FISH, WILDLIFE AND PETROLEUM PRODUCTION THE GULF OF ALASKA

SUPPLEMENTARY DATA - FISH AND WILDLIFE

APPENDIX 6 — FISH, WILDLIFE AND PETROLEUM PRODUCTION: THE GULF OF MEXICO; SANTA BARBARA CHANNEL, CALIFORNIA, AND COOK INLET, ALASKA

APPENDIX 7 — UNITED STATES AND REGIONAL FISHERY STATISTICS, 1939-1974

APPENDIX 8 — EXPLORATORY FISHING DRAGS FOR DEMERSAL FISH AND SHELLFISH, THE GULF OF ALASKA

GULF OF ALASKA OPERATORS COMMITTEE

SUPPLEMENTARY

FISH AND WILDLIFE DATA

FISH, WILDLIFE AND PETROLEUM PRODUCTION: THE GULF OF MEXICO; SANTA BARBARA CHANNEL, CALIFORNIA, AND COOK INLET, ALASKA

APPENDIX 6

UNITED STATES AND REGIONAL FISHERY STATISTICS

APPENDIX 7

EXPLORATORY FISHING DRAGS FOR DEMERSAL FISH AND SHELLFISH, THE GULF OF ALASKA

APPENDIX 8

PREPARED BY

William F. Gusey
Senior Staff Wildlife Specialist
Shell Oil Company

PETROLEUM PRODUCTION
AND
FISH AND WILDLIFE RESOURCES

THE GULF OF MEXICO
COOK INLET, ALASKA
SANTA BARBARA CHANNEL, CALIFORNIA

APPENDIX 6

William F. Gusey
Senior Staff Wildlife Specialist
Shell Oil Company
Houston, Texas

FOR THE
GULF OF ALASKA OPERATORS COMMITTEE

PREFACE

This appendix describes the status of fish and wildlife resources which are associated with the petroleum industry in the Gulf of Mexico; the Santa Barbara Channel and adjacent waters; and in Cook Inlet, Alaska.

The Gulf of Mexico is an ecosystem with massive energy capabilities. The naturally generated energy, a product of the rich nutrient systems of the estuaries, coastal wetlands, and shallow warm waters, is manifest in enormous and diverse plant and animal populations. That the Gulf region had a similar energy capability in the geological past is evidenced by its life product - the hidden resources of oil and gas.

More than seven million acres of wetlands, lakes, ponds, bayous, and estuaries provide valuable food and nursery habitat for many estuarine-dependent species of fish and shellfish, and spawning areas for others.

The coastal wetlands and water areas are, at times, inhabited by some of the largest concentrations of waterfowl, shorebirds, and fur animals found anywhere in the United States. The offshore barrier islands are used extensively for feeding and nesting by terns, gulls, pelicans, and colonial birds, in addition to a great number of wading bird species. Large populations of rails and gallinules inhabit the marshes, and a variety of shorebird species nest on the offshore islands during the summer.

The fishery resources of the Gulf of Mexico constitute one of the largest known fishery biomasses in the world. For more than 10 years, the fishery of the Gulf of Mexico has provided at least 25% of the United States total harvest, with more than 1/5 of the United States total landed in the 425-mile coastal zone between Pascagoula, Mississippi, and Port Arthur, Texas.

Further, the greatest concentration of offshore oil industry activity in the world has been established in the Gulf coastal region, consisting of: more than 18,000 gas and oil well completions offshore Louisiana and Texas; nearly 2,000 offshore platforms, well jackets and support structures in Outer Continental Shelf waters; more than 5,000 miles of pipeline in the Gulf of Mexico, extending more than 70 miles into the Gulf and into water depths greater than 300 feet; and total production of more than 4 billion barrels of crude oil and 19 trillion cubic feet of natural gas from offshore areas during the lifetime to-date of offshore operations.

In the Gulf of Mexico, petroleum platforms have provided millions of square feet of solid substrate where none existed previously, from which has evolved a totally new marine ecosystem. These platforms have been instrumental in the attraction and establishment of some fish species either not present or not taken previously in northern Gulf waters, and have led to the creation of a major salt water sport fishing activity. Concurrently, the commercial fishing industry has consistently increased its annual harvest from the same waters in which the petroleum industry operates and waterfowl continue to winter in abundance.

Apart from the presence of the petroleum industry in the Gulf region, and its relationship to surface values, the accidental loss of petroleum and subsequent effects upon fish and wildlife resources must be considered. Many marine species may be affected to some degree by petroleum, but is probable that only a few are particularly vulnerable, especially seabirds and their habitats, shellfish grounds, and inshore spawning areas.

The petroleum industry and the fish and wildlife resources of the Santa Barbara Channel, for the most part, experience an essentially neutral relationship. The area is rich in fish and shellfish, and supports a sport and commercial fishery. Birds are abundant on the Channel Islands, where substantial marine mammal populations will also be found. The area was the site of a California Department of Fish and Game Study from 1958 to 1961, to determine the influence of offshore petroleum platforms on marine life. They concluded that "there was no evidence of deleterious effects from any part of the operation. The entire operation was clean, and the island towers served to enhance the habitat. Many fishes were attracted to the installation, and a heavy encrustation of various organisms developed on the structures. This encrustation included such animals as kelp scallops, barnacles, and mussels, which added greatly to the available fish food. Further, washed drill cuttings deposited on the bottom as these sites were neither deleterious nor beneficial to the marine life in the area."

Cook Inlet supports, or is, a periodic habitat for populations of various species of waterfowl and seabirds, which on occasions number in the millions; is a permanent residence for sea otters — occasionally for sea lions; its beaches provide razor clam habitat; its waters support thriving fishing industries involving shrimp, king, snow and dungeness crabs, salmon and herring, an extensive recreational fishery; and the oil industry, which is the primary economic activity in the Inlet.

The petroleum industry in the Cook Inlet basin far outdistances any other primary economic activity in dollar value, and may increase substantially through the next decade. At the same time, fisheries, second in rank of the resource-based industries of the area, have experienced a nearly steady-state economic condition during the past ten years. The petroleum industry has expanded rapidly from exploration and early production in the late 1950's to large-scale production from eight major oil and gas fields and several smaller ones by the 1970's.

Although petroleum industry activity is centered in the upper Inlet, many miles removed from the bulk of these resources, it does share the same waters which ebb and flow past and over them; is surrounded by hundreds of square miles of valuable waterfowl habitat; and occupies the upper Inlet along with a set net salmon fishery.

In the final analysis, there are many facets of the association between fish and wildlife resources and the offshore petroleum industry. The issue is not whether the petroleum industry has been of any direct benefit to the faunal resources of the region, but whether it has been possible, in total for platforms, oil, fish, shrimp, and waterfowl to co-exist in a viable relationship.

The record is clear that, on the basis of supply and demand, these resources have not been unduly stressed; a high degree of compatibility has existed; and all objectives have been met - seafood and oil production.

INTRODUCTION - THE GULF OF MEXICO

The Gulf of Mexico, ringed on three sides with thousands of square miles of bays, estuaries, bayous, inlets, and wetlands, is an ecosystem with massive energy capabilities. The naturally generated energy, a product of the rich nutrient systems of those estuaries, coastal wetlands, and shallow warm waters, is manifest in enormous and diverse plant and animal populations. That the Gulf region had a similar energy capability in the geological past is evidenced by its life product — the hidden resources of oil and gas.

The nutrient laden shallows of the Outer Continental Shelf Gulf waters are a prime factor contributing to a concentration of commercial fish species. Further, more than seven million acres of wetlands, lakes, ponds, bayous, and estuaries[1] provide valuable food and nursery habitat for many estuarine-dependent species of fish and shellfish, and spawning areas for others. Abundant food and shelter also are available for migratory waterfowl and many other wildlife species.

The coastal wetlands and water areas are, at times, inhabited by some of the largest concentrations of waterfowl, shorebirds, and fur animals found anywhere in the United States. The offshore barrier islands are used extensively for feeding and nesting by terns, gulls, pelicans, and colonial birds, in addition to a great number of wading bird species. Large populations of rails and gallinules inhabit the marshes, and a variety of shorebird species nest on the offshore islands during the summer.

The fishery resources of the Gulf of Mexico, particularly those limited largely to the Outer Continental Shelf, constitute one of the largest known fishery biomasses in the world, exceeded only by those of the Peruvian coast. For 10 years, the commercial fishery of the Gulf of Mexico has provided at least 25% of the United States total harvest, with more than 1/5 of the United States total landed in the 425-mile coastal zone between Pascagoula, Mississippi, and Port Arthur, Texas.[2]

In a capsule, the waters over the Outer Continental Shelf of the Gulf of Mexico and adjacent coastal zone comprise, produce, or sustain:

— the second largest estuarine area on the North American Continent.

— the second largest fishery biomass known anywhere in the world.

— more than 30% of the United States' total fishery harvest during the past 7 years, exceeding 40% in 1971.

— a marine sport fishery involving more than 2 million fishermen in 1970, and resulting in a catch estimated to be in excess of 300 million pounds annually since 1960.

— approximately 400 species of birds.

— wintering grounds for more than 6 million migratory waterfowl.[3]

— twenty-five National Wildlife Refuges, numerous State and private refuges and sanctuaries, and one National Park.

— intermittent or permanent range of numerous species of fauna considered rare or endangered, including: 4 species of mammals, at least 12 species of birds, three species of reptiles, and one specie of amphibian.

— a furbearer population capable of sustaining a harvest greater than any comparable area elsewhere in the United States.

Further, the greatest concentration of coastal and offshore oil industry activity in the world has been established in the Gulf coastal region, comprising:

— more than 14,000 gas and oil wells in the Louisiana coastal marshes.

— more than 18,000 gas and oil well completions offshore Louisiana and Texas.

— nearly 2,000 offshore platforms, well jackets and support structures in Outer Continental Shelf waters.

— more than 5,000 miles of pipeline in the Gulf of Mexico, extending more than 70 miles into the Gulf and into water depths greater than 300 feet.

— more than 4,500 miles of canals and pipeline rights-of-way in the Louisiana coastal marshes.

— total production of more than 3 billion barrels of crude oil and 19 trillion cubic feet of natural gas from offshore areas during the lifetime to-date of offshore operations.

It is evident that the enormous energy and productivity of the Gulf of Mexico is manifest in two distinct strata, surface and subsurface. Yet, a direct relationship exists between surface wildlife resources on one hand, which periodically comprise a total biomass difficult to equal elsewhere on the North American continent, and on the other, subsurface gas and oil resources which have proven enormous in volume and are essential to the world society. Extraction and processing facilities for these latter resources and associated operations are conducted in a tightly woven proximity with the fish and wildlife resources of the region. Available data indicate a high degree of compatibility between these industrial operations and the production and maintenance of economically and esthetically valuable resources — even where the coastal and marine environment has been significantly altered over more than a 40-year period.

The "presence" of petroleum operations in the Gulf region is obvious. The "effect" of that presence is more difficult to describe, but includes an extensive network of canals and pipeline rights-of-way in the coastal wetlands of Louisiana which have contributed to altered water chemistry and movement, which in turn have borne on the management and harvest of oyster resources, and on the quality and quantity of estuarine areas upon which fish and shellfish are dependent. At the same time, these canals and waterways provide access to hunting and fishing areas within the coastal wetlands which previously were inaccessible to sportsmen, in addition to access for the harvesting of fur bearers.

In the Gulf, petroleum platforms have provided millions of square feet of solid substrate where none existed previously, from which has evolved a totally new marine ecosystem. These platforms have been instrumental in the attraction and establishment of some fish species either not present or not taken previously in northern Gulf waters, and have led to the creation of a major salt water sport fishing activity. Concurrently, the commercial fishing industry has consistently increased its annual harvest from the same waters in which the petroleum industry operates; waterfowl winter in abundance (with populations largely dictated by environmental conditions 2,000 miles to the north); and wetlands, which bear little resemblence to their former undisturbed state, continue to provide habitat for one of the highest furbearer populations of the country.

Apart from the presence of the petroleum industry in the Gulf region, and its relationship to surface values, the accidental loss of petroleum and subsequent effects upon fish and wildlife resources must be considered. Many marine species may be affected to some degree by petroleum, but it is probable that only a few are particularly vulnerable, especially seabirds and their habitats, shellfish grounds, and inshore spawning areas.

In the final analysis, therefore, there are many facets of the association between the fish and wildlife resources and the petroleum industry in the Gulf. On one hand some undesirable changes have occurred in the Gulf wetlands which should be minimized in the future. On the other hand, changes which are extremely favorable and vital, such as marine sport fishing and the development of energy sources, have been effected.

The issue is not whether the petroleum industry has been of any direct benefit to the faunal resources of the region, but whether it has been possible, in total, for platforms, oil, fish, shrimp, and waterfowl to co-exist in a viable relationship. Considering the broad spectrum of fish and wildlife resources and the wide scope of the oil industry in the Gulf of Mexico region, an affirmative opinion is realistic.

GAS & OIL EXPLORATION & PRODUCTION
COASTAL & OFFSHORE LOUISIANA & TEXAS

ONSHORE

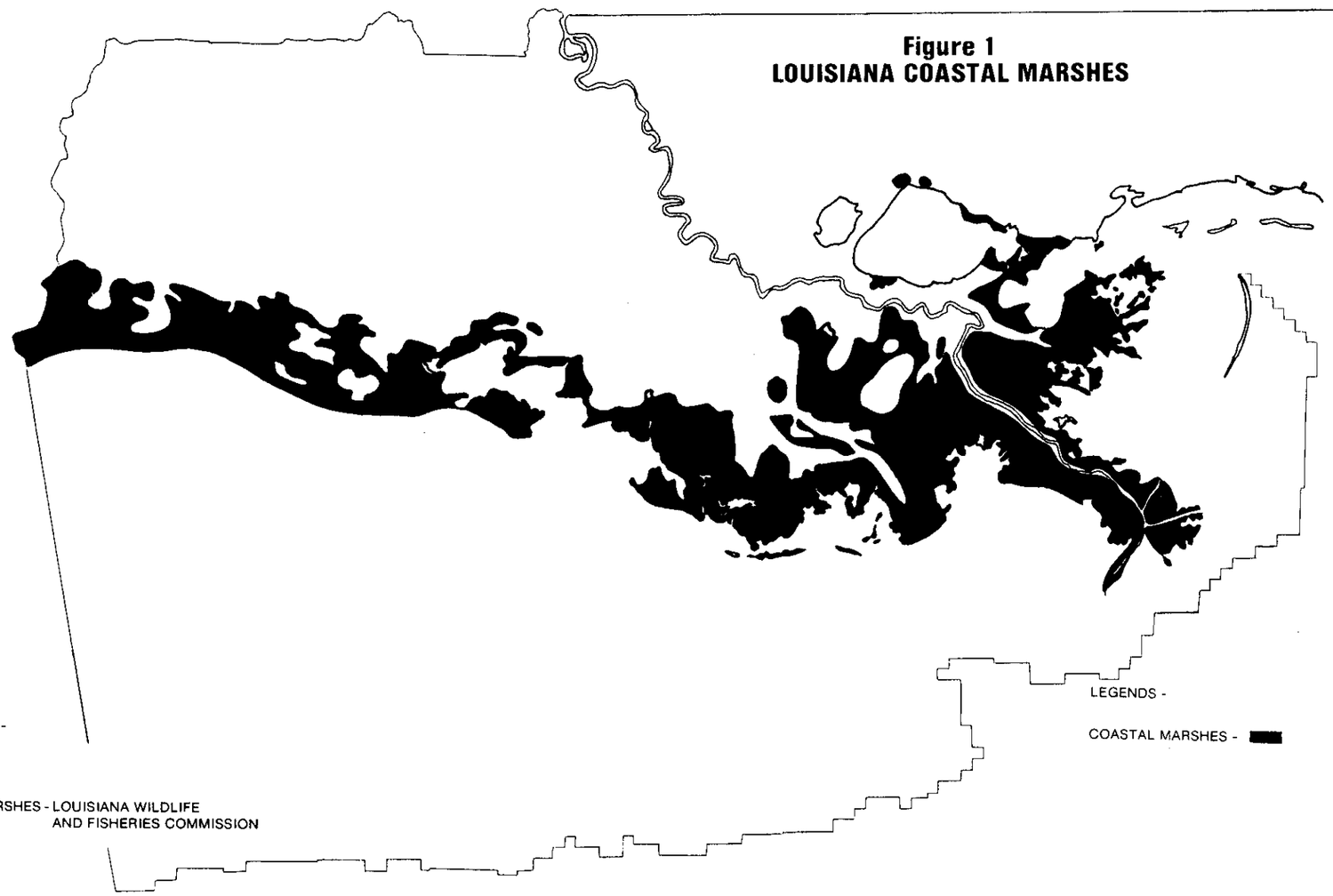
The coastal wetlands, estuaries and other aquatic areas of Louisiana are a product of 50 centuries of the delta building process of the Mississippi River. They cover some seven million acres[1], approximately one-fourth of the nation's total marshland area, and range in elevation 2 feet above and below mean sea level. (Figure 1) The development of these wetlands, which today comprise almost one-third of the total acreage of Louisiana, was gradual, based upon an undisturbed balance between the fresh water river, the saline Gulf of Mexico, worldwide fluctuations in sea level and sediment deposits from the Mississippi River. In contemporary times, human use of the area has significantly altered any semblance of a balance between the river and the Gulf, and most sediment transported by the river is now deposited in the deep Gulf of Mexico or along the Continental Shelf.

Flooding has been significantly reduced by manipulation of the flow of the river with a series of dams upstream on some of the significant tributaries and an extensive system of levees downriver. The Intracoastal Waterway, constructed to accommodate shipping, further inhibits natural drainage patterns. Other effects are related to agricultural drainage and clearing in the coastal zone.

To these can be added the influence of the petroleum industry which, since 1927, has constructed more than 4,500 miles of canals, drainage ditches, pipeline rights-of-way, and channels for petroleum exploration in the coastal wetlands of Louisiana.

Further, despite considerable sediment deposition in recent years and the growth of subdeltas, studies indicate an annual land-loss rate of 16.5 square miles during the past 25 to 30 years. Of this land loss, the Department of the Interior has reported that 3% to 13% is related to onshore pipelines. However, Dr. A. E. Smalley, Tulane University, considers these figures representative of the effects of early exploration in the wetlands and too high for current conditions. Offshore production has not been associated with such sediment loss.

Figure 1
LOUISIANA COASTAL MARSHES



LEGENDS -

COASTAL MARSHES -

MAP CREDITS -

COASTAL MARSHES - LOUISIANA WILDLIFE AND FISHERIES COMMISSION

The total results of all activities cannot be assessed entirely. However, among the gross changes which have occurred are confinement of the lower Mississippi River to a few channels discharging into the outer shelf area, and saltwater encroachment in the deltaic estuaries which has proven markedly detrimental to flora and fauna. These environmental alterations also involve: loss of fish and shellfish nursery areas from dredging, silting, boat traffic, leveeing, and erosion, with accompanying loss or dislocation of sessile animals and bottom organisms; marshes that have been destroyed or substantially altered; destruction or disruption of surface movement of animals; and, damage by marsh buggies and other heavy equipment to intertidal areas, wetlands, and shallow waters that constitute integral elements of the coastal ecosystem. (Figures 4 and 5)

Despite the ecological changes which have occurred on a massive scale in this highly unstable zone, the coastal wetlands continue to demonstrate an exceptionally high carrying capacity for wintering waterfowl, and can be considered among the better furbearer habitats in the United States, while continuing to function as major fish and shellfish spawning and nursery areas.

The first gas and oil exploratory activity in the coastal wetlands of Louisiana was conducted in 1927. By the end of 1970, more than 15,500 producing gas and oil wells had been established.

Crude-producing wells - 10,247*

Gas-producing wells - 5,464*

OFFSHORE

In 1937, the industry moved into the Gulf of Mexico as an extension of exploration and production activities in the coastal wetlands of Louisiana. The first offshore well was drilled about 10 miles east of the mouth of Calcasieu Pass, about one mile offshore, commencing October 10, 1937, and completing March 11, 1938, as the discovery well of the Creole Field.

The first significant Louisiana offshore lease sale was held in August, 1945, covering more than 129,000 acres in the Eugene Island area. The first Texas offshore lease sale was held approximately two years later and included more than 378,000 acres. For the next seven or eight years, Texas exploratory activity was slow, contrasted with accelerated activity offshore Louisiana where 121 oil wells and 40 gas wells had been brought in by 1953.

Drilling and producing statistics on oil and gas operations in the "offshore" areas of the United States have an indistinct early history because original data did not separate offshore from onshore operations. To clarify this situation, the Offshore Operators' Committee recently compiled data defining offshore operations as those where the wellhead is located over water beyond the natural shoreline. Data are as of January 1, 1972.

The majority of the offshore wells have been drilled in water depths to 150 feet, although some exploration has been conducted in depths up to 600 feet. More than 5,000 miles of pipelines have been laid, including pipelines interconnecting many wells, and an estimated 3,100 miles of common-carrier pipelines to shore.

	Wells Drilled			
	Oil	Gas	Dry	Total
Louisiana				
State	1547	365	1056	2968
Federal	4258	1571	3273	9102
Total	5805	1936	4329	12070
Texas				
State	52	92	292	436
Federal	28	96	187	311
Total	80	188	479	747
Florida				
State	-	-	15	15
Federal	-	-	2	2
Total	-	-	17	17
Gulf of Mexico				
State	1599	457	1363	3419
Federal	4286	1667	3462	9415
Total	5885	2124	4825	12834

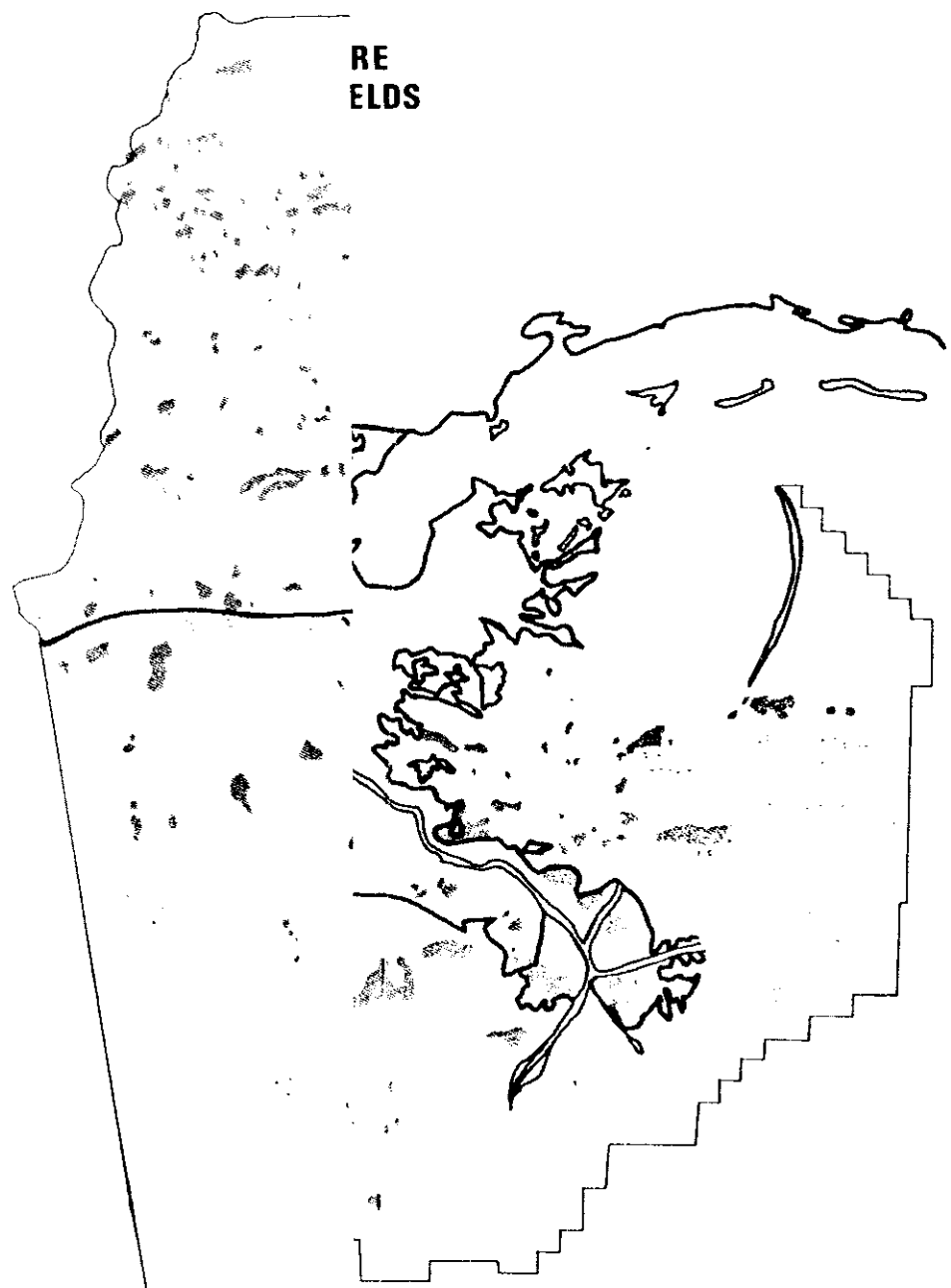
**Petroleum Information's Oil & Gas Yearbook, 1971, Petroleum Corp. (subsidiary of A. C. Nielsen), 1971.*

Figures 2 and 3 illustrates the present extent of oil and gas fields in coastal and offshore Louisiana and Texas.

The effects of the petroleum industry on the environment and the resources are significantly different in offshore areas than in the coastal wetland environment. Two important observations can be made. First, the offshore ecosystem tends to be more stable than the estuarine with qualities permitting it to cushion, absorb, or rebound from extraneous influences,[4] and, second, state, Federal, and industry-imposed regulations have been enacted with full recognition of potential environmental problems which the petroleum industry may encounter in offshore areas. Compliance with those regulations by the industry has proven to be generally adequate to mitigate any acute or long-term adverse effects on the marine ecosystem.[4]

However, problems have been encountered by fishing vessels. Federal regulations formerly required that stubs of abandoned wells be left projecting above the sea floor — thus creating problems for trawlers. Recent changes in Federal laws now require that stubs be removed below the sea floor. Further, unconsolidated backfills or spoil from new, buried, underwater pipelines have, on occasion, damaged trawls.

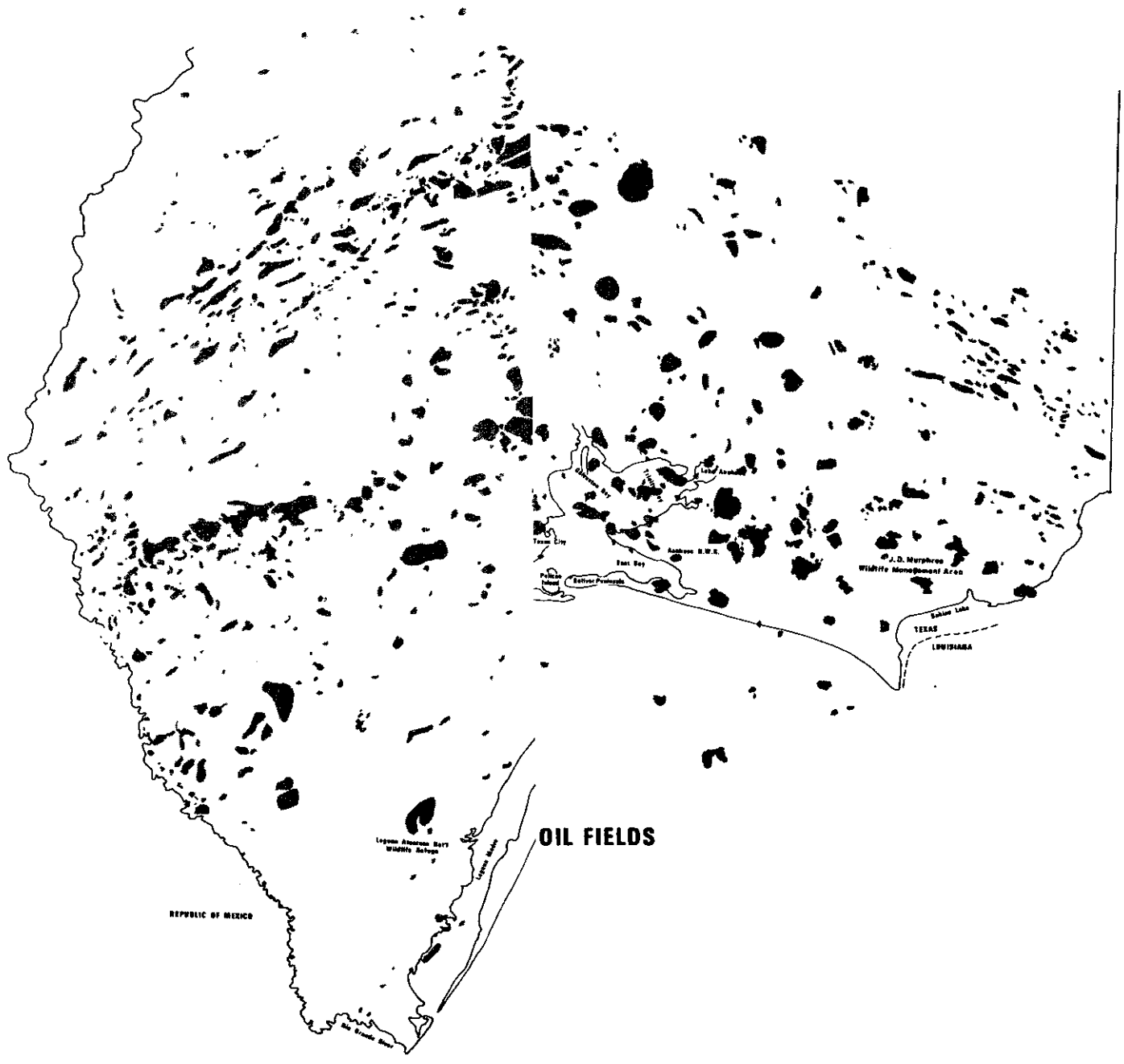
On the other hand, offshore platforms have proven beneficial by functioning as artificial reefs, with resulting concentration of fish and creation of a significant marine sportfishing activity. The platforms have also served as refuges for commercial and sport fishermen in times of stress.



MAP CREDITS -

GAS & OIL FIELDS - COURTES
GAS PIPEL

LEGENDS -
GAS AND OIL FIELDS -


OIL FIELDS
REPUBLIC OF MEXICO
TEXAS
LOUISIANA

THE GULF OF MEXICO COMMERCIAL FISHERY

For the past 10 years the fish and shellfish resources of the Gulf of Mexico have furnished more than 25% of the tonnage required for United States consumption as food and for industrial purposes. In 1971, the Gulf states led all regions of the United States in quantity (2,096,926,000 pounds) and value ($199,851,000) of fish and shellfish harvested, accounting for 42% and 31% respectively of the total United States catch.[5 6 7] This is greater than the Gulf states record set in 1970.

Gulf states fisheries have increased from only 4% of the total U. S. catch in 1930 to 42% in 1971 (Table 1 and Figure 4), due largely to growth in menhaden and shrimp fisheries. The 1.6 billion pound menhaden harvest in 1971 set a new record for the Gulf of Mexico. Fishery statistics from 1939 to the present illustrate the growth in the Gulf fishery, with estuarine-dependent species such as shrimp, oysters, and menhaden accounting for approximately 90% of the annual fisheries value.

With a harvest of 1,036 million pounds in 1973, Louisiana ranked first in the 50 states (Figure 5). Louisiana landings ranked third in value at 98.4 million dollars, behind first place Alaska and second ranked California.[5 6 7]

Commercial fishing occurs along approximately 1,500 miles of Gulf coastline but more than 20 percent of the country's total fishery products are landed from a 425 mile coastal strip between Pascagoula, Mississippi, and Port Arthur, Texas, a region referred to as the "Fertile Fisheries Crescent". The high poundage production in these waters lies in "industrial" fish and menhaden, while high value lies in shrimp, oysters, and crab. The area encompasses both sides of the mouth of the Mississippi River, the largest estuarine region of the North American continent, except possibly for Hudson Bay. In world production it is second only to the Peruvian coast.

Although during the last century redfish, black drum, speckled trout, and flounder were the principal commercial fish harvested from bays and estuaries of the Gulf coast, few of them have been widely accepted as food fish along the Gulf. The sport fishery may produce several times more tonnage of fish for human consumption in the Gulf region than does the commercial fishery.[8]

The most important fin-fish harvested in recent years have been menhaden and "industrial" fish. The latter, often referred to as "trash fish," comprise a substantial portion of the Gulf fishery, with approximately 100 million pounds caught and processed on the Missisippi and Louisiana coasts annually. Common and flat croaker constitute about half the weight. A portion of the industrial fish harvest is shipped frozen to northern mink farms while the balance is processed and canned for the pet food industry.[8]

The menhaden fishery, beginning but not developing during World War II, was revived in 1948 and grew until Gulf production exceeded 1 billion pounds in 1964 and 1966. Menhaden oil finds a market in paints, waxes, cleansers, lipstick, margarine, lubricants, and leather dressing. The meal and protein derivatives are commonly used in animal feeds, especially for poultry.

The numbers of people and vessels occupied in Gulf commercial fishing has increased slightly during the past 20 years. However, the gross tonnage of the vessels has increased substantially, and harvesting operations have been altered materially with changes in fishing gear.

Despite the impact commercial fishing exerts upon Gulf marine resources, there is no evidence that any species is being overharvested. At the same time, it must be acknowledged that the climbing rate of harvest does not reflect a continuing increase in the populations of the harvested species. Rather, the ascending scale tends to imply that fishery stocks are maintaining a reproductive rate adequate to sustain populations greater than are being harvested annually. There is no evidence to the contrary. Further, based upon experimental trawls in the Gulf by the National Marine Fisheries Service, it has been estimated that the catch could be increased substantially without affecting the base of the fishery resource.[9 10 11]

However, added to the harvest by American commercial fishing interests is the inestimable toll by Russian, Japanese, and Cuban vessels beyond the 12 mile territorial limit. It is known that fishing fleets from these countries are substantially utilizing blue and white marlin, swordfish, tuna, and sailfish, but the impact on total resources is unknown.

Table 1
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1939	Florida, West	56,987	3,833	60,820	9,349[2]	226[2]	3,979[2]	2,798[2]	3,587[2]
	Alabama	5,077	4,042	9,120	1,229	43	476	303	434
	Mississippi	9,874	14,852	24,726	2,692	192	2,340	631	579
	Louisiana	2,080	125,646	127,725	5,362	246	2,125	1,683	1,313
	Texas	4,840	12,585	17,425	1,920	69	715	573	354
	GULF TOTAL	78,858	160,958	239,816	20,552	776	9,635	5,988	6,267
1940	Florida, West	5,052	4,174	54,676	8,902[2]	199[2]	3,505[2]	2,597[2]	2,967[2]
	Alabama	4,462	6,882	11,344	1,134	41	517	379	534
	Mississippi	25,678	12,324	38,002	1,877	243	2,962	389	238
	Louisiana	914	125,713	126,627	4,858	288	2,449	1,490	1,173
	Texas	3,037	16,332	19,369	1,538	69	715	475	185
	GULF TOTAL	39,143	165,425	250,018	18,309	840	10,148	5,330	5,097
1945	Florida, West	63,551	5,771	69,322	8,902[2]	199[2]	3,505[2]	2,597[2]	2,967[2]
	Alabama	6,884	8,252	15,136	1,167	66	906	375	434
	Mississippi	58,288	12,499	70,787	1,669	215	2,701	602	127
	Louisiana	3,434	160,468	163,902	6,253	486	5,933	1,779	2,600
	Texas	5,153	16,780	21,933	1,635	203	2,215	427	265
	GULF TOTAL	137,310	203,770	341,080	19,626	1,169	15,260	5,780	6,393
1950	Florida, West	45,989	16,024	62,013	7,352	674	8,726	996	3,145
	Alabama	3,313	7,675	10,988	1,300	86	1,355	508	256
	Mississippi	70,130	14,008	84,138	2,594	321	5,357	690	163
	Louisiana	216,143	100,107	316,250	8,206	882	12,267	2,245	1,382
	Texas	50,926	46,326	97,251	4,315	741	15,176	931	255
	GULF TOTAL	386,501	184,140	570,641	23,767	2,704	42,881	5,370	5,201

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.
2) Total for both east and west coasts of Florida.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1951	Florida, West	–	–	88,271	–	–	–	–	–
	Alabama	–	–	13,643	–	–	–	–	–
	Mississippi	–	–	134,830	–	–	–	–	–
	Louisiana	220,778[3]	103,005[3]	323,738[3]	–	–	–	–	–
	Texas	–	–	98,290	–	–	–	–	–
	GULF TOTAL	428,829	220,839	649,668					
1952	Florida, West	–	–	101,135	–	–	–	–	–
	Alabama	–	–	13,506	–	–	–	–	–
	Mississippi	–	–	137,485	–	–	–	–	–
	Louisiana	292,405[3]	102,029[3]	394,734[3]	–	–	–	–	–
	Texas	–	–	122,725	–	–	–	–	–
	GULF TOTAL	532,623	226,884	759,507	–	–	–	–	–
1953	Florida, West	50,249	57,778	108,027	6,426	600	–	678	2,047
	Alabama	3,621	8,343	11,964	1,412	134	–	412	350
	Mississippi	67,493	10,247	77,740	2,674	404	–	393	157
	Louisiana	314,411	105,318	419,729	7,294	777	–	2,204	964
	Texas	70,020	1,514	141,962	4,595	851	–	820	411
	GULF TOTAL	505,794	253,628	759,422	21,359	2,359	47,476	4,507	3,929
1954	Florida, West	47,079	50,442	97,521	8,024	952	–	2,120	1,181
	Alabama	4,287	7,937	12,224	1,243	124	–	512	198
	Mississippi	106,250	10,494	116,744	1,943	288	–	554	194
	Louisiana	276,594	100,006	376,600	7,494	866	–	2,751	170
	Texas	57,269	94,343	151,612	5,696	995	–	1,251	252
	GULF TOTAL	491,479	263,222	754,701	23,498	2,948	60,917	7,188	1,992

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.
3) Fish and Shellfish data for 1951 & 1952 were furnished by the State of Louisiana, hence, Gulf total may not tally.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1955	Florida, West	49,827	55,929	105,756	8,094	1,107		2,087	903
	Alabama	3,571	9,870	13,441	1,297	139		465	194
	Mississippi	166,019	17,118	183,137	2,084	319		506	215
	Louisiana	303,942	93,261	397,203	7,419	884		2,702	107
	Texas	57,680	72,421	130,101	4,601	872		1,035	122
	GULF TOTAL	581,039	248,599	829,638	22,821	3,081	65,937	6,795	1,541
1956	Florida, West	50,973	56,621	107,594	8,483	1,050		2,682	1,059
	Alabama	3,158	9,162	12,320	1,269	158		469	187
	Mississippi	219,197	13,743	232,940	2,799	552		521	173
	Louisiana	327,444	81,216	408,660	7,716	1,004		2,609	27
	Texas	71,943	66,317	138,260	4,761	990		1,106	55
	GULF TOTAL	672,715	227,059	899,774	23,318	3,092	67,267	7,387	1,501
1957	Florida, West	57,291	51,984	109,275	8,070	1,126		2,437	739
	Alabama	3,100	8,788	11,888	1,209	177		453	194
	Mississippi	194,811	12,849	207,660	3,100	555		522	163
	Louisiana	168,651	54,149	222,800	7,444	946		2,437	37
	Texas	62,327	77,983	140,310	5,360	1,300		754	58
	GULF TOTAL	486,180	205,753	691,933	22,591	3,201	73,445	6,603	1,191
1958	Florida, West	68,407	58,178	126,585	7,502	1,194		2,219	719
	Alabama	3,395	6,948	10,343	1,268	206		445	169
	Mississippi	196,623	9,199	205,822	3,094	558		563	122
	Louisiana	257,163	59,887	317,050	8,330	1,214		2,719	73
	Texas	73,197	75,840	149,037	6,375	1,672		811	39
	GULF TOTAL	598,785	210,052	808,837	22,294	3,507	82,627	6,757	1,122

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	OPERATING UNITS[1] NO.[1] FISHERMEN	VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1959	Florida, West	81,267	50,620	131,887	7,748	1,748		2,908	453
	Alabama	4,016	10,006	14,022	1,377	234		486	161
	Mississippi	238,281	14,666	252,947	3,032	558		624	158
	Louisiana	468,230	77,528	545,758	8,784	1,362		2,733	64
	Texas	123,164	87,173	210,337	6,068	1,628		747	12
	GULF TOTAL	914,958	239,993	1,154,951	22,955	3,678	88,774	7,468	818
1960	Florida, West	67,815	67,720	135,535	7,613	1,111		3,001	402
	Alabama	3,268	8,838	12,106	1,448	234		502	154
	Mississippi	297,975	16,239	314,214	2,987	505		937	153
	Louisiana	485,011	81,400	566,411	9,379	1,415		3,292	65
	Texas	151,203	86,481	237,684	5,929	1,591		765	13
	GULF TOTAL	1,005,272	260,678	1,265,950	23,077	3,429	145,952	8,285	787
1961	Florida, West	66,231	59,148	125,379	7,389	1,141		2,946	229
	Alabama	3,582	4,876	8,458	1,439	200		525	176
	Mississippi	381,528	10,161	391,689	3,080	567		998	147
	Louisiana	593,591	54,743	648,334	8,417	1,131		3,563	60
	Texas	140,501	62,751	203,252	5,845	1,594		791	28
	GULF TOTAL	1,185,433	191,679	1,377,112	22,244	3,267	140,456	8,571	640
1962	Florida, West	68,600	51,007	119,607	7,874	1,116		3,361	222
	Alabama	4,253	4,828	9,081	1,375	183		545	119
	Mississippi	360,988	9,086	370,074	3,196	554		1,013	123
	Louisiana	702,062	64,478	766,540	8,613	1,117		3,796	130
	Texas	110,248	61,860	172,108	5,332	1,324		1,168	45
	GULF TOTAL	1,246,151	191,259	1,437,410	26,390	3,219	137,368	9,639	638

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	OPERATING UNITS[1] NO.[1] FISHERMEN	VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1963	Florida, West	68,500	56,183	124,683	7,835	1,148		3,072	224
	Alabama	4,832	10,056	14,888	1,791	268		632	117
	Mississippi	326,143	15,170	341,313	3,121	593		1,940	129
	Louisiana	650,672	101,612	752,284	10,205	1,498		4,212	114
	Texas	90,476	75,868	166,344	6,005	1,419		1,276	42
	GULF TOTAL	1,140,623	258,889	1,399,512	24,483	3,369	142,809	9,992	626
1964	Florida, West	69,040	60,619	129,659	8,584	1,278		3,391	187
	Alabama	5,081	9,986	15,067	1,733	251		564	113
	Mississippi	319,365	12,533	331,898	3,068	585		899	120
	Louisiana	618,080	78,060	696,140	10,407	1,602		4,289	128
	Texas	73,152	71,918	145,070	5,997	1,479		1,056	47
	GULF TOTAL	1,084,718	233,116	1,317,834	25,171	3,582	151,665	10,149	595
1965	Florida, West	69,854	66,452	135,866	8,342	1,255		3,307	114
	Alabama	5,854	11,935	17,789	1,854	316		552	107
	Mississippi	355,763	12,622	368,385	2,874	552		972	52
	Louisiana	704,845	82,242	787,087	10,556	1,585		4,495	144
	Texas	68,839	85,509	154,348	6,210	1,499		1,228	36
	GULF TOTAL	1,204,715	258,760	1,463,475	25,571	3,683	162,820	10,536	453
1966	Florida, West	71,696	54,279	125,975	7,997	1,279		3,079	65
	Alabama	6,459	14,103	20,562	2,084	389		583	95
	Mississippi	258,603	11,250	269,853	2,987	568		1,973	41
	Louisiana	580,315	76,519	656,834	10,523	1,616		4,506	38
	Texas	45,512	77,432	122,944	6,273	1,552		1,245	43
	GULF TOTAL	962,585	233,583	1,196,168	25,309	3,782	177,124	10,366	282

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1967	Florida, West	68,224	46,184	114,408	7,788	1,277		3,143	26
	Alabama	7,511	18,901	26,412	2,130	418		566	99
	Mississippi	247,632	14,427	262,059	3,140	545		1,197	34
	Louisiana	547,255	92,420	639,675	11,062	1,698		4,626	40
	Texas	29,162	109,065	138,227	6,741	1,794		1,073	49
	GULF TOTAL	899,784	280,997	1,180,781	25,923	3,968	200,916	10,600	248
1968	Florida, West	71,750	47,543	119,293	7,319	1,394		2,606	38
	Alabama	8,010	18,650	26,660	2,195	480		561	82
	Mississippi	225,539	15,113	240,652	3,306	665		1,249	16
	Louisiana	662,220	93,749	755,969	11,000	1,734		4,520	40
	Texas	56,989	90,732	147,721	6,989	1,903		1,219	46
	GULF TOTAL	1,024,508	265,787	1,290,925	25,470	4,237	226,255	10,131	222
1969	Florida, West	70,319	46,206	116,525	7,223	1,299	64,268	2,685	28
	Alabama	11,131	17,384	28,515	2,290	520	28,233	570	93
	Mississippi	294,860	12,076	306,936	2,900	551	30,370	1,199	12
	Louisiana	896,231	106,929	1,003,160	10,929	1,766	107,224	4,837	52
	Texas	78,561	80,809	159,370	6,681	1,917	120,717	953	50
	GULF TOTAL	1,351,102	263,404	1,614,506	25,048	4,316	234,993	10,222	235
1970	Florida, West	61,830	54,659	116,489	6,933	1,209	58,852	2,599	18
	Alabama	12,895	16,725	29,620	2,042	461	25,615	609	84
	Mississippi	210,634	12,392	223,026	2,848	536	29,762	996	1
	Louisiana	995,946	111,306	1,107,252	11,228	1,956	122,282	4,341	40
	Texas	48,459	98,537	146,996	6,311	1,819	116,994	845	22
	GULF TOTAL	1,329,763	293,618	1,623,381	29,362	5,981	353,505	9,390	165

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 1 (cont)
FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1971	Florida, West	63,204	44,282	107,486	6,798	1,189	59,881	2,517	10
	Alabama	15,136	19,101	34,237	1,958	470	27,185	598	82
	Mississippi	384,467	12,436	396,903	2,657	443	27,623	1,022	3
	Louisiana	1,273,944	116,888	1,390,832	11,088	1,808	125,414	4,426	36
	Texas	69,715	97,468	167,183	7,076	2,046	135,689	881	10
	GULF TOTAL	1,806,465	290,641	2,096,641	24,810	4,315	253,863	9,410	141
1972	Florida, West	63,966	44,235	108,201					
	Alabama	15,768	20,274	36,042					
	Mississippi	245,948	10,724	256,672					
	Louisiana	962,719	109,536	1,072,255					
	Texas	6,756	107,982	114,738					
	GULF TOTAL	(Prelim) 1,295,157	292,751	1,587,908	NA	NA	NA	NA	NA
1973	Florida, West	64,801	44,399	109,200					
	Alabama	22,026	14,723	36,749					
	Mississippi	261,002	6,692	267,694					
	Louisiana	936,003	99,956	1,035,959					
	Texas	7,341	90,528	97,869					
	GULF TOTAL	(Prelim) 1,291,173	256,298	1,547,471	NA	NA	NA	NA	NA
1974									

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, and C.F.S. No. 6400, March 1974.

