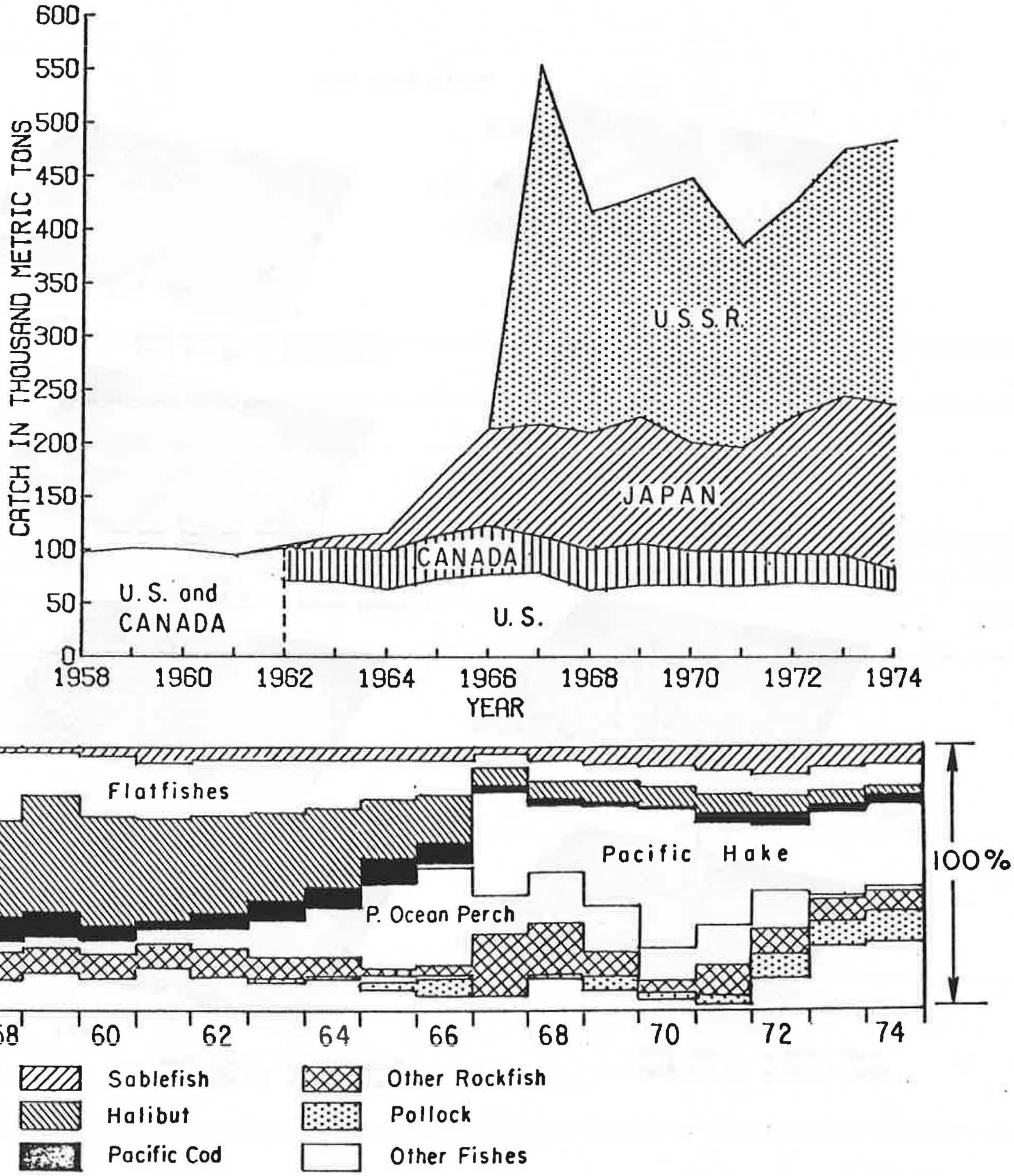

Fig. 12. Total catches of groundfish and their species composition in the Gulf of Alaska and off the Pacific Northwest, 1958-74.

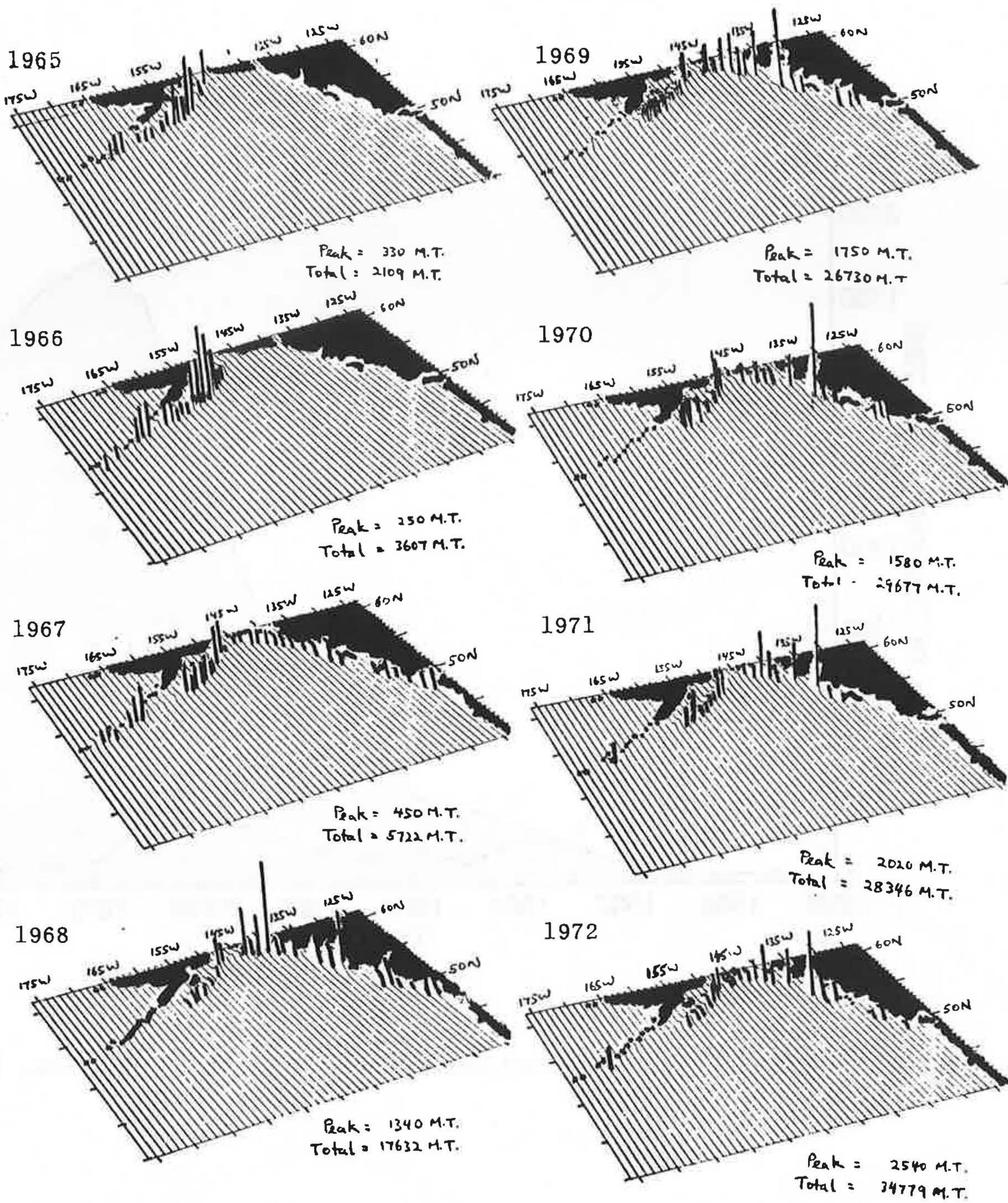

Fig. 13. Catch distribution of sablefish in the Gulf of Alaska and off the Pacific Northwest, 1965-72.