Fishery Statistics of the United States, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

Figure 4

CATCH OF FISH AND SHELLFISH

1939–1973

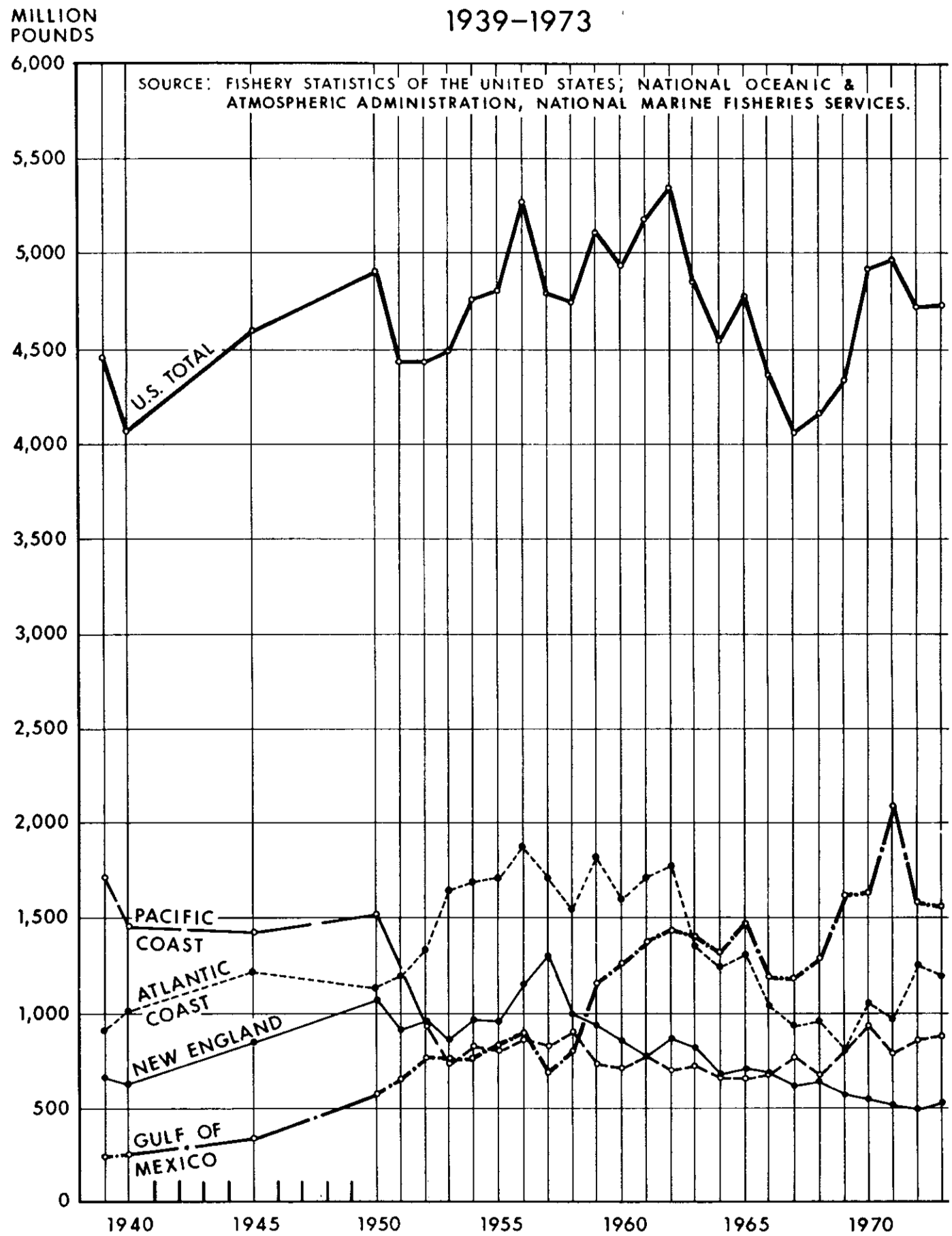
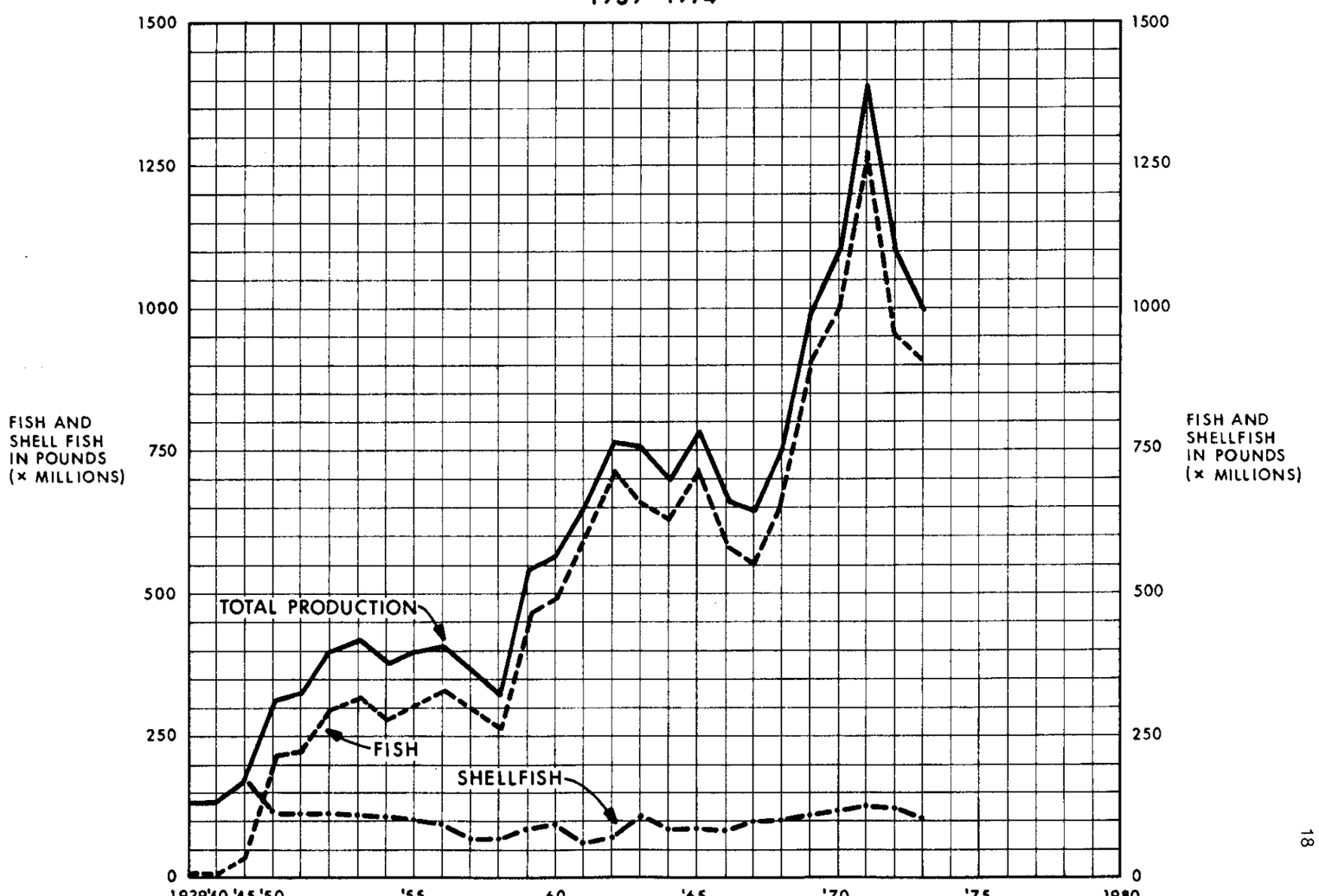


Figure 5
FISHERY STATISTICS
FOR LOUISIANA
1939—1974



OYSTERS

The only oyster species harvested from Gulf waters commercially is the common Virginian oyster, *Crassostrea virginica*. The prime production centers for this oyster are widely separated, the Louisiana coast and Chesapeake Bay. This species probably constitutes the greatest mass of any mollusc on the Gulf coast. Buried reef masses are quite extensive as deep as 30 feet. Although less abundant at greater depths, they are known to extend to 80 feet. Carbon dating has shown that all beds at depths of about 30 feet are about 6,000 years old, which corresponds with an apparent rapid rise in sea level about the same time. From that time on oysters have flourished.

The importance of salinity to the distribution of marine organisms is well illustrated by the oyster. Although this animal will apparently live and reproduce at sea water salinities, it grows, lives, and reproduces best under estuarine conditions, at salinities from about 10 to 30 ppt (seawater is 30-35 ppt). Oyster larvae move into and maintain themselves in the bays by dropping to the bottom during the falling tide and swimming upward with the rising tide.[12] Thus, larvae appear to select the salinities at which the species will do best. The distribution of three Gulf coast oyster species from the mouths of bays to far inland in the estuarine waters is in a sense foreshortened on oil well platforms in the open Gulf some miles offshore.[1] The surface waters are of low salinity, and the oyster grows here on the templets of the platforms. At lower levels, in water of oceanic salinity, oysters not associated with estuaries may be found.

The Louisiana seed oyster reefs east of the Mississippi are probably the best in the United States. They have been in use for more than a century, and have been dredged annually for seed oysters for more than 50 years. The annual removal supplies seed for hundreds of oyster leases both east and west of the Mississippi River. Production of these seed reefs was studied more than 20 years ago, and the present condition compares favorably with that of the early study period.

The production and harvest of oysters in the Gulf of Mexico from the late 1800's to the present has shown remarkable stability throughout the production areas. (Figure 5) However, within the past 20 years some significant changes in oyster culture have occurred, due largely to widespread environmental alterations. Prior to 1950, it was possible to work oysters year-round, from shallow to deep water. Recently, major silting and salinity problems have arisen in slack water and oysters must be moved more frequently in order to maintain production.

Many of these problems are related to changes in fresh water movement throughout growing areas, the result of levees, pipelines, oil well locations, and navigational channels. Further, the quality of oysters is less than it was 30 or 40 years ago. Oysters generally cannot be grown to "extra select" size due to predation and disease, phenoma often associated with increased salinity.[12]

In general, oysters are marketed at about 2 years of age. Spawning normally occurs during spring months. The fertilized eggs, hatching into larvae in less than 12 hours, attach to some solid substrate; rock, piling, surface of another shell, etc., or are lost. Shells and other surfaces covered with oil and greasy materials in polluted areas are not suitable for the attachment of larvae.[12]

Oysters are dredged at about 14 months (2½ - 3 inches) and moved to a growing area for about 6 months. The harvesting season generally runs from January through March.

Statistics, although indicative, cannot be considered an entirely reliable index of gross oyster production in coastal Louisiana waters. All indications are, however, that production in this area has been fairly consistent since 1938, the year of the first offshore petroleum well. The 1968 oyster harvest of 13.1 million pounds, valued at $5.3 million, was exceeded only by the 1939 catch of 13.5 million pounds. The lower harvest of 9.1 million pounds in 1969 resulted from extensive damage inflicted on the oyster industry by hurricane Camille in August 1969,[14] an influence which carried over into 1970. (Table 2, Production areas on the Louisiana coast are shown in (Figure 6).

Table 2
OYSTER HARVEST IN THE GULF STATES[1])
VARIOUS YEARS, 1880-1973
(In Thousands of Pounds)

YEARS	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	270	327	62	1,189	325	2,173
1890	1,611	1,506	2,008	3,392	2,133	10,658
1902	3,057	1,088	5,989	4,830	1,661	16,624
1911	1,140	1,162	1,621	12,419	1,766	18,108
1923	1,053	730	4,224	4,119	1,742	11,868
1930	1,501	287	4,896	4,846	1,157	12,688
1931	1,406	769	3,438	3,590	982	10,185
1932	1,109	859	5,222	2,978	981	11,149
1934	1,357	392	4,904	5,592	1,312	13,556
1936	917	992	5,771	5,743	823	14,246
1937	817	1,235	12,894	8,048	1,190	24,184
1938	858	1,359	2,241	10,222	1,356	16,036
1939	742	1,358	7,706	13,586	987	24,380
1940	669	936	2,270	12,412	1,297	17,584
1945	1,496	1,606	265	9,884	719	13,970
1950	873	2,070	508	8,715	125	12,292
1951	681	2,191	28	8,164	456	11,519
1952	542	1,842	23	11,402	828	14,637
1953	564	1,450	318	9,435	1,068	12,835
1954	668	739	976	8,361	699	11,444
1955	630	1,581	1,731	9,396	543	13,881
1956	856	770	846	10,056	986	13,514
1957	710	1,291	862	10,489	953	14,306
1958	795	458	579	8,265	311	10,407
1959	1,415	895	333	9,667	1,411	13,721
1960	1,931	1,169	2,391	8,311	2,296	16,098
1961	3,255	509	3,241	10,139	1,096	18,240
1962	4,952	443	3,073	10,160	1,210	18,838
1963	4,282	995	4,679	11,563	2,618	24,138
1964	2,793	1,005	4,829	11,401	3,357	23,385
1965	2,789	492	2,695	8,343	4,836	19,155
1966	4,157	1,304	2,232	4,764	4,725	17,183
1967	4,578	2,087	3,786	7,742	3,553	21,747
1968	5,317	1,212	3,786	13,121	3,302	26,738
1969[2)]	4,912	481	1,430	9,178	3,764	19,765
1970	3,573	279	548	8,639	4,675	17,714
1971	3,529	250	1,215	10,528	4,744	20,266
1972(Prelim)	3,288	1,064	1,265	8,417	3,857	17,891
1973 (Prelim)	2,409	590	611	8,954	2,348	14,912

(1) Source: Historical Catch Statistics (Shellfish)
USD1 Fish and Wildlife Service Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969. Statistics for 1968 are from the State Landings published annually by each respective state.

(2) Data for 1969 & 1973 from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Oysters are reported in weights of total meats.

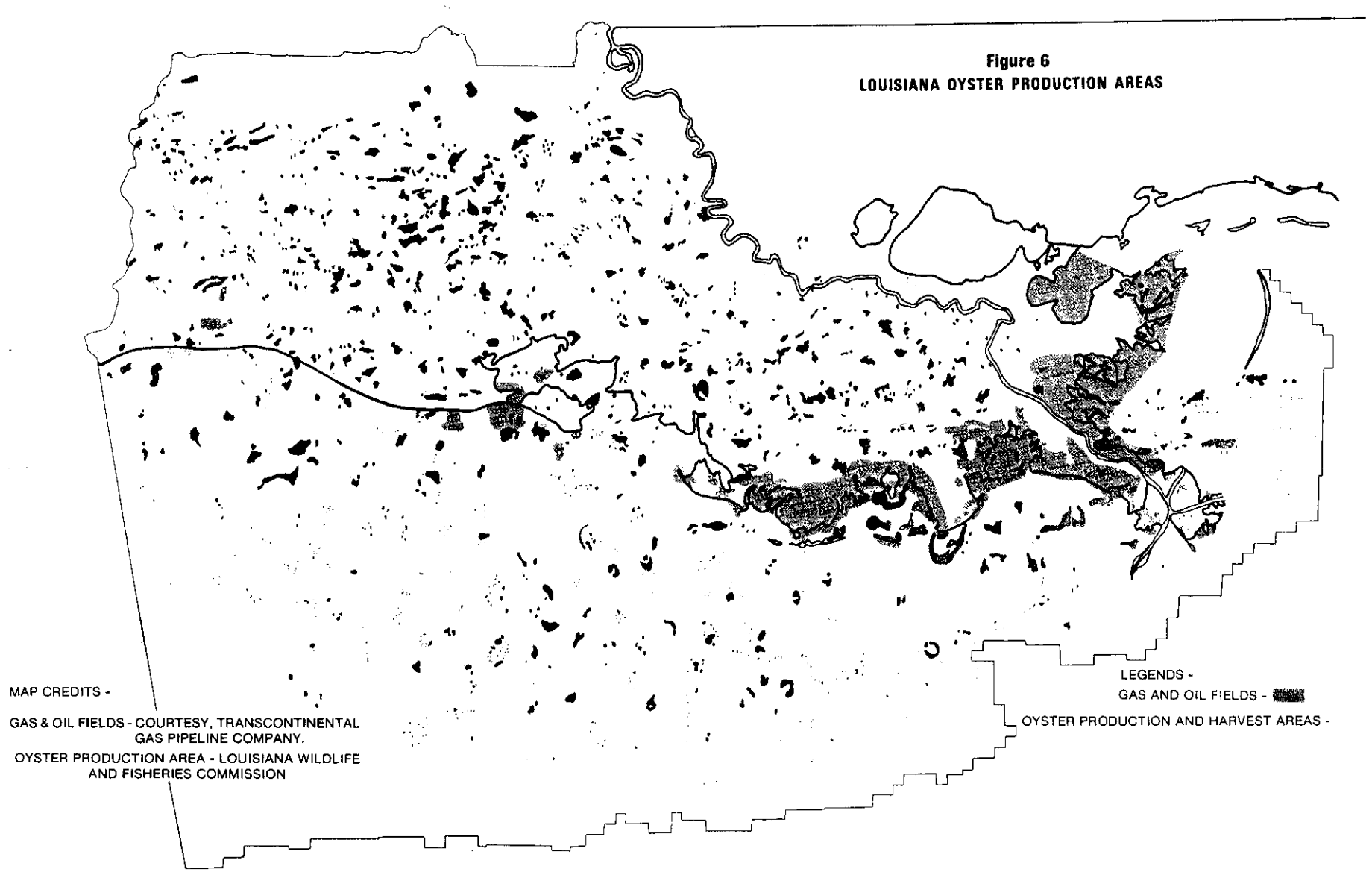


Figure 6
LOUISIANA OYSTER PRODUCTION AREAS

SHRIMP

The Gulf of Mexico shrimp fishery is dominated by three species: Brown shrimp *(Penaeus aztecus)*, White shrimp *(P. setiferus)*, and Pink shrimp *(P. duorarum)*. These constitute the highest value resource harvested in Gulf waters. Shrimp are biologically short-lived — probably not more than 1.5 years — and are capable of high rates of reproduction and rapid growth. Annual population densities are largely dependent on the hatching of up to one million eggs per female and survival of a large number of young. All three species spawn in offshore waters from early spring to late fall at depths ranging from 90 to 240 feet, depending on the species. Fertilized eggs develop rapidly into larvae and juveniles which are carried by currents shoreward into the extensive shallow estuaries, bays, and coastal wetlands. The larvae and juveniles inhabit this inshore region for a period probably not exceeding half a year. Their growth rate at this stage is prodigious. Following this, sub-adults return to more saline waters offshore to complete the life cycle.[15]

In 1950, shrimp were produced along 1,500 miles of Gulf of Mexico coastline — from Key West, Florida, to Brownsville, Texas. (Figure 7) The decline in shrimp production in northern Gulf of Mexico waters in the late 1950's and early 1960's, due in part to hurricane Audrey in June 1957 and hurricane Carla in September 1961, resulted in a great impetus in shrimp research by State and Federal agencies. Since then, based in part on implementation of research findings from the Louisiana Wildlife and Fisheries Commission and the Bureau of Commercial Fisheries (now National Marine Fisheries Service), the production of shrimp has increased in these waters and attained stable conditions in recent years.[14]

Data for all Gulf states indicates substantial stability in the shrimp resource since about 1940, with some remarkably productive years in the mid-50's corresponding with a period of accelerated petroleum activity in the Gulf. (Table 3)

Coincidental with the development of the petroleum industry in estuarine areas of the Gulf, a conspicuous change in population densities of brown and white shrimp occurred. Of the three major species, brown shrimp have dominated the shrimp industry in recent years in pounds landed. The fishery is relatively new, not beginning until the end of World War II. Prior to that, principal landings were of white shrimp (95% of total shrimp harvest), and although brown shrimp were abundant, marketing was difficult because of their darker color. The precise cause of the population shift is not fully understood, but increased saltwater intrusion may have been a significant factor. Brown shrimp are less tolerant of very low salinities than white shrimp, and thus, their populations may have been enhanced by increased salinities in the estuaries which resulted from dredging and canal construction. [6]

Another aspect of the increase in the brown shrimp fishery is one of preservation of the catch. Refrigeration was at a minimum, or non-existent, prior to 1940, and as a species available largely during warm weather, little could be done to move the harvest to market in a fresh state. With refrigeration available following the war, the brown shrimp fishery gained impetus.

Table 3
SHRIMP HARVEST IN THE GULF STATES[1])
VARIOUS YEARS, 1880-1973
(In Thousands of Pounds)

YEAR	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	1,172	–	–	534	638	–
1890	–	–	614	6,662	176	7,452
1897	–	41	1,903	4,487	361	6,792
1902	17	<1	4,424	7,635	291	12,367
1918	3,250	12,661	9,147	18,520	164	32,347
1923	2,881	3,182	9,879	27,753	3,422	47,117
1930	1,589	2,982	8,489	38,664	10,189	61,913
1931	1,803	2,475	17,716	35,148	13,814	70,956
1932	1,068	3,382	14,010	38,096	9,244	65,800
1934	1,539	4,557	15,330	55,572	16,359	93,357
1936	1,789	1,869	17,493	53,430	9,962	84,543
1937	1,490	3,104	33,558	68,781	16,905	113,838
1938	1,296	3,644	9,902	81,379	16,365	112,586
1939	800	2,124	5,676	100,612	11,173	120,385
1940	942	4,565	8,566	98,986	14,779	127,838
1945	1,783	4,439	6,595	116,904	15,722	145,443
1950	13,639	5,007	9,460	77,835	45,812	151,753
1951	29,756	6,356	7,475	85,718	64,346	193,651
1952	37,130	6,208	6,800	83,104	65,026	198,268
1953	52,804	5,806	8,517	86,941	70,435	224,503
1954	45,800	6,226	8,261	83,608	93,258	237,153
1955	48,598	6,676	13,617	71,994	71,517	212,402
1956	49,115	7,668	10,912	60,792	65,134	193,621
1957	41,921	6,035	9,569	34,103	76,825	168,453
1958	45,606	5,308	6,476	41,008	74,956	173,354
1959	32,252	8,018	11,319	57,353	84,561	193,503
1960	44,464	7,169	11,031	61,758	81,303	205,725
1961	36,069	3,525	4,408	31,027	58,766	133,795
1962	32,146	3,748	6,104	43,585	56,143	141,726
1963	34,941	7,760	9,375	80,809	70,231	203,116
1964	39,966	7,215	6,416	59,382	66,053	179,032
1965	37,759	9,624	8,233	62,593	77,028	195,237
1966	28,879	10,608	7,560	62,276	69,907	197,230
1967	23,449	14,456	9,625	75,325	102,876	225,731
1968	27,277	15,450	10,189	67,769	83,336	204,021
1969[2)]	22,964	14,976	8,906	82,888	70,695	200,429
1970	26,564	15,031	9,604	90,948	88,327	230,474
1971	21,622	16,709	9,469	92,379	86,904	227,083
1972 (Prelim)	22,770	17,542	7,791	83,000	97,385	228,488
1973 (Prelim)	26,137	12,019	3,605	58,641	81,720	182,122

(1) Source: Historical Catch Statistics (Shellfish)
USD1 Fish and Wildlife Service,
Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969.

(2) Data for 1969-1973 are from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Shrimp are reported in round weight (heads-on).

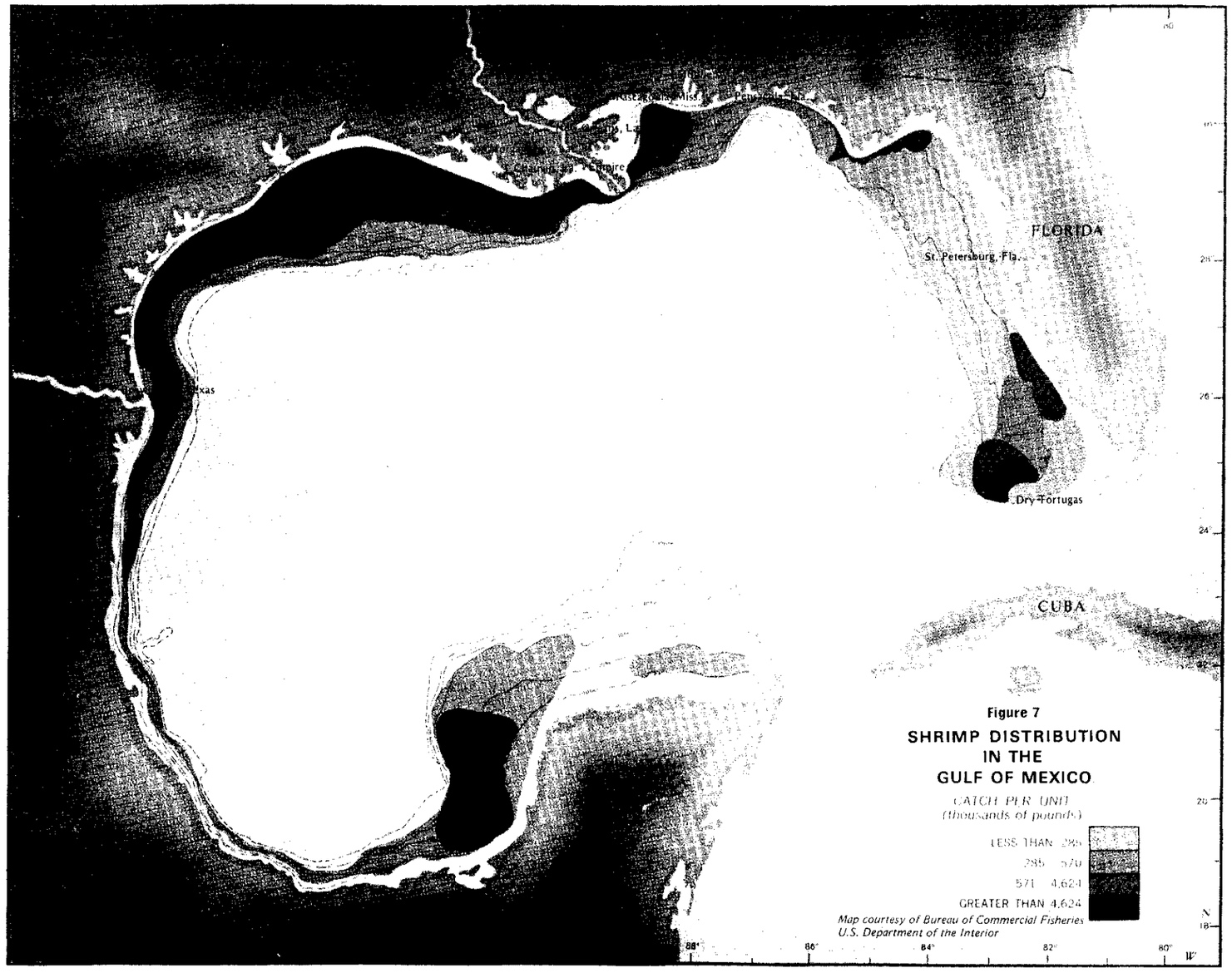


Figure 7

SHRIMP DISTRIBUTION IN THE GULF OF MEXICO

CATCH PER UNIT (thousands of pounds)

Map courtesy of Bureau of Commercial Fisheries U.S. Department of the Interior

Brown Shrimp

Brown shrimp are widely distributed over the Continental Shelf in the Gulf of Mexico; however, the fishery centers in the northwestern Gulf of Mexico. Largest commercial catches occur on sand and mud bottoms off Texas (Figure 8). Small quantities are taken along the entire coast from northern Florida to the Yucatan Peninsula in Mexico.

Although the species is caught over a relatively wide depth range, the best catches are made between 11 and 20 fathoms (approximately 60% of the total harvest). The species supports a summer and early fall fishery, with 80% of the landings made from June to October. In general, 80% of the brown shrimp landings occur offshore, with the harvest in bays and estuaries comprising the balance. [15]

White Shrimp

White shrimp are distributed generally throughout the same geographical range in the Gulf of Mexico as brown shrimp. However, the fishery is centered off the Louisiana coast on mud and sand bottoms (Figure 9).

The largest catches of the species are made in daylight since white shrimp do not burrow into the bottom during the day. They may occasionally be taken at night along with brown shrimp, especially during the spring and fall. Among the three species landed in recent years, white shrimp ranks second in pounds, although for many years this species supported the entire Gulf of Mexico shrimp fishery. Prior to the mid-1930's it was entirely an inshore fishery, but as markets developed, the fishery moved offshore and developed to a peak during the mid-1940's.

In the offshore fishery, almost 90% of the landings come from waters of less than 10 fathoms. The species generally supports a fall fishery, with almost 80% of the landings made from September to December. Of the total harvest, approximately 58% is taken offshore, with the balance harvested from inshore waters. [15]

Pink Shrimp

Pink shrimp are distributed almost continuously throughout the Gulf of Mexico over the Continental Shelf. Consistent commercial catches are made, however, only on shell, coral sand, and coral silt bottoms of the southern Gulf of Mexico. More than 90% of the pink shrimp harvest comes from two areas, one off southern Florida and the other off the Yucatan Peninsula (Figure 10).The harvest of pink shrimp from the northern Gulf of Mexico is sporadic and irregular, although significant commercial catches are made at times.

In general, the species is caught in greatest numbers in waters deeper than white shrimp, but in a more restricted depth range than brown shrimp. About 80% of the landings are made between 11 and 20 fathoms. They support a year-round fishery, although landings decrease somewhat in late summer. 98% of the total landings come from offshore waters. [15]

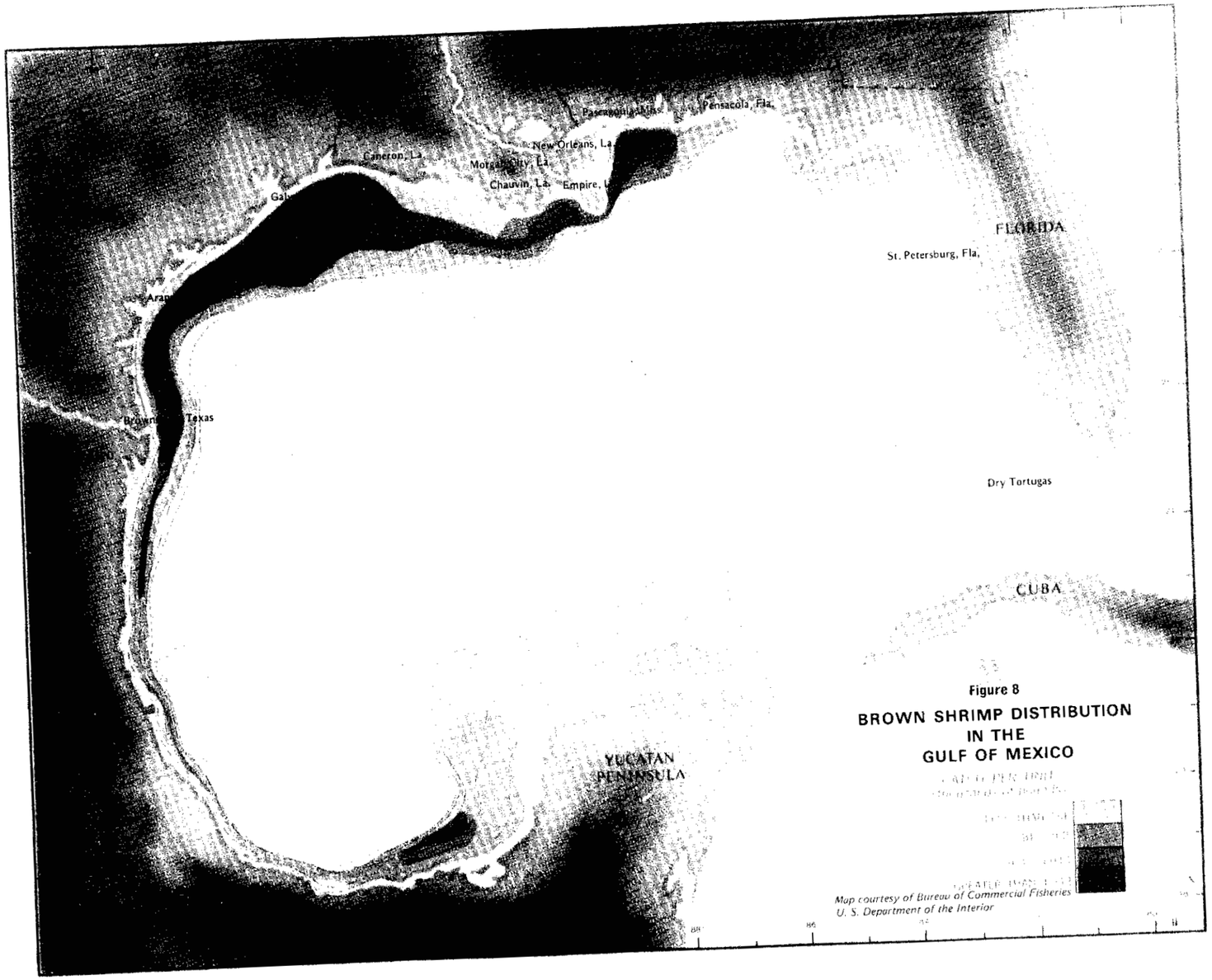


Figure 8

BROWN SHRIMP DISTRIBUTION IN THE GULF OF MEXICO

Map courtesy of Bureau of Commercial Fisheries U. S. Department of the Interior

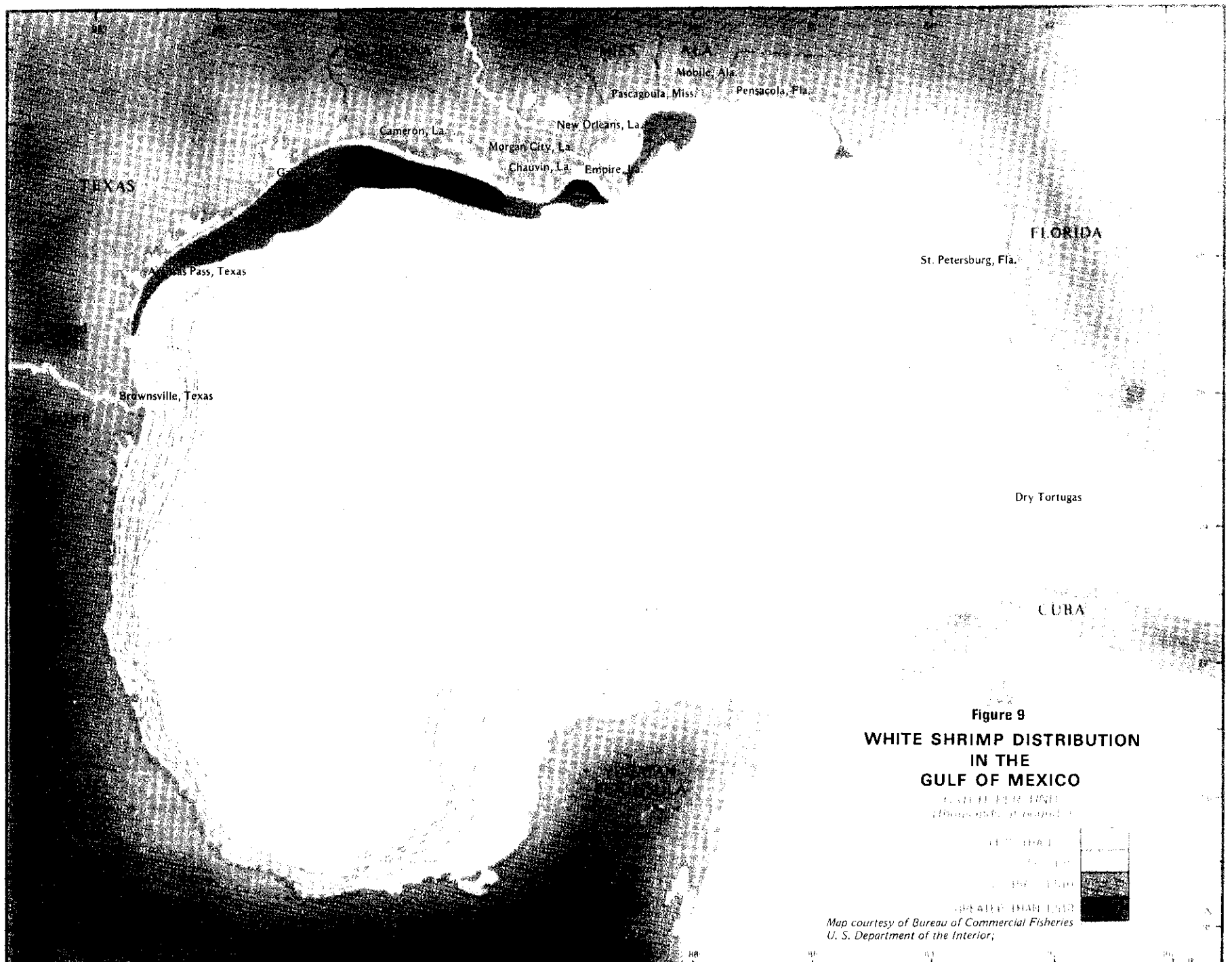


Figure 9

WHITE SHRIMP DISTRIBUTION IN THE GULF OF MEXICO

Map courtesy of Bureau of Commercial Fisheries U. S. Department of the Interior;

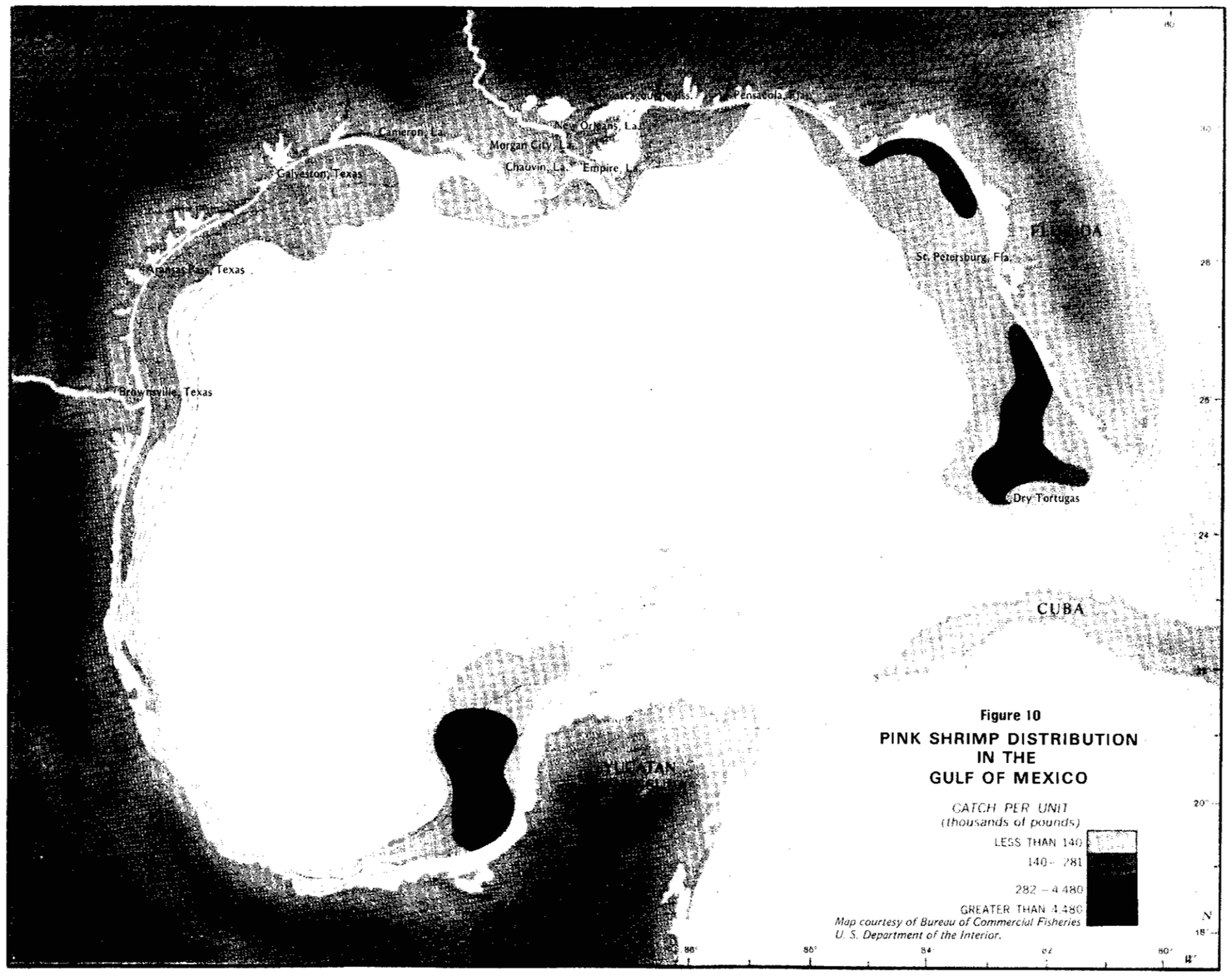


Figure 10

PINK SHRIMP DISTRIBUTION IN THE GULF OF MEXICO

Royal Red Shrimp

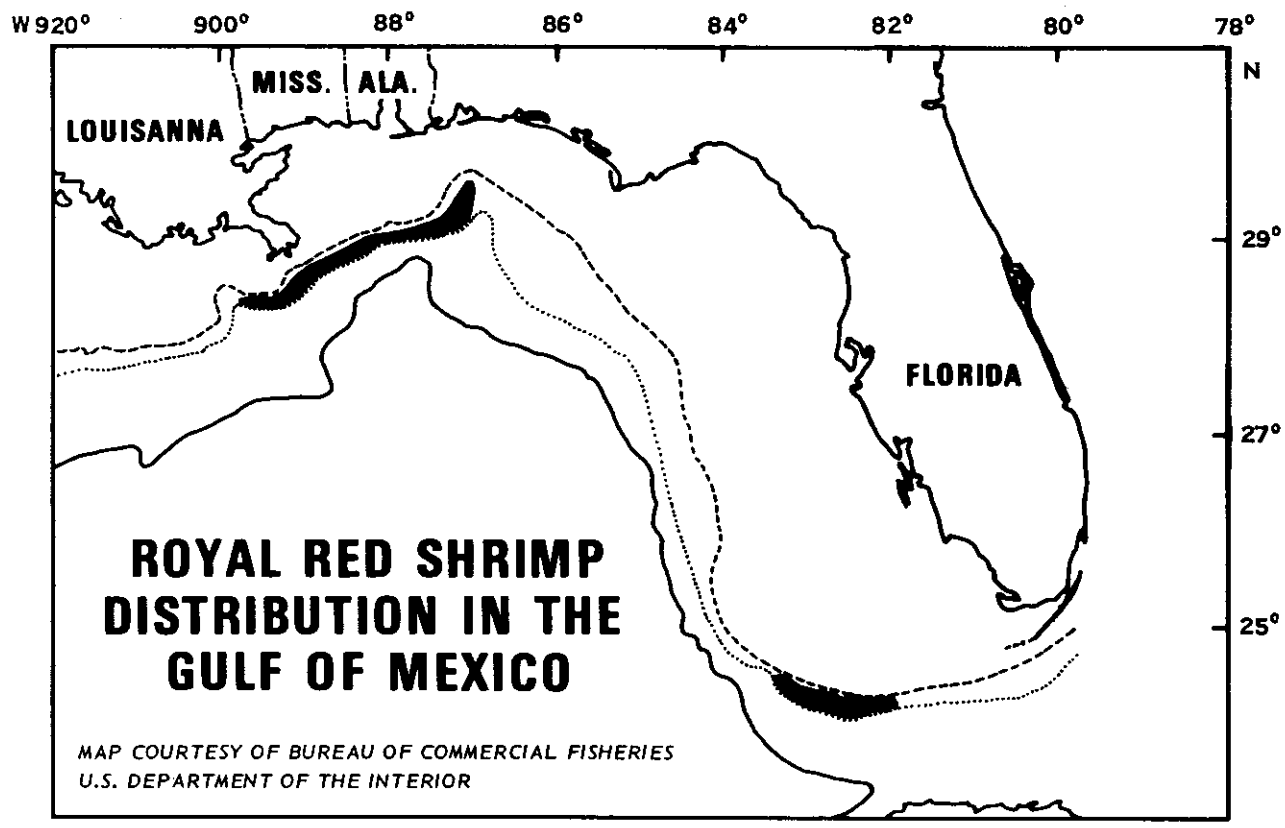
The Royal Red Shrimp *(Hymenopenaeus robustusp)* was first discovered off the mouth of the Misissippi River in July 1950. Although the "Royal Red" is a typical penaeid shrimp, it prefers deep, cold water. Little is known at present of its biology, reproduction, and early life history.

Two of the three potential royal red commercial grounds are in the Gulf of Mexico (Figure 11). The other lies off the east coast of Florida.

The Dry Tortugas grounds lie southwest of the Dry Tortugas along the Florida Straits. Shrimp are found at depths ranging from 900 to over 1800 feet deep, with highest densities at 1000 to 1500 feet. Despite the larger geographical area of the Delta grounds, shrimp are less concentrated here than on the Dry Tortugas grounds.

Because of the need for more sophisticated fishing gear, the harvest of this species has been limited. However, the harvest potential of "Royal Reds" may be substantial. [16]

Figure 11



BLUE CRAB

The Blue Crab (*Callinectes sapidus*), has been utilized for human food since prehistoric time. An estuarine species, this crab is most production in Chesapeake Bay and along the Louisiana coast.

Unlike its relative the shrimp, blue crabs are rarely found in the open sea, preferring the bays, sounds, and the mouths of rivers in waters ranging from true ocean salinity to brackish or even fresh water. The species is occasionally found in the Gulf on brackish water flats, and "sweet-water crabs" of the Atchafalaya River are taken in fresh water some 25 miles from its mouth. However, the commercial blue crab fishery is concentrated on bays and sounds where the species is most numerous. Mud bottoms are favored.

Spawning and early development occurs in moderately saline waters, from which young crabs migrate to fresher water areas and estuaries. Maturity is attained in about a year. On the Gulf coast, peak harvests occur from May through August.

Low crab landings in the 1960's were not necessarily due to decreasing supplies of crab but more directly to less effort in developing this industry. Lack of experienced crab meat pickers, and increased labor costs reduced profit margins, thereby forcing some processing plants to limit their operation. Secondly, in peak periods supply over-ran the demand with the result that fishermen were placed on quotas. Consequently, a number of fishermen transferred to the more profitable shrimp fishery. Conversely, in years of increased demand for crab, some of the smaller shrimp fishermen turned to commercial crabbing when shrimp were less available.[17] [18] With an increased stability of crab prices during recent years, the number of crab fishermen appears to have increased.

Harvest trends are shown in Table 4

Over the years, the species has been taken on hand lines and with seines. Trotlines are still used in the low salinity brackish waters of Louisiana. Generally, crab fishing has been taken over by the so-called "Virginia crab pot", a technique which should enhance the rate of capture and will have a significant bearing on crab harvests in the future.

About 2 million pounds of stone crab are harvested from the Gulf coast annually, principally from Florida, but with some production in Texas waters.

Table 4
CRAB HARVEST IN THE GULF STATES[1])
VARIOUS YEARS, 1880-1972
(In Thousands of Pounds)

YEAR	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	324	–	–	288	36	–
1890	–	–	47	981	191	1,219
1902	13	75	265	1,312	43	1,708
1908	64	246	427	322	200	1,259
1918	24	96	225	282	194	821
1923	7	84	443	316	109	959
1930	209	81	679	4,332	29	5,330
1931	124	80	459	5,106	49	5,818
1932	116	71	324	5,977	45	6,532
1934	616	259	607	12,328	258	14,068
1936	856	998	2,014	12,941	320	17,129
1937	816	757	1,437	15,046	922	18,978
1938	1,138	511	1,016	10,781	971	14,417
1939	750	558	1,469	11,443	406	14,626
1940	1,201	1,381	1,489	14,314	252	18,637
1945	1,145	2,207	5,639	33,650	339	42,980
1950	722	599	4,040	13,470	387	19,218
1951	2,139	1,109	1,630	9,060	280	14,218
1952	2,089	655	1,741	7,782	338	12,605
1953	3,263	1,087	1,412	8,619	432	14,813
1954	3,159	972	1,256	7,540	379	13,306
1955	5,206	1,613	1,770	11,392	356	20,337
1956	4,003	725	1,985	10,002	195	16,910
1957	5,545	1,462	2,417	9,110	201	18,735
1958	8,981	1,182	2,144	9,913	570	22,790
1959	14,154	1,093	3,014	10,175	1,192	29,628
1960	19,018	499	2,817	10,564	2,870	35,768
1961	17,588	838	2,512	12,530	2,877	36,345
1962	10,913	634	909	9,867	4,479	26,802
1963	13,812	1,297	1,115	8,311	2,982	27,517
1964	14,833	1,762	1,288	5,892	2,484	26,259
1965	21,264	1,812	1.693	9,488	3,622	37,879
1966	17,431	2,183	1,458	8,114	2,778	31,964
1967	14,830	2,353	1,016	7,705	2,625	28,529
1968	10,293	1,980	1,138	9,835	4,084	27,330
1969[2)]	11,584	1,920	1,740	11,602	6,343	33,189
1970	14,786	1,407	2,027	10,254	5,525	33,999
1971	12,279	1,997	1,259	12,186	5,810	33,531
1972 (Prelim)	13,000	1,581	1,360	12,432	6,557	34,930
1973 (Prelim)	11,632	2,098	1,814	22,850	6,881	45,275

(1) Source: Historical Catch Statistics (Shellfish)
USD1 Fish and Wildlife Service,
Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969.

(2) Data for 1969-1972 are from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Crabs are reported in live-weight. (1969-72 includes hard blue crabs only).

OFFSHORE SPORT FISHING

Thirty years ago sport fishing in the Gulf of Mexico was almost nonexistent, and largely was restricted to commercial fishermen and the few sport fishermen who could hire the limited number of charter boats capable of operating great distances offshore in natural fishing areas.

Today, though much of the offshore sport fishing can be attributed to the availability of fast, mass-produced small boats, increased leisure time, and greater affluence, the most significant contributor to increased fishing has been the establishment of offshore drilling platforms and the availability of millions of pounds of sport fish, previously an unknown (or nonexistent), and untapped resource. Virtually all sport fishing in offshore Louisiana waters occurs under oil platforms. As platforms have proliferated, so also have the number of fish, fishing areas, and fishermen.

Louisiana's prominence in this fishery was developing by 1946, a few years after the petroleum industry erected its first drilling rig in the Gulf — a million dollar "artificial reef". With this, and hundreds more like it, offshore sport fishing was revolutionized as fish were drawn to the "reefs" by the millions. Today these reefs serve as major concentration points for fish, and as limited fish and shellfish production sites. Salinity and predation constitute two significant factors limiting overall biomass production.

In 1950, blackfin and yellowfin tuna were known to be in the Gulf, but it was not until 1955 that these fish were taken by long-line fishing gear. Their presence was later confirmed by the Bureau of Commercial Fisheries Research Vessel OREGON, and the Louisiana Wild Life and Fisheries Commission Research Vessel ALBACORE, as were also the presence of white and blue marlin, swordfish, and sailfish. In the passing years, the presence of these giant game fish has become firmly established, and a major big game fishing center lies just 100 miles from New Orleans.

It is estimated that the annual sport fishing harvest in the Gulf exceeds 300 million pounds,[6] with black and red drum, speckled trout, flounder, and croaker the most frequently taken fish. Other salt water sport fish commonly taken are:

Amberjack	Jack Crevalle	Shark (over 7 feet)
Barracuda	Jewfish	Sheepshead
Bluefish	Mackerel, King, & Spanish	Spadefish
Bonito	Marlin, Blue & White	Speckled Trout
Catfish	Pompano	Tarpon
Cobia	Redfish	Tripletail
Dolphin	Red Snapper	Tuna, Blue and Yellowfin
Grouper	Sailfish	Wahoo

Fish taken under platforms include red snapper, croaker, grouper, cobia, red fish, trout, drum, spadefish, various jacks, blues and pompano. In open water near platforms, gamefish such as king mackerel, sailfish, marlin, and tuna are being caught with increasing regularity. Most of the fierce fighting king mackerel are caught within 200 feet of platforms, by trolling a bait down-current from boats moored to platforms.