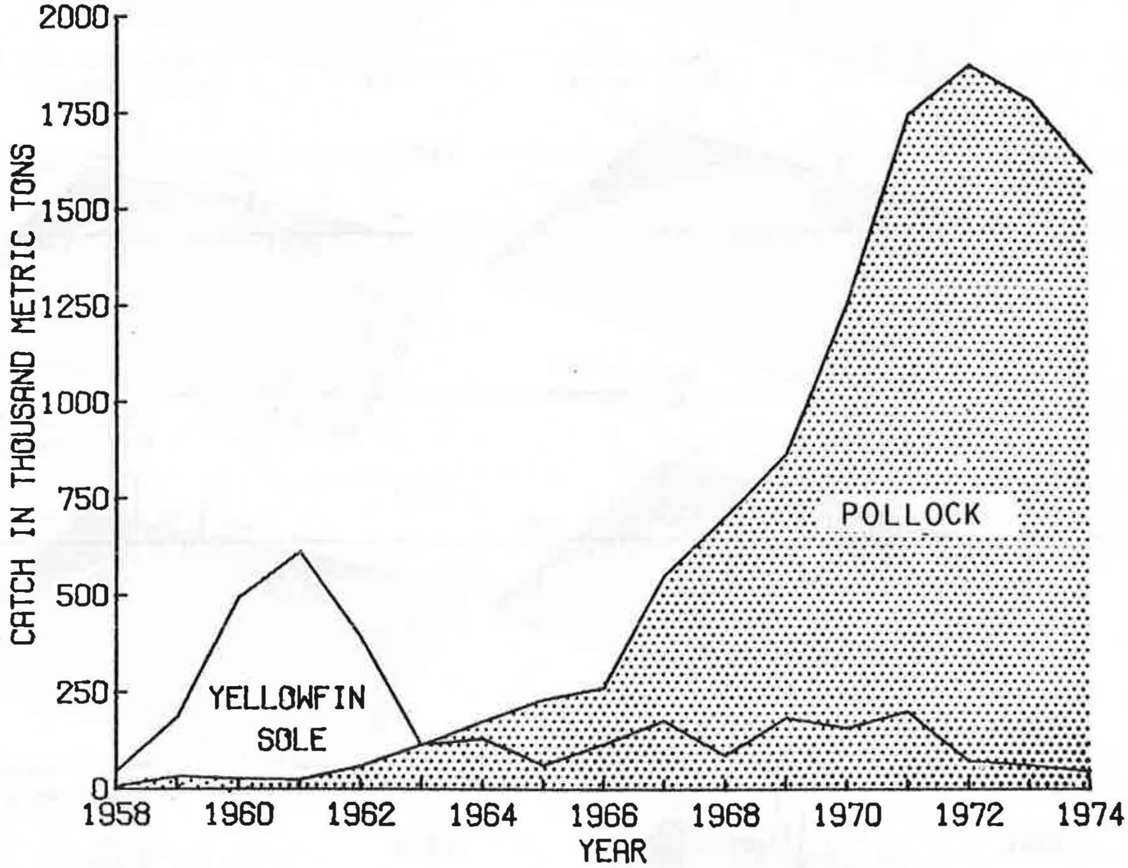

Fig. 14. Catches of pollock and yellowfin sole in the Bering Sea, 1958-74.