Bottom fish such as red snapper, spadefish, and grouper were seldom taken off the Louisiana coast before the introduction of drilling because natural reefs, which these fish require, were almost nonexistent. In addition, free swimming fish such as barracuda, pompano, and amberjack, which are readily caught around platforms today, were almost never seen before the advent of the oil industry. The famous Grand Isle Spearfishing Rodeo did not exist prior to the introduction of platforms (nor could it have), and most of the fish brought in during the 43 year-old Grand Isle Tarpon Rodeo now come from beneath oil platforms.

Studies conducted in the Santa Barbara Channel by biologists of the California Department of Fish and Game from May 1958 to December 1960, revealed that drilling platforms were extremely attractive to fish, as were reefs composed of car bodies, streetcars, and cement habitats. Populations grew from a few to several thousand semi-residents under the platforms. Within 12 months (August 1959) as many as 62,000 sea perch were counted under platform "Hazel". Off Santa Barbara, kelp and scallops (food for some fish) reached a density of 533/square foot or an estimated 8 million for the entire oil platform. Deepwater towers attracted pelagic schooling fish in addition to several species of rockfish not normally associated with in-shore areas. Fish populations increased rapidly during the first year and then fluctuated according to temperature, season, or other natural factors. Encrusting organisms rapidly covered all underwater areas and by December 1960, attachment space was at a premium. The investigation indicated rather conclusively that changes brought about by establishing offshore petroleum installations generally were beneficial to flora and fauna, and wash-drilling cuttings on the sea bottom at these sites were a neutral element to the marine life in the area.[19 20]

INCREASED PRODUCTIVITY

Though it has been known by fishermen for centuries that fish collect around rocks, reefs, and shipwrecks, the reasons are still not adequately understood. The underlying purpose of current artificial reef studies is to determine whether fish simply collect or if productivity is increased. Two schools of thought exist:

1. The attraction theory simply states that if a structure is placed in a given area containing 100 fish then only 100 fish can be attracted to the structure. Hence, there is no overall increase in productivity.
2. The productivity concept suggests that the same structure may eventually support a population of fish greater than 100. In other words, the increased food supply and protection from predators allows more fish to be born and survive. Therefore, a given body of water becomes more productive.

Resolving which factor is more important has significant consequences. If the fish are simply concentrated, then all artificial reefs do, ultimately, is allow fishermen a means of depleting the population more quickly. If, on the other hand, productivity is increased, the fish are less likely to be depleted. Though the basic question is difficult to resolve scientifically, most researchers in this field believe productivity is increased by artificial reefs and offshore platforms. Either theory requires that sound conservation practices be developed and employed with regard to fish production.

Biological Tracers

A rich and varied encrusting flora and fauna, which does not and cannot live on the surrounding sea bottom thrives on offshore platforms. Since many of these organisms are sessile (cannot move), it is apparent that they did not arrive by swimming. Even the mobile sea urchins, common on oil structures, could not have migrated across the surrounding mud bottom. These organisms (which occur in all stages of maturity) are typical Caribbean reef fauna, and probably arrived as microscopic planktonic larvae. They serve as biological tracers. They would have died had it not been possible to settle and become established on some hard substrate. One can safely conclude that productivity for these organisms has certainly been increased because of oil platforms. The same holds true for the dozens of typical Caribbean tropical reef fish which inhabit oil platforms in increasing numbers. In all likelihood, these fish survive because the platforms provide a reef-like environment.

It is less reliable, however, to apply the same logic to the larger edible sports and commercial fish living under platforms. Though by analogy, it seems reasonable that most of them arrived on the scene as drifting eggs, originating hundreds of miles away, many of them may have simply moved to the platform from some natural reef, despite the fact that large numbers of platforms are located 50 to 100 miles from natural rock outcroppings or coral reefs. However, such migrations could be occurring in stages by moving from one platform to the next. Due to the difficulites involved, it seems unlikely that research presently underway will be able to resolve this basic dilemma. Nevertheless, fishing under platforms is excellent — regardless of the multitude of factors which contribute to this phenomenon and remain yet to be evaluated.

WINTERING WATERFOWL

The coastal zone of the northern Gulf of Mexico provides some of the best, if not the "premier", waterfowl wintering habitat in North America. Of this total area, the coastal marshes of Louisiana and the rice area of southwest Louisiana constitute the largest general waterfowl wintering area within the United States. However, not all of the coastal marsh zone is suitable for waterfowl. Since most waterfowl food plants are confined to fresh and brackish-water marshes, and to fresh water ponds throughout the area, waterfowl tend strongly to concentrate in these areas. There is little evidence that the more saline marshes are used by waterfowl to any extent. Throughout the coastal marsh area, food and water conditions are highly variable, and waterfowl concentrations shift frequently from one area to another. Consequently, waterfowl do not winter generally throughout the entire coastal marsh area and may be totally absent from some areas throughout the winter.

Great fluctuations in Gulf coast waterfowl habitat have marked these marshes from the beginning. Hurricanes, marsh fires, erosion, subsidence, silt deposition, animal populations, and human activities are but a few of the factors that cause constant change in the waterfowl habitat of coastal Louisiana. Levees and canals have had an adverse effect; but, nevertheless, the coastal marshes continue to demonstrate an exceptionally high carrying capacity by holding more than 2/3 of the total wintering population in the Mississippi flyway. In 1968, the Mississippi flyway contained more than 1/3 of the U. S. population of wintering waterfowl.

However, because of the continuing annual habitat loss through human and natural forces, protection and development of the remaining acreage of habitat is needed to assure the future of waterfowl. During the mid-50's, waterfowl populations built to levels higher than possibly will ever occur again. At the same time, the main wintering area experienced a drastic reduction of bottomlands through drainage, drought, clearing for agriculture, and the end-products of an unfavorable stage of plant succession. Mallards are now using harvested soybean and milo fields in the delta regions of eastern Louisiana. Other waterfowl have bypassed unsuitable areas and seem not to have suffered as a result. More recently, Hurricane Audrey in 1957, and some human activities, reversed plant succession over broad areas of the Gulf coast marshes to a stage more favorable for the maintenance of waterfowl populations. The improvement, however, was only temporary; the long-range effects of hurricanes on waterfowl habitat are decidedly detrimental.

Louisiana has nearly six million areas of waterfowl habitat, much of it along the Gulf coast. Intensified management practices, such as those at Rockefeller Refuge, have increased the carrying capacity of parts of the winter range to a point seldom experienced in the past.

National Wildlife Refuges, comprising more than half-a-million acres of land, and many state, local, and private wildlife sanctuaries, refuges, and management areas rim the northern Gulf of Mexico. Gas and oil fields and producing wells have been developed on many of the larger refuges in Louisiana and Texas. There is no evidence that waterfowl wintering in these areas have been affected adversely by this close relationship. In fact, duck numbers will continue to be largely controlled by the quantity and quality of waterfowl habitat from the reaches of northern Canada southward to their wintering grounds.

The prairie pothole region in south-central Canada and north-central United States, which comprises only 10 percent of the waterfowl breeding area of North America, produces 50-75 percent of the ducks for the entire continent. This region covers about 300,000 square miles, including Alberta, Saskatchewan, and Manitoba in Canada, and North and South Dakota and western Minnesota in the United States.[21]

This habitat was at its best in the middle fifties and declined drastically with the drought of the late fifties and early sixties. Heavy precipitation in the fall and winter of 1968 increased the pothold numbers in 1969 and 1970.

The decrease of duck breeding populations in the prairie regions of Manitoba, Saskatchewan, and Alberta was closely associated with the decrease or increase of water areas. Populations dwindle almost in direct proportion to the decline in water. Moderately favorable weather is vital to waterfowl at every stage of its development. Waterfowl can be maintained in abundance only if millions of acres of wetlands are preserved, and fluctuations in wintering populations will continue to be related to the availability of these wetlands, food in the wintering areas, and total continental populations.

Populations of waterfowl wintering in the coastal zones of the Gulf states are shown in Tables 5 & 6. The general wintering periods for waterfowl in Louisiana coastal marshes are shown in Table 7.

Table 5
WATERFOWL WINTERING POPULATION — LOUISIANA COASTAL ZONE

1956—1971

YEAR	POPULATION				
			GEESE		
	DUCKS *(Thousands)*	COOTS *(Thousands)*	CANADA	SNOW	BLUE
1956	1,538	567	11,330	35,900	409,450
1957	1,667	70	6,905	26,201	327,265
1958	2,033	163	10,505	36,800	370,700
1959	2,641	219	8,350	43,900	312,900
1960	3,351	379	8,440	55,800	414,900
1961	4,348	423	9,490	52,240	463,900
1962	4,432	458	6,521	39,340	317,400
1963	4,240	362	7,200	40,670	345,400
1964	6,640	548	5,655	68,620	359,000
1965	4,409	730	7,065	43,140	337,430
1966	4,210	718	6,807	55,700	319,020
1967	3,982	883	6,010	52,170	273,855
1968	3,738	590	1,499	50,600	297,000
1969	5,086	956	1,300	47,700	219,900
1970	4,469	742	1,100	61,800	254,100
1971	3,844	1,679	1,400	66,700	352,700

Source: Mr. R. S. Pospahala, Research Biologist, Bureau of Sport Fisheries & Wildlife, Section of Migratory Game Bird Studies.

Table 6
COMBINED GULF COAST WINTERING WATERFOWL POPULATIONS FROM 1956 TO 1971

YEAR	DUCKS, COOTS AND CANADA, BLUE & SNOW GEESE	LOUISIANA & TEXAS ONLY	APPROXIMATE PERCENT OF TOTAL
1956	7,427,400	6,032,387	81
1957	3,926,734	2,911,357	74
1958	5,282,039	4,839,538	91
1959	5,797,831	5,366,325	92
1960	5,682,933	5,466,003	96
1961	7,247,957	7,010,357	96
1962	6,441,020	6,282,120	97
1963	6,574,313	6,293,613	96
1964	8,930,561	8,619,651	96
1965	7,109,798	6,975,145	98
1966	7,045,482	6,666,590	94
1967	7,149,628	6,850,528	95
1968	5,966,294	5,620,551	94
1969	7,696,380	7,381,880	95
1970	6,816,525	6,674,325	97
1971	8,635,540	8,404,041	97

It is evident that the preponderance of waterfowl wintering in the Gulf coastal region and most of the coastal and offshore petroleum activity are concentrated largely in the same area.

Table 7
WATERFOWL WINTERING PERIODS
LOUISIANA COASTAL MARSH REFUGES

SPECIES	DURATION	PEAK MONTHS
Ducks		
Mallard	October 15 to March 15	November - December
Pintail	September 1 to April 1	November - December
Gadwall	October to April 1	November - December
Baldpate	September 15 to April 1	November - December
Green-winged Teal	September 15 to March 15	November - December
Blue-winged Teal	August 15 to May 1	September - October
Shoveler	September 15 to April 15	October - November
Mottled Duck	Year round resident	September - October
Lesser Scaup	November 1 to February 15	December - January
Hooded Merganser	November 15 to February 15	December - January
Canvasback	November 1 to February 15	November - December
Ring-necked Duck	November 1 to February 15	November - December
Coot	October 1 to April 1	November - December
Geese		
Blue/Snow	October 1 to March 1	December
White-fronted	October 1 to March 15	November

Source: Louisiana Wildlife and Fisheries Commission

WILDLIFE REFUGES - GULF COAST

Wildlife refuges are established to provide wildlife with natural environments in which a degree of protection and maintenance can be afforded as well as habitats which are intensively manipulated for specific values. At present there are 332 units in the National Wildlife Refuge System comprising nearly 30,000,000 acres. The system includes lands administered by the Department of the Interior as wildlife refuges, wildlife ranges, game ranges, wildlife management areas and waterfowl production areas, as well as sanctuaries for fish and wildlife threatened with extinction.

Nationwide, about 250 national wildlife refuges have been created primarily as migratory waterfowl habitat, to provide for the nesting, feeding, and resting of a varied continental waterfowl population. The national network of waterfowl refuges is considerably enhanced by waterfowl areas established and operated by state game departments, municipalities and private organizations, including hunting clubs. Twenty-five national wildlife refuges border the Gulf of Mexico (Figure 12). Of these, thirteen are closely related to petroleum operations on the Texas, Louisiana, and Mississippi coasts, along with seven significant Louisiana and Texas state refuges and management areas. Three nationally renowned private refuges are similarly associated with coastal gas and oil production in these two states — Avery Island, the Rainey Refuge of the National Audubon Society, and the Welder Wildlife Foundation.

Few wildlife habitats are as productive as estuaries along sea coasts and no habitats are more subjected to destruction through dredging, filling, and pollution. Refuges on estuaries therefore are of special significance. Such national wildlife refuges on the Gulf coast include Chassahowitzka, St. Vincents, and St. Marks in Florida, Sabine, Delta, and Lacassine in Louisiana, Brazoria, Anahuac, Aransas, San Bernard, and Laguna Atascosa in Texas.

Twenty-seven wildlife species threatened with extinction are found on National Wildlife Refuges. In the Gulf coast region these include the red wolf, key deer, Florida everglade kite, southern bald eagle, whooping crane, American alligator, and the brown pelican.[23] [24]

Simultaneously with provisions for surface values such as fish, wildlife, timber, and range, refuge lands also derive support from and provide for subsurface values. In 1970, royalties on gas and oil leases accuring to the Federal Government on all refuge lands amounted to more than 1.5 million dollars. With more 150 gas and oil wells on Federal refuges in the Gulf coast region, the financial return to the Federal Government is substantial. In fact, gas and oil royalties paid more to National Wildlife Refuges during the year than did any other lessee or concessionaire, including forest product sales and grazing permit fees.[23] Royalties from the Delta National Wildlife Refuge in Louisiana constituted nearly $400,000 of this total.

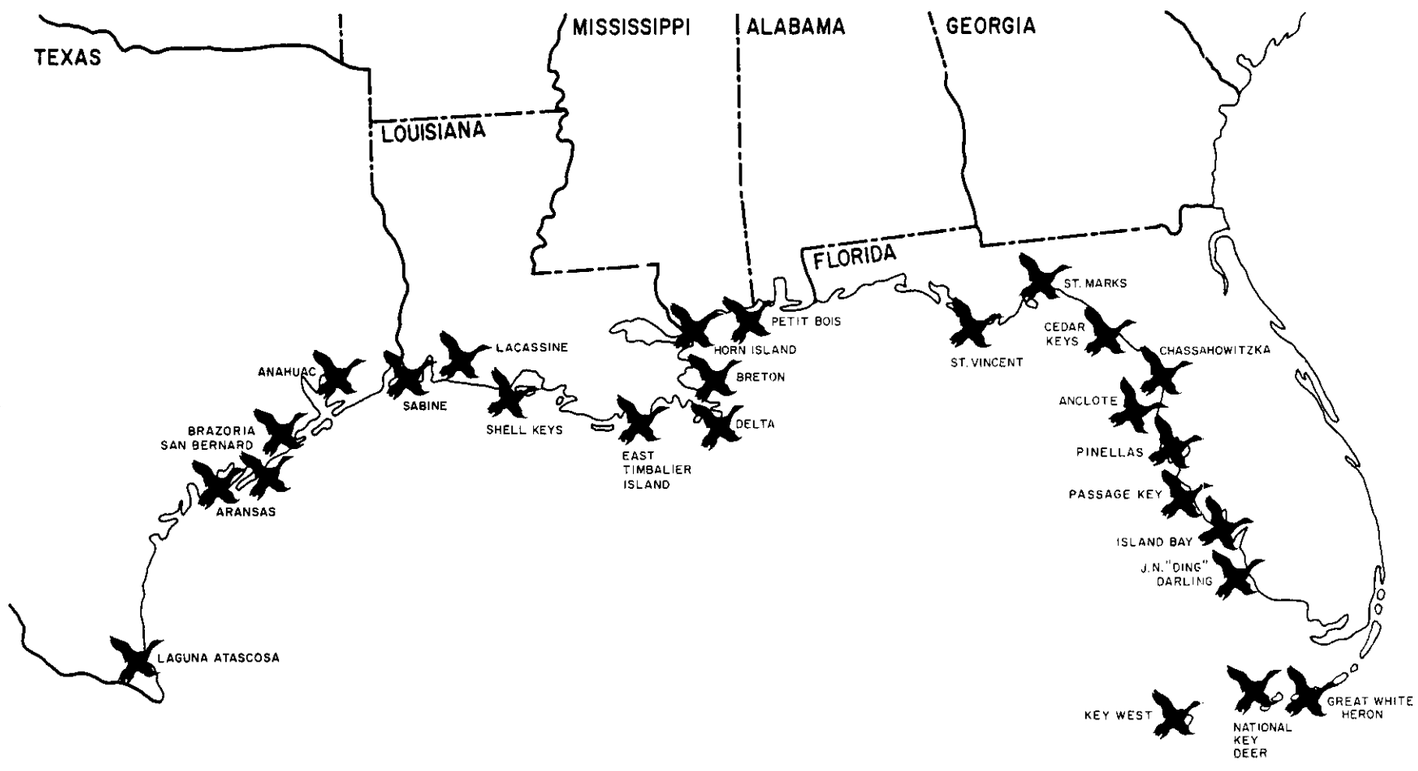


Figure 12
NATIONAL WILDLIFE REFUGES
GULF OF MEXICO

TEXAS

Anahuac National Wildlife Refuge

Anahuac, located on the southeast terminus of the central flyway, also attracts waterfowl from the southwestern limit of the Mississippi flyway, and is an important link in the chain of refuges extending southward along the Gulf coast of Texas. It consists of coastal marsh and wet prairie typical of the western fringe of the great coastal marsh that extends from the mouth of the Mississippi to the territory between the Sabine and Trinity Rivers in Southeast Texas. Consisting of nearly 10,000 acres, the refuge is managed principally for migrating and wintering waterfowl and secondarily for resident forms of wildlife. Thousands of blue-winged teal and pintails arrive on the refuge in August and September. Fulvous tree ducks formerly concentrated on fresh water ponds in the fall and moved further south before the end of November, but have been rare in recent years.

Most wintering waterfowl common to the area have arrived by the middle of November, and although 30 species have been recorded, at least 25 species can be expected to be represented each fall. Peak populations of 60,000 snow and blue geese, 1,000 Canada geese, and 2,800 white-fronted geese were reported on the refuge early in 1972.

Nearly 1,200 acres of open salt water are included in the refuge, and are utilized by common loons, eared grebes, cormorants, and white pelicans as well as wading birds such as roseate spoonbills, white ibises, white-faced ibises, wood ibises, and a variety of herons and egrets. Southern bald eagles and an occasional golden eagle have been recorded in fall and winter.

Other wildlife present on the refuge include otter, mink, muskrat, shunk, raccoon, armadillo, gray fox, bobcat, opossum, and swamp and cottontail rabbits, and the endangered Texas red wolf. The American alligator population on the refuge is increasing, and nutria are abundant.

Aransas National Wildlife Refuge

Established in 1937, about one month after petroleum exploration commenced, the refuge is famed as the ancestral home and the only known remaining wintering ground of the endangered whooping crane. Under complete protection, the species has increased from only fifteen birds in 1941 to 56 birds on the refuge during the 1971-1972 winter.

The refuge supports the endangered Attwater's prairie chicken and the American alligator, and serves as a wintering ground for a multitude of migratory waterfowl species, including Canada, blue, and snow geese, pintails, gadwalls, baldpates, mallards, and other ducks. A wide variety of shorebirds, wading birds, including the endangered roseate spoonbill, as well as egrets and herons, which are fairly common, are found also on the refuge. Sandhill cranes are also present except during summer months. Wild turkeys, whitetail deer, and peccaries, are common on the area. In total, more than 300 species of birds will be found on the refuge in various seasons, along with many native mammals.

As a result of gas and oil exploration, there are about 15 active gas wells and 15 active oil wells on the refuge. Refuge officials and representatives of the operating company have worked closely together to insure maximum protection for the wildlife and their habitat and to preserve the natural beauty of the refuge. The extensive wildlife populations on the refuge attest to the high degree of compatibility between the extraction of subsurface resources and the maintenance of surface values.

Brazoria National Wildlife Refuge

Established in 1966 and comprising more than 9,500 acres, the land area is made up of coastal marsh and prairie. Three-fourths of the refuge is less than four feet above sea level. The saltmarsh vegetation is broken in only a few areas by wind-breaking plantings of salt cedar and knolls created by spoil from the Intracoastal Waterway. The refuge was created to provide protection and quality habitat for wintering waterfowl, other migratory birds, and wildlife species, including the endangered Texas red wolf, and the American alligator.

Species nesting on the refuge include the pied-billed grebe, least bittern, willet, black-necked stilt, Wilson's plover, king, black and clapper rails, common and purple gallinules, mottled duck and blue-winged teal. White pelicans are common except during the spring. Great blue herons, black-crowned night herons, common and snowy egrets and Louisiana herons are common year round. Wood, white-faced, and white ibis and roseate spoonbills are fairly common in summer. In total, 253 species of birds have been recorded on the refuge, which is one of three areas in the country where all six of the secretive rails (clapper, king, yellow, virginia, black, and sora) can be found regularly.

Two gas wells were established on the refuge prior to acquisition.

San Bernard National Wildlife Refuge

The newest refuge on the Texas coast, nearly 15,000 acres have been acquired to date, with final acquisition planned for 21,000 - 22,000 acres. Most of the refuge area is low marsh, subject to flooding by tide water and surface water from heavy rainfall. About one-half of the acreage is considered wetlands.

The wetlands, ponds, lakes, mud flats, the Gulf and intercoastal waterway are attractive to a wide variety of bird species at all times of the year. Because of the extensive marsh areas and food, the refuge attracts a large number of Canada, snow, and blue geese. Peak numbers occur usually in late November and December, with as many as 3,500 lesser Canada geese on the refuge during that period. Blue and snow geese are more numerous on the refuge, with numbers estimated at 75,000 in 1971.

Eight species of ducks use the refuge extensively, with green-winged and blue-winged teal the most numerous, in addition to shovelers, pintails, gadwalls, American widgeon, lesser scaups, and mottled ducks. The latter is the most important nesting duck on the refuge. At various times, 20,000 - 25,000 ducks may use the San Bernard area.

In numbers varying from a few dozen to thousands, many species of shorebirds utilize the refuge permanently or intermittently, including four species of gulls and six species of terns. Four species of egrets, and five species of heron are year-round residents with numbers varying from a dozen to 300. Three species of ibises are common summer residents, with populations ranging from a dozen to 500. The roseate spoonbill is also common during the summer, with a few year-round residents.

Laguna Atascosa National Wildlife Refuge

This refuge is the southernmost link in the chain of waterfowl refuges along the central flyway. The value of the refuge has greatly increased because of extensive loss of other marsh areas along the coast.

Concentrations of 200,000 or more redheads have been seen during the fall migration, with pintails the next most common species. Populations of these have exceeded 100,000. More than 9,000 geese, Canada's, blue and snow, wintered on the refuge in 1971. Other waterfowl include coots, mottled ducks, fulvous tree ducks, and black-bellied tree ducks. The latter two species nest on the refuge. The rare white-tailed hawk is a year-round resident, and the white-tailed kite is usually present during the winter. Total wintering duck population have approached one million, including the continent's largest concentration of redheads. Nine hundred white pelicans wintered on the refuge during the 1970 - 1971 winter. A variety of other water and shorebirds number in the hundreds of thousands during the fall and winter migrations.

Other species common on the refuge include mourning, ground, and white-winged doves, and bobwhite quail. Common mammals include the whitetailed deer, javelina, raccoon, opossum, rabbit, skunk, coyote, and bobcat. Rarer mammals include jaquarundi and ocelot.

There are no oil wells on the refuge.

TEXAS PARKS AND WILDLIFE DEPARTMENT
J. D. MURPHREE WILDLIFE MANAGEMENT AREA

This state wildlife management area, comprising some 8,400 acres of marsh, provides wintering grounds for migratory birds, in addition to year-round habitat for a number of nesting birds including mottled ducks, wading, and shorebirds. Fulvous tree ducks occupy the area in the spring, and masked ducks, although rare, have been observed.

Waterfowl populations vary from year to year, from less than 2,000 ducks and geese to more than 200,000 total birds, including mottled ducks, mallards, pintails, gadwalls, baldpates, shovelers, green-winged and blue-winged teal. Diving ducks and mergansers include lesser scaup, ring-necked ducks, ruddy ducks, and hooded mergansers. Lesser snow geese also winter on the area.

Other species include substantial alligator populations and a number of endangered red wolves, in addition to otter, mink, muskrat, and nutria. [28]

LOUISIANA

Gas and oil wells are located on three of the National Wildlife Refuges in Louisiana: Delta Refuge — 140 producing gas and oil wells; Lacassine Refuge — 12 gas wells; and Sabine Refuge — 2 oil wells and 6 gas wells.

Petroleum related influences and alterations in the biota notwithstanding, it is appropriate to note that the high carrying capacity of refuge lands and the extensive wildlife populations on those areas bear testimony to the overall compatibility which has been maintained between surface resources and the withdrawal of subsurface resources.

Peak overwintering waterfowl populations for National Wildlife Refuges in Louisiana:

REFUGE	YEAR	CANADA GEESE	WHITE-FRONTED GEESE	BLUE & SNOW GEESE	DUCKS
Delta	1970	–	–	26,000	114,900
	1971			33,000	132,300
Lacassine	1970	945	30,000	30,700	241,800
	1971	1,070	38,000	53,000	296,200
Sabine	1970	125	900	41,000	90,645
	1971	80	2,000	45,000	111,170

Delta National Wildlife Refuge

The refuge contains 48,800 acres of deltaic marshes, shallow ponds within the marshes, passes, bayous, and canals. It was established primarily as a sanctuary, feeding, and resting habitat for large wintering populations of blue and snow geese and more than 18 species of ducks, and is accessible only by boat. In past years, the refuge has wintered up to 1,000,000 ducks and 350,000 geese. The most abundant duck species wintering at the refuge are the widgeon, gadwall, pintail, shoveler, and green-winged teal, which arrive in October. In September, numerous blue-winged teal pass through enroute to wintering grounds in the West Indies, Central, and South America. The mottled duck is a year-round resident.

Migratory birds normally reach their greatest numbers in early December, and have generally begun their northern migration by the end of March.

Other species common to the refuge during the summer are great blue herons, Louisiana herons, little blue herons, yellow-crowned and black-crowned night herons, common and snowy egrets, white and glossy ibises, and various shore birds. Least and American bitterns, green herons, rails, and gallinules nest on the refuge. The brown pelican is only occasionally seen. Alligators are seen frequently but are not abundant.

Lacassine National Wildlife Refuge

The refuge area, of approximately 31,125 acres, is primarily a wintering area for migratory waterfowl. In addition to one of the largest populations of fulvous tree ducks in the United States, one of the greatest concentrations of white-fronted geese in the Mississippi Flyway winter here. Other species commonly wintering include pintail, gadwall, mallard, blue and green-winged teal, shoveler, baldpate, ring-necked duck and scaup. Mottied ducks, roseate spoonbills, anhingas, and ibises are also present. Waterfowl populations vary according to water and food conditions within the refuge, with a low of about 56,000 in 1946 and a high of 450,000 in 1956.

The Canada goose flock is now only a remnant of a once well established flock. Highs of 15,000 were reached in 1952 and 1953, but the current winter inventory totaled less than 1,100.

There are currently 12 active gas wells within the refuge boundaries. Where necessary, access roads were built into the 16,000 acre fresh water impoundment. These roads have proven beneficial from the standpoint of access into the refuge area and creation of beneficial habitat for some forms of wildlife. However, where such roads have been built in natural marsh conditions there has been an impairment of the natural water flow within the marsh and a tendency to drain the areas.

The list of wildlife species inhabiting Lacassine at various times of the year is impressive, and includes at least 202 species of birds, 9 species of salamanders, 12 species of frogs, 30 species of snakes (including 5 venomous species), 17 species of turtles, a fairly abundant alligator population, and 22 principal mammal species (not including rats & mice).

Shell Keys National Wildlife Refuge

As a result of past hurricanes, wind, and wave action, little remains of this small 8-acre refuge. The area is a bare shell reef and receives limited use by shore birds common to the Gulf Coast.

Sabine National Wildlife Refuge

The Sabine is the largest waterfowl refuge on the Gulf Coast and was established to preserve a large block of marsh habitat for wintering blue and snow geese and ducks.

Consisting of more than 142,000 acres, the refuge also serves as a major habitat for the American alligator, many furbearers, the roseate spoonbill and many other marsh and water birds.

Waterfowl reach peak populations on the refuge from December through mid-January, although large flights of pintail and blue-winged teal pass through in late August headed for wintering grounds in Central and South America. The most abundant ducks wintering on the refuge are mallard, pintails, gadwalls, green-winged teals, and American widgeon. Huge flocks of blue and snow geese winter on the refuge, in addition to Canada and white-fronted geese, and mottled ducks. Some blue-winged teal are year-round residents.

Roseate spoonbills nest on the refuge, which is also the home of the first American nesting colony of cattle egrets outside of Florida. Thousands of white-faced ibises, white ibises, common and snowy egrets, Louisiana and little blue Herons, black crowned and yellow crowned night herons nest on the refuge, in addition to great blue herons, anhingas, and olivaceous cormorants. Other wildlife include nutrias and armadillos. Alligators are common, as well as otters, mink, raccoon, muskrat, skunks, and rabbits. Red wolves are present in the parish, but are not common on the refuge. [25] [26]

MISSISSIPPI

Gulf Island National Wildlife Refuge

Gulf Island includes three refuge areas in the Gulf of the Louisiana-Mississippi Coast — *Horn Island, Petit Bois,* and *Breton.* The areas are available only by water. Sea turtles nest on the islands. It is a general wintering area for waterfowl and a year-round residence for brown pelicans, black skimmers, shorebirds, gulls, and terns. About 23,000 ducks wintered here in 1971.[26]

LOUISIANA WILDLIFE & FISHERIES COMMISSION REFUGES AND MANAGEMENT AREAS

Rockefeller Wildlife Refuge

The Rockefeller Wildlife Refuge, comprising 84,000 acres in the coastal marshes of southwestern Louisiana, borders the Gulf of Mexico for more than 26 miles and extends northward to the Grand Chenier Ridge, a complex six miles inland from the Gulf.

Because of Louisiana's position at the southern end of the Mississippi Flyway, the state serves as the wintering ground for a high percentage of all waterfowl migrating from northern nesting grounds. This refuge provides some of the most important winter habitat in the state. Many transient birds that winter in central and south America rest on the refuge enroute. About 600,000 waterfowl winter on the refuge annually, and although the area is primarily for these species, the total area is inhabited by a varied assortment of shorebirds, wading birds, and other water-oriented birds and mammals. The high number of waterfowl present mid-winter, 400,000 - 600,000, is largely the result of habitat improvement within the refuge. Prior to the establishment of variety of water impoundments, less than 75,000 ducks wintered here.

In addition to a nesting mottled duck population, other nesting species are pied-billed grebes, black-necked stilt, killdeer, night herons, green herons, and captive flocks of Canada geese. The official bird list for the refuge includes 269 species.

Also, nutria, muskrat, raccoon, otter, and alligators are found in substantial numbers on the area year-round.

Numerous mineral leases have been developed on the refuge in recent years, with extreme care exerted to prevent damage that would prove detrimental to the area. Older petroleum operations on the refuge, involving excavation of canals 60 - 80 feet wide and about 8 feet deep to permit the movement of drilling rigs and other heavy equipment, resulted in the loss of many acres of marsh. Further, this system affected natural drainage patterns, tidal flow, and resulted in increased salinities. New regulations require that all mineral developments be conducted on a system of roadways, thus eliminating many problems created by earlier canal systems. Revenues derived from mineral operations on the area are returned to the refuge to enhance the area for wildlife. Surplus funds from mineral development go for the development and improvement of public education and health within the state of Louisiana.[27]

State Wildlife Refuge

This 13,000 acre tract on the southwestern shore of Vermillion Bay, is considered the first such refuge in the world established by private donation to a public agency. The area has been operated as a refuge since its establishment in 1911.

The area serves a unique and important purpose for wildlife as a blue and snow goose wintering area. The marshes north of the refuge are heavily hunted and the refuge serves as a place of retreat for as many as 50,000 of these birds. In addition, normal wintering populations includes 20,000 ducks consisting mainly of gadwalls, baldpates (American widgeon), pintails, lesser scaup, and teal.

As with other refuge areas in Louisiana, the State Wildlife Refuge provides protection for the alligator. This refuge is flanked by the Paul J. Rainey Wildlife Refuge of the National Audubon Society and the Marsh Island Wildlife Refuge of the Louisiana Wildlife and Fisheries Commission, which in total, form a large unit affording protection for this reptile.[27]

Marsh Island Wildlife Refuge

The 82,000 acre Marsh Island Wildlife Refuge lies between Vermillion Bay and the Gulf of Mexico and is accessible from the mainland only by boat or air. The terrain is flat with elevation ranging from approximately six inches to one foot above sea level except along a south beach ramp. In recent years, 80,000 - 90,000 blue and snow geese have wintered on the refuge along with a similar number of ducks. Alligators are present in large numbers in the heart of the refuge despite almost total depletion by hurricane Audrey in June 1957.

Marsh Island is probably unsurpassed in this section of the state as a nursery ground for shrimp, with millions of small shrimp drifting into the waterways of the island in the spring, maturing and moving out in the late summer and fall. Blue crabs and other forms of marine fishes are found in abundance throughout the waters of the refuge.

Like the alligators, many deer are present, despite virtual extermination by hurricane Audrey. Thousands of shorebirds and wading birds utilize the area.[27]

Pass-a-Loutre Waterfowl Management Area

This 66,000 acre tract of marsh land, located at the mouth of the Mississippi River, has served as a public waterfowl hunting area since 1921. Several hundred thousand waterfowl winter on the area each year.

Hunting camps are located throughout the central portion of the area and occupy some 20,000 acres of prime hunting ground. In addition to that portion of the management area reserved for public camps, the total area is open to hunters using personal equipment.

In 1965, hurricane Betsy wrought extensive damage to some hunting facilities, and hurricane Camille in 1969 severely damaged or totally destroyed all public hunting facilities on the refuge. Uncountable thousands of all forms of wildlife were killed although small numbers of all species remained and will repopulate the refuge.[27]

Salvador Wildlife Management Area

Acquired in 1968, this management area is located on the northwestern shore of Lake Salvador, approximately 12 miles southwest of New Orleans, and comprises more than 28,000 cares. The land was originally purchased from the Humble Oil Company. Primarily a fresh water marsh, numerous marsh ponds scattered through the area provide ideal conditions for the production of waterfowl food plants. Wildlife species on the area include deer, rabbit, squirrel, alligators, rail, waterfowl, and furbearers such as mink, nutria, raccoon, muskrat, and otter.

An extensive oil field has been developed on the Salvador area. Canals dug to provide access to this operation have created ideal conditions for excellent fresh water sports fishing, and also serve as routes for hunters to reach choice hunting areas.

Future management plans on the Salvador area are directed to increasing waterfowl utilization of the area through the construction of the earthen dams, levees, and installing water control structures, similar to those on the refuges in southwest Louisiana which regulate water levels through the year for management purposes.[27]

Point-au-Chien Wildlife Management Area

This management area is located approximately 15 miles southeast of Houma, comprises more than 27,000 acres of marsh land, and was acquired along with the Salvador tract. The area is broken up by numerous natural streams which can be placed under intensive management by the construction of numerous low level weirs and earthen plugs. Efforts by the Commission will be directed towards creating conditions suitable for the production of waterfowl plants in order to increase waterfowl utilization of this area.[27]

FURBEARERS

The coastal wetlands produce most of the species harvested annually for their fur: otter, raccoon, mink, muskrat, and nutria.

Nutria, an introduced species, comprise a substantial portion of the furbearer population of the Louisiana coast. To some extent, the muskrat is similarly a recent resident of the wetlands, with no record of their presence there before 1850. It was not until the early 1900's, however, that commercial aspects of muskrat pelts were recognized, and the species harvested.

For the 1968-69 season, Louisiana's entire fur production was valued at $7.1 million. This resource is harvested almost exclusively from the coastal area of the state. Nutria and muskrat production brought in the highest revenue among all furbearers caught in the past decade. The nutria harvest increased tremendously in the 1960's due to the demand for a versatile fur to accommodate fashion trends and for meat for ranch-mink and pet food. Nutria pelts rose from 902 valued at $451.00 in 1944-45 to a record high of 1.7 million valued at $3.8 million in 1968-69 (Table 8). For the past two decades, muskrats have decreased appreciably in numbers while the nutria harvest increased. Trappers attribute the decline to muskrat and nutria competition for available food. On the other hand, land loss from erosion is serious, and changes in the saline characteristics of wetlands are reflected by shifts in vegetation types — with declining muskrat populations quite likely one of the results. However, through good management practices, muskrat and nutria populations have stabilized in recent years in the state.[14]

In Texas, about a dozen species have been designated as furbearers. These include nutria, muskrat, otter, mink, opossum, raccoon, skunk, and gray fox. The latter four occur in significant numbers in the wetlands of the lower Texas gulf coast, but are not harvested for pelts. Sport hunting is minimal. Since most of the wetlands are located on wildlife refuges or large private tracts of land, access to these animals is strictly controlled.

Further north along the Texas coast, except for skunk and gray fox, all of the species listed, in addition to nutria, are harvested, with the demand largely governed by the garment industry.

Generally, the recent 20-year trend has been towards increased nutria harvest. Muskrat catches dropped from highs in the 1930's and 1940's reaching a low in the late 1950's and early 1960's, primarily due to low populations in the marshes. During the past two years, however, these animals have demonstrated a strong increase.

Marsh drainage, navigation projects, oil development, and urban and agricultural drainage have been significant factors in altering muskrat populations. Brackish water has been eliminated from much of the potential muskrat marsh and has had a serious effect on plant succession. Dredging and filling of marshes has also eliminated large acreages of prime muskrat habitat, but at the same time, in many cases has provided habitat for nutria, mink, raccoon, and opossum.[28 29]

In Mississippi, mink and muskrats are important furbearers, but no records are available for population trends. There has been a significant decline in trapping as compared with 20 years ago, due to a combination of factors including abundance of the species, demand for fur and interest in trapping.[30]

Alabama's coastal wetlands of south Mobile and Baldwin Counties support low populations of muskrat and raccoon. Generally, the habitat is poor, consisting of thousands of acres of needlerush marsh. The furbearer harvest is nil.[31]

Table 8
FUR CATCH IN LOUISIANA
SPECIES

YEAR	OTTER	RACCOON	SKUNK AND CIVET CAT	MINK	MUSKRAT	NUTRIA
1935	–	–	–	–	–	–
1936	–	–	–	–	–	–
1937	–	–	–	–	–	–
1938	920	87,300	48,500	82,480	3,110,540	–
1939	760	86,000	48,900	89,000	3,346,280	–
1940	1,273	71,419	4,655	85,391	6,432,025	–
1941	1,713	163,895	13,846	112,425	5,405,425	–
1942–43	1,399	164,199	17,580	128,311	3,946,978	–
1943–44	2,404	–	28,052	144,717	4,440,638	–
1944–45	1,912	176,911	11,155	132,821	5,963,156	902
1945–46	2,367	244,502	12,224	168,598	8,337,411	8,784
1946–47	2,832	186,750	4,830	153,027	8,029,764	18,015
1947–48	5,078	126,933	1,415	153,120	5,794,317	28,176
1948–49	2,222	104,034	1,144	91,541	2,948,281	26,738
1949–50	2,968	73,035	302	123,850	2,195,324	38,988
1950–51	4,801	104,420	1,006	184,552	2,477,464	78,422
1951–52	4,849	89,353	1,062	95,784	1,011,202	77,966
1952–53	4,198	63,429	982	113,073	1,247,705	89,526
1953–54	3,884	49,857	311	58,706	1,173,209	160,654
1954–55	5,407	84,223	120	65,170	1,383,114	374,199
1955–56	4,653	61,520	273	57,142	1,821,840	418,772
1956–57	5,261	72,522	526	62,872	1,589,433	543,160
1957–58	4,382	75,048	478	61,377	2,165,723	510,679
1958–59	5,166	68,139	623	88,365	1,302,606	461,311
1959–60	5,559	80,814	524	58,838	1,531,788	694,110
1960–61	3,602	65,588	388	32,272	961,287	716,435
1961–62	4,195	109,470	464	41,399	632,558	912,890
1962–63	8,484	160,218	465	51,316	346,647	1,357,806
1963–64	4,274	58,424	301	18,805	240,079	1,304,267
1964–65	3,288	68,627	296	23,311	201,510	1,568,233
1965–66	3,588	78,348	161	28,216	324,204	1,257,385
1966–67	4,118	83,876	283	62,150	529,438	1,307,121
1967–68	3,466	50,790	136	27,498	929,964	1,115,410
1968–69	5,426	95,654	250	46,918	1,556,764	1,754,028
1969–70	6,632	103,725	108	46,294	1,232,052	1,604,175
1970–71	4,808	55,726	6	21,648	777,960	1,226,739

Sources: 1) Fur Catch in the United States, (1935–1969), Published by Bird and Mammal Laboratories Division of Wildlife Research, Bureau of Sport Fisheries and Wildlife.

2) Biennial Reports (1962–63, 1968–69, and 1970–71) Published by Louisiana Wild Life and Fisheries Commission.

RARE AND ENDANGERED SPECIES OF WILDLIFE

Introduction

In the year 1600, the world's wildlife wealth included 4,226 species of mammals and 8,684 species of birds. Since then 36 mammals (0.85%) have become extinct and at least 120 (2.84%) are currently in some degree of danger of extinction. Ninety-four birds (1.09%) have become extinct and at least 187 (2.16%) are faced with extinction. These figures apply to full species. Geographical races or subspecies of higher animals also have suffered similar fates.

In total, 1% of our higher animals have become extinct in the last 372 years and nearly 2½% are in danger. Among surviving species of mammals, more than 64 races became extinct during this period. An additional 223 races survived but are classed as "rare" or "endangered". Among the birds, 164 races are extinct and a minimum of 287 are considered endangered.[32]

This represents a rate of attrition of wildlife resources unparalleled in man's total association with wildlife. Although natural causes are a part of the process of evolution, with no species living more than a few million years before disappearing, the accelerated rate of disappearance of wildlife resources from the face of the earth in recent history is directly attributable to Homo sapiens. It is quite likely that humans, directly or indirectly, are responsible for the disappearance of at least 3/4 of all species which have vanished during the past 372 years.

A broad spectrum of fish and wildlife species are associated with petroleum activities in the Gulf coast region. However, it is appropriate to single out a few species which have been classified as "rare" or "endangered" by the U. S. Department of the Interior and the International Union for the Conservation of Nature and Natural Resources (IUCN), whose year-round or seasonal ranges overlap areas where the petroleum industry operates or may frequent for seismic, exploration, or transportation activities.

Both "rare" and "endangered" classifications are somewhat arbitrary, but both realistically specify a need for protection. "Endangered" species or subspecies are those whose prospects for survival and reproduction are in immediate jeopardy. A "Rare" species or subspecies is one which is not immediately threatened with extinction, but is in such small numbers throughout its range that it may be endangered if its range or habitat is further altered or damaged. "Peripheral" indicates the presence of a species at the extreme margin of its total range.[33]

Gulf of Mexico Region

Species with rare, endangered, or peripheral status which are indigenous or seasonal migrants to the Gulf of Mexico region include twelve birds, three reptiles, four mammals, and one amphibian.

Brown Pelican (Endangered)

Distribution: Breeds on islands along Gulf coast from Florida to Texas.

Estimated Population: No estimate for Gulf coast.

Causes of Decline: Collapse of thin-shelled eggs shown to be associated with excessive amounts of DDE in food fishes, the contents of pelican eggs and tissues of these birds.

Florida Great White Heron (Rare) The largest Heron native to the U.S.

Distribution Breeds in Florida Keys, Florida Bay and southern penninsula of Florida north to Cape Romano. Birds occasionally found farther north along Florida coast and rarely in adjacent states.

Estimated Population: 2,000

Causes of Decline: Former illegal hunting and hurricane caused mortality.

Florida Everglade Kite (Florida Snail Kite) (Endangered)

Distribution: Fresh water marshes of southern Florida; from Lake Okeechobee south into the northern part of the Everglades National Park.

Estimated Population: About 120 in 1969.

Causes of Decline: Shooting, declining habitat and drainage of marshes for agriculture and residential use.

Southern Bald Eagle (Endangered)

Distribution: Nests in estuarine areas of the Gulf coast from Florida to Texas. Adult population of southern Florida is essentially resident.

Estimated Population: About 235 active nests were located in 1965 throughout the total range, 99 of which were successful. Only 2 or 3 active nests were located in the Gulf region outside of Florida.

Causes of Decline: Increase in human population in primary nesting areas. Illegal shooting, loss of nest trees, and possible reduced reproduction due to pesticides.

Arctic Peregrine Falcon (Endangered)

Distribution: Occurs in migration along the beaches of outer islands all along the Gulf coast.

Estimated Population: No estimates available for the Gulf region.

Causes of Decline: Evidence points to cumulative effects of chlorinated pesticides on reproduction.

Attwater's Greater Prairie Chicken (Endangered)

Distribution: Local and scattered over 11 counties in small, disjunct populations in the Gulf coastal prairie of Texas, chiefly in Refugio and Colorado counties.

Estimated Population: About 1,000.

Causes of Decline: Reduction of natural tall grass prairie habitat, chiefly by plowing and overgrazing the original prairie.

Whooping Crane (Endangered)

Distribution: Winters at Aransas National Wildlife Refuge and nearby islands on the Gulf coast of Texas. Occasionally, wanders as far as northeastern Mexico.

Estimated Population: 80, including 59 wild birds on Gulf coast winter of 1971-72, 21 in captivity in winter of 1971-72.

Causes of Decline: Interference by man; also probably illegal shooting of nonbreeding birds in summer and migrating individuals in fall in the northern grain producing farm land. Occasional shooting on wintering area.

Florida Sandhill Crane (Rare)

Distribution: West prairies throughout peninsular Florida and southern Mississippi.

Estimated Population: Between 2,000 and 3,000 estimated by Bureau of Sport Fisheries and Wildlife in 1964. Less than 50 in southern Mississippi.

Causes of Decline: Decline not definite in Florida, but increased human population and conversion of some wet prairie habitat for agriculture could initiate downward trend. Surface drainage by lumber companies and other human encroachment on habitat caused decline in Mississippi.

Eskimo Curlew (Endangered)

Distribution: Known only from one or two spring migrants seen on the Texas coast in 1950, 1959, 1960, 1961, and 1962.

Estimated Population: No estimate

Causes of Decline: Former excessive shooting. Present limiting factors unknown.

American Ivory Billed Woodpecker (Endangered)

Distribution: Thought to occur at present in southeast Texas. Very few birds may exist in widely scattered localities in eastern Texas, Louisiana, and Florida. Probably very close to extinction because of scarcity of suitable habitat. Organized efforts to locate either Ivory Bills or favorable habitat for this species in Texas, Louisiana, and Florida have produced sightings of one bird and sound recordings of another in the Neches river drainage of southeast Texas in 1967 and 1968.

Population: No estimate

Causes of Decline: Illegal shooting and reduction of overmature forests with dead and dying trees which supply the wood-boring beetle larvae required for food.

Red-Cockaded Woodpecker (Endangered)

Distribution: Resident in open, old pine woodlands in Gulf coast region from Florida to eastern Texas.

Population: No estimate

Causes of Decline: Lack of nesting sites in old, living pines infected with red-heart disease.

Cape Sable Sparrow (Endangered)

Distribution: Resident in fresh and brackish water marshes in southwestern Florida.

Estimated Population: Estimated at less than 1,000, perhaps less than 500.

Causes of Decline: Limited and unstable habitat resulting from drought, fires, hurricanes, encroachment of mangroves on marsh grass, and reduction of habitat by real estate development.

American Alligator (Endangered)

Distribution: Mississippi west to Corpus Christi, Texas

Population: Unknown

Causes of Decline: Heavy poaching; destruction of habitat, young subject to predator and human pressure.

The American Crocodile (Peripheral)

Distribution: South Florida and Florida Keys

Population: Unknown

Causes of Decline: Poaching for skins; destruction of habitat; frequent hatching failures.

Green Turtle (Peripheral)

Distribution: Tropical oceans, inshore waters. Present on the United States coast during summer. May nest on Florida coast.

Population: Very few in the United States, but fairly abundant world-wide.

Causes of Decline: Widely used for food; eggs and young subject to very heavy predator and human pressure.

Red Wolf (Endangered)

Distribution: In unmixed form throughout Chambers and Jefferson Counties in extreme southeastern Texas and Cameron County in southwestern Louisiana. Occurs as a hybrid with the coyote and domestic dog throughout most of the rest of eastern Texas.

Population: No estimates available.

Causes of Decline: Heavy trapping and hunting pressure. Habitat changes favor the coyote, with which red wolves appear to readily hybridize.

The Florida Manatee (Endangered)

Distribution: Coastal areas of Florida; found along the edges of Everglades National Park and occasionally throughout the Florida Keys.

Population: No reliable estimate

Causes of Decline: No evidence of recent decline, but previous decline due to hunting for flesh, oil, and skins, slaughter for "sport", silting of coastal feeding grounds, and injuries from keels and propellers of power boats.

Florida Panther (Cougar, Puma) (Endangered)

Distribution: Believed present in four counties in Florida, and rumored to be in the vicinity of St. Mark's Refuge in Wakulla County.