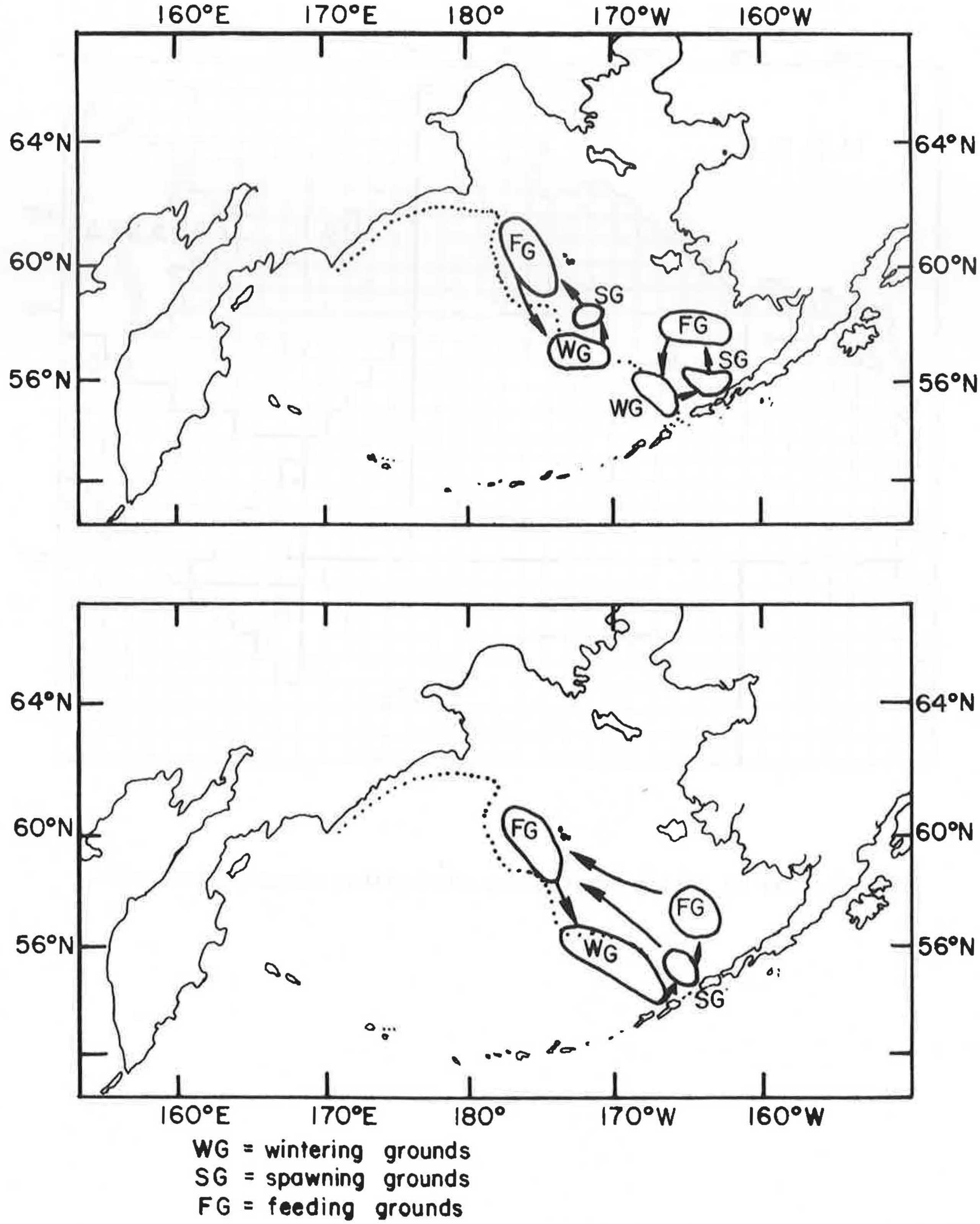

Fig. 15. Schematic diagram showing the concept of one and two stocks of pollock in the eastern Bering Sea (Maeda 1972).

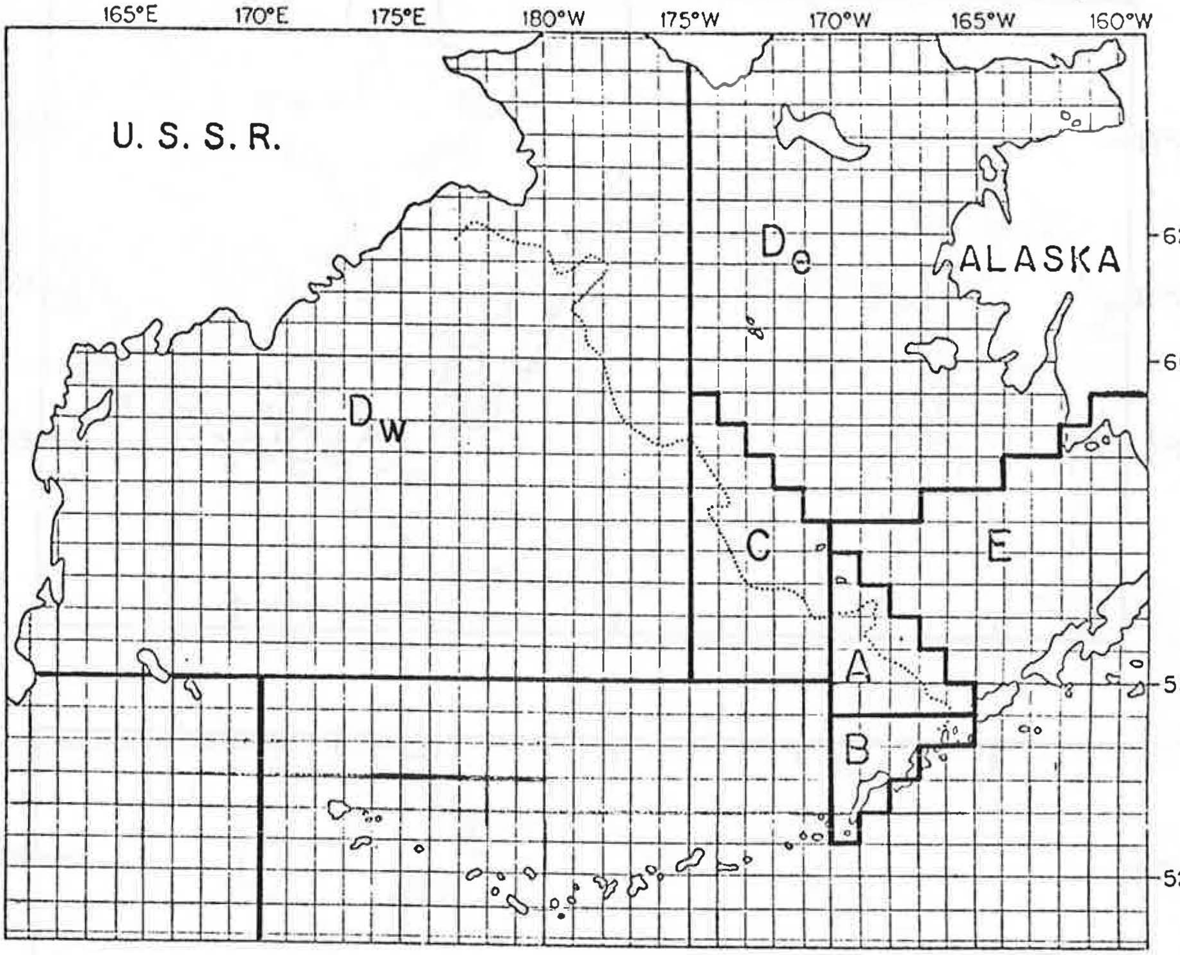

Fig. 16. Map of Bering Sea showing six halibut conservation areas.

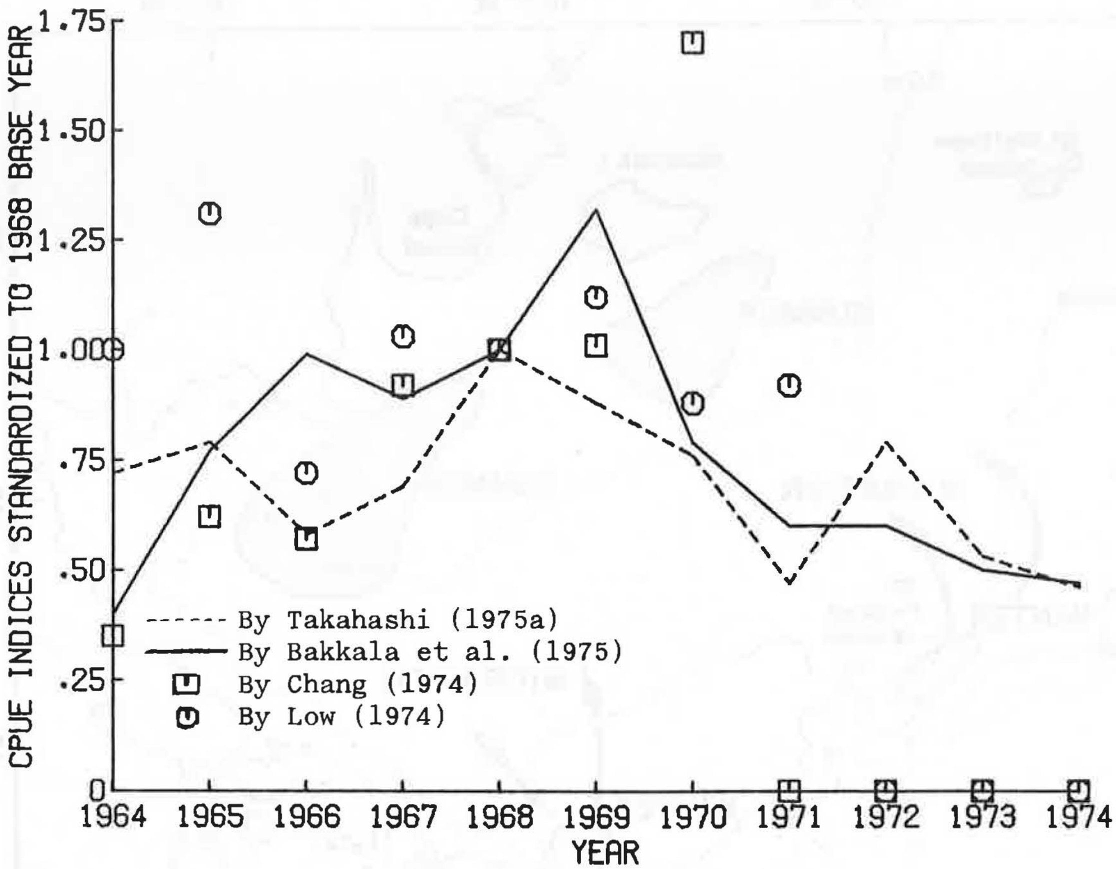

Fig. 17. Indices of pollock abundance in the Bering Sea from four sources, each standardized to the 1968 base year, 1964-74.