Population: 100-300

Causes of Decline: Heavy trapping and hunting pressure; inability to adapt to changing environmental conditions; pressures from civilization.

Key Deer (Endangered)

Distribution: Monroe County, Florida, Key Deer National Wildlife Refuge.

Population: About 575

Causes of Decline: Occupation and development of islands by man; hurricanes and fires. Habitat and road kills are critical factors in sustaining the population.

Houston Toad (Endangered)

Distribution: Associated with loblolly pine in the area of Houston, Texas.

Population: No estimates

Causes of Decline: Destruction of habitat through lumbering, road construction and expansion of suburban area. Population within Houston city limits is probably gone due to city growth.[54] [55]

The foregoing list is not complete since adequate data are not available for all "rare" or "endangered" species which migrate to or through the Gulf region. However, the following comment from "The Coastal Resources Management Program of Texas", published by "the Interagency Natural Resources Council" is of interest:

> "The 1968 edition of the *Red Book*, the list of endangered animals, lists 38 species and subspecies of birds which are threatened by extinction. Of these, *not less than 31 either are permanent residents of the (Texas) coastal zone or migrate through our coast or establish temporary residence on our shores.*"[35]

BIBLIOGRAPHY

1. Barrett, Barney, 1970, "Water Measurements of Coastal Louisiana", Louisiana Wild Life and Fisheries Commission.

2. Gunter, G., 1967, "Some Relationships of Estuaries to the Fisheries of the Gulf of Mexico," *In Estuaries,* edited by G. H. Lauff pp. 621-638. *American Associated Adv. Sci.,* Publication No. 83, 757 pages.

3. Posphala, R. S., 1970 Research Biologist, Section of Migratory Game Bird Studies, Bureau of Sport Fisheries and Wildlife. (Personal Communication), September 22, 1970.

4. St. Amant, Lyle S., 1972, "The Petroleum Industry as It Affects Marine and Estuarine Ecology", *Journal of Petroleum Technology,* April, 1972.

5. Fisheries of the United States. United States Department of Commerce National Marine Fisheries Service, C.F.S. No. 5900, 1971; No. 6400, 1973.

6. Fishery Statistics of the United States, 1971, United States Department of Commerce, National Marine Fisheries Service Statistical Digest No. 65, 1971.

7. Fisheries of the United States, 1970. United States Department of Commerce, National Marine Fisheries Service, C.F.S. No. 5600.

8. The Encyclopedia of Marine Resources, New England Marine Resources Information Program, University of Rhode Island, Frank E. Firth, Ed., Van Nostrand.

9. Klima, E. F., Acting Base Director, Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi (Personal Communication), June 28, 1971.

10. "The Automated Fishing Platform", Technical Conference on Fish Finding, Purse Seining and Aimed Trawling, E. F. Klima, FAO, Reykjavik, March 16, 1970.

11. Latent Fishery Resources of the Central West Atlantic Region, Bullis, H. R., Jr., and Carpenter, James S., Future of the Fishing Industry in the United States, University of Washington Publications in Fisheries, New Series, Volume IV, 1968.

12. Galtsaff, Paul S. The American Oyster *Crassostrea vinginica* Gmelin, Fishery Bulletin No. 64, United States Department of the Interior, Bureau of Commercial Fisheries, 1964.

13. Ford, T. B. Assistant Director, Sea Grant Development Program, Louisiana State University (Personal Communication), September, 1970.

14. 13th Biennial Report, 1968-1969. Louisiana Wild Life and Fisheries Commission, May, 1970.

15. Shrimp Atlas - Gulf of Mexico, United States Department of the Interior, Bureau of Commercial Fisheries, Circular 312.

16. Distribution of Royal-Red Shrimp, *Hymenopenaeus robustus,* On Three Potential Commercial Grounds off the Southeastern United States, by Richard B. Roe, Published September, 1969.

17. Louisiana Landings, 1963. United States Department of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 3552 (Annual Summary), July, 1964.

18. Louisiana Landings, 1966. United States Department of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 4485.

19. Carlisle, J. G., Jr. O. H. Turner and E. E. Ebert. Artificial habitat in the marine environment. California Department of Fish and Game, Fish Bulletin 124:73-74, 1964.

20. Turner, C. H., J. G. Carlisle, Jr., E. E. Ebert. Offshore oil drilling, its effect upon the marine environment. California Department of Fish and Game, Marine Resources Operations, 1962.

21. Migratory Game Bird Briefing Book: United States Department of the Interior, Bureau of Sport Fisheries and Wildlife.

22. Waterfowl Status Report, 1961 and 1969, United States Department of the Interior, Bureau of Sport Fisheries and Wildlife.

23. National Wildlife Refuges, United States of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, 1968, 1969, and 1970.

24. McDaniel, Jimmie, Wildlife Biologist, Florida Game and Fresh Water Commission (Personal Communication) June 22, 1972.

25. Carlson, C. Edward, Regional Director, Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, Atlanta, Georgia (Personal Communication) June 1, 1972.

26. National Wildlife Refuges in the Southeast, United States Department of the Interior, Bureau of Sport Fisheries and Wildlife, April, 1970.

27. Joanen, Ted, Louisiana's Refuge Division, Louisiana Wild Life and Fisheries Commission.

28. Stutzenbaker, Charles D., Project Leader, Waterfowl, Texas Parks and Wildlife Department.

29. Winkler, Charles K., Texas Parks and Wildlife Department (Personal Communication) May, 1972.

30. Phares, John H., Chief of Game, Mississippi Game and Fish Commission, (Personal Communication) May 3, 1972.

31. Beshears, W. Walter, Jr., Wildlife Biologist, Alabama Department of Conservation and Natural Resources (Personal Communication) April 25, 1972.

32. *Wildlife in Danger,* James Fisher, Noel Simon, Jack Vincent; the Viking Press, 1969.

33. Rare and Endangered Fish and Wildlife of the United States. *RED BOOK,* Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, December, 1968.

34. Aldrich, John W., Research Staff Specialist, United States Department of the Interior, Bureau of Sport Fisheries and Wildlife, Division of Wildlife Research, (Personal Communication) May, 1972.

35. The Coastal Resources Management Program of Texas, The Interagency Natural Resources Council, Goodwin and Moseley, Ed. 1971.

COOK INLET, ALASKA

INTRODUCTION — COOK INLET, ALASKA

Cook Inlet is a large tidal estuary in South-Central Alaska which enters the Gulf of Alaska east of the base of the Alaskan Peninsula. The inlet is bordered by more than 100 square miles of tidal marsh, most of which is located in the Susitna Flats, Trading Bay and Redoubt Bay on the northwest side of the Upper Inlet, and Chickaloon Flats on the south side of Turnagain Arm. Other smaller marshes are found mainly in bays.

Cook Inlet is also bordered on three sides by mountains: the Aleutian Range and Alaska Range on the northeast; the Talkeetna Mountains to the northeast; and the Chugach and Kenai Mountains on the southeast. Glaciers are common throughout these mountain ranges.

Major tributaries include the McNiel, Tuxedni, Drift, McArthur, Chackachatna, Beluga, Susitna, Little Susitna, Matanuska, Knik, Eagle, Twenty-Mile, Placer, Resurrection, Swanson, Kenai, Kasilof, Ninilchik, Anchor and Fox Rivers. Many of these carry heavy glacial sediment loads. Numerous other rivers and creeks also contribute to the flow into the inlet.

The Susitna River and the tributaries to Knik Arm contribute a high proportion of the fresh water to the inlet. Most of these carry large glacial silt loads; and, together with other glacial streams, contribute a heavy sediment load to the inlet, particularly at its upper end.

Five active volcanoes, Mts. Augustine, Spurr, Redoubt, Iliamna and Douglas border the inlet on the west side.

A rim of lowlands separate the mountains from most of the inlet. In places, this is narrow, or absent, as along the southern margins of the inlet in fiords where the mountains rise directly from the water. It is wide in the Upper Inlet, and the lake-dotted Kenai lowlands extend for more than 60 miles from the East Foreland to the Kenai Mountains. The Susitna River Valley is also a broad, lake-studded lowland, in places more than 60 miles wide.

Cook Inlet supports, or is, a periodic habitat for populations of various species of waterfowl and seabirds, which, on occasions, number in the millions; is a permanent residence for sea otters — occasionally for sea lions; its beaches provide razor clam habitat; its waters support thriving fishing industries involving shrimp, king, snow and dungeness crabs, salmon and herring, an extensive recreational fishery; and the oil industry, which is the primary economic activity in the inlet.

Although petroleum industry activity is centered in the Upper Inlet, many miles removed from the bulk of these resources, it does share the same waters which ebb and flow past and over them; is surrounded by hundreds of square miles of valuable waterfowl habitat; and occupies the Upper Inlet along with a set-net salmon fishery.

The fishing and fish-processing industries of Cook Inlet are second to the petroleum industry in annual dollar value of production, and constitute an important segment of the regional economy. The fishery resources are renewable, and with proper management can provide the State of Alaska with a valuable and relatively stable industry indefinitely.

Cook Inlet fishery resources are not only of significant commercial value, but also provide recreation, economic and social benefits associated with sport fishing and tourism. Various species of both finfish and shellfish are important in the economy of Cook Inlet.

Deep-water trawls conducted by the U.S. Bureau of Commercial Fisheries (National Marine Fisheries Service) revealed the presence of 25 species of finfish, including abundant butter sole, yellowfin sole, turbot and pollock. Five species of shrimp, three species of crabs, octopus, scallops and other invertebrates were also recorded.

The petroleum industry in the Cook Inlet basin far outdistances any other primary economic activity in dollar value, and may increase substantially through the next decade, if not longer. At the same time, fisheries, second in rank of the resource-based industries of the area, have experienced a nearly steady-state economic condition during the past ten years. The petroleum industry has expanded rapidly from exploration and early production in the late 1950's to large-scale production from eight major oil and gas fields and several smaller ones by the 1970's. Production increases have leveled off. However, only a small percentage of the area considered favorable for petroleum production in the Cook Inlet basin has been intensively explored. The lower two-thirds of the Cook Inlet basin is essentially untouched.

THE PETROLEUM INDUSTRY

The petroleum industry in the Cook Inlet basin exceeds all other primary economic activities in dollar value. This may well increase substantially through the next decade, if not longer. At the same time, fisheries, second in rank of the resource-based industries of the area, have experienced a nearly steady-state economic condition during the past ten years. The petroleum industry has expanded rapidly from exploration and early production in the late 1950's to large-scale production from eight major oil and gas fields and several smaller ones by the 1970's (Figure I). Production increases have currently levelled off. The lower 2/3 of the Cook Inlet basin is essentially untouched. If the producing formations of the Upper Inlet prove to extend south of the Forelands for any great distance, substantial increases over present production levels are to be expected.

Present estimated of potential reserves run as high as 7.9 billion barrels of oil and 14.5 trillion cu. ft. of gas for the entire region. With reserves in the ground estimated at approximately 2.6 billion bbls. of oil and 5 trillion cu. ft. of gas,[1] the margin for growth is great. The Alaska Division of Oil and Gas estimates that about 500 million barrels of this oil are recoverable.

Estimates of Cook Inlet basin reserves rate the region as one of the major petroleum-producing areas of the world. To date, Cook Inlet's oil gas fields have produced 450 million bbls. of oil and 1 trillion cu. ft. of gas (more than 99 percent of the state's production to date), and rank Alaska seventh among the petroleum-producing states (Figure 2). Total values for these products are estimated to be more than 1.1 and 0.6 billion dollars respectively (Table 1).

Cumulative income to the State of Alaska from lease bonuses, rents, taxes and royalties from Cook Inlet petroleum development now exceed $250 million. Production royalties account for approximately 1/2 of this figure. Further, 100 million of the total 127 million dollars in royalties have accrued to the state since 1968, the year in which the installation the last of the offshore drilling platforms was completed. The State of Alaska, Department of Natural Resources, estimates that the current level of royalty payments, in excess of $25 million per year, will continue at that rate for several more years.

COASTAL FACILITIES

There are five major ports and four small boat harbors serving Cook Inlet at present. The ports handle more than 11 million tons of petroleum products per year and more than 400,000 tons of general cargo. Almost 90 percent of the general cargo is containerized.

Use of all port and harbor facilities is influenced by the tremendous tidal ranges (up to 30 feet) in Cook Inlet. Many small boat harbors, docks, and anchorages are unuseable at low tide and any boats or ships using them are bottomed.

Table 1
VALUE OF OIL & GAS PRODUCTION IN COOK INLET BASIN

(Thousands of Dollars)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Total
Value of Oil Production	295	1,230	17,652	31,187	32,650	33,627	34,073	44,007	91,164	186,695	200,289	232,829	234,337	1,139,974
Value of Gas Production	16	30	129	467	1,111	1,719	1,799	2,794	3,610	4,388	11,158	18,164	17,972	63,357
Total	311	1,260	17,781	31,654	33,761	35,346	35,872	46,801	94,774	191,083	211,386	250,993	252,309	1,203,331

STATE REVENUES DERIVED FROM PETROLEUM DEVELOPMENT IN COOK INLET BASIN

(Thousands of Dollars)

Royalty Payments														
Oil-State Lands	0	0	0	0	0	0	0	942[1]	3,517[1]	14,233	17,395	22,146	27,731	86,180
Gas-State Lands	0	0	0	4	40	76	96			241	391	756	897	2,285
Oil & Gas-Federal Lands	13	97	1,640	2,499	3,860	3,375	3,266	3,601	4,071	4,955	5,189	2,876	3,047	38,489
Total	13	97	1,640	2,503	3,900	3,451	3,362	4,543	7,588	19,429	22,975	25,778	31,675	126,954
Lease Bonuses & Rents														
Bonuses	2,977	79	14,411	15,626	3,682	1,056	4,581	1,241	18,127	0	0	0	0	76,802
	(Onshore bonuses not available by year, but are reflected in total figure)													
Rentals-State Lands	(Information not available by years for Cook Inlet Area: State share of federal rentals not available)													16,000**
Total														
Taxes														
Production Severance	3	11	160	270	298	313	314	397	676	2,276	5,406	7,397	11,411	28,932
Disaster Severance	0	0	0	0	0	0	0	0	24	1,526	1,794	1,561	0*	4,905
Conservation	1	1	22	45	52	46	54	57	113	164	314	247	0*	1,116
Total	4	12	182	315	350	359	368	454	813	3,966	7,514	9,205	11,411	34,953
Total State Revenues														254,709

**Estimate from Pedro Denton, State Department of Natural Resources, Division of Mines and Geology*
**State of Alaska Department of Natural Resources, Division of Oil and Gas. Various statistical reports.*
State of Alaska Department of Natural Resources, Division of Lands. Various Unpublished Data.

[1]1966 and 1967 figures are for oil and gas combined/no breakdown available.

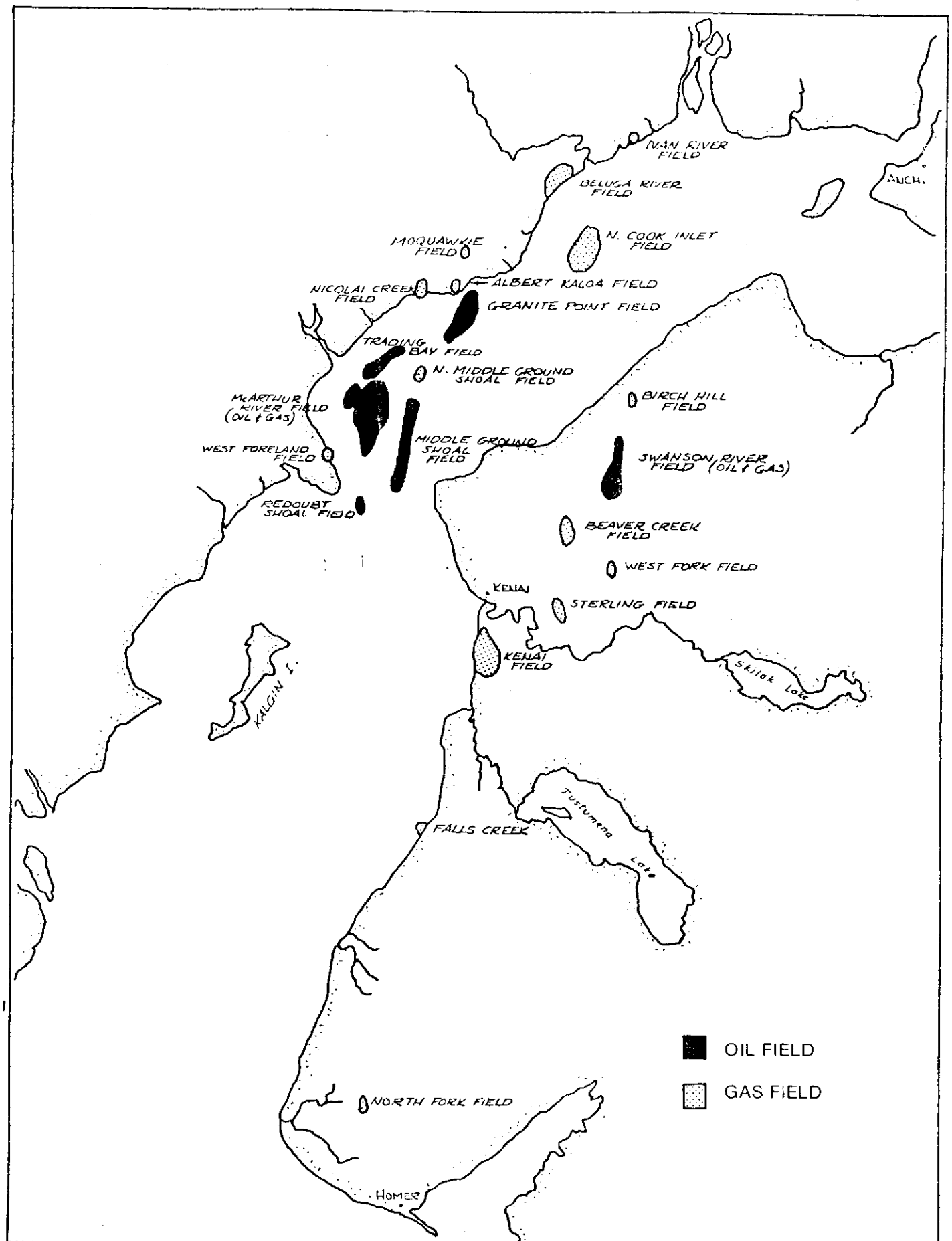
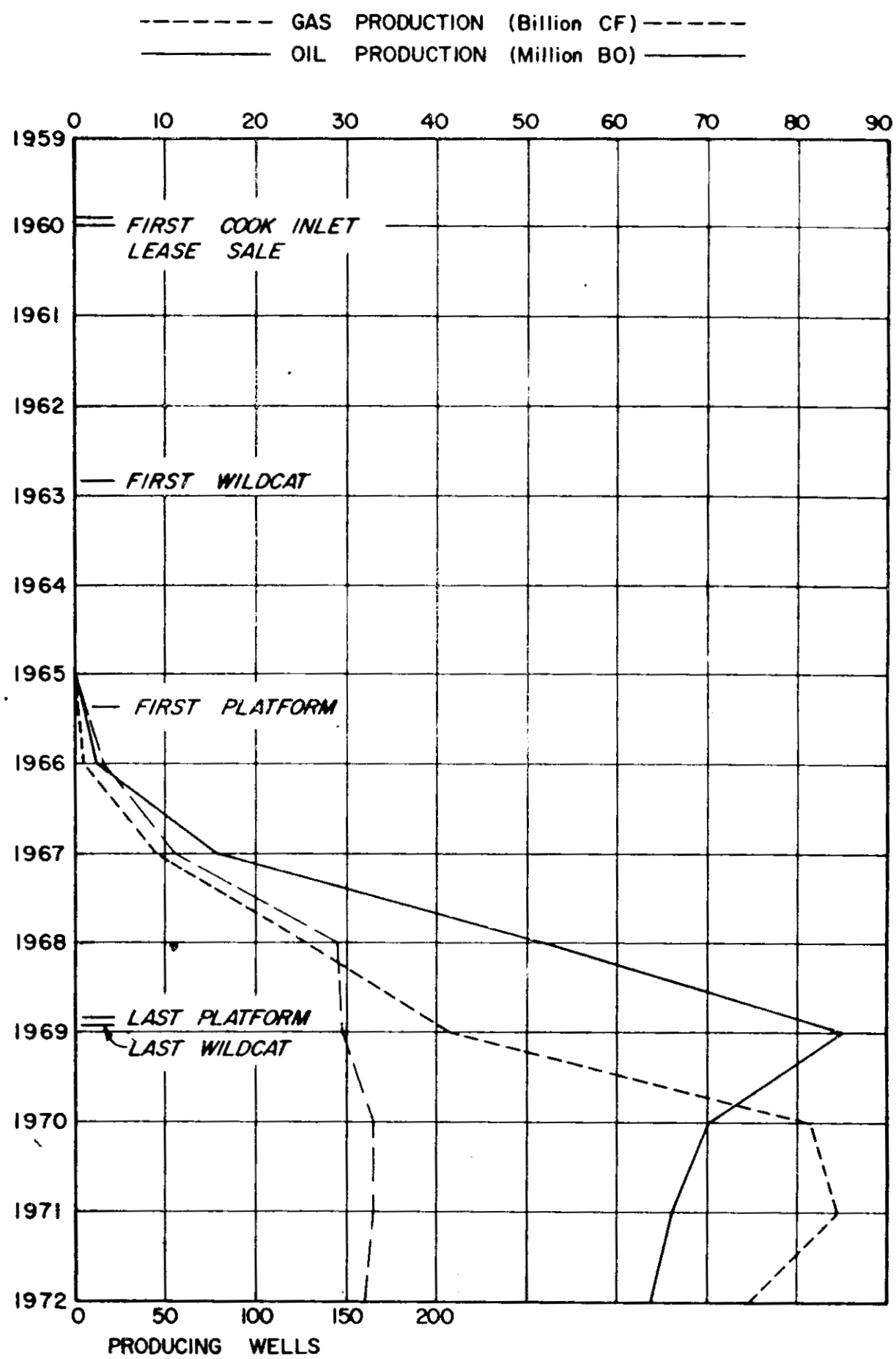


Figure 1 - OIL AND GAS FIELDS OF THE COOK INLET AREA

Figure 2
OIL EXPLORATION & PRODUCING ACTIVITY
COOK INLET SUBMERGED LANDS



MAJOR PORTS

In Table 2, a port is identified as an oil or gas or timber port only if those commodities make up a significant part of its total cargo. Ports are treated as complexes and may cover areas 20 miles long as at Kenai/Nikiski, or they may be compact, as at Anchorage.

Table 2
MAJOR PORTS IN COOK INLET

Name	General Cargo	Oil & Gas	Fish Processing	Timber Processing	Ferry Terminal
Homer	X	X*	X		X
Seldovia	X		X	X	X
Draft River		X			
Kenai/Nikiski		X	X		
Anchorage	X	X	X		X**

No major shipments through the port, but tankers lie in the roadstead at times awaiting improvements in ice conditions or weather
***Summer schedule only.*

OUTBOUND PETROLEUM PRODUCTS

Nikiski and Drift River are the two principal oil-shipment ports. Shipments from Nikiski in 1971 amounted to about 19 million barrels of crude, residuum, and finished products, while regular shipments of liquified natural gas (LNG) were made from this port on a weekly basis. Urea is also made at Nikiski and shipped from there to Japan.

Shipments of crude oil from Drift River amount to about 60 million barrels per year. This amount will remain constant for the next several years, then decline unless further discoveries are made in Upper Cook Inlet.

INBOUND PETROLEUM PRODUCTS

The great bulk of petroleum products shipped into Cook Inlet ports are destined for Anchorage where 10,305,396 barrels were received in 1971. Minor shipments are received at Seldovia, Kenai and Homer. Some of the shipments are intra-regional transfers from Nikiski to Anchorage.

PIPELINES

There is an extensive offshore pipeline system north of the Forelands in Cook Inlet, connecting to onshore pipelines on both sides of the Inlet (Figure 3).

About 180,000 barrels per day, or 5.4 million barrels per month, are pumped through 20 oil pipelines in this complex. The individual fields and their production are shown in Table 3.

Table 3
PRODUCTION FROM COOK INLET OIL FIELDS*

Code (Fig.)	Oil Field Name	Number Pipelines Serving Field	Production Per Month (bbl)
B	Granite Point	4	750,000
C	Middle Ground Shoal	4	800,000
D	Trading Bay 1 & 2	6	850,000
E	McArthur River	6	3,000,000
		20	5,400,000

From files of Alaska Dept. of Natural Resources, Division of Oil & Gas, Anchorage.

There are, in addition, two pipelines serving the North Cook Inlet gas field, which supply some of the gas for conversion to LNG at Nikiski.

The pipeline supplying the natural gas to Anchorage crosses Turnagain Arm between Bird Point and Potter. Gas lines also have been constructed to Granite Point and McArthur River Fields to carry gas formerly flared.

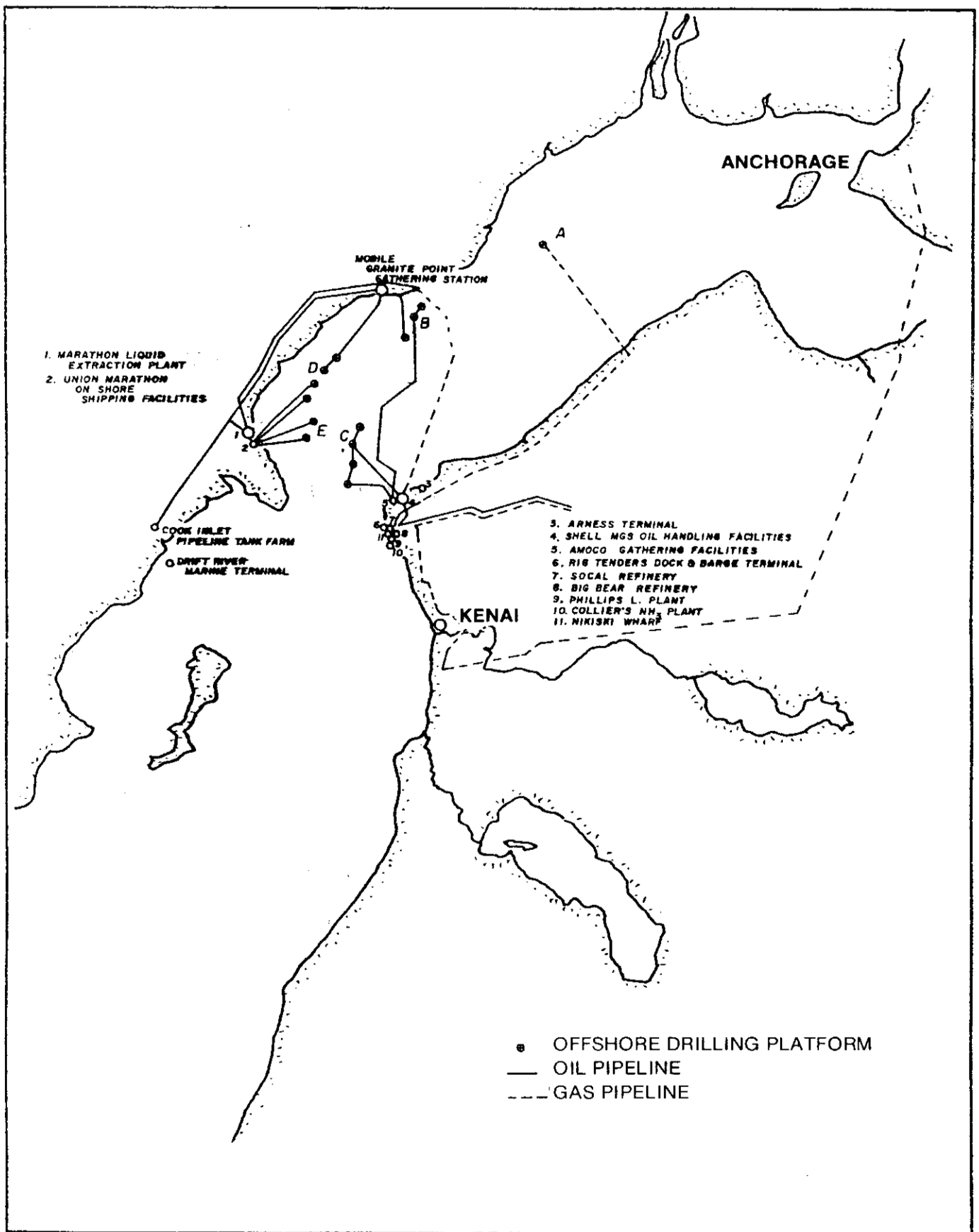


Figure 3
PETROLEUM INSTALLATIONS IN COOK INLET BASIN

FISH AND WILDLIFE RESOURCES

THE FISHING INDUSTRY

The fishing and fish processing industries of Cook Inlet are second to the petroleum industry in annual dollar value of production, and not only constitute an important segment of the regional economy, but also provide recreation, economic, and social benefits associated with sport fishing and tourism. The fishery resources are renewable, and with proper management can provide the State of Alaska with a valuable and stable industry indefinitely.

Various species of fish and shellfish are important to the industries in Cook Inlet. Exploratory deep water trawls conducted by the U.S. Bureau of Commercial Fisheries (National Marine Fisheries Service) revealed the presence of 25 species of finfish, of which butter sole, yellowfin sole, turbot and pollock, were most abundant. Five species of shrimp, three species of crabs, octopus, scallops and other invertebrates were also recorded. Systematic inventories of pelagic species have not been made.

Estimates of the total value to fishermen, from all species from 1962 through 1970 are shown in Figure 1.

Unless otherwise noted, maps, graphs and tables related to fish, shellfish and waterfowl are from "The Cook Inlet Environment, A Background Study of Available Knowledge," by Charles D. Evans, and Eugene Buck, Richard Buffler, Greg Fisk, Robert Forbes, and Walter Parker, University of Alaska, Alaska Sea Grant Program, August 1972.

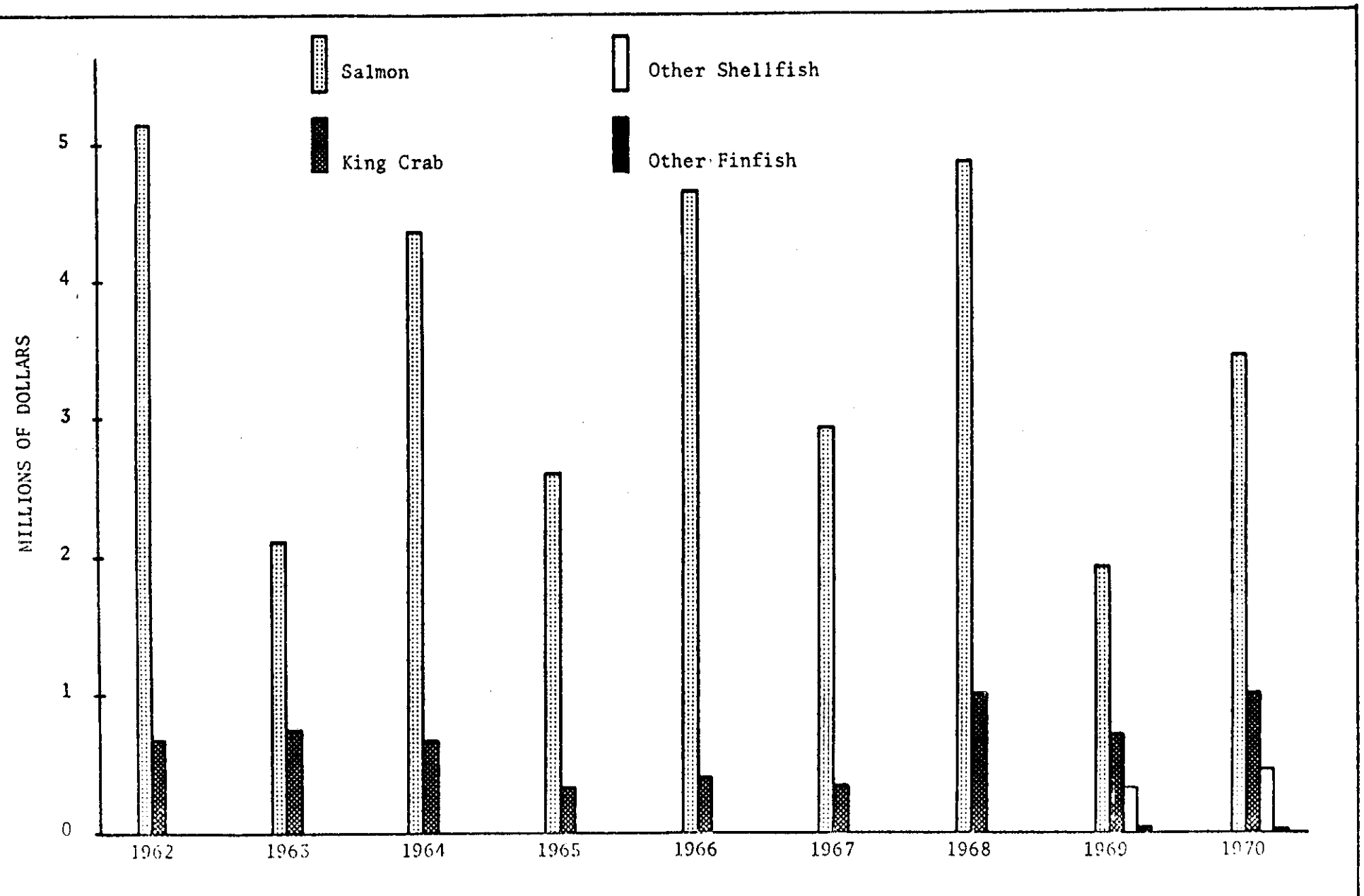


Figure 1 VALUE OF THE COOK INLET FISHERIES, 1962-1970

FISH

Fish populations in Cook Inlet include anadromous species, such as salmon, and resident species, such as flounders and sculpins. Other species, including halibut, while not anadromous, may be considered migratory since they move into shallower water at certain times of the year.

SALMON

All five North American species of Pacific salmon, the chinook *(Oncorhynchus tshawytscha)*, sockeye *(O. nerka)*, pink *(O. gorbuscha)*, coho *(O. kisutch)* and chum *(O. keta)* inhabit Cook Inlet in significant numbers.

The Cook Inlet — Resurrection Bay area — has been divided for management purposes into seven districts as shown in Figure 2.

Much of the Cook Inlet salmon population is widely distributed and spawns in, or travels through, turbid waters of the upper inlet. As a consequence, spawning ground survey information is limited and exploratory fishing has not been intensive enough to provide usable information. Reliance, therefore, must be on catch information supplemented by available steam survey data.

Trends in salmon harvest for the 76-year period, 1893-1969, are shown in Table 3 in terms of ten-year averages. In recent years, there has been a drastic reduction in harvest of chinook salmon. What portion of this results from a reduction in the salmon population, and how much results from more restrictive regulation is only conjectural. Harvests of sockeye have held relatively steady. Even-numbered years during the 1960-69 period produced the highest average pink salmon harvest in the history of this fishery.

Surprisingly, the coho and chum harvests appear to be highest in even years, even though these species are normally four-year fish.

A further breakdown of the 1960-69 average harvest by species by district is shown in Table 4.

The very low catch in the Kamishak District could result as much from its remoteness as from lack of fish. Flagg** points out that since 1968 the catch of pink and chum salmon in that district has increased, probably as a result of increased interest. The high catch in the Central District could have resulted from fish destined for spawning areas in the Upper Inlet as well as the Productive Kenai-Kasilof systems that passes through there.

**Flagg, Loren B., Commercial Fish Div., Alaska Dept. of Fish and Game, Homer.*

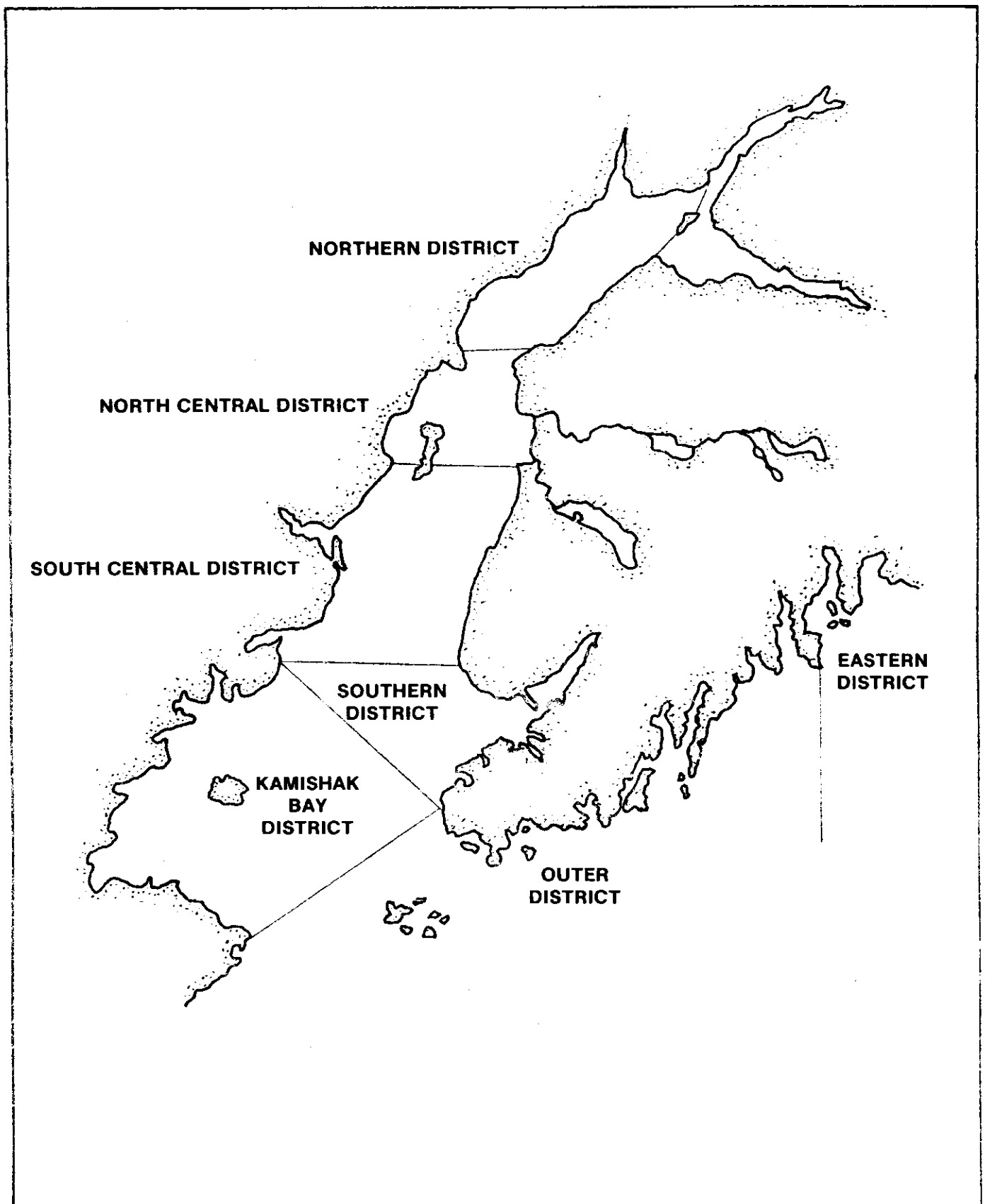


Figure 2
COOK INLET - RESURRECTION BAY COMMERCIAL FISHERY MANAGEMENT DISTRICT

Table 3

TEN YEAR HARVEST AVERAGES COOK INLET SALMON
(Thousands of fish)

	Chinook	Sockeye		Pink	Coho	Chum	Total
1893-1899	19.3	382.3					
			O		39.0(3)		402.8
			E	38.0(1)*	43.3(3)		495.0
1900-1909	39.4	486.7					
			O	5.3(3)	83.2(4)		555.2
			E	172.7(3)	57.4(5)		727.8
1910-1919	51.4	1395.9					
			O	40.0	104.8	34.4	1637.4
			E	1108.0	160.0	79.8	2771.4
1920-1929	49.3	1250.9					
			O	137.0	187.0	54.8	1649.6
			E	597.0	313.0	85.4	2324.6
1930-1939	64.6	1606.6					
			O	364.6	211.8	138.6	2230.2
			E	821.4	340.2	143.4	3132.2
1940-1949	91.6	1645.6					
			O	1061.2	333.8	274.4	3349.2
			E	1714.6	488.2	365.8	4363.2
1950-1959	78.6	1352.5					
			O	539.4	186.2	553.0	2624.2
			E	2045.6	287.4	630.8	4460.4
1960-1969	13.3	1176.3					
	(14.5%)	(71.5%)	O	177.5(16.7%)	152.0(45.6%)	356.1(64.5%)	1875.2(56.0%)
			E	2659.5(100%)	379.2(77.8%)	920.1(100%)	5148.4(100%)

O=odd numbered years
E=even numbered years

**Figures in parenthesis indicate number of years data available*
***The percentage of maximum 10 year average catch represented by the 1960-69 average catch*

Table 4
TEN-YEAR AVERAGES 1960-69 SALMON HARVEST - COOK INLET
(Thousands of fish)

District	Chinook	Sockeye	Coho	Pink	Chum	Total
All Years						
Northern	3.8	108.5	91.1	225.5	65.4	494.3
Central	9.5	1,051.2	171.0	955.0	536.9	2,723.5
Kamishak	tr	1.5	0.5	41.9	26.1	70.0
Southern	tr	15.1	3.0	196.1	9.7	223.9
Total Harvest	13.3	1,176.3	265.6	1,418.5	638.1	3,511.8
Even Years						
Northern			144.4	443.0	96.5	796.2
Central	as	as	230.4	1,887.1	781.0	3,959.3
Kamishak	above	above	0.1	46.7	31.0	79.3
Southern			4.3	282.6	11.6	313.6
Total even year			379.2	2,659.5	920.1	5,148.4
Odd Years						
Northern			37.9	8.0	34.3	192.5
Central	as	as	111.5	22.8	292.7	1,487.7
Kamishak	above	above	0.9	37.1	21.2	60.7
Southern			1.8	109.6	7.8	134.3
Total odd year			152.0	177.5	356.1	1,875.2

Chinook Salmon

Figure 3 plots the distribution of the commercial harvest of Chinook salmon by district for the years 1954 through 1971.

The declining harvest probably results in part from regulations imposed which outlawed chinook salmon gear, but permitted fishermen to retain chinook caught incidentally. The extreme reduction in catch in the Northern District for the years 1964-68 may have resulted from effective protection of spawners bound for the Susitna system by a late opening of the commercial season.

Sockeye Salmon

Sockeye salmon harvests for the years 1954-71 are shown in Fig. 4 for the Northern and Central Districts. There are not enough data for the Southern and Kamishak Districts from which to draw conclusions. As in the case of chinook salmon, most of the catch is in the Central District. Major sockeye spawning systems are the Kenai-Russian. (Figure 5)

Figure 3
COOK INLET CHINOOK SALMON HARVEST
1954-1974

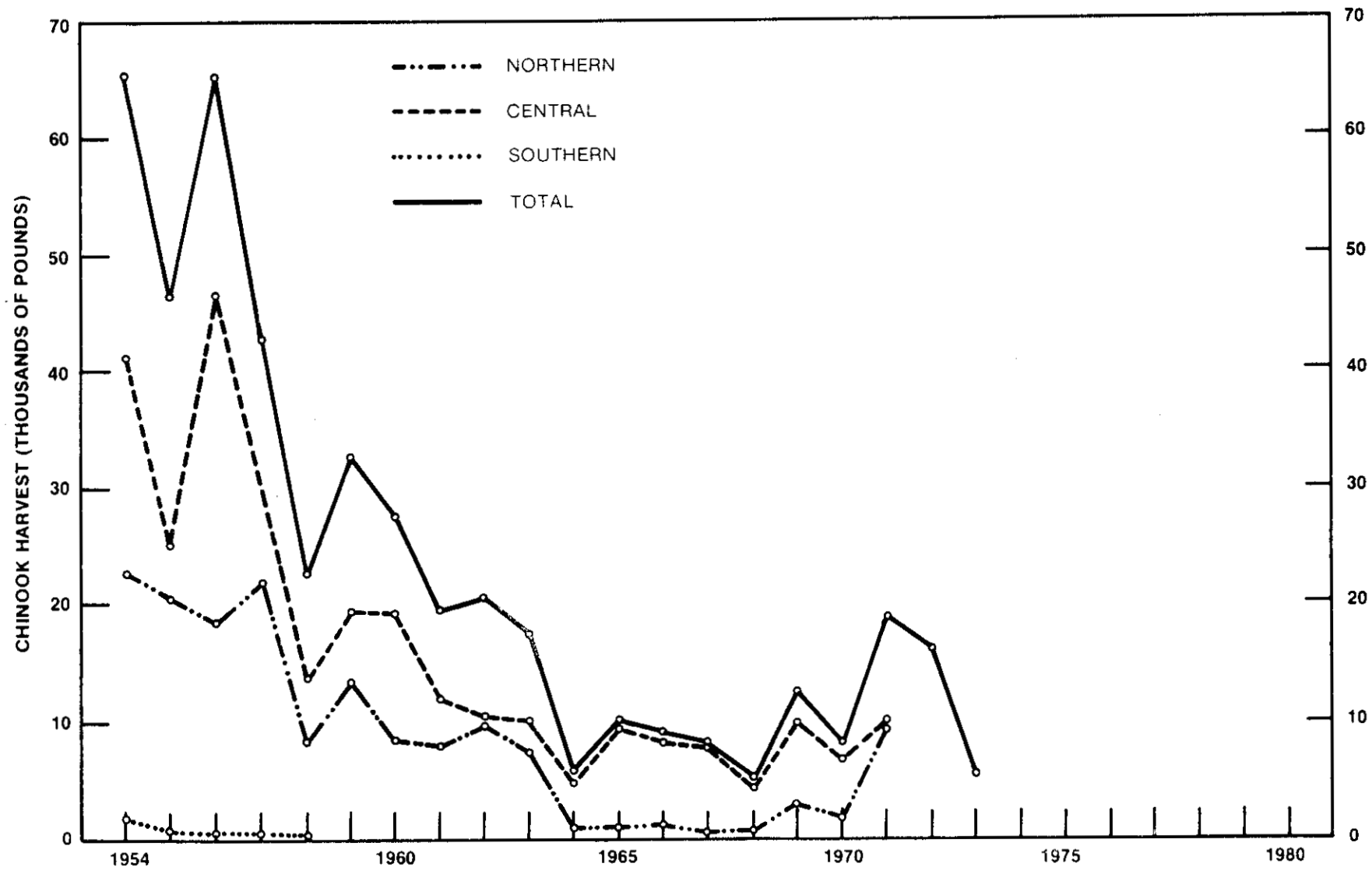
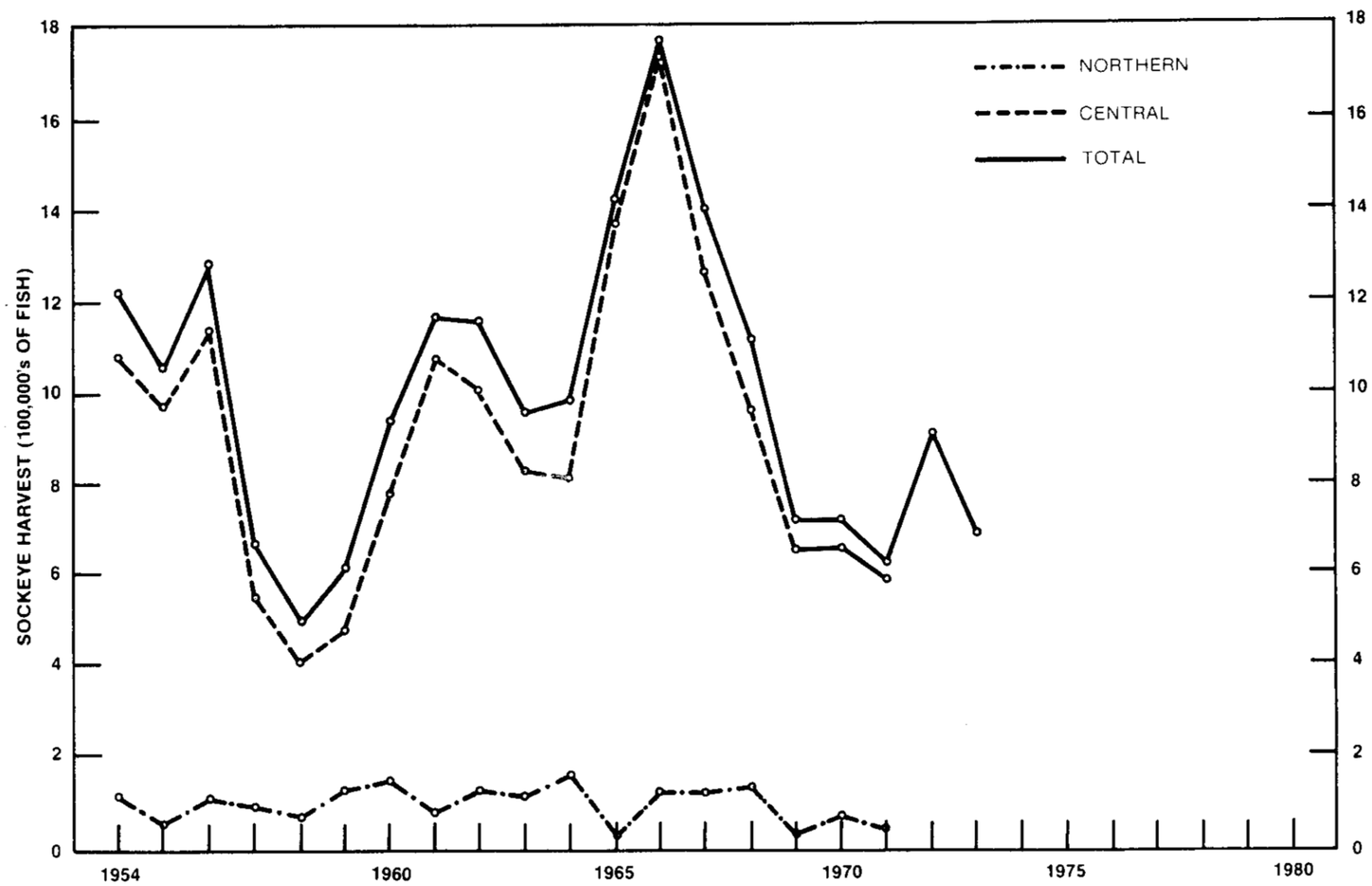


Figure 4
COOK INLET - SOCKEYE SALMON HARVEST
1954-1974



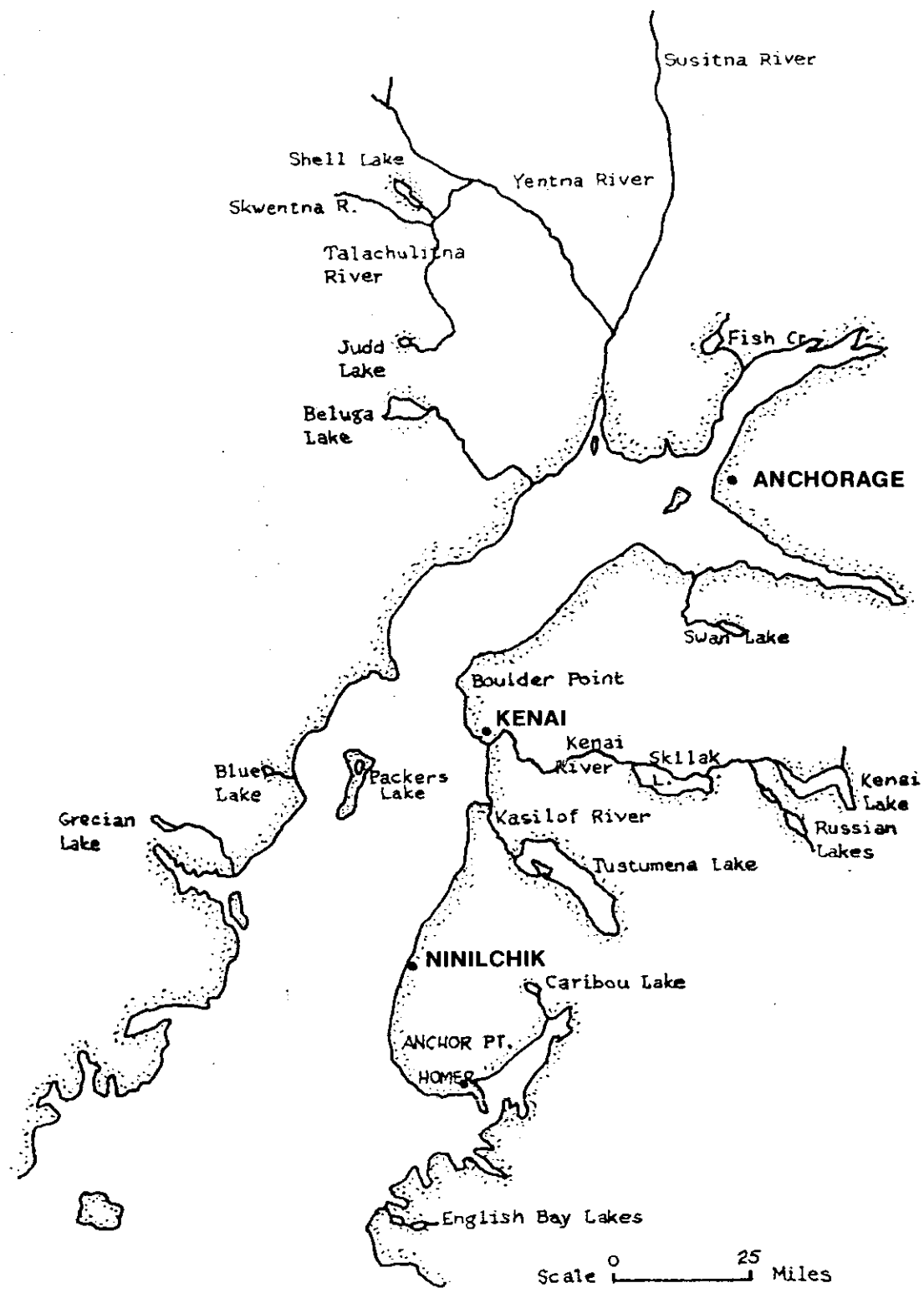


Figure 5
SOCKEYE SALMON SPAWNING SYSTEMS

Pink Salmon

The pink salmon harvest for the years 1954-71 for the Northern, Central and Southern Districts is shown in Figure 6.