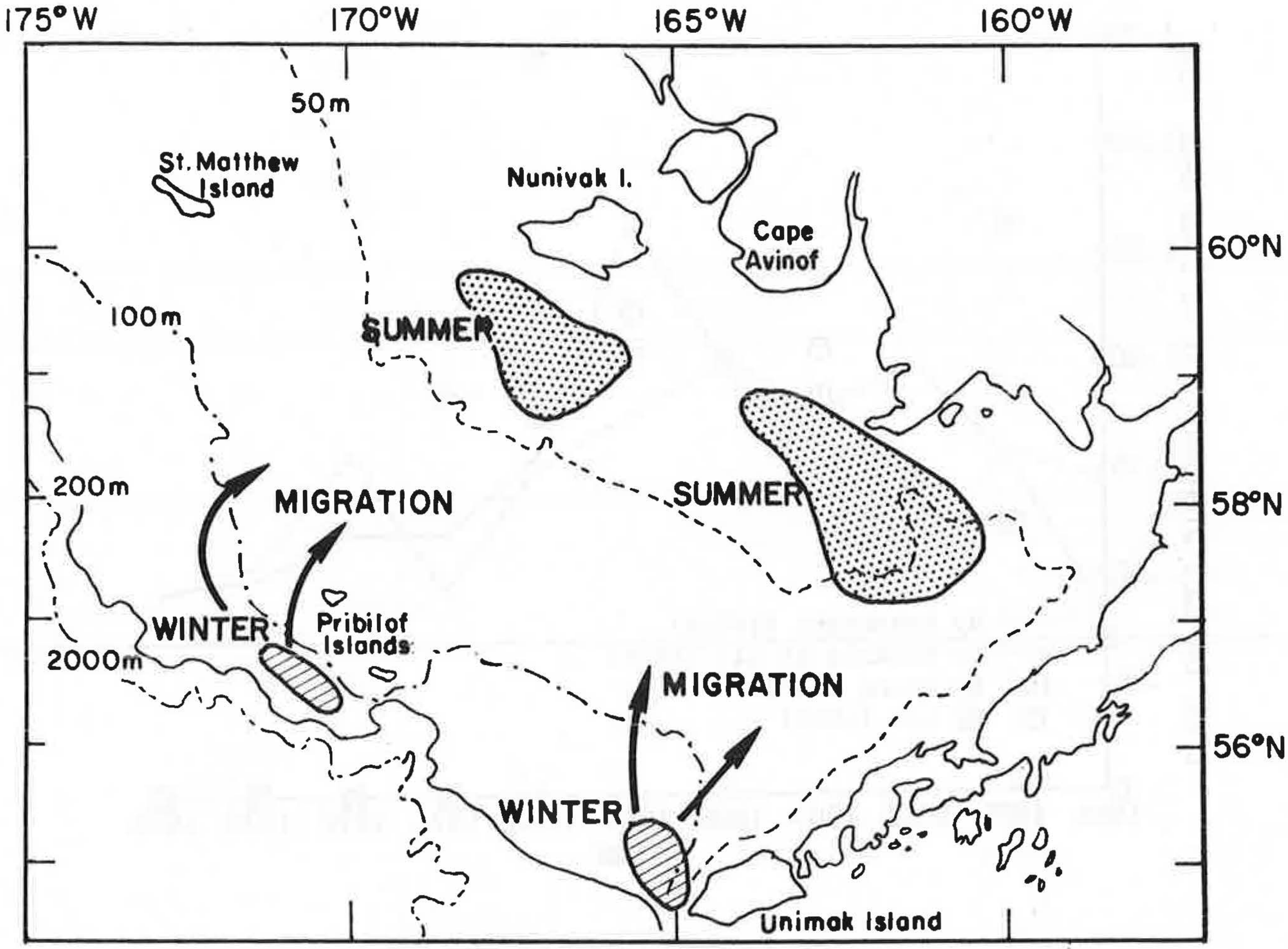

Fig. 18. Schematic diagram showing location of winter and summer concentrations of two yellowfin sole stocks in the eastern Bering Sea.

Fig. 19. Mean size of yellowfin sole caught in the eastern Bering Sea, 1957–74.