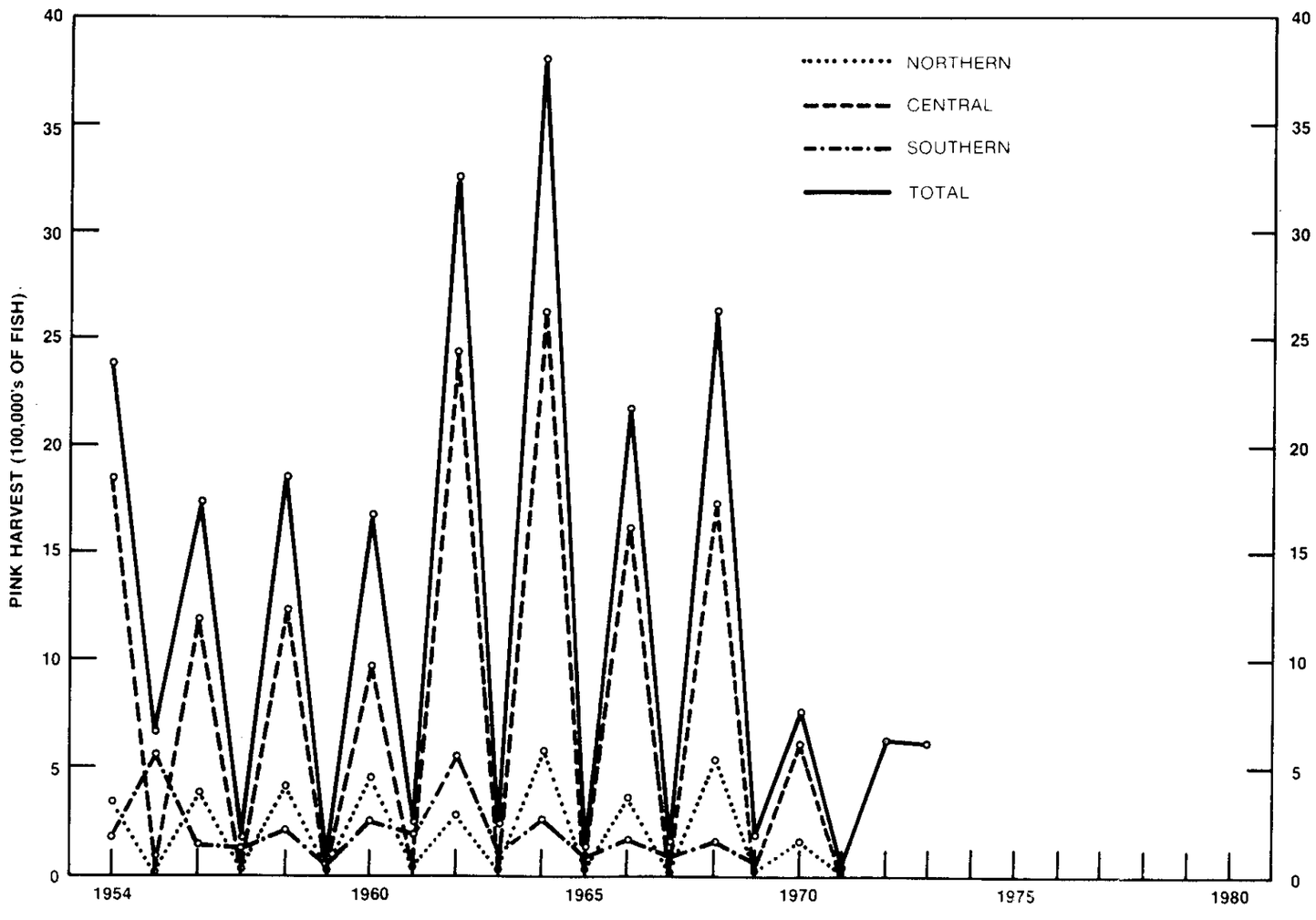
Because of the marked even-year periodicity in the pink salmon runs, the even and odd-year total catches for the period 1954-1971 have been plotted separately in Figure 7. Table 5 shows the ten-year average harvest for the period 1960-69 by district and points out that by far the greatest difference between odd and even years occurs in the Northern Central Districts. The Northern District, that is mostly supported by the streams of the Susitna River system, has a short harvest period. The Central District, with runs into more streams, has a longer harvest period.[3]

Southern District pink salmon streams which are important to the Cook Inlet salmon fishery are Humpy, Tutka, Seldovia and Point Graham. In the Southern District, many fish are caught before the end of June and a high rate of fishing activity continued into mid-August. There are probably two pink salmon runs in the inlet.[3] The first run is bound for the Susitna River system and the harvest starts in the first week of July and continues into early August. The second run is bound for the Kenai and Kasilof Rivers and peaks during the first week in August.

Table 5
PINK SALMON CATCH BY DISTRICT - ODD AND EVEN YEARS
TEN YEAR AVERAGE 1960-1969
(Thousands of fish)

District	Even Years	Odd Years
Northern	443	8
Central	1,887	23
Kamishak	47	37
Southern	282	110
Total	2,659	178

Figure 6
COOK INLET - PINK SALMON HARVEST
1954-1974



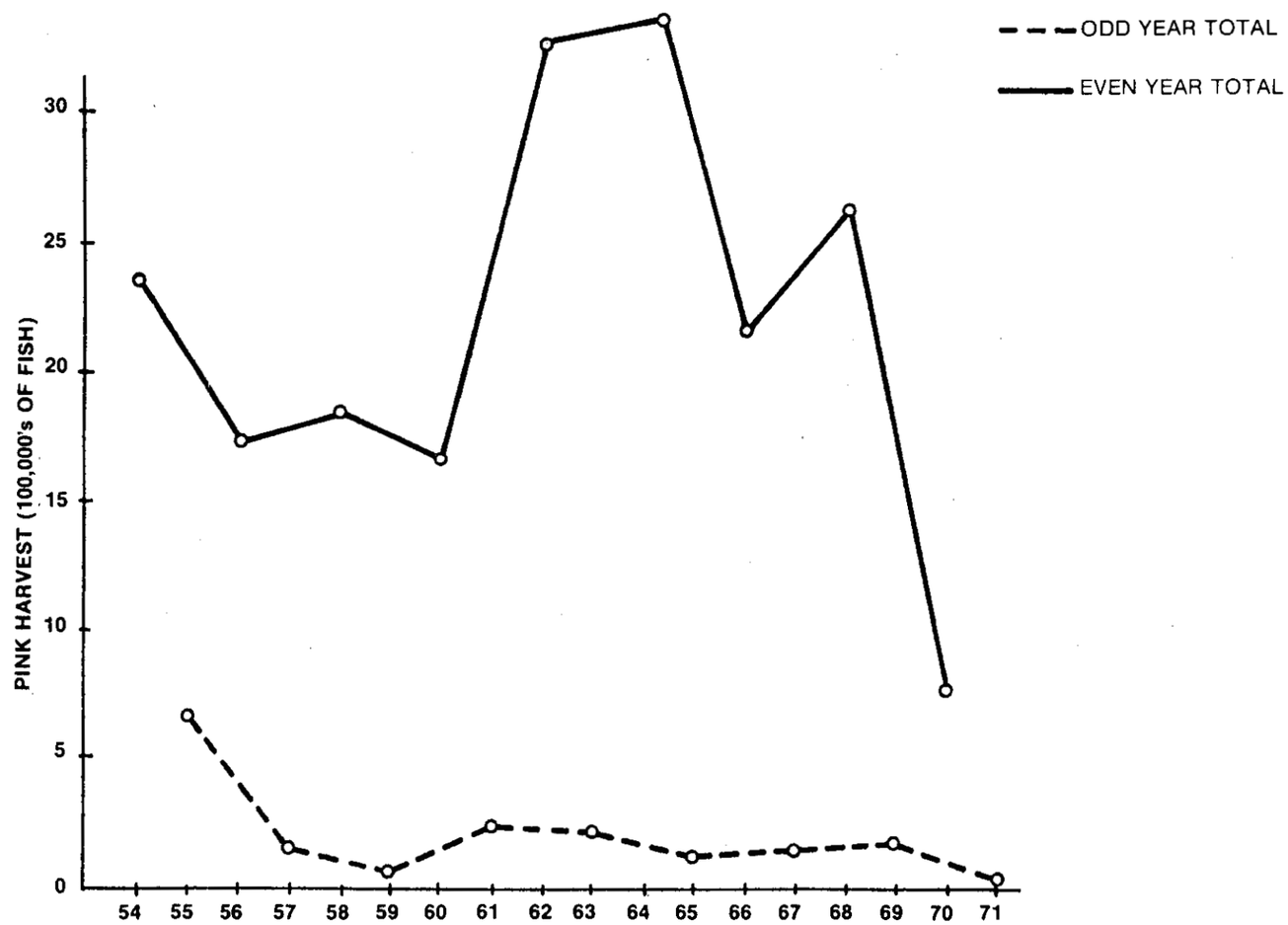


Figure 7
COOK INLET - PINK SALMON HARVEST 1954-1971

Coho Salmon

The coho salmon harvest in the Northern and Central Districts for the years 1954-71 are shown in Figure 8. The even-year periodicity of the coho harvest shown by this figure might result from a periodicity of fishing effort based on expected strength of pink salmon runs; however, the coho salmon sport catch in fresh water in the Upper Inlet is also normally greater in even years.[4] This periodicity, shown in Figure 9, although not as marked as in the pink salmon, is nonetheless consistent.

The harvest begins slowly in late June, but does not peak until considerably later. Cohos enter streams of Upper Cook Inlet mid-July to September, and some are in the Inlet until mid-October. A report some years ago indicated that cohos entered the Anchor River by August 3, and that the run was substantially over by the end of September.[5] This is a considerably later schedule than is indicated by the catch data, suggesting that cohos spend a long period in the Inlet before entering spawning streams.

The major coho spawning streams in the Inlet are on the east side north of Ninilchik and include the Kasilof, Kenai and Susitna Rivers.

Chum Salmon

The chum salmon harvest for the years 1954-71 in the Northern and Central Districts is shown in Figure 10. Catch trends for chums are similar to cohos in their even-year periodicity of larger catches, probably for the same reason. Figure 11 shows the even-year and odd-year chum harvests separately for the same period, and indicates an unusual odd-year high in 1957 and an even-year low in 1958. Davis[1] lists the Susitna Basin, Cottonwood Creek, Iniskin River, McNiel River, Chinitna Bay and other west side streams as major chum producers. No chums are reported in the Kenai or Kasilof Rivers.

Seasonal Presence of Salmon

Figures 12 and 13 summarize, by species, the mid-80 percent of the catch for the period 1966-71. The height of the graph indicates the number of years that significant harvests occurred during that portion of the fishing season. The highest portion of the graph indicates the period during which harvest was most active. The check mark indicates the average date by which 50 percent of the catch had been made.

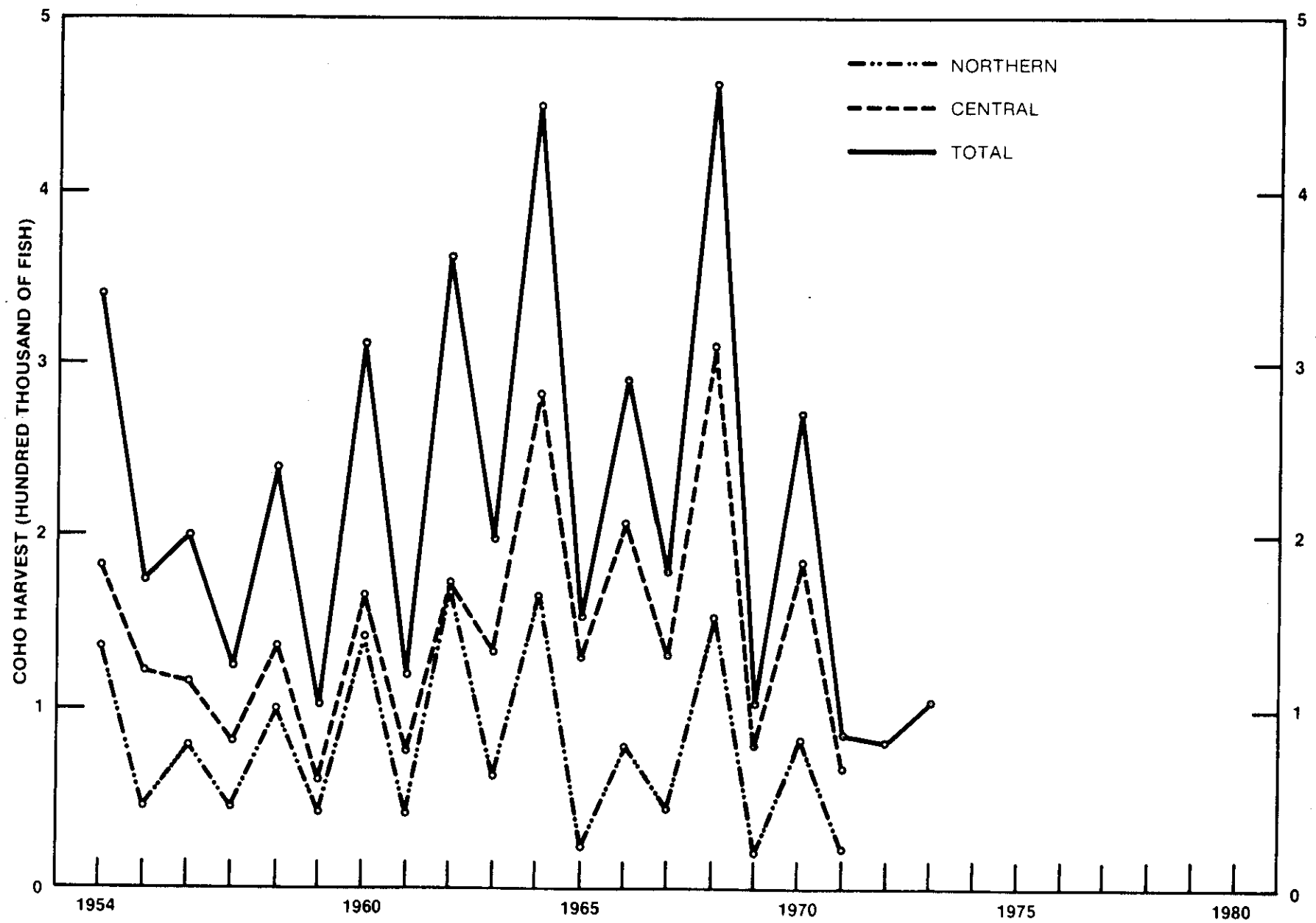
Figure 14 summarizes these data and serves as an indicator of the harvest rate for all species combined in the Northern and Central Districts. The period of greatest activity is from July 1 to August 10.

Because the timing of the catch is only a rough indication of the presence of fish, inferences based on the shape of the catch curve and stream survey information have been used to extend the catch curves. We can thus infer the period when adult salmon probably are present in Cook Inlet in significant numbers, as shown in Figure 15.

The presence of significant numbers of adult salmon in the Inlet probably begins with chinook about May 15 and ends with coho smolt migration from the Kenai River in 1967 began in strength on May 25 and peaked about June 5 and 6.[6] A mark and recapture program in 1967 indicated that 5,000,000 sockeye smolts migrated down the Kenai River. There is, however, no quantitative information on abundance or timing of presence of salmon smolts in the Inlet.

As indicated by the foregoing data, salmon, either adults or smolts, are present in Cook Inlet waters from about May 1 to about September 20.

Figure 8
COOK INLET - COHO SALMON HARVEST
1954-1974



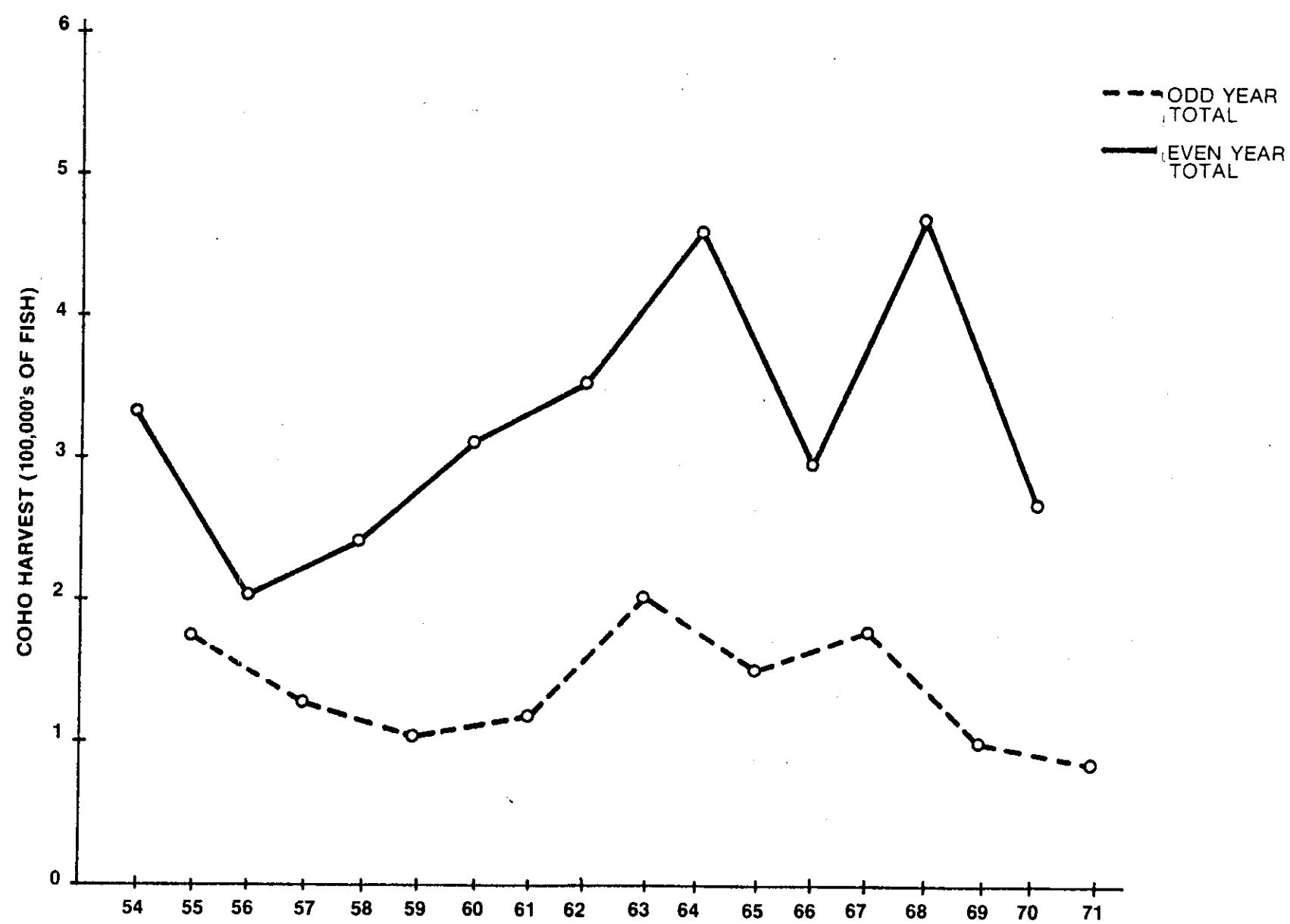
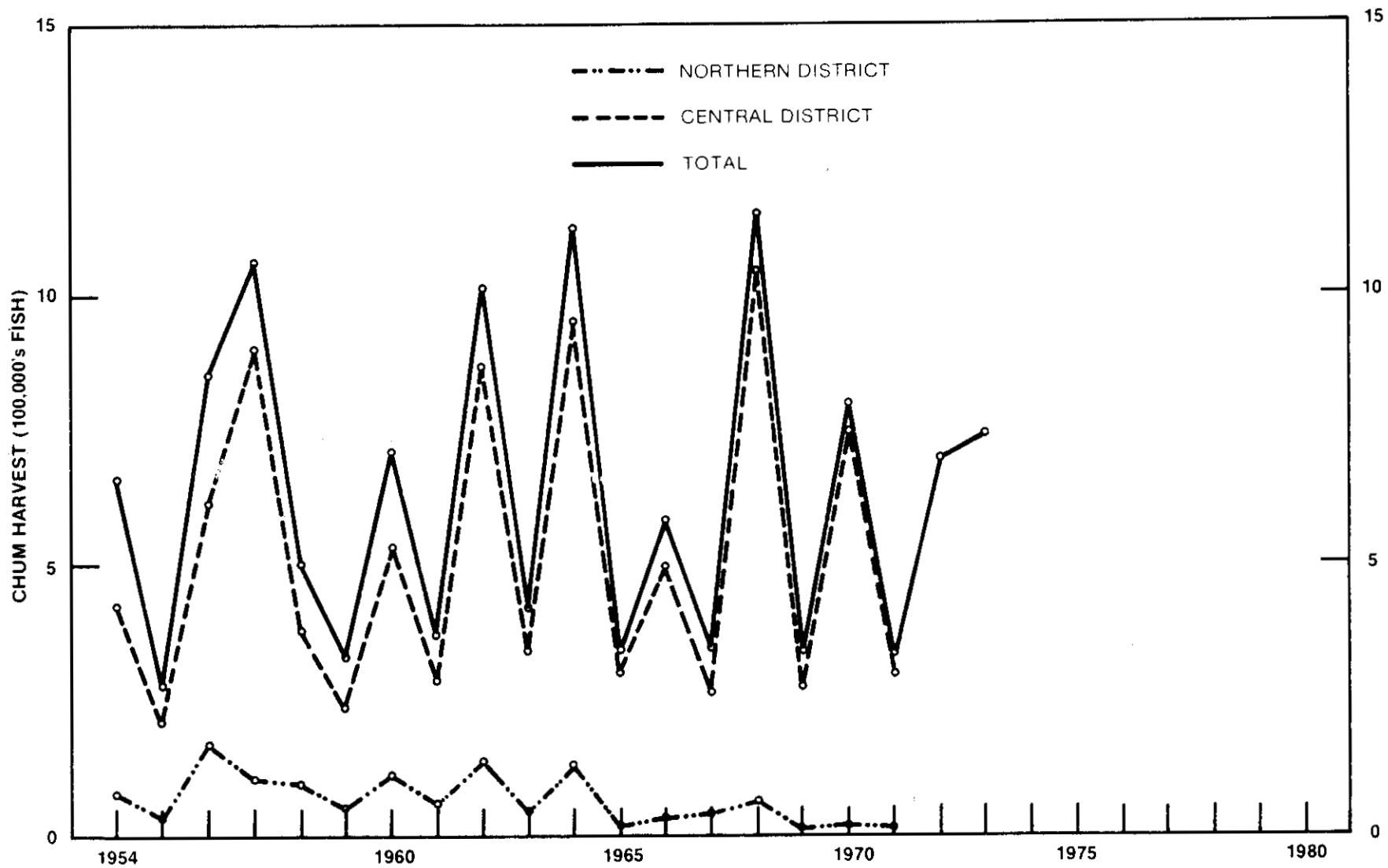


Figure 9
COOK INLET - COHO SALMON HARVEST 1954-1971

Figure 10
COOK INLET - CHUM SALMON HARVEST
1954-1974



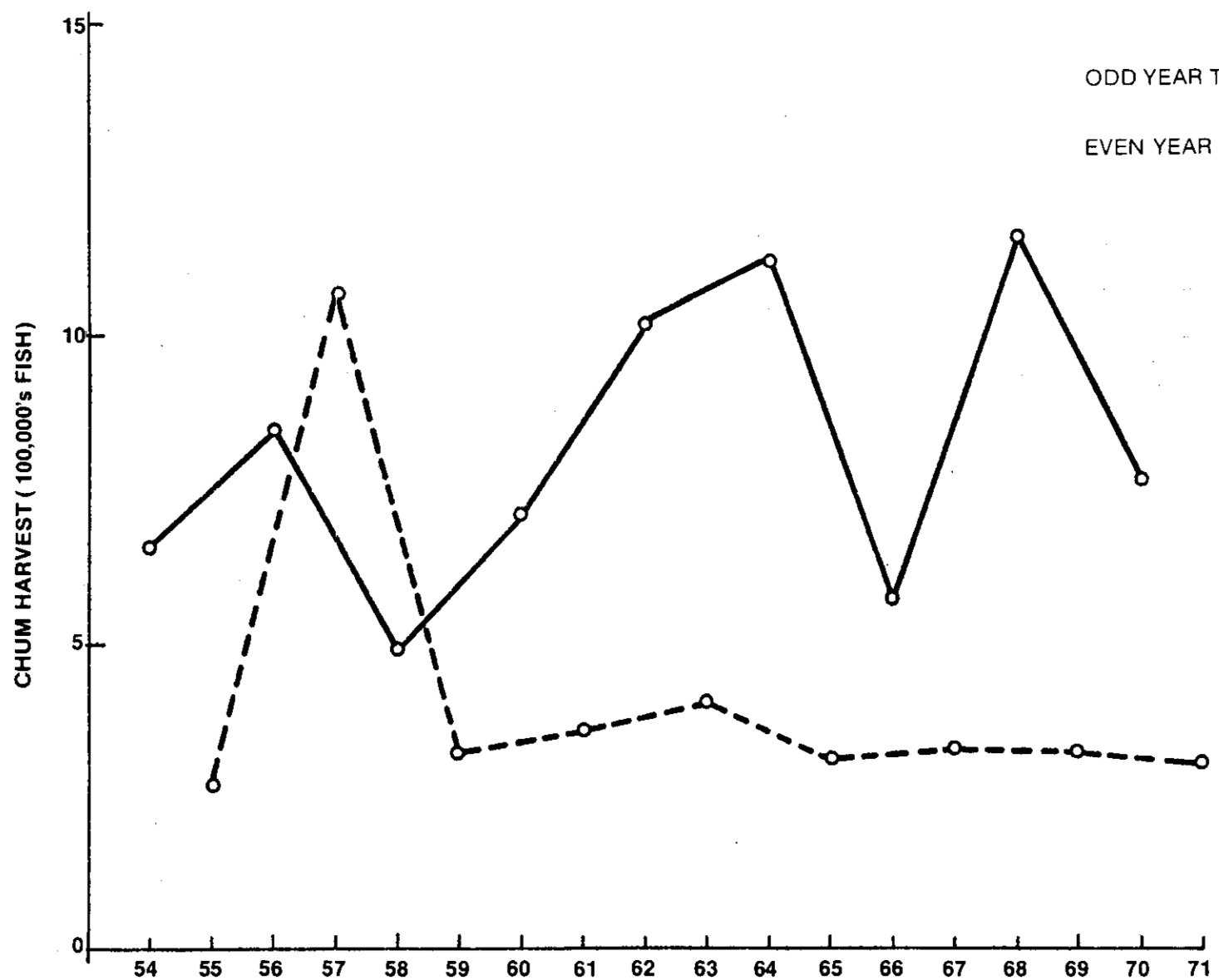


Figure 11
COOK INLET - CHUM SALMON HARVEST 1954-1971

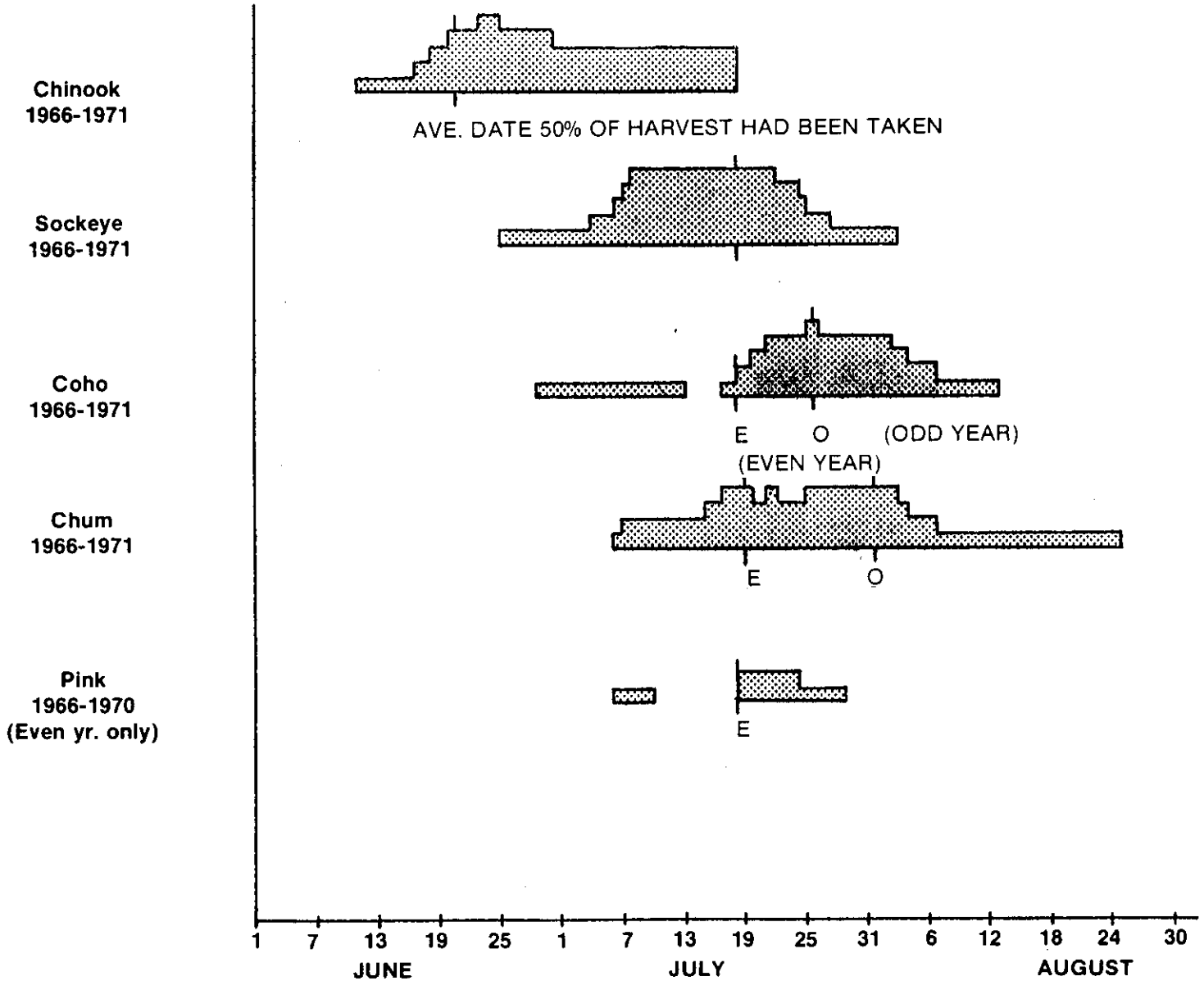


Figure 12
TIMING OF SALMON HARVEST - NORTHERN DISTRICT COOK INLET

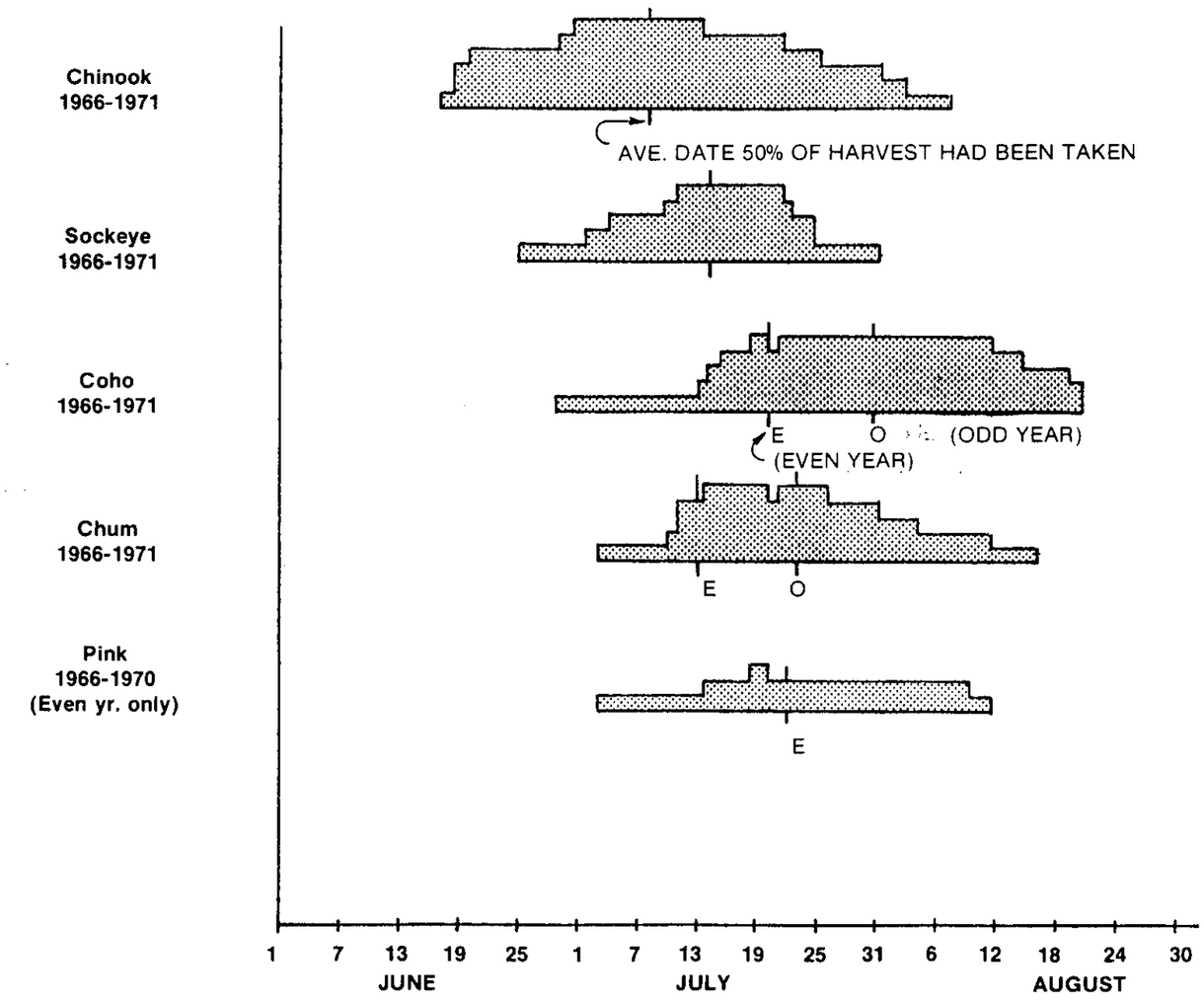


Figure 13
TIMING OF SALMON HARVEST — CENTRAL DISTRICT COOK INLET

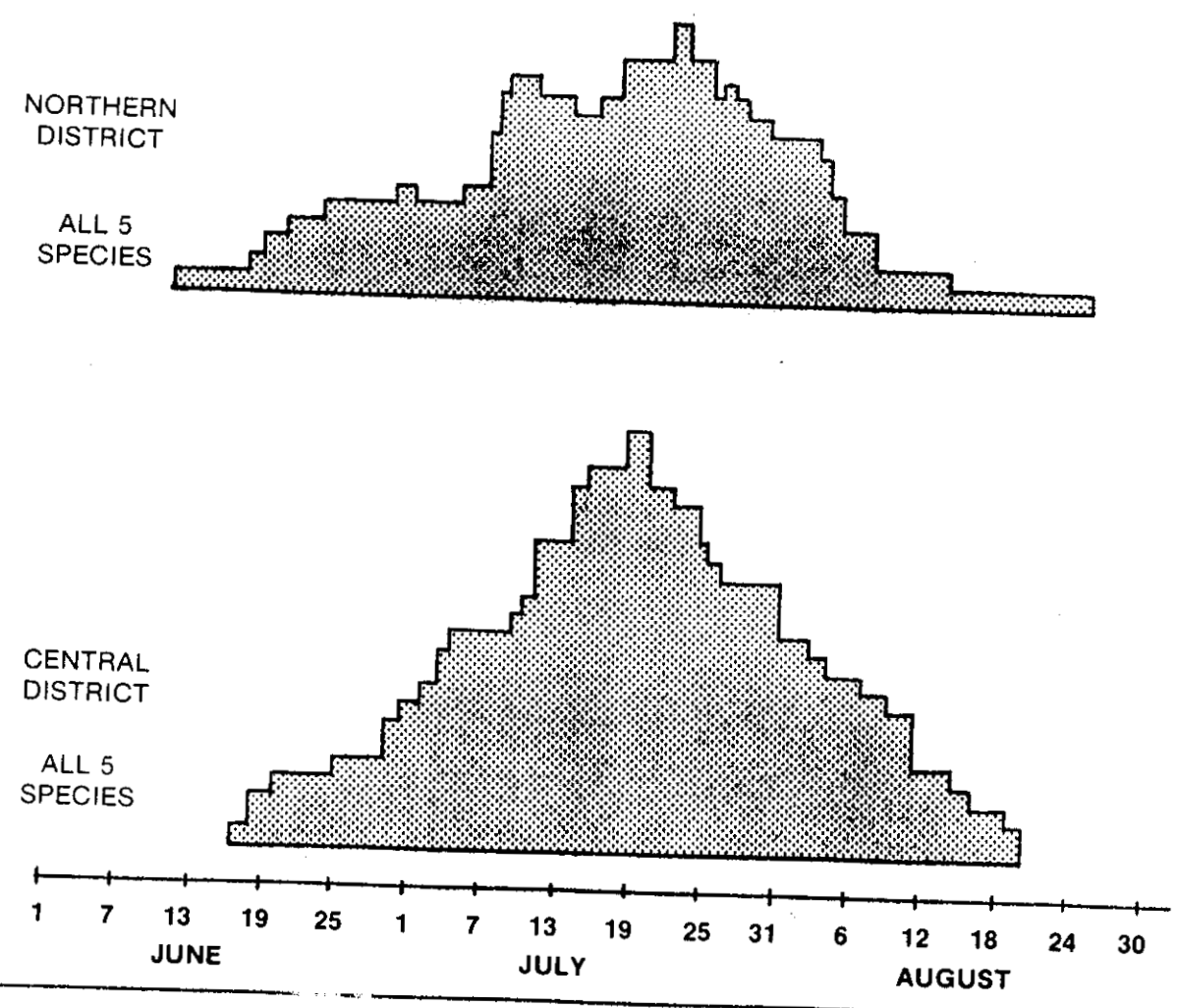


Figure 14
TIMING OF SALMON HARVEST - UPPER COOK INLET

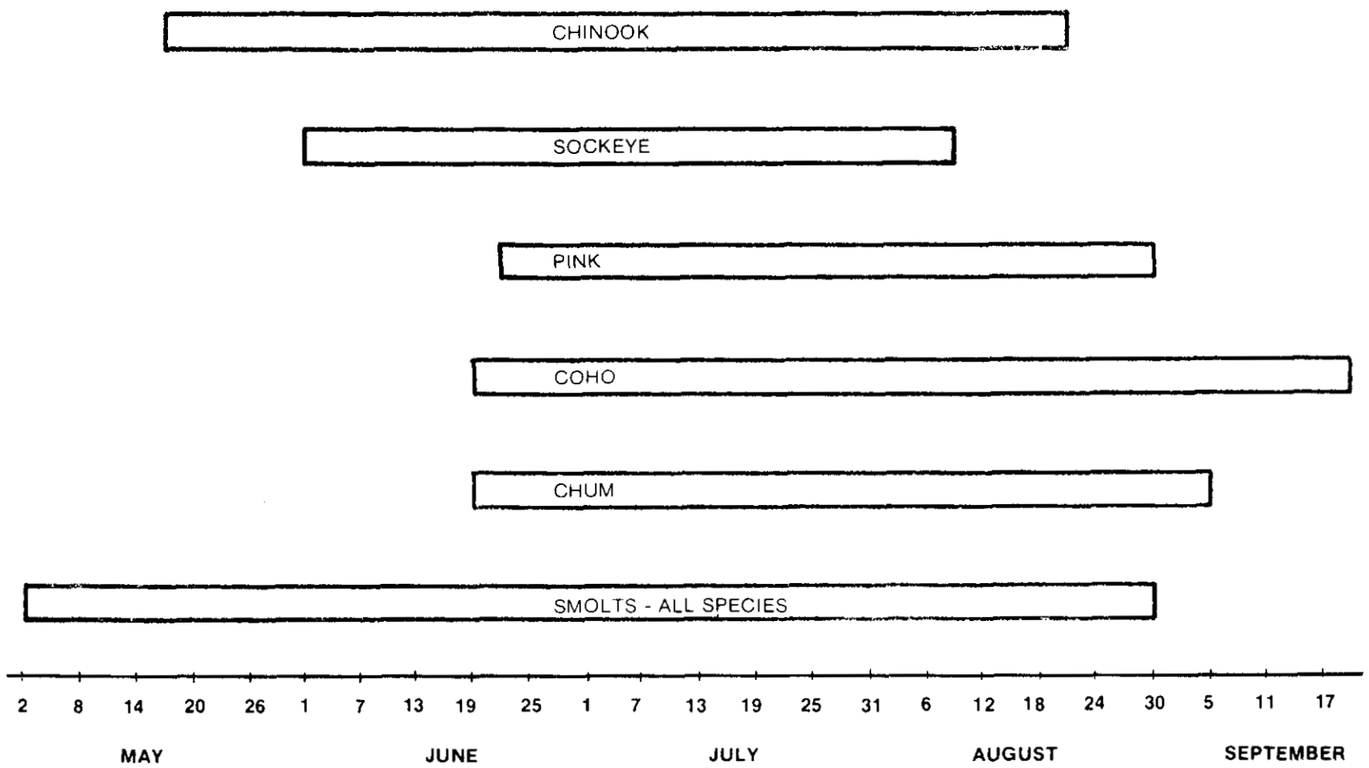


Figure 15
PROBABLE PERIOD DURING WHICH SIGNIFICANT NUMBERS OF ADULT SALMON ARE IN COOK INLET. BASED ON CATCH DATA, SHAPE OF CATCH CURVE AND STREAM SURVEYS

Salmon — Sport Fishery

The Cook Inlet salmon are an important recreational resource. Table 6 lists Cook Inlet streams which support a significant sport fishery.

A sport fishery for Chinook is developing in salt water off the mouth of Deep Creek. Such a fishery is also developing in the Anchor and Ninilchik Rivers. A substantial number of pink salmon, a few hundred sockeyes, and a few cohos have been taken incidentally in this fishery. The shoreline in this area also sustains a sport fishery for pinks and cohos.

The most intensive sport fishing in Cook Inlet appears to be on the Russian River, a tributary to the Kenai River. Engel (1970)[7] shows data for the Russian River sockeye sport harvest and compares it with the total escapement. Table 7 shows his figures for the period 1962-1969.

Steelhead *(Salmo gairdneri)*

Steelhead run in the Anchor River, Deep Creek, Ninilchik River and Stariski Creek. (Logan).* Sport fishermen have reported taking fish in the Kenai River. The Anchor River sustains the strongest of the known runs.[5]

Steelhead move downstream in late May and June, and out of the Inlet to the open sea where they remain for a little more than a year before returning. The return run begins about August 15 and continues until about October 14.[5]

Dolly Varden *(Salvelinus malma)*

Dolly Varden are widely distributed throughout the Inlet and are an important sport fish in many streams draining into the Inlet. They probably move out under the ice, since they have never been observed in their outmigration. They apparently move down to Kachemak Bay where they are often caught during the summer, returning to the streams from July through October.

---

*Logan, Sidney M., Area Management Biologist, Alaska Department of Fish and Game, Soldotna.

Table 6
COOK INLET STREAMS WITH SPORT FISHING FOR SALMON

Streams	Species Caught					
	Chinook	Sockeye	Pink	Coho	Chum	Steelhead
Northern District						
Lewis River	*		*	*		
Susitna R + tributaries	*	*	*	*	*	
Little Susitna	*	*	*	*	*	
Fish Cr (Big Lake)		*	*	*		
Cottonwood Cr		*		*		
Wasilla Cr				*		
Matanuska R + tributaries	*		*	*	*	
Eagle R	*		*	*		
Ship Cr	*		*	*	*	
Campbell Cr	*	*[1]	*	*		
Bird Cr	*		*			
Twenty-mile R				*		
Resurrection R			*	*		
Swanson R		*		*		
North Central District						
Kenai R	*	*	*	*		
Kasilof R	*	*	*	*		
South Central District						
Ninilchik R + tributaries	*		*	*		*
Deep Cr + tributaries	*		*	*		*
Stariski Cr + tributaries	*			*		*
Silver Salmon Cr				*		
Polly Cr				*		
Kamishak Bay District						
McNiel R					*	
Southern District						
Anchor R + tributaries	*		*	*		*
Tutka Bay + tributaries				*		

[1]*Known from past records but run insignificant for current sport fishery*

Table 7
RUSSIAN RIVER SOCKEYE SALMON SPORT HARVEST

Year	1962 - 1969 Harvest Early Run	Harvest Late Run	Total Escapement	Effort (Man-Days)
1962	3,410	1,290	56,670	6,595
1963	3,670	1,390	65,500	7,880
1964	4,970	1,885	59,630	4,940
1965	7,760	2,940	43,330	8,320
1966	16,360	5,460	51,090	17,890
1967	8,500	3,640	63,190	16,470
1968	8,250	4,480	58,080	17,300
1969	5,430	1,100	34,000	13,970

HALIBUT *(Hippoglossus stenolepsis)*

Halibut are in the Inlet south of Kalgin Island from May through August. Although most of them winter in ocean waters, a few may remain in the Inlet in winter where they have been taken in shrimp hauls in Kachemak Bay.