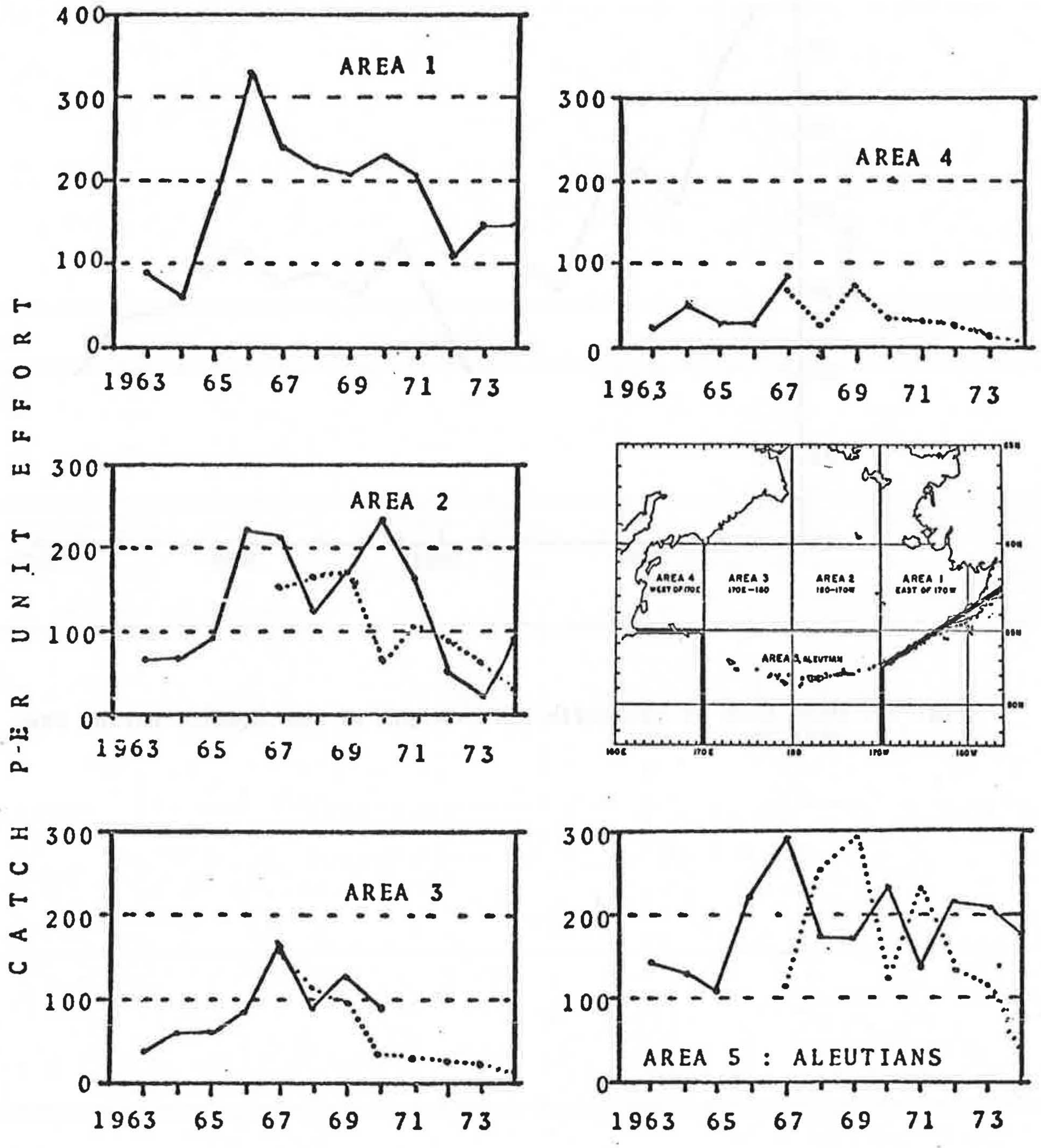

Fig. 20. Catch per unit effort (CPUE) trends for sablefish by Japanese longliners (solid line) and landbased stern trawlers in the Bering Sea and Aleutians, 1963–74. Longline CPUE is in kg per 10 hachi longline units and trawler CPUE is in kg per hour trawling.