Figure 16 shows the distribution of halibut taken in trawls in the Southern and Kamishak Districts during three U.S. Bureau of Commercial Fisheries exploratory fishing cruises in July, August and September of various recent years. The highest concentration of halibut was in Kachemak Bay.

Sport fishermen take halibut in the Lower Inlet when they are available, generally from May through August.

Halibut are not an important commercial fishery in Cook Inlet.

HERRING *(Clupea pallasii)*

Herring have been harvested in Cook Inlet in considerable quantities, but the fishery has declined drastically in recent years (Table 8). Herring are reported to be inshore in spring and summer, with active spawning in the Southern District in Kachemak Bay and southward into the Outer District. They are most abundant in Kachemak Bay.

Table 8
COOK INLET HERRING HARVEST
(pounds)

1914	311,346	1924	14,080,002
1915	29,400	1925	19,228,331
1916	138,474	1926	14,272,399
1917	1,886,745	1927	7,181,349
1918	3,970,029	1928	4,304,157
1919	5,296,386		
1920	1,918,497	1969	1,103,041
1921	5,222,176	1970	5,417,385
1922	1,007,690	1971	25,050
1923	7,562,356	1972	2,046

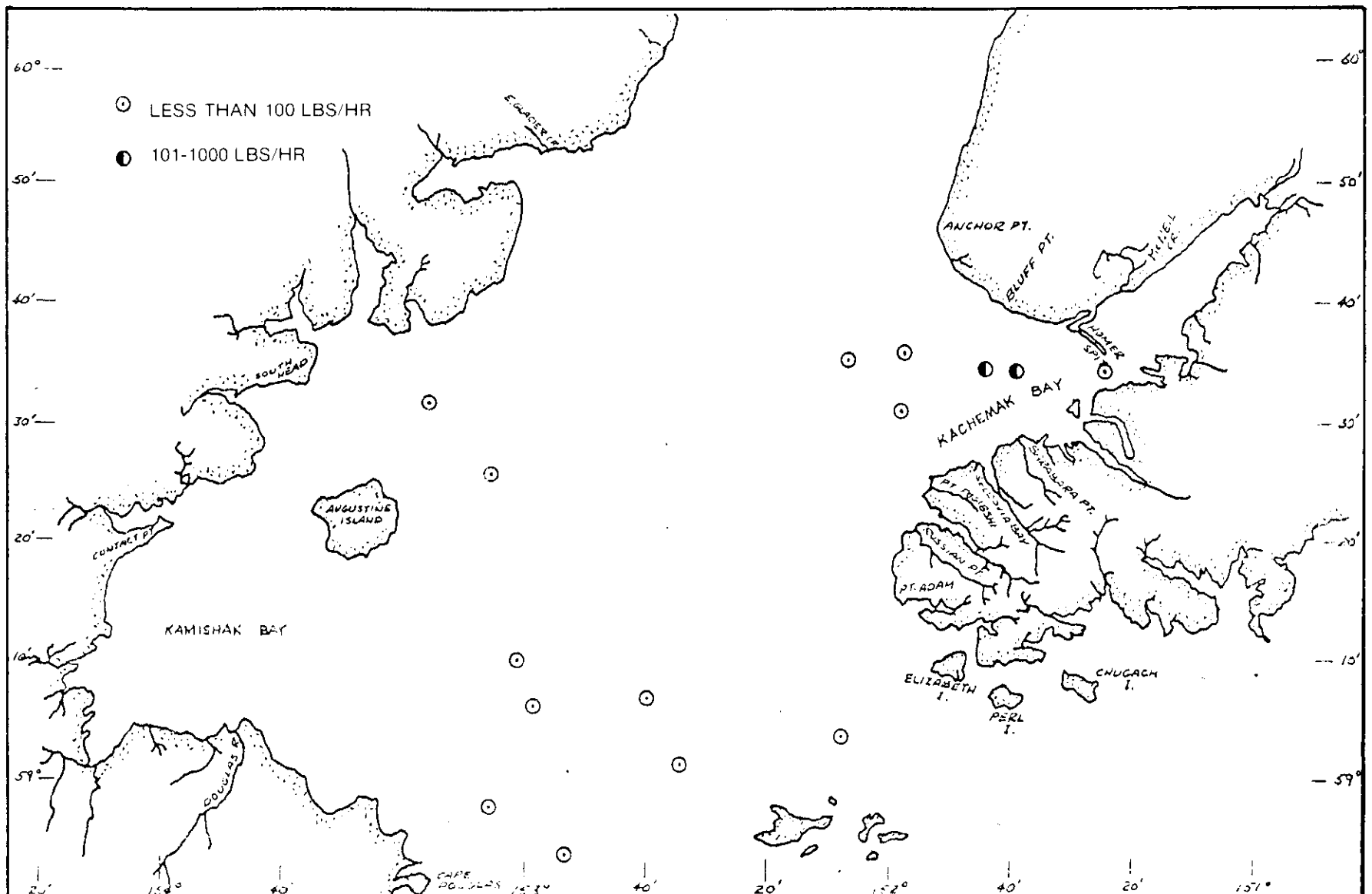


Figure 16
HALIBUT EXPLORATORY TRAWLS

SHELLFISH

CRABS

King Crab *(Paralithodes camtschatica)*

The commercial king crab fishery began in Cook Inlet in 1951[8] and developed through 1959. By 1960, 60 boats were registered for king crab. Since 1964, there has been a shift in effort from Cook Inlet toward Kodiak and westward. A quota system was established in 1969 to improve the distribution of effort in Cook Inlet from Kachemak Bay in the Southern District into the Kamishak Bay District. Table 9 shows the harvest for the period 1951 to 1971 and reflects the shift outward from Kachemak Bay.

Table 9
KING CRAB HARVEST COOK INLET
(pounds)

	Southern	Kamishak	Barrens	Total Inlet
1951	3,119			3,119
1952	87,968			87,968
1953	1,710,880			1,710,880
1954	1,275,852			1,275,852
1955	1,915,821			1,915,821
1956	2,129,035			2,129,035
1957	620,858			620,858
1958	752,990			752,990
1959	2,191,437			2,191,437
1960	4,219,776			4,219,776
1961	2,988,880	1,205,679		4,194,559
1962	1,968,980	4,305,444		6,274,424
1963	2,667,279	5,538,349		8,205,628
1964	1,731,577	4,934,366		6,665,943
1965	1,811,022	963,412		2,774,434
1966	1,887,948	1,974,559		3,862,507
1967	1,279,708	1,530,943		2,810,651
1968	1,001,398	2,810,683	154,975	3,967,056
1969	1,303,655	1,335,019	97,818	2,736,492
1970	1,495,759	1,899,224	447,134	3,842,117
1971	1,237,802	2,302,583	599,720	4,157,600
1972				4,607,900
1973				3,349,200

Value of the crab catch to the fishermen exceeded one million dollars in 1971, and the first wholesale value of the catch exceeded three million dollars. The fishery is estimated to have the potential for a sustained yield 5 million or more pounds per year. Figure 17 shows the distribution of king crabs in Cook Inlet as determined by exploratory fishing drags of the U.S. Bureau of Commercial Fisheries. Heaviest catches were made in the deeper waters between Augustine and the Barren Islands.

King crabs are somewhat migratory in the Inlet. Much of the winter fishery in Kachemak Bay is based on transient crabs that are resident near the Barren Islands and Kodiak during late summer and fall. Crabs tagged east of Cape Douglas occupied deep water in summer and later moved into shallower water around Augustine Island and Kachemak Bay.[9] Some populations, however, are resident in Kachemak Bay. King crabs are found in commercial quantities in all water south of a line between Anchor Point and Chisik Island.

In early spring, adults move from deep waters (about 100 fathoms) to the shallows (15-30 fathoms) to breed following moulting by females. King crabs moult from February to May. Eggs are laid in spring and are carried for a year to hatch the following spring (mid-March to early May). The hatching peak occurs about the third week in April. The free-swimming young occupy the middle and bottom zones of shallower waters (15-30 fathoms).

Snow Crab (Tanner Crab) *(Chionectes sp.)*

The commercial harvest of snow crab in Cook Inlet began in 1968[10] and exceeded 8,000,000 pounds in 1973, with the harvest principally in the Southern and Kamishak Districts (Table 10).[8]

Although there is a 12-month season for snow crabs, the catch falls off in autumn (Table 11).[8]

Distribution of snow crabs in Cook Inlet, based on exploratory fishing cruises of the U.S. Bureau of Commercial Fisheries, is shown in Figure 18. These crabs were taken in greatest numbers in deep water midway between Augustine and the Barren Islands.

The life history of snow crabs, in terms of movement, appears identical to the kings. However, snow crabs breen and moult in June and July. After hatching, the young spend two weeks to four months, depending on species, as floating larvae.[11]

Table 10
COOK INLET SNOW CRAB HARVEST
(pounds)

1968	165.1
1969	1,468.1
1970	1,328.7
1971	2,116.8
1972	4,807.8
1973	8,509.1

Table 11
SNOW CRAB LANDING, BY AREA, COOK INLET, 1971

Month	Southern	Kamishak	Outer	Total
January	26,545	1,758	1,258	29,561
February	107,832	2,468	2,816	113,116
March	227,506	690		228,196
April	358,024	7,876		365,900
May	231,751	175,222		406,973
June	82,357	349,115		431,472
July	3,024	268,925		271,949
August				
September	728			728
October	602	328		930
November	56,992		21,712	78,704
December	87,450		101,870	189,320
	1,182,811	806,382	127,656	2,116,849

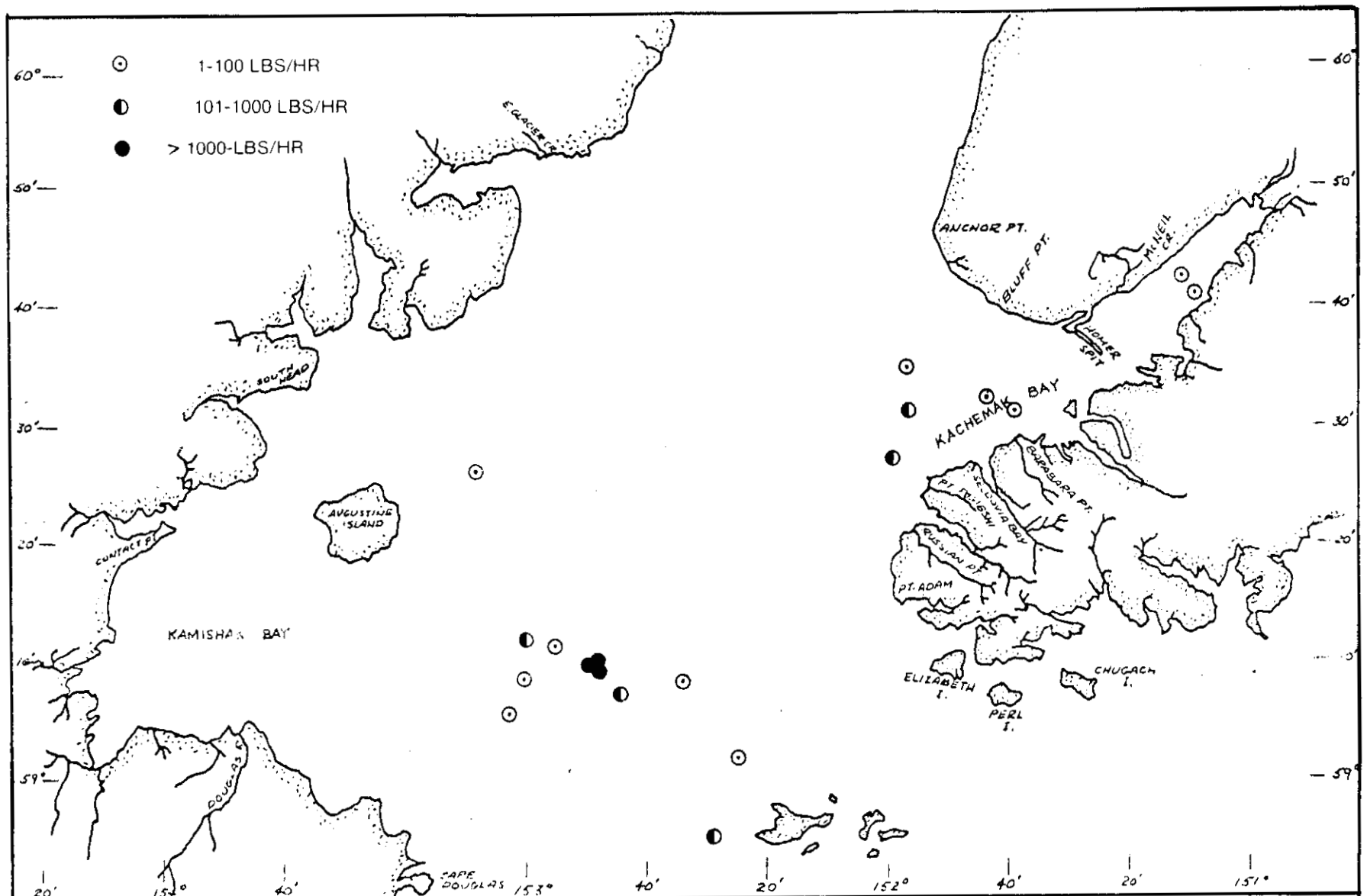


Figure 17
KING CRAB DISTRIBUTION IN COOK INLET (BASED ON EXPLORATORY CRUISES CONDUCTED BY U.S. BUREAU OF COMMERCIAL FISHERIES)

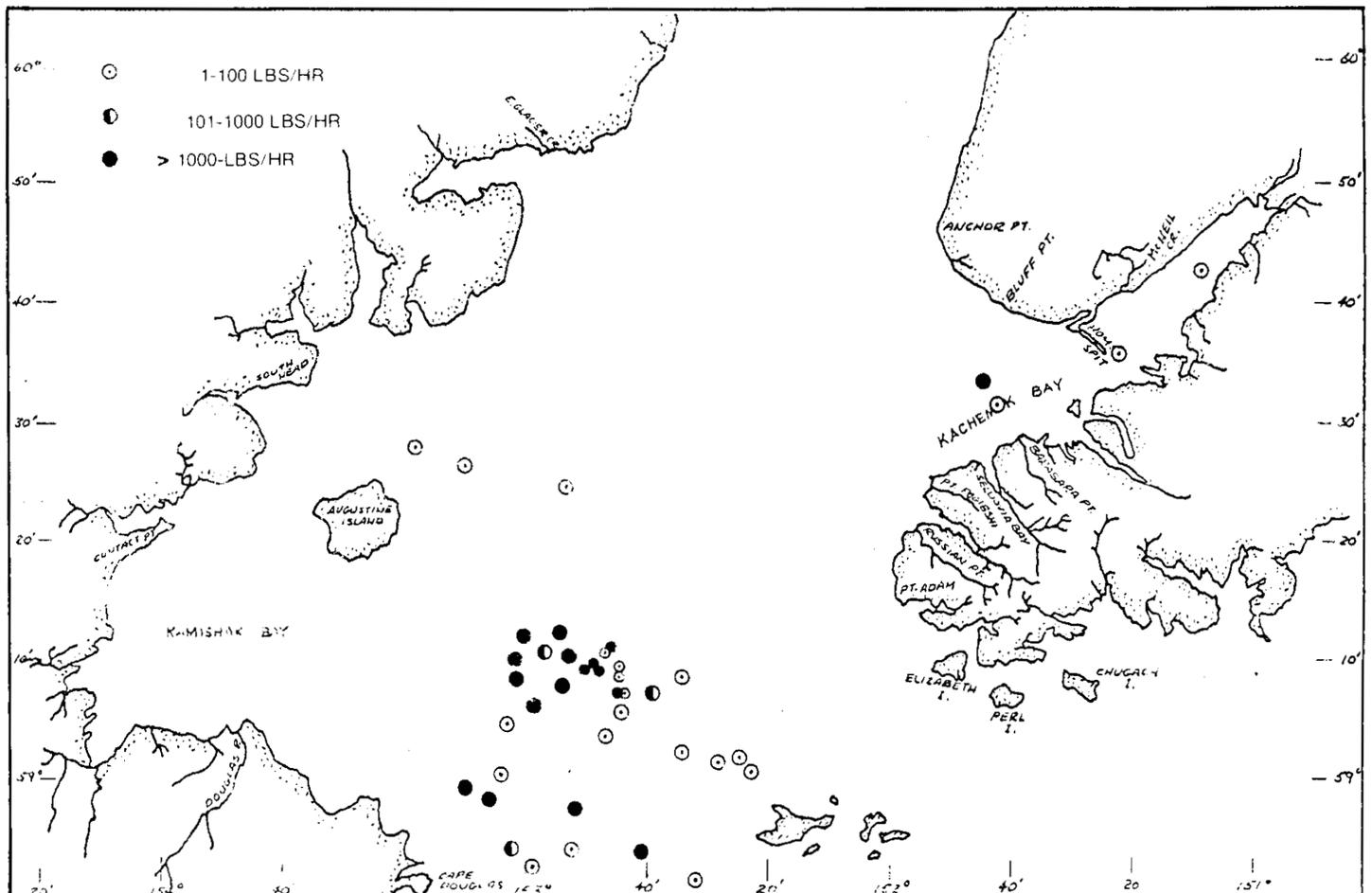


Figure 18
TANNER CRAB DISTRIBUTION IN COOK INLET (BASED ON EXPLORATORY CRUISES CONDUCTED BY U.S. BUREAU OF COMMERCIAL FISHERIES)

Dungeness crab *(Cancer magister)*

The harvest of dungeness crab in Cook Inlet has fluctuated with a high of more than 1.5 million pounds in 1963 (Table 12). Catches are made predominantly in Kachemak Bay from June through October.[8]

Adult dungeness crab move into and out of Kachemak Bay seasonally, migrating into shallow waters in spring and summer and returning to deeper waters in fall and winter. The distribution of dungeness crabs is similar to that of king crab, except that they are seldom taken in deep waters.

Dungeness crabs mate in May and June. The eggs are laid in fall and are carried by the female until they hatch in spring into free-swimming larvae.[12]

Table 12
COOK INLET DUNGENESS CRAB CATCH, 1961-1973

Year	Crab	Pounds
1961		191,588
1962	204,573	460,725
1963		1,677,204
1964	177,708	421,452
1965	32,378	82,280
1966	45,625	127,977
1967	2,141	7,168
1968		481,764
1969		48,501
1970		209,800
1971		97,200
1972		38,900
1973		329,900

SHRIMP

The shrimp harvest in Cook Inlet is composed of several species, including pink shrimp *(Pandalus borealis)*, humpy shrimp *(P. goniurus)* and sidestripe shrimp *(Pandalopsis dispar)*. Several species of families *Hippolytidae* and *Crangonidae* were abundant in most of Kachemak Bay.

Commercial harvests began in 1958 and have grown rapidly in recent years, as shown in Table 13. There is presently a 5,000,000 pound harvest quota in effect for Cook Inlet. Monthly distribution of the catch in 1973 was relatively even with a high in July and lows in May, September and October. Highs and lows fluctuate considerably on a monthly basis from year to year.[10]

Table 13
COOK INLET SHRIMP HARVEST
(POUNDS)

1960	711,355
1961	1,045,170
1962	582,291
1963	1,897,580
1964	601,410
1965	128,100
1966	309,700
1967	741,400
1968	43,400
1969	1,847,200
1970	5,817,500
1971	5,451,300
1972	5,548,600
1973	4,897,100
1974	
1975	
1976	
1977	
1978	
1979	
1980	

Exploratory trawls by the U.S. Bureau of Commercial Fisheries found highest concentrations of shrimp in Cook Inlet, predominantly pink, in Kachemak Bay and in deep waters east of Cape Douglas (Figure 19).

The breeding season for shrimp generally begins in September with moulting of adults. They lay eggs in October and carry them through May, when they hatch. The predictability of shrimp movement is uncertain, and apparently varies depending on species.

Sport Fishery

A small "sport" or "personal use" fishery for shrimp has developed on Homer Spit. No figures on the magnitude of this fishery are available.

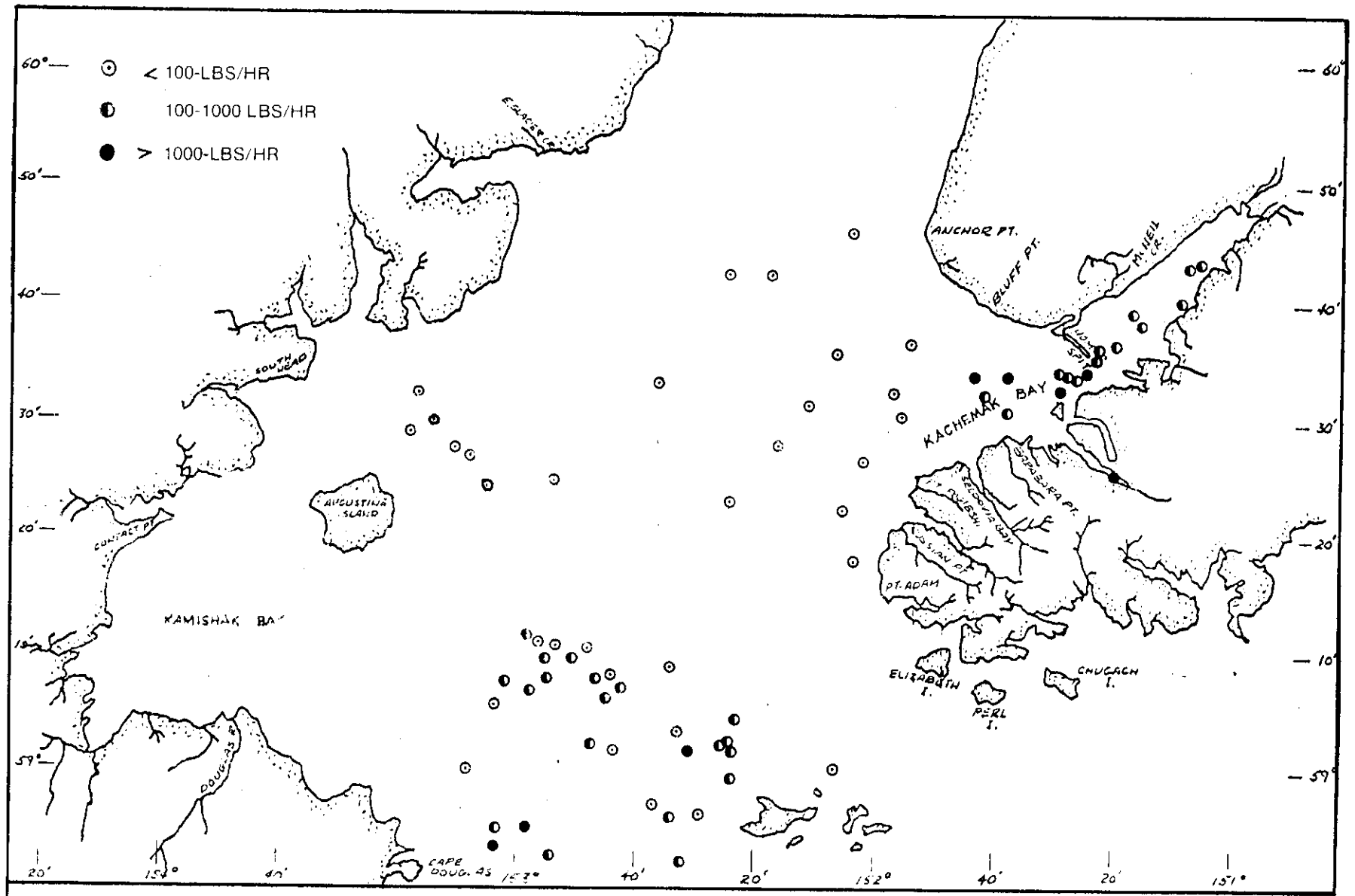


Figure 19
COOK INLET SHRIMP ABUNDANCE FROM EXPLORATORY FISHING CRUISES

RAZOR CLAMS *(Siliqua patula)*

Razor clams occur on the eastern beaches of Cook Inlet along the Kenai Peninsula between the Kasilof River and Homer Spit with the greatest abundance in the Clam Gulch and Deep Creek-Stariski Creek areas. On the western side of the Inlet, they are scattered on various sandy beaches from Harriet Point southward. Heavy concentrations occur at Polly Creek and the northeast side of Chinitna Bay.

The sport use of this resource has increased steadily in recent years (Table 14). The majority of the harvest is made on the easily accessible eastern beaches, although diggers are making increasing use of beaches on the western side. Half of the total sport effort normally occurs during May.

Commercial exploitation of razor clams within the Inlet has been sporadic since early in this century. Currently, a small commercial operator is harvesting clams in the vicinity of Polly Creek.

The clam harvest has not impaired the productivity of this resource; and, during the past eight years, diggers have consistently averaged about 30 razor clams per trip. The average size has not declined, despite the increase in digging pressure.

Razor clams in Alaska spawn in late June, July and early August. The larvae remain in a free-swimming stage about eight weeks, during which they live in or on the sand near where they were spawned.[13]

Table 14
COOK INLET RAZOR CLAM SPORT HARVEST

Year	Effort (man-days)	Clams Harvested
1965	1,800	63,000
1966	1,900	76,000
1967	2,300	68,000
1968	4,600	126,000
1969	12,200	375,000
1970	11,100	307,000
1971	6,800	188,000
1972	14,700	411,000

SCALLOPS *(Patinopecten caurinus)*

Scallops occur in Cook Inlet, but all districts are presently closed to commercial fishing. The only commercial effort was in 1969 when 240 pounds were harvested in the Kamishak District.[10] Scallops, taken in exploratory surveys of the U.S. Bureau of Commercial Fisheries in 1968 revealed the greatest abundance occurred in the Kamishak District between Augustine and the Barren Island (Figure 20). No seasonal movements are known for the species.

Most Kodiak scallops spawn between June 3 and June 8, although some spawning extends into July.[14]

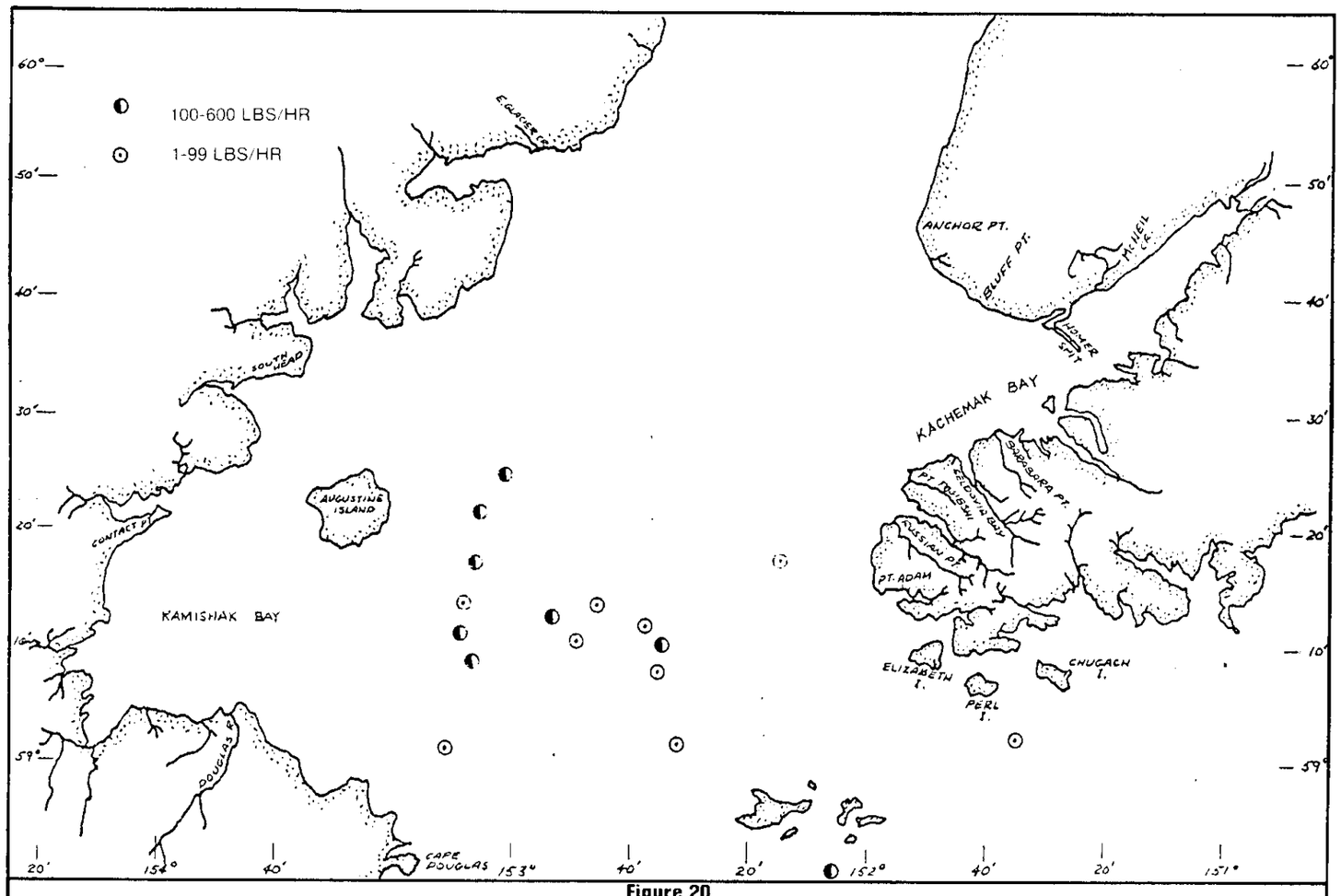


Figure 20
SCALLOP EXPLORATIONS. FISHING LOG OF THE FV VIKING QUEEN. CRUISES 3. 4. AND 5. MAY 14 TO JUNE 6. 1968. YAKUTAT BAY TO KODIAK ISLAND.

BIRDS

One hundred five species of birds have been observed at several locations around Cook Inlet: Gibson (1967);[15] Quimby (1971);[16] Krohn (1966);[17] Snarski (1971a);[18] Tremblay (1966);[19] and Bader (1970).[20] Table 15 is a compilation of these observations. Presence of a species is indicated in this table by an asterisk. Two asterisks indicate that the species was "common," and three indicate it was "abundant." These species are also rated as to their use of salt water, according to Robbins *et al.* (1966)[21] and Gabrielson and Lincoln (1959).[22] Fifty-nine species of birds were recorded that make at least frequent use of salt water or come into frequent contact with it; sixteen species were recorded that come into occasional contact with salt water; eight species occasionally contact salt water, mostly in hunting or searching for food; and, 22 species make significant use of coastal marshes.

Sowl and Evans* aerial survey provides some measure of bird densities on the Inlet. Birds were inconspicuous on open waters of the Northern District and were not recorded there. Abundance was low in the North and South Central Districts, but very high in the Southern and highest in the Outer District, where 16 species totalled 301 individuals per square mile (Table 16).

These observations were minimal as to numbers of birds and number of species. Fulmars, otherwise not recorded in the Inlet, averaged more than 30 per square mile. They were most abundant near the Barren Islands and northeast of them. Scoters and eiders were numerous in Kamishak Bay. Kachemak Bay contained numerous scoters, also.

A number of marshes important to birds surround Cook Inlet. They are listed below with some indicators as to their use by birds.[23,24,25]

Palmer Hay Flats
Geese, swans and ducks during spring and fall migration — some nesting, much hunting.

Goose Bay
Ducks and geese during migration — some hunting, some nesting.

Susitna Flats
Ducks, geese and swans during spring and fall migration. Some nesting, much hunting. 38 private aircraft on the flats.

Trading Bay
Ducks and geese in spring and fall migration. Some nesting, some hunting.

Redoubt Bay
Ducks and geese in fall migration. Some hunting, some nesting.

Chickaloon Flats
Heavy concentrations of ducks and geese in migration. As many as 20,000 or more Canada geese and 500 or more swans. Heavily hunted at times. Used extensively by sandhill cranes during migration. Nesting ducks.

Other small marshes (Potter, Eagle River, Portage) are migration stopovers and are hunted. Some nesting.

Table 17 shows waterfowl populations in four marsh areas around the north and west side of the Inlet as observed. Geese are an important segment of the bird population of these

Sowl, L. S. and C. D. Evans, Results of an aerial survey conducted August 3, 1972, covering open waters of Cook Inlet.

marshes, particularly in spring. The same is true of the Chickaloon Flats, where birds often concentrate when bad weather closes Portage Pass. As many as 6,000 ducks and 4,000 geese may be found there in late summer and early fall.[24] 21,000 Canada geese and 200 snow geese were reported there October 5, 1971.[25] Data from six separate counts in 1970 and five in 1971 illustrate to some extent the seasonal trends in waterfowl populations on the Susitna Flats (Tables 18 and 19). Fluctuations in population during the migration period are sometimes very rapid and sufficient data are not available to determine just when these peaks normally occur or the shape of the population curve.

The fall buildup in these marshes begins in early August and peaks when the interior of the state freezes up in late September. Frequently 10,000 or more waterfowl occupy the area at that time. The marshes usually freeze over about mid-October in the Upper Inlet and the migration is then at an end.

Highest populations of these marshes are in spring when they are used by several thousands of lesser Canada and snow geese, a few thousand ducks and occasional swans and cranes. There is an unknown exchange of birds that make use of inlet marshes.

The Fox River Flats may have as many as 6,000 mallards (Havens, 1970). Smaller numbers of cuska dna geese numbering in the hundreds are often found in such places as Halibut Cove, China Poot Bay, Sadie Cove, Tutka Bay, and other bays and coves around the Inlet.[25]

TABLE 15
BIRD OBSERVATION -COOK INLET - SUMMER UNLESS OTHERWISE INDICATED

Species	Gibson (Katmai)	Quimby (Chickaloon Flats)	Krohn & Snarski (Tuxedni)	Snarski Open water	Tremblay 3-1-66 Kachemak Bay	Tremblay 4-5-66 (Kamishak Bay)	Bader (Potter Marsh)	1972 Sowl and Evans N. Central	S. Central	Kamishak	Southern	Outer	Habits [1]
Common Loon	**		*										SW
Arctic Loon	*	2/	**				*		*				O
Red-throated Loon	**		*										SW
Red-necked Grebe		*	*				**			*			SW
Horned Grebe	**	*	*				*						SW
Fulmar										**	**	***	SW
Sooty Shearwater			**	**					*	*		**	SW
Fork-tailed Petrel	*									*	*	**	SW
Double-crested Cormorant	**		*										SW
Pelagic Cormorant	**		**	**					*	*		**	SW
Red-faced Cormorant	*												SW
Whistling Swan	*	*	*				**						O
Trumpeter Swan							*						O
Lesser Canada Goose			*				**						O
Cackling Canada Goose		*				*	*						O
Black Brant	**		*	*									SW
Emperor Goose													SW
White Fronted Goose							*						O
Snow Goose		**					*						O
Mallard	**	*	*		**	**	**						O
Gadwall		*					*						O
Pintail	**	*	**	*			**						O
Green-winged Teal	*	*	*										O
Blue-winged Teal							**						M
American Widgeon	*	*	*				*						O
European Widgeon							*						O
Shoveler	*	*	*				**						O
Canvasback		*					*						O
Greater Scaup	*	*	*		*		*						SW
Lesser Scaup							*						SW
Common Goldeneye	*	*	*				*						SW
Barrin's Goldeneye					**	*	*						SW
Bufflehead	*				*		*						SW
Oldsquaw	*		*		**	*							SW
Harlequin	**	*	*				*						SW
Steller's Eider	*												SW
Common Eider	*		**	*		*				**			SW
King Eider	*												SW
Spectacled Eider													SW

Table 15 (Cont'd)

Species	Gibson (Katmai)	Quimby (Chickaloon Flats)	Krohn & Snarski (Tuxedni)	Snarski Open water	Tremblay 3-1-66 Kachemak Bay	Tremblay 4-5-66 (Kamishak Bay)	Bader (Potter Marsh)	1972 Sowl and Evans N. Central	S. Central	Kamishak	Southern	Outer	Habits[1]
White Winged Scoter	*		*		*	*			*	**	*	*	SW
Surf Scoter	*		***	**	**	*		*		**	**		SW
Common Scoter	**		**								*		SW
Common Merganser	*		*				*						SW
Red-breasted Merganser	**	*	*		*		*						SW
Rough-legged Hawk	*						*						I
Bald Eagle	**	*	*		*	*	*			*			I
Golden Eagle							*						I
Marsh Hawk	*	*	*				*						I
Osprey			*				*						I
Peregrine	*		*				*						I
Gyrfalcon			*				*						I
Pigeon Hawk	*		*				*						I
Sandhill Cranes		*	*				**						M
Black Oyster Catcher	**		*							*			SW
Semipalmated Plover	*	*	*				*						M
Killdeer							*						M
American Golden Plover	*	*					*						M
Black-bellied Plover	*	*											M
Surfbird	*		*				*						SW
Ruddy Turnstone	*	*											SW
Black Turnstone	**		*										SW
Common Snipe	*	*	*				*						M
Whimbrel	*	*	*										M
Spotted Sandpiper	**	*	*				*						O
Solitary Sandpiper							*						M
Wandering Tattler	*		*										M
Greater Yellowlegs	**	*	*				**						M
Lesser Yellowlegs			*	*			**						M
Rock Sandpiper	*												SW
Pectoral Sandpiper		*					**						M
Baird's Sandpiper	*		*				*						M
Least Sandpiper		*	*				**						M
Dunlin	*		*				*						SW
Short-billed Dowitcher	*		*				**						M
Long-billed Dowitcher		*					*						M
Semipalmated Sandpiper		*	*										SW
Western Sandpiper	*	*	*										SW
Marbled Godwit	*												M
Hudsonion Godwit							*						M
Sanderling							*						SW
Northern Phalarope	*	*	*				**				*		SW
Pomarine Jaeger			*	*				*		*	*		SW
Parasitic Jaeger								*					SW
Long-tailed Jaeger													SW

Shorebirds

Table 15 (Cont'd)

Species	Gibson (Katmai)	Quimby (Chickaloon Flats)	Krohn & Snarski (Tuxedni)	Snarski Open water	Tremblay 3-1-66 Kachemak Bay	Bader (Potter Marsh)	1972 Sowl and Evans N. Central	S. Central	Kamishak	Southern	Outer	Habits[1]
Glaucous Gull			*			*						SW
Ivory Gull						*						SW
Glaucous-winged Gull	***	*	**	**		**	**	*	**	*	*	SW
Herring Gull						**						SW
Mew Gull	**	*	*	*		**	**	*	*	*	*	SW
Franklin's Gull			*									SW
Bonaparte's Gull		*	*	*		**						SW
Black-legged Kittiwake	*		***	***			**	***	*	***	**	SW
Arctic Tern		*	*	*		**	**		*	**	*	SW
Common Murre	*		***	**				*	*	*	**	SW
Pigeon Guillemot	*		**	*				*	*	*		SW
Marbled Murrelet	*		*									SW
Kittlitz's Murrelet			*	*				*	*	*	*	SW
Ancient Murrelet			*									SW
Parakeet Auklet			*								*	SW
Rhinoceros Auklet			*									SW
Horned Puffin	**		**	**				*	*	*		SW
Tufted Puffin	**		**	**					*	*	***	SW
Short-eared Owl	*		*			*						M
Common Raven	*		*									M
Northwestern Crow	**											M

Key to Habits

1/ SW - Predominantly salt water residents at least part of the year
O - Make at least occasional use of salt water
M - Marshes or Inlet shores only
I - Incidental contact with salt water

2/ Brackets indicate cases where observers grouped species. In this instance, observations were recorded as "Loon".

Table 16
COOK INLET BIRD SURVEY, AUGUST 3, 1972
(Sowl & Evans)

Species	District											
	North Central		South Central		Kamishak		Southern		Outer		Total	
	No/per sq mi		No/per sq mi		No/per sq mi		No/per sq mi		No/per sq mi		No/per sq mi	
Loon			1	.1	1	.1					2	tr.
Fulmar					110	7.1	152	10.9	1461	182.6	1723	34.3
Shearwater			2	.2	5	.3	5	.4	37	4.6	49	1.0
Petrel					21	1.4	15	1.1	13	1.6	49	1.0
Cormorant			6	.7	18	1.2	1	.1	34	4.3	59	1.2
Common Eider					315	20.3			18	2.3	333	6.6
Scoter	5	1.1	7	.8	731	47.2	1039	74.7	10	1.3	1792	35.6
Black Oyster Catcher					50	3.2					50	1.0
Northern Phalarope									30	3.8	30	.6
Jaegar			5	.6			7	.5	5	.6	17	.3
Glaucous Winged Gull	13	2.9	3	.4	296	19.1	63	4.5	22	2.8	397	7.9
Black Legged Kittiwake	25	5.6	66	7.9	84	5.4	311	22.3	265	33.2	751	14.9
Arctic Tern	35	7.8			3	.2	100	7.2	20	2.5	158	3.1
Common Murre			1	.1	34	2.2	50	3.6	203	25.3	288	5.7
Pidgeon Guillemot			11	1.3	4	.3	3	.2			18	.4
Puffin			7	.8	41	2.6	36	2.6	257	32.1	341	6.8
Murrelet			21	2.5	5	.3	23	1.7	5	.6	54	1.1
New Gull	12	2.7	5	.6	18	1.2	3	.2	20	2.5	58	1.2
Bonaparte's Gull							50	3.6			50	1.0
Other			4	.5	3	.2			8	1.0	15	.3
	90	20.0	139	16.5	1739	112.2	1858	133.7	2408	301.0	6234	123.9

Table 17
DATA FROM SPRING AND FALL SURVEYS OF FOUR MARSHES IN COOK INLET

	May 2, 1972				August 24, 1967			
	Pt. MacKenzie Little Susitna	Little Susitna to Big Susitna	Big Susitna to Beluga River	Palmer Flats	Pt. Mac Kenzie Little Susitna	Little Susitna to Big Susitna	Trading Bay	Redoubt Bay
Swans	30	500	50	100				
Canada Geese	1700	3300	300	800	40			
White Fronted Geese	150	10	50	2		40	300	
Snow Geese	1300	2200	50	80				
Mallard							100	
Pintail					150	150	300	100
	150	200	50	250				*
Teal					50	250	500	
Widgeon					300	400	700	200
Scaup								
Goldeneyes								**
Scoter		50		30				
Cranes	3		3	4				
TOTAL WATERFOWL	3333	6260	503	1266	540	840	1900	300

*Brackets indicate species grouped in dabbling ducks
**Brackets indicate species grouped in diving ducks

Table 18
WATERFOWL SURVEY DATA, SUSITNA FLATS[1]

Species	April 16, 1970	May 5, 1970**	May 28, 1970	June 25, 1970	Aug. 12, 1970	Sept. 28, 1970	Oct. 5, 1970
Dabbler	0	0	0	0	525	2570	4484
Pintail	134	1440	122	659	1855		
Pintail w/brood	0	0	0	1	0		
Mallard	31	990	69	126	846		
Widgeon	0	625	56	1321	1185		
G-W Teal	0	110	8	121	1045		
G-W Teal w/brood	0	0	0	1	0		
Shoveler	0	30	9	179	0		
Gadwall	0	0	2	0	0		
Scaup*	0	0	119	46	0		
Canvasback	0	0	6	3	0	6	
Goldeneye*	0	0	9	0	0		
Divers	0	0	0	0	0	20	165
TOTAL DUCKS	165	3195	400	2457	5452	2596	4649
Canada Geese	312	3395	493	6	685	125	100
B. Brant	0	0	50	0	0	0	0
W-F Geese	15	600	58	9	420	0	0
W-F w/brood	0	0	0	3	0	0	0
Snow Geese	0	200	0	0	0	0	0
TOTAL GEESE	327	4195	601	18	1105	125	100
Swan*	0	509	2	7	2	157	1296
Crane	0	0	4	0	5	0	0
TOTAL WATERFOWL	492	7899	1007	2482	6564	2878	6045

*Not identified to species
**Estimates by D. Bader
[1]From Havens, 1970

Table 19
WATERFOWL SURVEY DATA, SUSITNA RIVER[1]

Species	May 6, 1971	Aug. 27, 1971	Sept. 17, 1971	Oct. 5, 1971	Oct. 27, 1971
Dabbler	35,000	8,650	6,750	1,375	2,425
Canada Geese	17,500	1,200	140	270	695
Snow Geese	17,500				
Swan	*	*	26	1,288	1,032
TOTAL WATERFOWL	70,000	9,850	6,916	2,933	4,152

*Not surveyed
[1]From Havens, 1971

SEABIRD DISTRIBUTION AND ABUNDANCE IN COOK INLET

Seabirds remain always at sea except for a few summer months when the concentrate on rocky cliffs to nest. They are closely tied to pelagic areas as well as estuarine and intertidal zones where they forage on small herring, needle fish and other animal and plant life.

There are 12 known seabird colonies in the Cook Inlet region (Figure 21), all of which are located in the lower Cook Inlet as far north as Tuxedni Bay (Map ref. nos. 1-12, Table 20). Three of these seabird colonies are found in Tuxedni Bay (nos. 1-3), two in Chinitna Bay (nos. 4 and 5), one in Augustine Island (no. 6), three in Chugach Islands (nos. 8-10), two in Barren Islands (nos. 11 and 12), and one in Iliamna Lake (no. 7). There are no known seabird colonies in upper Cook Inlet; however, Kalgin Island may have some small colonies of nesting glaucous-winged gulls. Perhaps more colonies of gulls and other seabirds are present in upper Cook Inlet but locations are unknown at this time. Only a few gulls and other seabirds are present during winter months in this area.

Migration of pelagic seabirds is apparently restricted to movements from the open sea to their nesting colonies during the summer months although wintering areas do differ somewhat from fall-spring use areas.

Unlike the southern shoreline of Cook Inlet, the northeastern shoreline is not a particularly productive marine habitat for seabirds, as this area is suffering from glacial siltation of upper Cook Inlet.[26]

Table 20
SEA BIRD COLONIES IN COOK INLET[26]

Map Ref. No.	Location	Species Present
1	Tuxedni Bay	glaucous-winged gull, double-crested cormorant.
2	Chisik Island	black-legged kittiwake, glaucous-winged gull, common murre, pigeon guillemot, tufted puffin, double-crested and pelagic cormorants.
3 4 5 6	Duck Island Glacier Spit Gull Island Augustine Island	glaucous-winged gull, black-legged kittiwake, Arctic tern, pelagic, red-faced and double-crested cormorants, horned and tufted puffins, common and thick-billed murres, Pacific fulmar, Cassin's, least, parakeet and crested auklets, mew gull, marbled, ancient and Kittlitz's murrelets, pigeon guillemot.
7	Iliamna Lake	double-crested cormorant, glaucous and glaucous-winged gulls, Arctic tern, marbled murrelet.
8 9 10	Elizabeth Island Perl Island East Chugach Island	glaucous-winged gull, black-legged kittiwake, common murre, tufted puffin, horned puffin, parakeet auklet, mew gull, ancient, Kittlitz's and marbled murrelets, pigeon guillemot, double-crested cormorant.
11 12	Nord Island East Amatuli Island	glaucous-winged gull, pelagic cormorant.

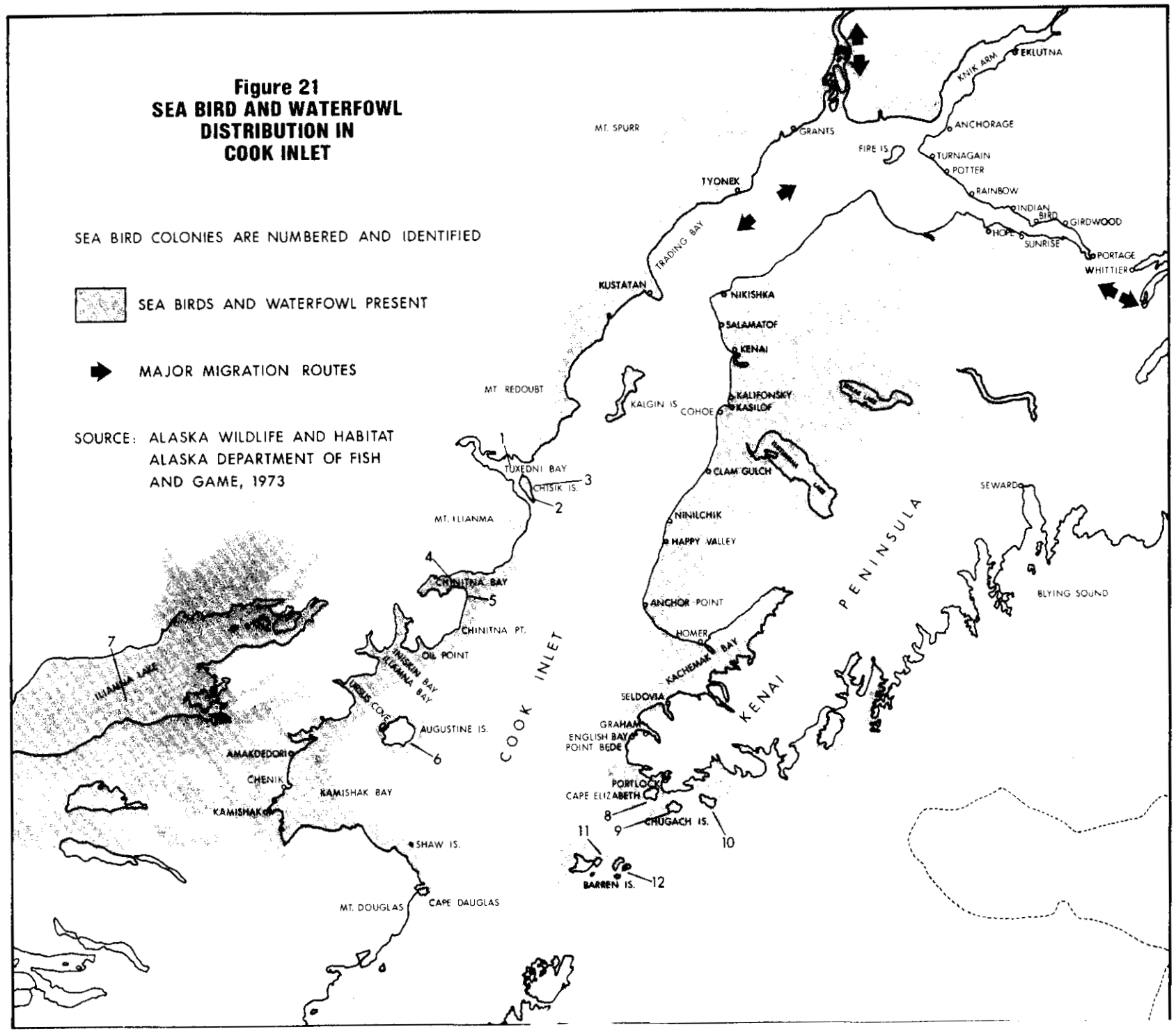


Figure 21
SEA BIRD AND WATERFOWL DISTRIBUTION IN COOK INLET

SEA BIRD COLONIES ARE NUMBERED AND IDENTIFIED

MARINE MAMMALS

SEA OTTER DISTRIBUTION AND ABUNDANCE IN COOK INLET

Sea otters frequent shallow coastal waters less than 40 fathoms deep where abundant populations of marine invertebrates or bottom fish are found. Populations are primarily limited by the abundance of food. Few sea otters ever inhabited the upper Cook Inlet. Large populations once occurred when extensive habitat was available near Augustine Island, the south side of Kenai Peninsula, and lower Cook Inlet as far north as Anchor Point were almost exterminated in these areas through intensive sea otter hunting in the 19th century. When fur hunting ended around 1900, a small number may have survived near Augustine Island. This population has been growing steadily and since 1960 the sea otters have spread south-westward to Katmai Bay and eastward to Port Dick.

In the mid 1960's, several hundred sea otters appeared between Port Graham and Port Chatham, perhaps after immigrating from either the Barren Islands or Augustine Island.

At present, sea otters are abundant near Augustine Island (Figure 22, and Map ref. no. 16, Table 22). Scattered animals occur along Bruin Bay and Cape Douglas in the western side of lower Cook Inlet. A few are also present from the south side of the Kenai Peninsula to as far north as Seldovia Bay in the east side of lower Cook Inlet. They are now common in Port Dick, Chugach Bay and Port Chatham with a population of approximately 500. As numbers increase, they should expand into Kachemak Bay and repopulate all of its former habitat.

Population estimates based on aerial surveys from Augustine Island to Pulae Bay show more than 1,000 sea otters with the population increasing.

With strict restrictions imposed on sea otter hunting, all areas of former habitat should support sea otter population again since there has been little alteration of their marine habitat.[26]

STELLER SEA LION DISTRIBUTION AND ABUNDANCE IN COOK INLET

Sea lion populations are largely limited to the lower Cook Inlet region as far north as Flat Islands near Port Graham. Map reference numbers 43-51 (Table 21) show the location of nine rookeries and hauling grounds in the lower Cook Inlet area (Figure 23).

Intense harvesting of sea lions by coastal natives prior to the 1900's resulted in a drastic reduction of the population. However, populations have recovered to near maximum levels at the present time. The Barren Islands support nearly 12,000 sealions with 10,000 of these present on Sugarloaf Island. This island currently sustains the greatest number of sea lions in the Gulf region. Augustine Rocks near Augustine Island also provide good resting areas for 500 sea lions. The present population of sea lions in the lower Cook Inlet area numbers approximately 12,700.

Not all sea lions go to rookery areas during the breeding season from late May to mid-July, but may gather on hauling grounds for breeding activities. By late July, rookery populations decrease as hauling ground populations increase when territorial bulls and females without pups leave the rookeries for the hauling grounds.

Sea lions tend to thrive best in remote island areas with intensive shallow water and rocky bottoms highly productive of fish life. Offshore rock piles exposed through all stages of the tide are important resting areas. Although they are excellent swimmers, most of their feeding activity is confined to waters less than 50 fathoms deep. They prefer relatively clear waters and are rarely seen in glacial areas where water is turbid.[26]

Figure 22
SEA OTTER DISTRIBUTION IN COOK INLET

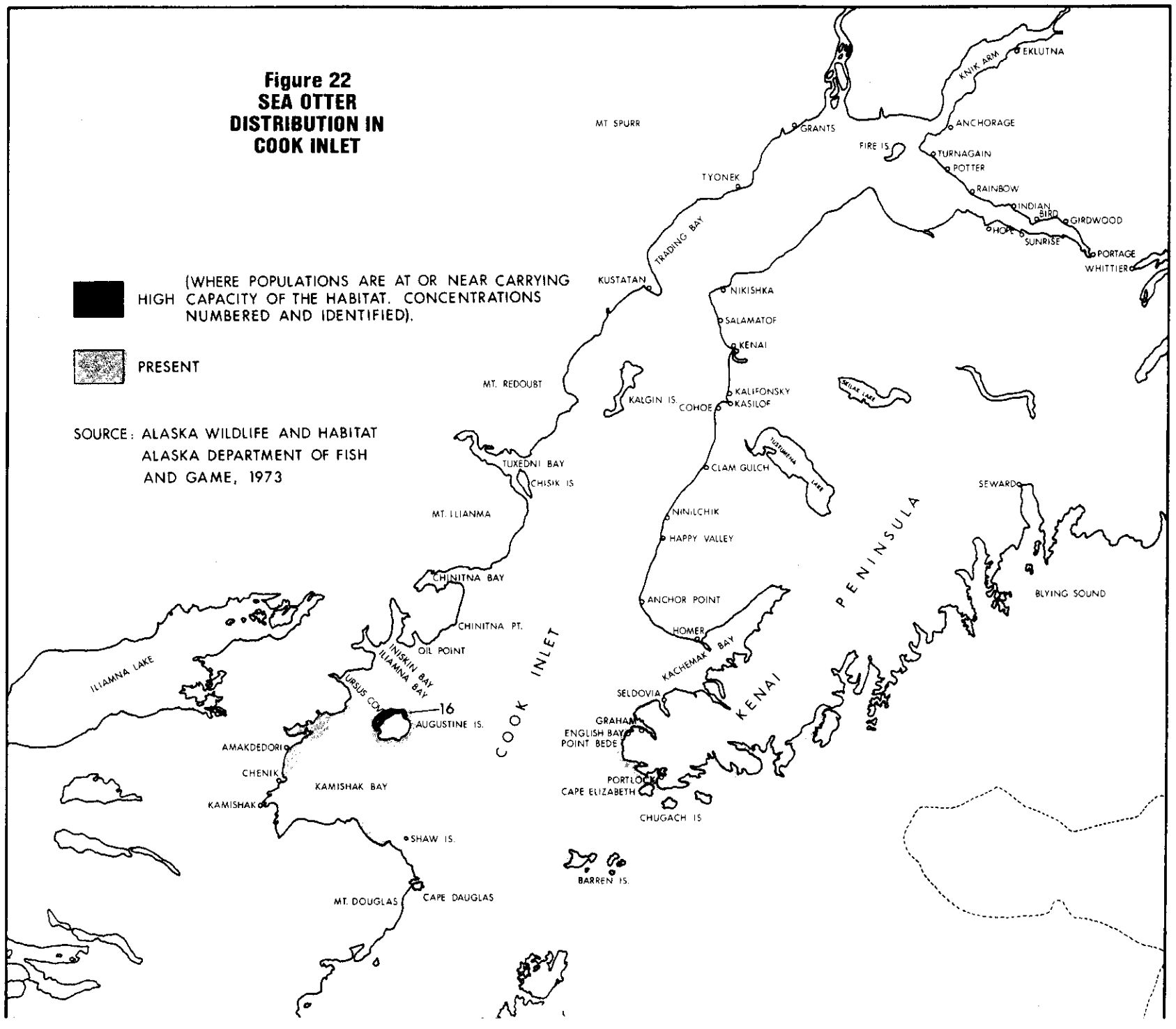


Figure 23
STELLER SEA LION CONCENTRATIONS, ROOKERIES AND HAULING GROUNDS IN COOK INLET

SITES OF ROOKERIES AND HAULING GROUNDS ARE NUMBERED AND IDENTIFIED. LINE DRAWN ALONG 50-FATHOM CURVE DESIGNATES SEA LION HABITAT.

SOURCE: ALASKA WILDLIFE AND HABITAT ALASKA DEPARTMENT OF FISH AND GAME, 1973

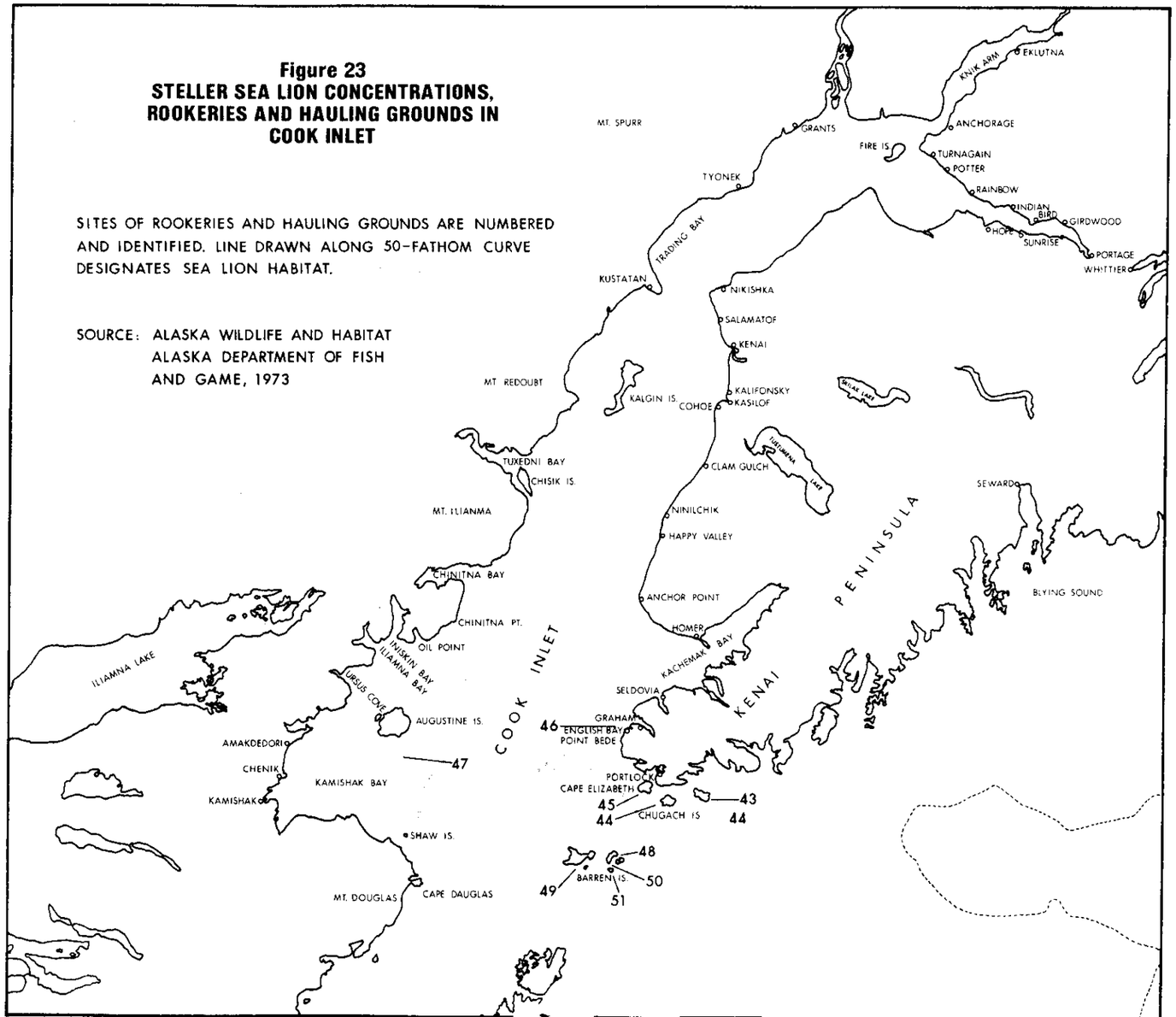


Table 21
STELLER SEA LION ROOKERIES AND HAULING GROUNDS IN COOK INLET

Map Ref. No.	Location	Population
43	East Chugach Island	20
44	Nagahut Rocks	50
45	Cape Elizabeth	30
46	Flat Islands	300
47	Augustine Rocks	500
48	West Amatuli (rocks on west end)	100
49	Ushagat Island	100
50	West Amatuli (southeast end)	1,600
51	Sugarloaf Island	10,000
	TOTAL	12,700

Table 22
SEA OTTER CONCENTRATION POINTS IN COOK INLET

Map Ref. No.	Location
16	Augustine Island (north end)

HARBOR SEAL DISTRIBUTION AND ABUNDANCE IN COOK INLET

Harbor seals are common residents in all coastal waters around Cook Inlet, usually in waters less than 30 fathoms deep. They thrive equally well in areas with rocky or muddy ocean bottoms and clear or turbid waters.

There is no estimate of harbor seal populations in Cook Inlet. The upper Cook Inlet region, however, does not sustain large numbers of harbor seals. The exception is at the mouth of the Susitna River, particularly during summer, when salmon migrate up the streams. In the lower Cook Inlet, seals commonly haul out on offshore rocks and sand bars temporarily exposed during low tide. They also use flat beach areas and large rock outcrops worn smooth by surf and glacial ice. Most of these areas are seldom occupied by more than 100 seals at a time.

The hauling out areas are widely distributed along Kachemak, Tuxedni, Chinitna, Iniskin, Iliamna, and Kamishak Bays, Kalgin and Augustine Islands and areas around Cape Douglas (Figure 24, and Map ref. nos. 145-172, Table 23). Heavy concentrations of seals also occur in Port Dick, Chugach Islands and Barren Islands (Map ref. nos. 139-144, 208-210). More than 1,000 seals are known to use Sud Island in the Barren Islands (Map ref. no. 210).

Lake Iliamna is the only known fresh-water habitat of harbor seals in Alaska. The resident population numbers 50-150 seals throughout the year.

The hauling out areas are especially important for pupping as well as for resting. Although harbor seals can tolerate disturbance of their hauling out areas, land areas were pups are born are particularly important to seals and disturbance of these areas should be avoided especially during the first three weeks in June.[26]

Figure 24
HARBOR SEAL DISTRIBUTION IN COOK INLET

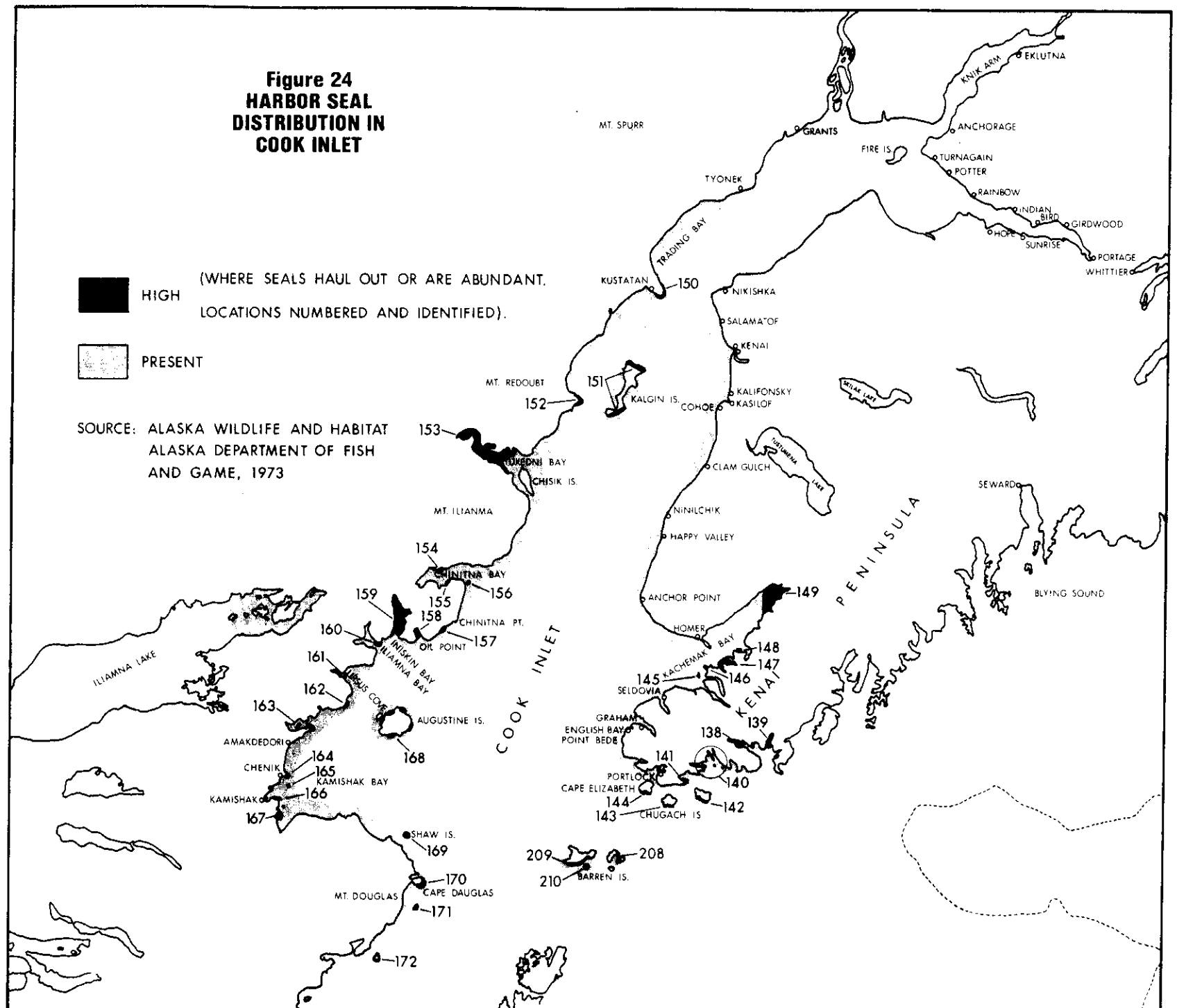


Table 23
HARBOR SEAL CONCENTRATION POINTS IN COOK INLET

Map Ref. No.	Location
138	Port Dick
139	Taylor Bay
140	Windy and Rocky Bays
141	Chugach Bay
142	East Chugach Island
143	Perl Island
144	Elizabeth Island
145	Yukon Island
146	Cohen Island
147	China Poot Bay
148	Ismailof Island
149	Kachemak Bay
150	Knutruin Rock
151	Kalgin Island (north and south ends)
152	Harriet Point
153	Tuxedni Bay
154	Chinitna Bay (Glacier Spit)
155	Chinitna Bay (Seal Spit)
156	Chinitna Bay (Gull Island)
157	Dry Bay
158	Oil Bay
159	Iniskin Bay
160	Iliamna Bay (North Head)
161	Ursus Cove
162	Rocky Cove
163	Bruin Bay
164	Kamishak Bay (Chenik Head)
165	Kamishak Bay (Nordyke Island)
166	Kamishak Bay (McNeil Cove)
167	Akumwarvik Bay
168	Augustine Island
169	Shaw Island
170	Cape Douglas
171	Douglas Reef
172	Kiukpalik Island
208	West and East Amabw and
210	Sud Island

WHALES AND PORPOISES

BELUGA WHALES *(Delphinapterus Leucas)*

Schneider* believes the Cook Inlet belugas are a discrete population, and Klinkhart[27] reports a summer population in the Inlet of 300 to 400 animals. They move up Cook Inlet as far as the Susitna River and Ship Creek. The presence of salmon, adults and smolt, which are important food items, probably accounts for the presence of beluga in the turbid waters of the Upper Inlet. Schneider indicates that winter movements of the Cook Inlet beluga are not known.

Most reproductive activity in Alaskan belugas probably takes place in May and June.[27] Gestation probably takes 12 months, and this would be the date of calving. The calf remains with its mother several years after an eight-month lactation period.

OTHER MARINE MAMMALS

Schneider indicates that other whales are commonly observed in the Lower Inlet and killer whales *(Orcinus orca)* have been sighted in Kachemak Bay. This is supported by reports of fishermen in Kachemak Bay and observations of Sowl and Evans during their bird survey August 3, 1972, when a killer whale, 12 Dall porpoises *(Phocoenoides dalli)* and two harbor porpoises *(Phocoena phocoena)* were seen in the Lower Inlet.

*Schneider, Karl, Marine mammals biologist, Alaska Department of Fish & Game, Anchorage.

BIBLIOGRAPHY

1. Davis, Allen S. and Paul D. Kissner, *Sockeye Salmon Investigations* (Annual Technical Report 5-18-R, 1970 Field Season, Commercial Fisheries Research and Development Act, Alaska Department of Fish and Game, State of Alaska, 40 pp.) 1971.

2. Davis, Allen S., *Cook Inlet Sockeye Salmon Investigations* (Quarterly Progress Report 5-6-R-4, July 1, 1968, through September 30, 1968, Commercial Fisheries Research and Development Act, Alaska Department of Fish and Game, State of Alaska, 21 pp.) 1970.

3. Davis, Allen S., *Forest Research on the 1970 Cook Inlet Area Pink Salmon Fisheries* (ADFG Information LEAFLET No. 143, Alaska Dept. of Fish and Game, State of Alaska, 17 pp.) 1970.

4. Kubik, Stanley, *Population Studies of Anadromous Fish in Cook Inlet* (ADFG - Federal Aid in Fish Restoration Annual Report of Progress (1967-1968) Project F-5-R-9, Vol. 9: pp. 167-171) 1968.

5. Davis, Allen S., *Game Fish Investigation of Alaska Anchor River File* (Project F-1-R-4, Quarterly Progress Report, October 1, 1954, through December 31, 1954, U.S. Fish and Wildlife Service and the Alaska Game Commission) 1955.

6. Davis, Allen S., *Cook Inlet Sockeye Salmon Investigations* (Quarterly Progress Report, July 1, 1967, through September 30, 1967, Commercial Fisheries Research and Development Act, Alaska Department of Fish and Game, State of Alaska, 22 pp.) 1967.

7. Engel, Larry J., *Studies on the Russian River Red Salmon Sport Fishery* (ADFG - Federal Aid in Fish Restoration, Annual Report of Progress, Project No. F-9-2, Vol. 11: pp. 129-134) 1970.

8. Flagg, Loren B., *1971 Cook Inlet Annual Report - Shellfish Section* (Alaska Department of Fish and Game, Commercial Fisheries Division) 1972.

9. Powell, Guy C. and R. E. Reynolds, *Movements of Tagged King Crab (Paralithodes Camtschatica (Tilesius) in the Kodiak Island, Lower Cook Inlet Region of Alaska, 1954-1963* (Alaska Department of Fish and Game Informational LEAFLET No. 55) 1965.

10. Alaska Department of Fish and Game, *Alaska Catch and Production: Commercial Fisheries Statistics - 1970, 1971, 1972, 1973* (Statistical LEAFLETS No. 21, 1971, No. 23, 1972; No. 25, 1973; No. 26, 1974).

11. National Marine Fisheries Service, *Tanner Crab: Joint Plan for the Fishery* (NMFS, 86 pp.) 1971.

12. Cleaver, Fred, *Life History and Habits of the Commercial Crab, Cancer Magister* (Alaska Department of Fish and Game, State of Alaska) undated.

13. Loosanoff, V. L., *Commercial Clams of the Pacific Coast of the United States* (Fishery LEAFLET No. 223, Bureau of Commercial Fisheries) 1947.

14. Hennick, Daniel P., *Reproductive Cycle, Size at Maturity and Sexual Composition of Commercially Harvested Weathervane Scallops (Patinopecten caurinus) in Alaska* (Journal of Fisheries Restoration Board Canada 27: 2112-2119) 1970.

15. Gibson, Daniel D., *Bird Observations on Katmai National Monument — 24 February through 1 September, 1967* (Administration Report to National Park Service, Anchorage, Alaska) 1967.

16. Quimby, Ronald, *Chickaloon Flats Weekly Report, May 4-11, April 26 - May 3, 1971* (Administrative Report to Manager, Kenai National Moose Range, Kenai (Processed)) 1971.

17. Krohn, W. B., *A Brief Survey of the Tuxedni National Wildlife Refuge* (14 pp. inch map - Typed Administrative Report to Kenai National Moose Range, Kenai, Alaska) 1966.

18. Snarski, D. A., *Observations of Birds on Tuxedni National Wildlife Refuge and Vicinity* (Administrative Report to U.S. Bureau of Sport Fisheries and Wildlife (Processed)) 1971a.

19. Tremblay, R. H., *Waterfowl Winter Inventory* (Administration Letter Report to Waterfowl Supervisor, U.S. Bureau of Sport Fisheries and Wildlife, Juneau, April 22, 1966) 1966.

20. Bader, D. A., *Greater Anchorage Area Borough on Birds of the Potter Marsh* (Letter to Planning Department, June 12, 1970) 1970.

21. Robbins, C. S., B. Bruun and H. S. Zim, *Birds of North America - A Guide to Field Identification* (Golden Press, New York) 1966.

22. Gabrielson, F. N. and F. C. Lincoln, *Birds of Alaska* (Stackpole Co., Harrisburg, Pennsylvania, 922 pp.) 1959.

23. Shepherd, P. E. K. and B. L. Hilliker and J. H. Crown, *Small Game and Fur-Bearer Investigations - Waterfowl* (Alaska Department of Fish and Game Project W-13-R-2) 1967.

24. Havens, P. D., *Waterfowl Survey - Inventory Progress Report* (In ADFG Report of Survey and Inventory Activities, Part III, Waterfowl and Small Game, Vol. II, Federal Aid in Wildlife Restoration Project W-17-3) 1970.

25. Havens, P. D., *Report of Survey and Inventory Activities - Waterfowl* (Vol. III, ADFG Federal Aid in Wildlife Restoration Project W-17-4) 1971.

26. *Alaska's Wildlife and Habitat* (Alaska Department of Fish and Game) January, 1973.

27. Klinkhart, E. G., *The Beluga Whale in Slaska* (Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Report, Vol. VII, Project W-G-R and W-14-R) 1966.

SANTA BARBARA CHANNEL, CALIFORNIA

OIL AND GAS RESOURCES

The continental shelf of California consists of an area of 35,000 square miles, about one-fifth the size of that of the land area of the state (Figure 1). North of San Francisco the shelf is 15 to 30 miles wide; but it fans out to the south and is more than 160 miles wide at the Mexican Border. The depth of the water varies out to the edge of the shelf, where the maximum ranges from 600 feet in the north to 5,000 feet in the south.

The Supreme Court of the United States in 1966 explicitly delineated the area that the state may exploit for mineral extraction. It can be approximately defined as the area between the coast of California or that of the offshore islands and a line three geographical (nautical) miles seaward; the total area is about 4,700 square (nautical) miles, or slightly over 13 percent of the shelf. Not all this area is owned by the state; portions have been granted to cities, therefore the distinction is here made between state-owned and state-regulated lands.

The continental shelf is topographically and geologically an extension of the adjoining coast. Relatively little sea floor geologic mapping has been done; however, the main structural trends have been projected, with the offshore islands serving as valuable tie-in points. Most of the geologic studies have been made in the Santa Barbara Channel area because of its economic importance.

Oil and gas are found in areas where sedimentary rocks have been deposited. An area of this type of deposition, in which the strata dip inward, is called a basin. There are nine major sedimentary basins along the California coast and each of these extends into the continental shelf. The two southernmost basins, Ventura-Santa Barbara and Los Angeles, are areas of major oil and gas development onshore and presently are the only ones with oil production offshore. (Figure 2)

Of the 18 producing oil fields off the California coast, only one is wholly within federal waters. Another field overlaps the three-mile line and contains both federal and state leases. Seven of these fields also produce onshore. There are five productive dry gas fields, or zones, on the shelf, and they are all in state waters.

Through 1970, the cumulative offshore production was more than 1.21 billion barrels of oil and 1.07 billion Mcf. of gas; of these quantities, 1.18 billion barrels and 1.04 billion Mcf. were from state-controlled lands. During 1970, offshore production from state fields was about 79 million barrels of oil and 58 million Mcf. of gas.

The estimated known or proved reserves, with current operating practices, for fields on state-controlled lands (including Wilmington field) are about 1.0 billion barrels of oil and 1.1 billion Mcf. of gas. In comparison, the estimated proved reserves for the entire state are 5.7 billion barrels of oil.

Two methods of stating oil reserves are as proved reserves or potential reserves; proved reserves are those known to exist, and potential reserves are those presumed to exist.

Before development began in federal waters, it was estimated that the potential oil reserves in the Santa Barbara Channel were 4.0 billion barrels. Subsequent development of Dos Cuadras and Carpinteria Offshore fields have made proved oil reserves about 250 billion barrels. Recent discoveries by Humble Oil and Refining Company and Mobil Oil Corporation in the channel are reported to have possible reserves on the order of 1.0 billion barrels of oil. State Lands Division has estimated the potential oil reserves under all California coastal waters to the 200-fathom line to be nearly 6.0 billion barrels. The resumé of OCS development in the Santa Barbara area is given in Table 1. Figures 3 and 4 identify leased areas and sanctuaries.

FIGURE 1

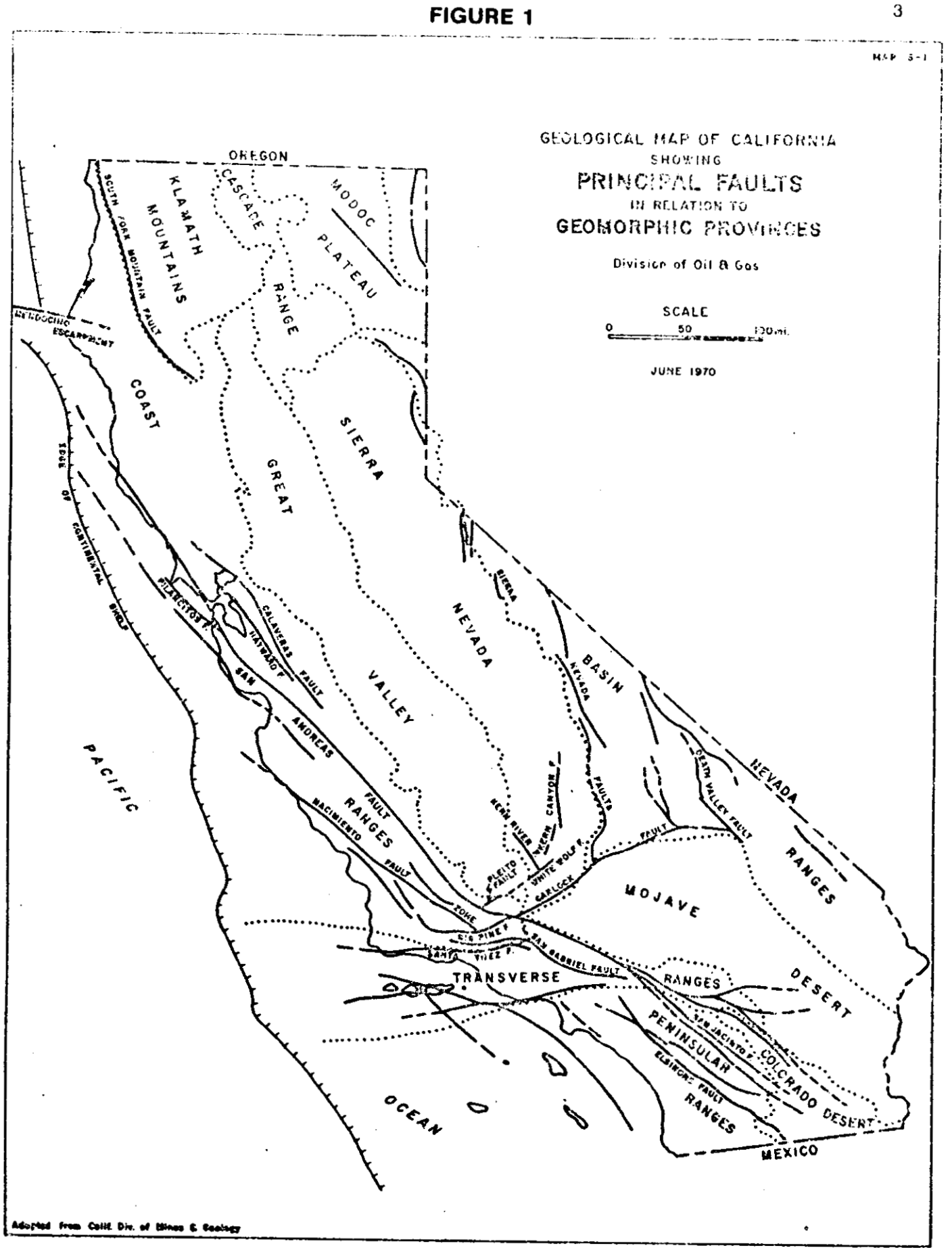

MAP 5-1
GEOLOGICAL MAP OF CALIFORNIA
SHOWING
PRINCIPAL FAULTS
IN RELATION TO
GEOMORPHIC PROVINCES
Division of Oil & Gas
SCALE
0 50 100 mi.
JUNE 1970
OREGON
KLAMATH MOUNTAINS
CASCADE RANGE
MODOC PLATEAU
SOUTH FORK MOUNTAIN FAULT
MENDOCINO ESCARPMENT
COAST RANGES
GREAT VALLEY
SIERRA NEVADA
SIERRA NEVADA BASIN
RANGES
PACIFIC OCEAN
SHELF OF CONTINENTAL
CALAVERAS FAULT
HAYWARD F.
SAN ANDREAS FAULT
HACIENDA F.
NACIMIENTO FAULT
KERN RIVER FAULTS
KERN CANYON F.
WHITE WOLF F.
GARLOCK FAULT
PLEITO FAULT
TOKE FAULT
DEATH VALLEY FAULT
MOJAVE DESERT
SAN GABRIEL FAULT
TRANSVERSE RANGES
PENINSULAR RANGES
SAN JACINTO F.
ELSINORE FAULT
COLORADO DESERT
MEXICO
Adapted from Calif. Div. of Mines & Geology

FIGURE 2

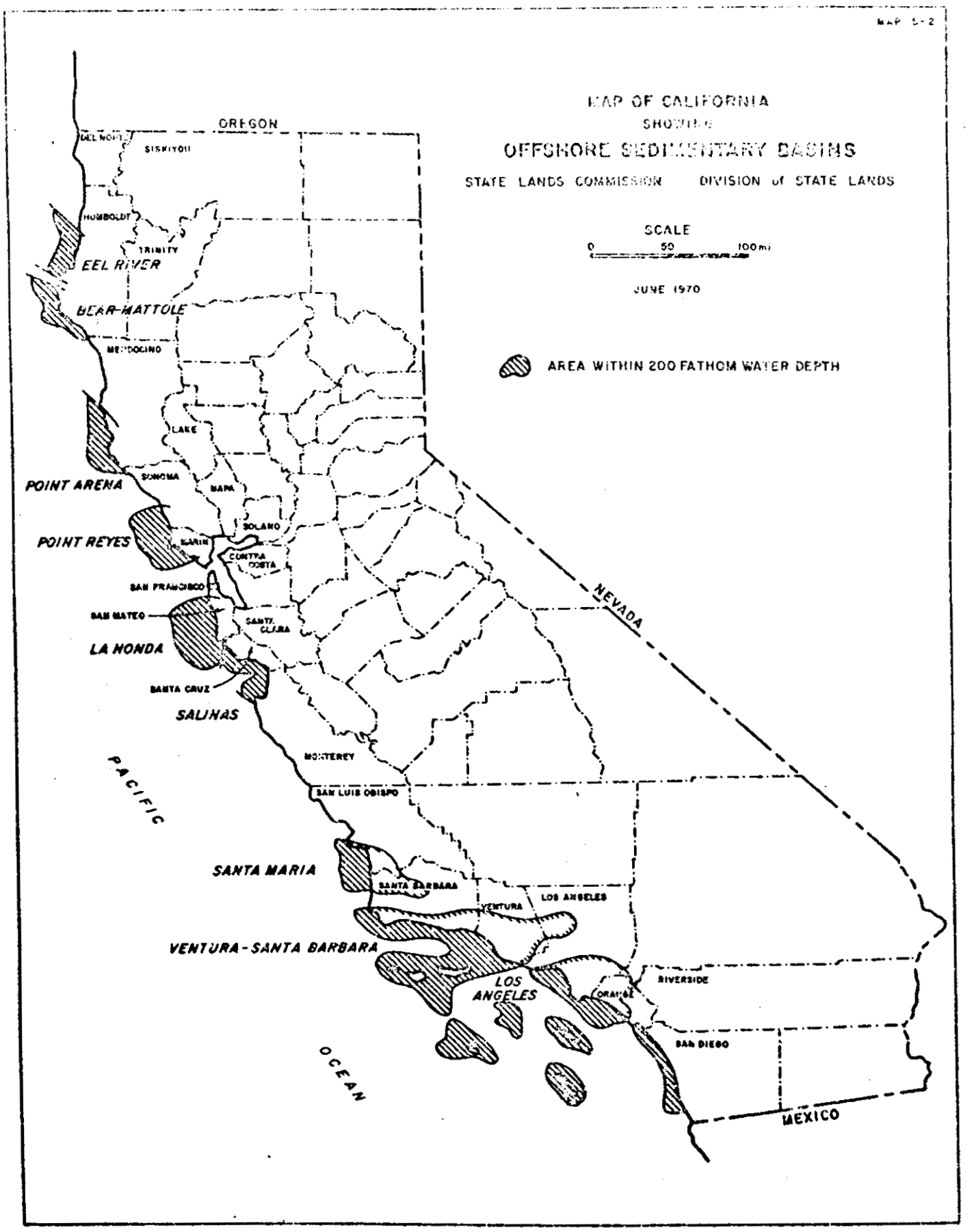

MAP OF CALIFORNIA
OFFSHORE SEDIMENTARY BASINS
STATE LANDS COMMISSION
DIVISION of STATE LANDS
SCALE
0
50
100 mi
JUNE 1970
AREA WITHIN 200 FATHOM WATER DEPTH
OREGON
NEVADA
MEXICO
PACIFIC
OCEAN
EEL RIVER
BEAR-MATTOLE
POINT ARENA
POINT REYES
LA HONDA
SALINAS
SANTA MARIA
VENTURA-SANTA BARBARA
LOS ANGELES
SISKIYOU
HUMBOLDT
TRINITY
LAKE
SONOMA
NAPA
SOLANO
MARIN
CONTRA COSTA
SAN FRANCISCO
SAN MATEO
SANTA CLARA
SANTA CRUZ
MONTEREY
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
SAN DIEGO

TABLE 1

RESUME OF OFFSHORE DEVELOPMENT HISTORY

1896: First offshore production in California at Summerland, Santa Barbara County.

1921: First tidelands leasing act (Chapter 303, Statutes of 1921). Subsequent discovery of oil at Rincon, Elwood and Capitan.

1933: Huntington Beach tideland production established as a result of court-ordered well surveys.

1938: The State Lands Act of 1938 established the State Lands Commission.

1939: First wells drilled into tidelands granted to a municipality at Long Beach (Wilmington field).

1953: Discovery of oil in the offshore area of West Montalvo field. Discovery of oil on granted tidelands in the offshore area of West Newport field.

1954: First man-made island, "Monterey," built one and one-half miles offshore from Seal Beach to develop the Belmont Offshore field.

1955: Cunningham-Shell Tidelands Act restricted leasing to areas of known potentiality. Provided for the erection of drilling platforms.

1956: Oil discovered offshore from Redondo Beach on granted tidelands.

1957: Cunningham-Shell Tidelands Act amended. Specified sliding-scale royalties beginning at not less than 16-2/3 percent.

1958: First permanent drilling platform, "Hazel", erected two miles offshore from Summerland. (Summerland Offshore field). Rincon Island constructed with causeway to shore.

1960: Platform Hilda installed west of "Hazel" in the Summerland Offshore field. Platform Helen erected offshore from Gaviota (Cuarta Offshore field).

1961: First well completed on the sea floor (west of Rincon Island). Platform Harry installed one mile offshore from Point Conception (Conception Offshore).

1962: Molino Offshore Gas, Caliente Offshore Gas and the offshore area of Alegria oil field discovered. All wells completed on the sea floor.

1963: Platform Herman installed east of "Harry" (Conception Offshore field). Platform Emmy erected one and one-quarter miles offshore from Huntington Beach.

1964: Platform Eva installed west of "Emmy" (offshore area of Huntington Beach field). Legislation passed to develop the eastern portion of Wilmington field on tidelands granted to the City of Long Beach (Senate Bill No. 60, Ch. 138, Statutes of 1964, 1st E. S.). Subsequently, four islands, "Chaffee", "Grissom", "White" and "Freeman", were built in the inner Long Beach Harbor.

1965: Island Esther built east of Island Monterey (Belmont Offshore field). Platform Hope erected three miles offshore from Carpinteria (Carpinteria Offshore field).

1966: First federal lease issued in the Santa Barbara Channel (federal portion of Carpinteria Offshore field). Platform Heidi erected east of "Hope". Oil discovered offshore from Venice Beach (Venice Beach field) on tidelands granted to the City of Los Angeles.

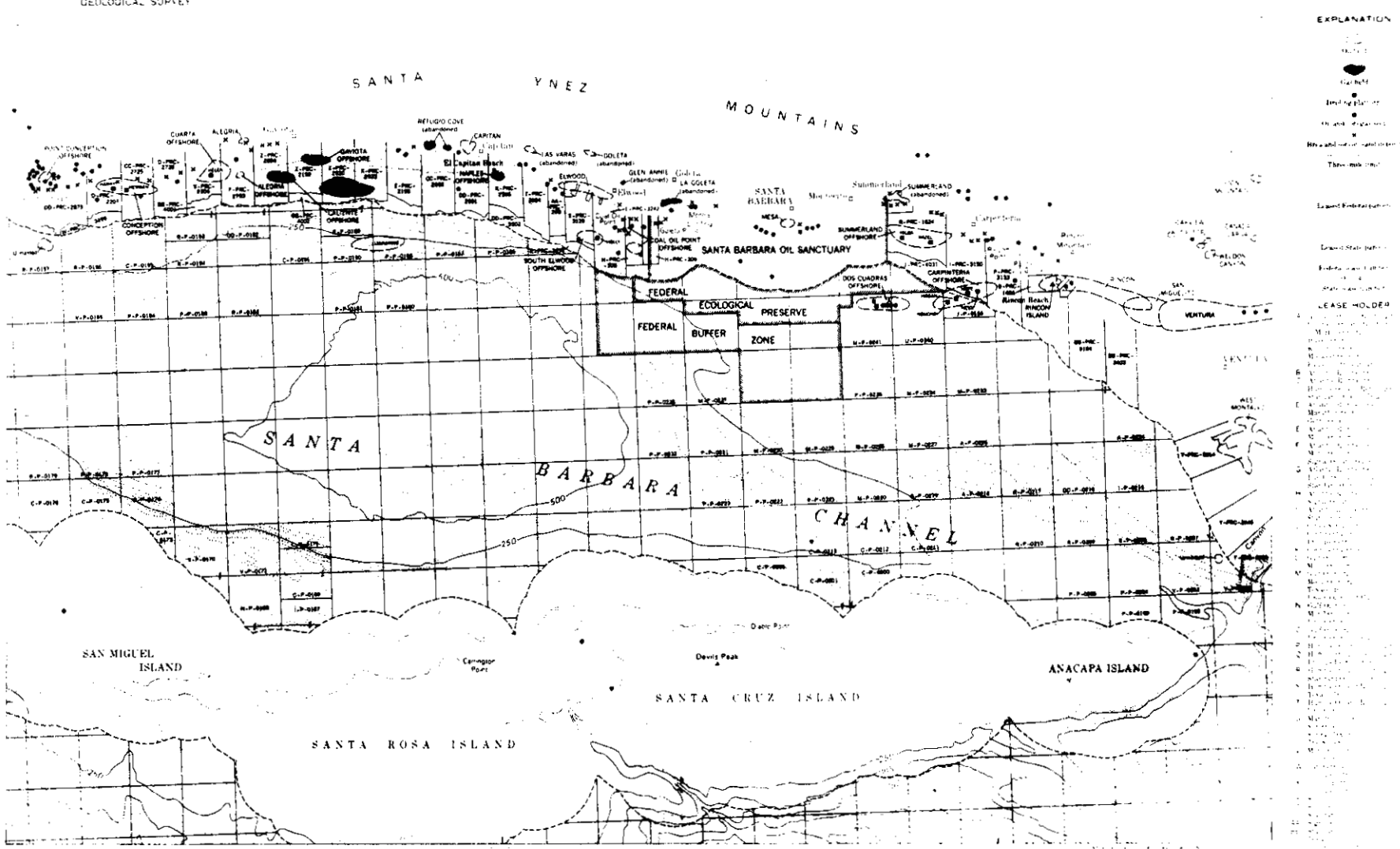
TABLE I (Continued)

1967: Platforms Hogan and Houchin installed on Federal OCS Tract 298 (federal portion of Carpinteria Offshore field).

1968: Federal Bureau of Land Management leased 71 tracts in the Santa Barbara Channel for a total cash bonus payment of $602,719,261. Platforms A and B erected on Federal OCS Tract 402 (Dos Cuadras field).

1969: Well blowout on Platform A. Federal ban on all drilling in the Santa Barbara Channel. Drilling later resumed. All new drilling on state-owned tidelands banned subject to State Lands Commission review. Platform Hillhouse installed on Federal OCS Tract 401 (Dos Cuadras field).

1971: Secretary of the Interior refuses permission to erect additional platforms on Federal OCS Tract 401 and 402 (Dos Cuadras field).