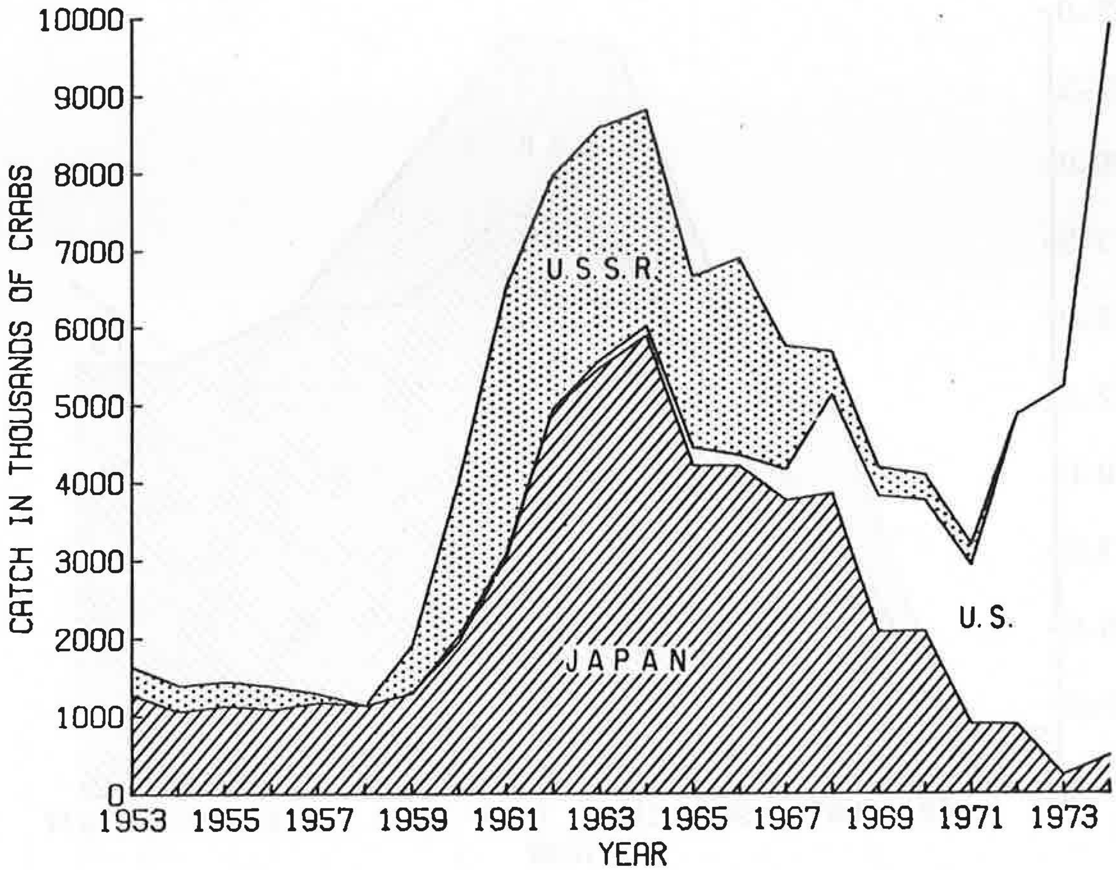

Fig. 21. King crab landings in the eastern Bering Sea.

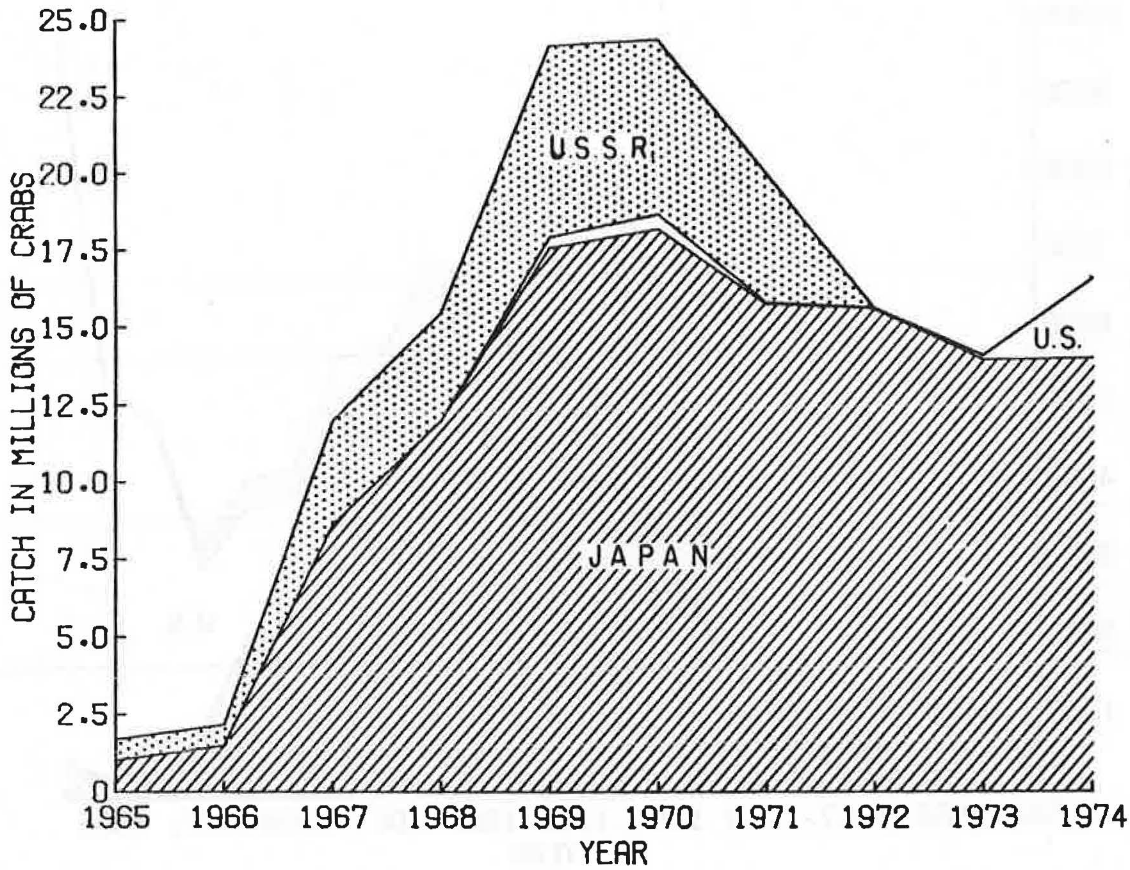

Fig. 22. Tanner crab landings in the eastern Bering Sea.