EXPLANATION

LEASE HOLDER

MAP SHOWING OIL AND GAS FIELDS, LEASED AREAS, AND SEEPS IN THE SANTA BARBARA CHANNEL REGION

FIGURE 3

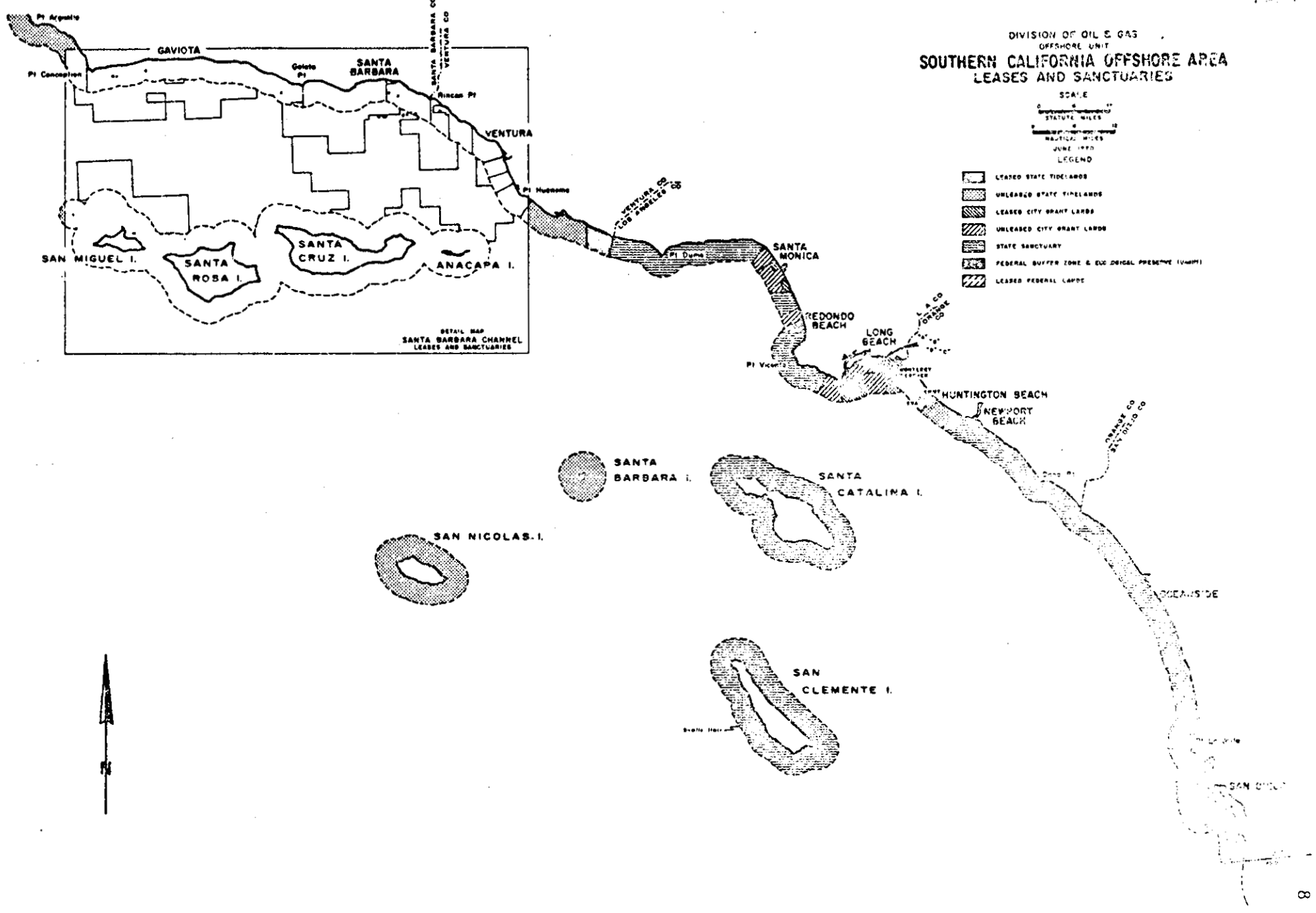

DIVISION OF OIL & GAS
OFFSHORE UNIT
SOUTHERN CALIFORNIA OFFSHORE AREA
LEASES AND SANCTUARIES
SCALE
STATUTE MILES
NAUTICAL MILES
LEGEND
LEASED STATE TIDELANDS
UNLEASED STATE TIDELANDS
LEASED CITY GRANT LANDS
UNLEASED CITY GRANT LANDS
STATE SANCTUARY
FEDERAL BUFFER ZONE & ECOLOGICAL PRESERVE (VARIES)
LEASED FEDERAL LANDS
Pt Argello
Pt Conception
GAVIOTA
Goleta Pt
SANTA BARBARA
SANTA BARBARA CO
VENTURA CO
Rincon Pt
VENTURA
Pt Hueneme
VENTURA CO
LOS ANGELES CO
Pt Dume
SANTA MONICA
REDONDO BEACH
LONG BEACH
L.A. CO
ORANGE CO
Pt Vicente
HUNTINGTON BEACH
NEWPORT BEACH
ORANGE CO
SAN DIEGO CO
OCEANSIDE
SAN DIEGO
SAN MIGUEL I.
SANTA ROSA I.
SANTA CRUZ I.
ANACAPA I.
DETAIL MAP
SANTA BARBARA CHANNEL
LEASES AND SANCTUARIES
SANTA BARBARA I.
SANTA CATALINA I.
SAN NICOLAS I.
SAN CLEMENTE I.
N

FIGURE 4

NATURAL SEEPS

Oil and tar patches on the beach were a common complaint of coastal residents for many years prior to the Santa Barbara oil well blowout. Usually, oil operations were blamed, but most of the oil came from the numerous natural seeps that occur on the ocean floor or along the coast. The earliest mention of an offshore oil seep was by Father Pedro Font who wrote of his travels near Santa Barbara in 1776, . . . "much tar which the sea throws up is found on the shores, sticking to the stones and dry. Little balls of fresh tar are also found. Perhaps there are springs of it which flow out into the sea . . ." The occurrence of seeps is an established but still not widely known fact. All areas of the world that have petroleum leak oil, that is, have seeps. Thus, the presence of seeps is of considerable interest to industrial geologists evaluating the economic potential of any offshore area. As a consequence, seeps are sought out and the actual seepage from the ocean floor observed wherever possible.

Most seeps are easily seen as oil slicks or gas bubbles on the surface of the sea. Some remain dormant for extended periods of time and then become reactivated, probabily by pressure buildup or earth movement. Because of the transient nature of many seeps, an accurate count is difficult to obtain; however, it appears that there are probably 50 to 60 seeps and seep areas on the ocean floor between Point Conception in Santa Barbara County and Huntington Beach in Orange County. Figures 5 and 6 identify the oil, gas and tar seeps that have been documented by the Division of Oil and Gas.

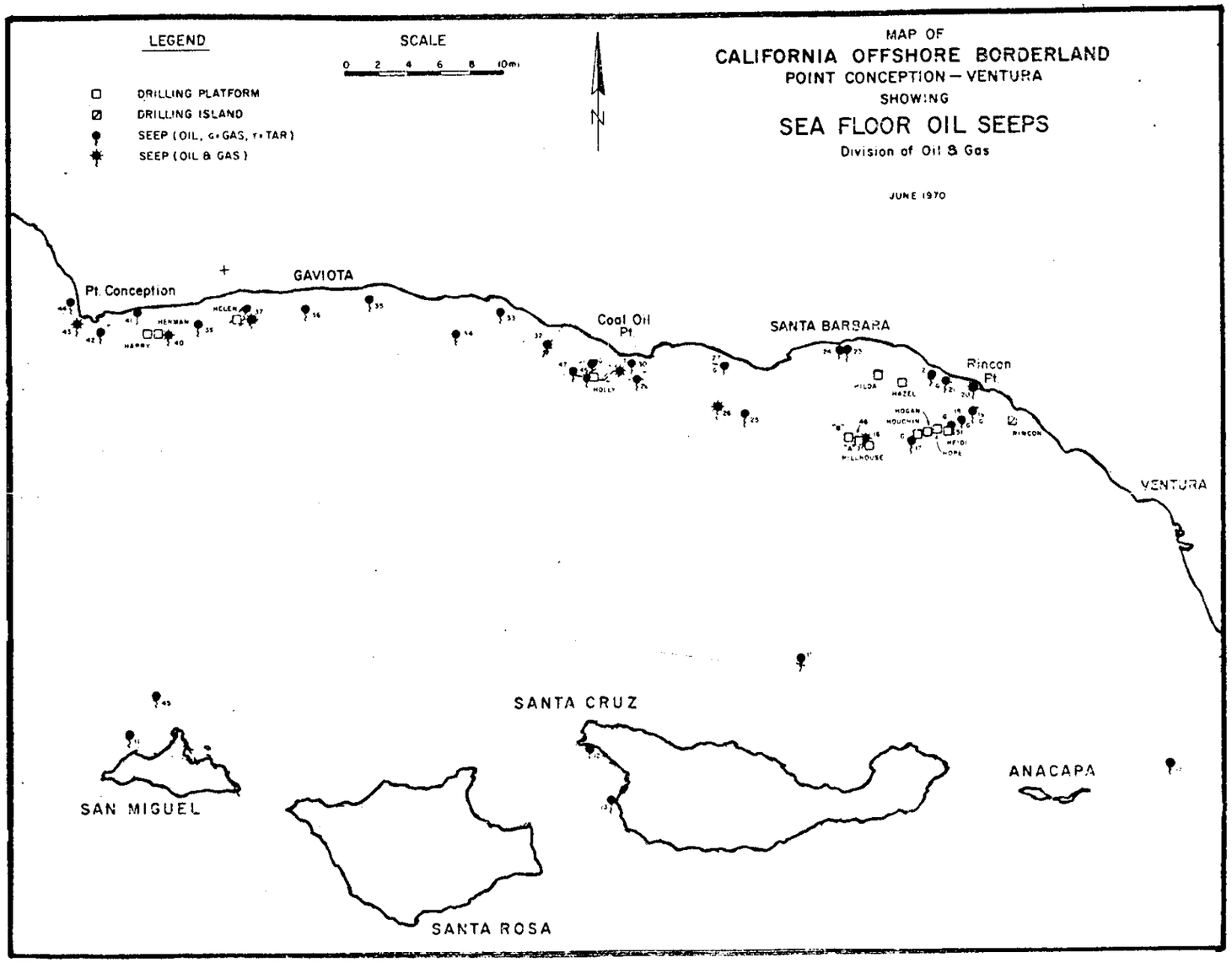

LEGEND
DRILLING PLATFORM
DRILLING ISLAND
SEEP (OIL, GAS, TAR)
SEEP (OIL & GAS)
SCALE
0 2 4 6 8 10mi
N
MAP OF
CALIFORNIA OFFSHORE BORDERLAND
POINT CONCEPTION — VENTURA
SHOWING
SEA FLOOR OIL SEEPS
Division of Oil & Gas
JUNE 1970
Pt. Conception
GAVIOTA
Coal Oil Pt.
SANTA BARBARA
Rincon Pt.
VENTURA
SANTA CRUZ
ANACAPA
SAN MIGUEL
SANTA ROSA

FIGURE 5

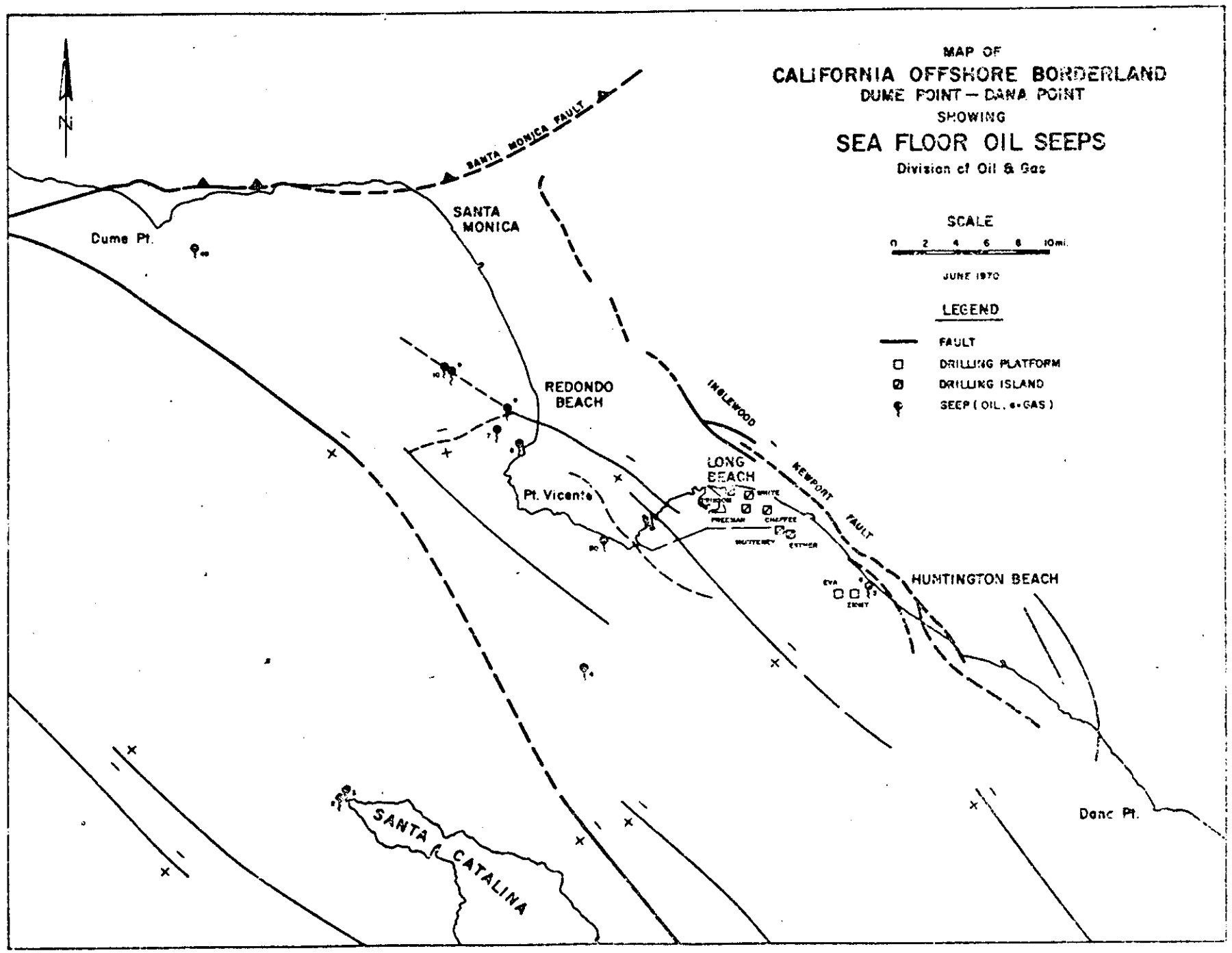

MAP OF
CALIFORNIA OFFSHORE BORDERLAND
DUME POINT — DANA POINT
SHOWING
SEA FLOOR OIL SEEPS
Division of Oil & Gas
SCALE
0 2 4 6 8 10mi.
JUNE 1970
LEGEND
FAULT
DRILLING PLATFORM
DRILLING ISLAND
SEEP (OIL, +GAS)
N
SANTA MONICA FAULT
SANTA MONICA
Dume Pt.
REDONDO BEACH
INGLEWOOD
NEWPORT FAULT
LONG BEACH
Pt. Vicente
HUNTINGTON BEACH
SANTA CATALINA
Dana Pt.

FIGURE 6

SANTA BARBARA WELL BLOWOUT

On February 6, 1968, at a lease sale in Los Angeles, the Federal Government accepted the highest bids for oil leases on 71 tracts in the Santa Barbara Channel from 20 companies, acting alone or in partnerships. An oil discovery was made the following month on Tract 402, a parcel leased by a group consisting of Union Oil Company of California, Gulf Oil Corporation, Mobil Oil Corporation, and Texaco Inc., with Union Oil Company of California acting as the operator. The field was named Dos Cuadras. In September 1968, Platform A was set into position about five and one-half statute miles off the coast in 188 feet of water. The platform, designed to accommodate 54 producing wells, was equipped with both a conventional and a tilted drilling rig.

HISTORY OF THE SPILL AND CLEANUP OPERATIONS

Development drilling from the platform, which began in November 1968, was stopped when the fifth well, No. 402-A21, blew out on January 28, 1969. The well, which had been approved by the U.S. Geologic Survey District Engineer, was at a total depth of 3,479 feet and the drill pipe was being removed from the hole so that an electric log could be run, when gas began blowing at the surface through the drill pipe. The crew took various steps to shut in the well; finally dropping the drill pipe down the hole and successfully containing the well by closing the rams on the blowout preventers. Pressure from the lower zone (top of approximately 3,000 feet) overpressured the shallower Brown zone (top at approximately 400 feet) and the successful containment was short-lived, as there was insufficient overburden above the bottom of the surface casing to contain the pressure from the lower zone within the well bore. Oil and gas erupted from the sea floor to the surface of the ocean. During the ten days of uncontrolled oil flow from the ocean floor the flow rate was variously estimated to be between 500 and 16,000 barrels per day. Further operations were undertaken in the well to cement off the lower zone and thus retain the pressure within the zone. After ten days, this was successful. Oil still seeps from the shallow zones through fractures to the ocean floor although most of it is being captured by submarine tents.

At first, following the blowout, containment and removal or dispersal of this oil was attempted by various methods. Chemical means were tried for only a few days and were unsuccessful. Several types of booms were constructed but could not be maintained in the heavy seas. Several skimming methods were attempted but proved ineffective. Thereafter, efforts were limited to the application of straw and its subsequent removal from harbors and the shore. A general cleanup of the beaches, harbors and boats was undertaken by the operator as soon as the well was generally contained. Operations included blowing of straw on the oily water and subsequently collecting the the oil-soaked straw mulch, steam cleaning and sandblasting rocks and breakwaters, removal of oil-soaked sand, and cleaning or repainting of boats. Beach operations were retarded by the vast amounts of debris, estimated at more than 30,000 tons, which was deposited by a large storm that just preceded the blowout. The oil-soaked material was disposed at dump sites in Ventura County, as the City of Santa Barbara refused use of its dump and the Santa Barbara County dump was closed by storm damage. Cleanup operations were performed by Conservation Camp inmates, supervised by Department of Conservation and Department of Corrections personnel, and contract labor.

BIOLOGICAL EFFECTS OF THE SPILL

Oil released from the well and formation fissures initially formed oil slicks which covered large areas of the channel. Spreading and movement of the slick was highly variable as a result of wind, wave and current conditions. Dos Cuadras oil is a moderately paraffinic 21 to 30° API gravity oil having low toxicity compared to other crude oils. The oil did not blanket the ocean with a uniform film, but tended to break up with time into "windrows" (parallel to advancing wave fronts) and irregular "ropes". Furthermore, the oil masses moved at a different rate from the water below. Therefore, light penetration and oxygenation required for phytoplankton and zooplankton growth were little affected.

Effects on the marine and intertidal biota from the oil in the open channel and from movement of the slick onto the beaches will be discussed in four sections:

1) Birds

2) Intertidal and nearshore communities

3) Offshore and benthic communities

4) Marine mammals

1) Birds

The most visible and immediate effect of the oil spill was the contamination of marine birds with oil. As the slick moved towards shore several days after the blowout, oil-soaked birds appeared on the beaches. Species that swim or dive for their food were most affected, including grebes, cormorants, scoters, loons, pelicans, murres and mergansers. Seagulls were the least affected. The California Department of Fish and Game estimated the loss of birds due to the spill to be about 3700 at the end of March, 1969, which did not account for birds which perished and sank in the channel. During this period they estimated that over 12,000 living birds were present in the channel. The bird population was low at the time. Only four months later 85,000 birds were present.

Bird washing and rehabilitation stations were established at two locations. One was operated by the Childs Estate (a municipal zoo) in Santa Barbara, the other by the Union Oil Company in Carpinteria. Treatment consisted of washing the birds with a dispersant (usually Polycomplex A-11), followed by placing them in a warm recovery room. Confinement for several weeks was then required in order to restore water repellancy to the feathers and for general rehabilitation. An estimated 10 percent of the treated birds survived. [1]

Bird populations quickly returned to normal, with the distribution of species the following year about the same as before the spill.

2) Intertidal and Nearshore Communities

The oil, which came ashore in thick layers in the upper intertidal area, had already been at sea for several days before it was washed ashore, thus giving it a chance to lose its volatile components. In lower intertidal areas it tended to stick less but was washed on and off by the tides. In areas where the oil stuck to the substrate in a thick layer, animals appeared to be smothered because nearby species not covered by the oil survived. In areas exposed to strong wave action, the oil was removed from the substrate within three weeks.

Death by smothering was illustrated by studies of two species of barnacles. [2,3,4,5] Mortalities were high among *Chthamalus fissus*, one of the most abundant invertebrates in the upper intertidal region. This barnacle is small (less than 5 mm high) and was often seen completely covered by oil. Survival was greater among *Balanus glandula*, another common sessile intertidal barnacle in Southern California. *B. glandula* is a larger species (adults usually over 5 mm high), and was often found with the mouth protruding through coats of oil which smothered *C. fissus*. [5]

Further studies were made by Dr. Dale Straughan of the Allan Hancock Foundation, University of Southern California, of repopulation of oiled areas by barnacles. [7] The studies *C. fissus*, *B. glandula*, and *Pollicipies polymerus*, a stalked barnacle found in lower intertidal areas. She did not detect any effect on breeding in either *C. fissus* or *B. glandula*. However, in *P. polymerus* with oiled exteriors, there was a significant reduction in the fraction of adults brooding eggs. Of these three barnacles, the first to repopulate oiled areas was *B. glandula*, which settled on oil less than seven weeks after the spill. Next was *C. fissus*, which was not observed on oiled surfaces until November, 1969 - ten months after the spill. *P. polymerus* had still not been observed in 1971 on moderately or heavily oiled surfaces.

These different tolerances for oil can be explained by the specialized forms of these three barnacle species of the same group. *B. glandula* which settled first has a calcareous basal plate that separates the animal from the substrate. This basal plate is absent in *C. fissus*. Dr. Straughan speculated that "this basal calcareous plate, which prevents direct exposure of the animal to the oiled substrate, may be the characteristic that permits *B. glandula* to settle on oiled surfaces earlier than *C. fissus*. *P. polymerus* has a noncalcareous stalk." [6]

The observations described above for oil-covered surfaces were made on small, sheltered areas on the rocks. Almost all of the rock surfaces had been cleaned of oil either mechanically or by wave action within two months after the spill. Resettlement by any of the species occurred as soon as the oil was lost from the substrate.

There were few long term changes in the relative numbers of each species in the beach environment. A year after the spill, reductions in the reproduction of the barnacle, *Pollicipes polymerus*, were apparent. Furthermore, the breeding in the mussel, *Mytilus californianus*, was probably reduced after oil pollution. The conclusion drawn by most investigators was that oil had no widespread effects on the intertidal area. [7] California Department of Fish and Game reported that "species diversity remained high and there were no indications of major modifications in numbers." [8]

Flora

Surf Grass

The surf grass *Phyllospadix torreyi* is susceptible to injury and mortality by oil. Blades of the grass float on the surface of tide pools and lack a mucoid coating. Up to 100 percent of the *Phyllospadix* blades at stations exposed to heavy amounts of oil were reported coated and/or killed by oil. [3] The grass turns yellow on contact with oil. However, complete recovery after contact with oil was usual. The grass at Anacapa Island was heavily coated by oil in February, but was normal appearing and abundant by August-September.

Kelp

Kelp beds were unharmed by oil. The California Department of Fish and Game found that oil was easily shaken off stipes, indicating that storms or heavy seas would clean the beds. Dr. Wheeler J. North, who had previously studied kelp beds, stated that the kelp beds were unharmed. He explained that kelp secretes a mucous substance (polysacharide) which prevents oil from adhering to a living plant. [9]

Algae

The brown algae *Egregia* sp. is found floating on the surface of tide pools along with *Phyllospadix* (surf grass). Because this algae has a mucoid film, it was not as heavily coated or killed by oil as *Phyllospadix*, according to Foster, Neushal, and Zingmark. [3]

High zoned algae (*Enteromorpha intestinalis* and seven other species) were reported covered and damaged by the oil. [3] On Santa Cruz Island, the algae *Hesperophycus harveyanus*, originally heavily coated by oil in February, was clean by August (CDFG, 1969). In addition, numerous young plants were present.

3) Offshore and Benthic Communities

Phytoplankton

Phytoplankton studies in the Santa Barbara Channel by Oguri and Kanter revealed no conclusive evidence of any major effect which could be directly attributed to the spilled oil. [10] These studies were based on 11 stations which were resampled 12 times from 1969 to 1970. The data

show higher productivity occurring inshore, seasonal variations in productivity, and the presence of a phytoplankton bloom in August, 1969. The authors found no low-productivity values resulting from the presence of oil on the surface of the water. For example, at Station 11 nearest to the oil platform, values for productivity and chlorophyll for May 1969 and May 1970 are "strikingly similar" and show "no marked reduction in productivity per unit of chlorophyll" even though oil was easily detected on the surface of the water.

Zooplankton

A twelve month study of zooplankton in the eastern end of the Santa Barbara Channel showed no effects of oil pollution. [11]

Fish

California Department of Fish and Game trawls of 14,070 fishes representing 59 species failed to show damage directly related to oil pollution or starvation which might imply impairment of the food chain (CDFG, 1969). U.S. Bureau of Commercial Fisheries (National Marine Fisheries Service) personnel found no gross evidence of dead or deformed embryos in fish eggs, nor gross changes in the composition of the ichthyoplankton in the channel during February 1969.

A decline in fish catches in the months immediately following the spill as compared to catches in those months in previous years was probably due to a reluctance on the part of fishermen to operate in oily waters. However, the total commercial fish landings for the year 1969 were higher than those in 1969: 34,614,177 lbs. in 1969 as compared to 20,552,278 lbs. in 1968. (California Fish and Game reports of California Marine Fish Catches.)

Invertebrates

Few adverse effects of the oil on benthic invertebrates were reported by either the Allen Hancock Foundation or California Department of Fish and Game. California Department of Fish and Game divers observed oil on barnacles and mollusks from February to August 1969 but reported them to be in good condition and unharmed (CDFG, 1969). The same report noted California spiny lobsters, *Panulirus interruptus*, at a number of stations which showed no ill effects.

Further, the divers reported no observable deleterious effects on invertebrates when they surveyed the subtidal areas on the mainland during May 1969. The California report states that bottom grab samples taken during February 1969 indicated that invertebrates living in the bottom sediments were in good condition and were not affected by the oil leak (CDFG, 1969).

4) Marine Mammals

Mammals were apparently little affected by the oil. No changes in whale, seal or sea lion populations could be attributed to the leak of 1969.

Grey whales were migrating northwards in March, and were thought to be endangered by the oil. Straughan and Abbott reported:

> "Grey whale strandings were not significantly higher in 1969 than recorded in other years. Crude autopsy, which included examination of tissues for oil on one stranded specimen, failed to indicate that oil was associated with the death of the animal. Similarly, when oil came ashore in an area of the seal colony on San Miguel, fears were expressed for the safety of these animals. Once again, both through autopsy and studies of the population, it has not been possible to prove mortality due to oil pollution." [12]

Reasons for the Limited Biological Damage

Damage to marine organisms was not as great as anticipated. Predictions were in error because they were based on the history of spills of oil with a greater toxicity, or where large amounts of toxic dispersants were used. Biological damage was limited because:

1) Dos Cuadras crude oil has a low solubility in water, and low toxicity, being moderately paraffinic. Crude oils are much less toxic than refined oils.

2) The oil was released in deep water several miles from shore. Water soluble components could be extracted from the crude and greatly diluted by large volumes of water. Evaporation of volatile components from the water and from the oil directly could also occur some distance from shore. Although the oil volume was sufficient to form a slick covering a large area of the channel, nonuniform oil thickness and movement of the slick relative to the water underneath permitted oxygenation and sunlight penetration.

3) The topography of the shoreline was favorable. There were few bays, estuaries or marshes where oil could be trapped and then not be subjected to wave action.

4) The marine organisms in the channel may have had a high tolerance to oil built up by almost continuous exposure to small amounts of similar oil from natural seeps over long periods.

5) Dispersants were used sparingly. The dispersants used (Corexit and Polycomplex A-11) had far lower toxicity than those used in the Torrey Canyon tanker spill. In the Torrey Canyon cleanup, thousands of tons of extremely toxic dispersants were used.

As a result of these conditions, damage to the biota was slight. Dr. Straughan's main finding was that "... only the barnacle *C. fissus* and pelagic birds were badly affected by the oil. This is not to say, of course, that other species were not affected to some degree. It is difficult, however, to isolate minor effects in such a study, particularly when detailed background information for the spill is not available for comparison." [13]

SUMMARY OF "OFFSHORE" OIL DRILLING - ITS EFFECT UPON THE MARINE ENVIRONMENT"*

By C. H. Turner, J. E. Carlisle, Jr., and E. E. Ebert

Beginning in July, 1958, and for nearly three years following, the California Department of Fish and Game studied the effects of offshore oil drilling on marine biota associated with drilling platforms. This study included the effects of man-made structures on marine life and of the presence of washed drill cuttings on the ocean floor. Special attention was paid to the possible deleterious effects of the latter operation.

The principal study sites were the Standard-Humble Oil Platform "Hazel" at Summerland and the Richfield Oil Island at Rincon. These stuctures are less than 10 miles south of Santa Barbara. Several dives were made under the Monterey Oil Platform off Seal Beach, Orange County, and the Standard-Humble Oil Platform "Hilda" after its completion in May 1960. "Hilda" is less than a mile from "Hazel." One dive was made under the Texaco platform at Gaviota, which is north of Santa Barbara.

Standard-Humble Oil Platforms
"Hazel" and "Hilda", Summerland

These platforms are approximately 2 miles offshore, about three-fourths mile apart, in 100 and 106 feet of water, respectively. The bottom is a dark grey, silty mud with many sea pens, *Stylatula elongata,* and tube anemones, *Pachycerianthus,* sp., living in it. Construction of "Hazel" and "Hilda" was completed in July 1958 and May 1960, respectively. Sea life was monitored at almost monthly intervals for 29 months around "Hazel" after its construction and for the 5 immediate months around "Hilda" after it was finished.

Colonization by marine life proceeded somewhat more rapidly around "Hilda" than "Hazel", possibly because it could draw from "Hazel" in addition to the natural reef located about 1-1/2 miles from both. Since the development of marine life immediately after the construction of these platforms was so similar, both in numbers of species and of individuals, the prolific marine life observed at "Hazel" over the longer period of monitoring undoubtedly occurs at "Hilda" as well.

Within two months, schools of Pacific sardines, *Sardinops caerulea,* and jack mackerel, *Trachurus symmetricus,* swam under the platform of "Hazel" while Pacific bonito, *Sarda chiliensis,* cruised just outside the perimeter of "Hazel". Shiner sea perch, *Cymatogaster aggregata,* and halfmoon, *Madialuna californiensis,* were observed near the surface. Nudibranchs, *Hermissenda crassicornis,* fed on the encrusting organisms kelp scallops, *Leptopectan latiaurata,* and barnacles, *Balanus,* sp.

Ultimately, sea perch were the most common fish of the 46 species in 20 families and 34 genera represented under and around the platform. In addition to the previously mentioned shiner sea perch, black sea perch, *Embiotoca jacksoni;* rubberlip sea perch, *Rhacochilus toxotea; pile sea perch, Rhacochilus vacca;* and white sea perch, *Phanerodon furcatus* were also present. The next most prevalent fish, the rockfishes, were represented by ten species, the five most prevalent being boccacio, *Sebastodes paucispinis;* brown rockfish, *S. auriculatus;* whitebelly rockfish, *S. vexillaris;* olive rockfish, *S. aerranoides;* and grass rockfish, *S. rastrelliger.*

Silversides, present evidently because the shadow of the platform duplicated that of a kelp colony where they normally are found, were represented by jacksmelt, *Atherinopsis californiensis,* and top smelt, *Atherinops affinis.* Sea basses included kelp bass, *Paralabrax clathratus,* and sand bass, *Paralabrax nebulifer.* Many other types of fishes were present in smaller numbers.

* *A report included in the document, "Installation of Platforms "C" and "Henry" on Federal Oil and Gas Leases OCS-P 0241 and 0240 Issued Under the Outer Continental Shell Lands Act, Santa Barbara Channel Area Off the Coast of California (EIS), " prepared by the U.S. Geological Survey, Washington, D.C., August 26, 1971. National Technical Information Service Identification No.: PB-198 979-F.*[14]

The total fish population stabilized at approximately 6000 fishes. As a consequence, the area under and immediately surrounding the platform is heavily fished by local sportsmen.

Other marine life include hydrozoans, sponges, segmented worms, sea anemones, barnacles, mussels, and crabs. Rocky scallops and bay scallops colonized on the structural members of the platforms quickly but were soon displaced by barnacles, especially *B. tintinnabulum* and *B. cariosus.* In time, the bay mussel, *Mytilus edulis,* displaced most of the barnacles.

Giant kelp, *Macrocystis pyrifera,* and strap kelp, *Egregia laevigata,* became quickly established but barely survived because of heavy grazing by fish.

The washed cuttings resulting from drilling operations were deposited on the ocean floor under the platform. They have neither added anything favorable to nor greatly detracted from the environment. Because they developed as a smooth surfaced, silty pile without holes for shelter, they did not attract fish nor did it offer a suitable substrate, at least within the first 29 months, for the attachment of plants or animals. This material, if transported a mile or so away and covered by large rocks or junked automobiles, would have created another artificial reef where more marine life would have propagated and more sport fishing would have resulted.

Richfield Oil Island, Rincon

Several miles south of "Hazel" lies a drilling island one-half mile offshore in approximately 50 feet of water. This island, composed of large quarry rocks capped with huge concrete tetrapods on the seward side, was constructed about a year earlier than "Hazel". This reef afforded an excellent habitat for many kinds of animals and plants. The heavy kelp beds in the lee of the island served as nursery grounds for many species of fish, and the space between the rocks sheltered many marine organisms. Thus, an even more diversified marine community exists than at platforms "Hazel" and "Hilda". Altogether, 55 species of fish belonging to 44 genera in 22 families were present. The damselfish, especially the blacksmith, *Chromis punctipinnis,* is the most significant fish found at Rincon but not present at the platforms. All the principal fish described as being present at the platforms are also found at Rincon.

The sessile community was more numerous and more complex also. Ostrich plume hydroids, a sea fan, stony corals, and more anemones were observed. Several varieties of algae, shrimp, crabs, clams, limpets, snails, murexs, tunicates, starfishes, sea urchins, and other organisms were also represented.

Other Structures

The Monterey Oil Platform, located in 55 feet of water 3 miles southwest of Seal Beach, Orange County, provided an environment for about 3000 fish representing 33 species belonging to 29 genera and 16 families. A well-established invertebrate fauna community is reported but is not described in detail. The construction date of this platform is not given.

The Texaco platform, located in 98 feet of water 4 miles west of Gaviota, was visited three months after its completion. This platform is about 35 miles north of "Hilda" and "Hazel". Already, the fish population included 12 species representing 8 genera and 6 families. Rockfish were the most predominant. The encrusting growth of barnacles, kelp, scallops, bryozoans, hydroids, and algae was still sparse at the time of inspection.

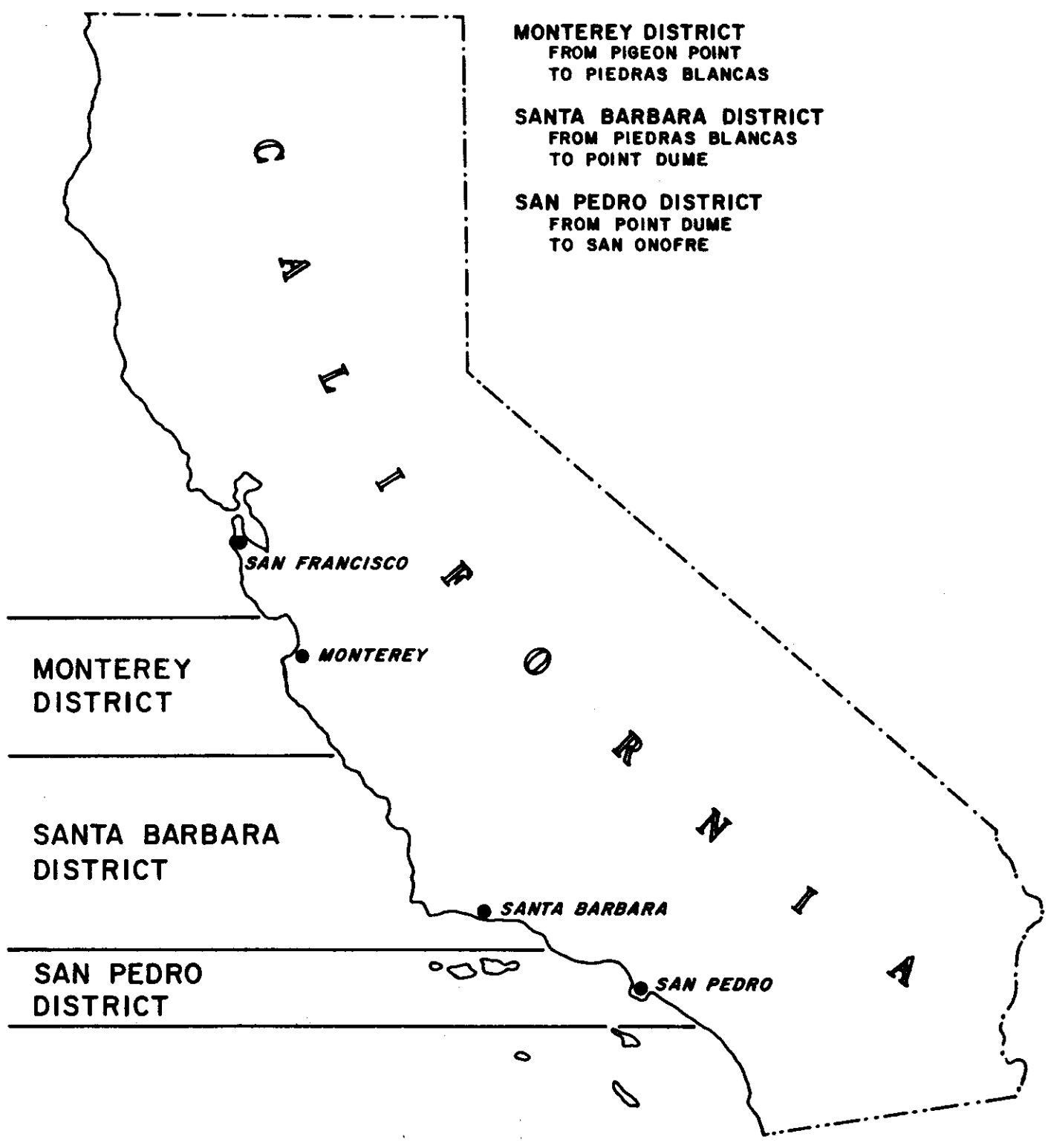
Conclusion

The structures served to enhance the habitat. Encrusting organisms rapidly covered all exposed underwater areas so quickly that within a few months available attachment space was scarce. These organisms added greatly to the available fish food. Thus, because of the shelter provided by the structures and the food available on them, literally thousands of fish now populate the area under and around each structure. Washed drill cuttings deposited on the ocean floor at these sites appear to be neither deleterious nor beneficial to the marine life in the area.

COMMERCIAL FISHERIES

Santa Barbara District
San Pedro District

CALIFORNIA DISTRICTS



PACIFIC COAST FISHERIES
FISH AND SHELLFISH RESOURCES - SANTA BARBARA DISTRICT

STATUS OF THE FISHERY RESOURCES

The Santa Barbara District in Southern California is one of six fishing districts that comprise the California commercial fishery. Compared with the others, the Santa Barbara District, extending from Piedras Blancas to Point Dume, ranks fifth in volume and value of the California fishery. Beginning in the 1950's, Santa Barbara fish landings declined drastically due to the depletion of sardines along the entire Pacific Coast. In 1951, 75 million pounds of sardines, valued at $1.5 million, were harvested from the Pacific. Due to overfishing, the Pacific sardine population was decimated. The fishery that once was the largest in the western hemisphere, producing nearly 25 percent of all fish caught in the United States, no longer exists.

In 1951, total commercial fishery landings in the Santa Barbara area amounted to 84.0 million pounds, valued at $2.2 million. By 1967, landings had declined to 24.0 million pounds. Despite this, the annual value of the catch has been generally within the $2.0 million range due to increased landings of highly valued abalone and albacore tuna.

The following discussion of the fishery, populations and range of major fish and shellfish identifies those species that are, or may be, harvested by commercial and sport fishermen in the Santa Barbara area.* [15]

A. SHELLFISH

1. Ocean Shrimp

The ocean shrimp industry is one of California's youngest commercial fisheries. In 1953, catches from shrimp grounds located between Morro Bay and Point Conception amounted to 199,000 pounds. In early 1960, the population estimate indicated less than 1.0 million pounds available in this area. However, California ocean shrimp catches have been steadily going up since the 1950's reaching 3.0 million pounds in 1970 with Northern California (from Oregon border south to False Cape) as the consistent producer.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Ghost shrimp, *Callianassa californicus*	Exploited; used as bait in sport fishing.	Not known.	9,211 pounds (1970).	Oregon to Mexico, but the chief gathering areas are Point Mugu, Seal Beach, Huntington Harbor, Newport Bay and San Diego Bay.	Ghost shrimp inhabit most bays and estuaries in California. They are found in tidal mud flats in permanent burrows.
Ocean shrimp, *Pandalus jordani*	Exploited; abundant (under management through quotas).	6,200,000 pounds (1969); 7,100,000 pounds (1970).	3,951,834 pounds, commercial (1970); 4,047,589 (including shrimp caught north of the Oregon border (1970).	Oregon border to Santa Monica.	Found almost entirely on green mud and combination of green mud-fine sand bottoms. Shrimp beds in California cover approximately 300 square miles. Shrimp schools generally occupy from 10 to 50 percent of total areas.

*Source: Fish & Wildlife Resources Relationships and Water Quality Requirements, California Dept. of Fish & Game, Bell, R.R. and Ally, J.R.R., August, 1972 [15]

2. Ridgeback Prawn

Like ocean shrimp, this fishery is comparatively young, with the commercial prawn fishery not starting until 1966. Prior to that, trawl fishermen operating in the Santa Barbara area observed small amounts of prawns in their bottomfish catches. The first year's catch of 30,238 pounds dropped to slightly over 400 pounds by 1967 and 1968. The Santa Barbara-Venture area is the only known location where concentrations may be large enough to support a fishery. However, the outlook for this fishery does not look bright due to the low demand of this product.

3. Dungeness or Market Crab

This species is considered rare south of Point Conception. Dungeness crab catches in Santa Barbara have declined since 1960. Temperature apparently determines the distribution, and the 38° - 65°F surface isotherms are considered the limits of the range.

4. Rock Crab

Since the late 1950's, there has been an upward trend in commercial rock crab landings, with the majority of the landings made in Santa Barbara and Los Angeles. While rock crabs are not too important commercially, they support a sizable sport fishery along the entire California coast.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Rock crabs *Cancer anthonyi* (yellow), *Cancer antennarius* (rock) *Cancer productus* (red)	Exploited; abundant; probably not fully exploited.	No estimates available.	539,579 pounds (1970).	Entire California coast.	All three species inhabit inshore areas.

5. Spiny Lobster

From a record 10-year period (1946-1955), landings of spiny lobster began to decline despite increased fishing efforts and consumer demand. Taking undersized, illegal lobsters have contributed to this decline. Fishing areas include all rocky coastal regions from Point Conception to the U.S.-Mexico border where they have been recorded from the intertidal zone to depths in excess of 240 feet.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
California spiny lobster, *Panulirus interruptus*	Exploited; common.	No census of the population has been made. The harvest reached 2,000,000 lbs in 1950. Southern California population estimated to be 300,000 lobsters (legal size).	225,399 pounds (1970); 6,000 lobsters (southern California party boat catch, 1969).	Cayucos to Mexico.	Rocky areas, intertidal zone to 240 feet. Females with eggs are generally found in warm inshore waters less than 30 feet deep.

6. Littleneck Clams

Most clam exploitation is by sport diggers; therefore, there is no reliable estimate for the total sport take. Clams are confined to muddy back bay environments south of Point Conception. Their accessibility will become more restricted with the dredging and filling of intertidal mud-flat habitat although they are likely to survive the advances of urbanization.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Common littleneck, Protothaca staminea.	Exploited; abundant.	No estimates available.	Highly esteemed for food and much sought throughout the entire state by both sport and commercial diggers.	Oregon to Mexico. Extremely common at Malibu Point and San Mateo Point south of San Clemente. Good beds exist in Bodega and Tomales Bays.	Often found in coarse, sandy mud of bays, sloughs and estuaries; seldom more than two or three inches beneath the surface. On the open coast the species is found in nearly any area where there is a rocky point or reef with small cobbles with a coarse sand underneath.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Bean clam, Donax gouldi	Exploited by sportsmen.	No estimates available. Populations on a single beach may run to several billion individuals.	No estimate available.	Pismo Beach to Mexico (Cape San Lucas).	Found at the surface on exposed sandy beaches along the outer coast. These clams are subject to resurgent population increases and during some years they are so numerous they form a solid pavement several layers deep in the intertidal zone.
Bent-nose clam, Macoma nasuta	Abundant; very little used.	No estimates available.	No estimates available.	Entire coast from Oregon to Mexico.	Mostly found in heavy mud or muddy sand of sheltered bays, lagoons, and estuaries. These clams always lie on the left side and may be at depths of four to eight inches beneath mud. Siphons are extended
California jacknife clam, Tagelus californianus	Exploited for fish bait in southern California	No estimates available.	58,726 pounds, commercial (1970).	Humboldt Bay to Mexico (and south to Panama). Most abundant in Elkhorn Slough, Alamitos Bay, Anaheim Slough, Mission Bay, San Diego Bay, and Tijuana Slough.	Found in mud or muddy sand of back bays, sloughs, and estuaries. Digs a smooth-lined permanent burrow. The burrow may extend vertically down 15 to 20 inches.
Pismo Clam, Tivela stultorum	Exploited heavily by sportsmen.	Estimated to be 20-25 million adult clams.	The number of clam diggers in California is not known, but it is considerable. It was estimated that on one weekend 150,000 people were seeking those clams on Pismo Beach. During a 2-2-1/2 month period some 4 million pounds were taken from a 4-mile stretch of Pismo Beach.	Half Moon Bay to Mexico (Magdalena Bay).	Usually lives in the intertidal zone on flat sandy beaches of the open coast exposed to the full force of the surf. Has been taken in 80 feet of water
Rosy Razor Clam, Solen rosaceus	Lightly exploited; uncommon.	Not known.	Taken incidentally by clam diggers usually seeking other species.	Humboldt Bay to Mexico (mazathan)	Usually found at depths from a few inches to a foot or more in sandy mud of sheltered bays, sloughs, and estuaries.
Bay mussel, Mytilus edulis	Abundant.	Not known.	97,388 pounds (1970) includes Sea mussel.	Oregon to Mexico.	Found in sheltered areas attached to rocks, wharfs, ship's pilings, by means of byssal threads. Usually in dense beds at or near water level at low tide.
California Sea-mussel Mytilus californianus	Abundant.	Not known.	97,388 pounds (1970) includes bay mussel. Extensively used for fish bait along the entire coast.	Oregon to Mexico.	Attached to rocks by the byssus, sometimes in great masses between the tide lines where it is directly exposed to surf.

7. Oysters

The oyster industry does not exploit a native marine resource. Pacific oysters (Crassostrea gigas), imported from Japan for about 40 years, are being cultivated in California bays. About 13 percent of the commercial Pacific oyster catch in California is landed in the Santa Barbara district. Low water temperatures inhibit spawning and survival of oyster larvae. Therefore, oystermen plant seed annually to maintain production on a sustained yield basis.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Giant Pacific oyster, Crassostrea gigas	Cultivated.	Imported from Japan as seed and raised commercially.	1,102,739 pounds (1970). (14,000,000 pounds harvested in 1959).	Humboldt Bay, Tomales Bay, Drakes Estero, Morro Bay, and Encina Lagoon.	Bays and estuaries; may be exposed at low tide.

8. Abalone

Since the middle 1950's, commercial abalone landings in the Santa Barbara area have remained relatively constant. Abalone has the highest economic value among all species landed in Santa Barbara, supporting a fishery of about a half a million dollars a year.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Green Abalone, Haliotis fulgens	Fully utilized	Unknown	270,000 pounds, commercial (1970).	Pt. Conception to Mexico (Magdalena Bay).	This is a shallow water abalone inhabitating the rocky areas from about low tide out to 25 feet of water; occasionally individuals are taken at from 50 to 60 feet but most are located in 10 to 20 foot depths.
Pink Abalone, Haliotis corrugata	Fully utilized. Possibly over-fished	Unknown.	1,408,921 pounds, commercial (1970).	Pt. Conception to Mexico (Turtle Bay). They are abundant on Santa Barbara and San Clemente Islands.	Along the rocky shores from the intertidal area out to 180 feet of water with major quantities located in 20 to 80 foot depths. They are found in the more protected coves and bays as well as the exposed coast.
Red Abalone, Haliotis rufescens	Fully utilized; landings are dropping. No commercial harvest Yankee Pt. north.	Northern California, the population is large. Central California population is declining.	1,194,788 pounds, commercial (1970).	Oregon to Mexico. Farallon Islands and Channel Islands. Not common south to Pt. Conception.	Inhabits rocky shores along the coast from high tide mark out to 540 feet, with maximum concentration between 20 and 50 feet. This abalone requires an active surf and perfers rocky headlands and promontories.
White Abalone, Haliotis sorenseni	Fully utilized.	Unknown.	11,212 pounds, commercial (1970).	Pt. Conception to Mexico. Most abundant at Santa Catalina, Santa Cruz, Santa Barbara, San Clemente Islands.	A deep water form found from 15 feet to 150 feet, with greatest concentration between 80 and 100 feet.

B. FISH

1. Anchovies

Anchovy landings in Santa Barbara area showed a phenomenal rise in 1953 with a catch of 34.7 million pounds valued at $0.6 million. In southern California, the fishery concentrates in areas south and east of Point Conception and offshore from Catalina Island during the first few months, and shifts into the Catalina Channel in the latter part of the season. Due to their low economic value, anchovies are landed only in quantity when other species are scarce; therefore, the rise and fall of anchovy landings do not show the abundance or scarcity of the resource. Further, costly packing of anchovies provide strong competition from less expensive Japanese imports.

SPECIES	STATUS	POPULATION SIZE	HARVEST		DISTRIBUTION	HABITAT
				FISHERY REDUCTION	LIVE BAIT	
Northern anchovy, Engraulis mordax	Landing quota on fishery regulated by the California Fish & Game Commission. Currently 110,000 tons can be taken from August 1 through May 15.	California population estimated to be 2,000,000 tons with area of abundance from San Francisco south.	1966	62,280,000 lbs	13,382,000 lbs	Pelagic within California current to 300 miles off-shore. Probably spends most of life within 200 to 300 feet of surface, though during summer and fall they may be found at depths between 300 and 600 feet at night. Anchovies enter bays and harbors where they feed and rest and become vulnerable to live bait fishermen.
			1967	69,609,000 lbs	10,774,000 lbs	
			1968	31,076,000 lbs	14,353,000 lbs	
			1969	135,278,000 lbs	10,627,000 lbs	
			1970	192,485,000 lbs	12,210,000 lbs	
					Extends along the continental shelf.	

2. Pacific Sardines

During the 1930's and early 1940's, the Pacific sardine fishery was the largest in the western hemisphere; but, due to overfishing, this species has disappeared in commercial quantities. In 1951, landings of Pacific sardines in the Santa Barbara district reached 75 million pounds valued at $1.6 million. Since then, catches have declined progressively, reaching a spectacular collapse in the late 1960's. Another cause of the decline is the presence of the northern anchovy, the sardine's chief competitor for food. Both species occupy the same general geographic range with their centers of greatest abundance occurring in the same area.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Pacific sardine, Sardinops sagax	The sardine population has declined from an estimated 4 million tons in the early 30s to such a "low" level of abundance in the 60s that a moratorium on fishing was enacted in 1967.	Estimated to be between 2,000 and 5,000 tons in 1970 off southern California and northern Baja, California.		In the 30s and 40s, found off the whole coast in abundance, but now only found in isolated areas off southern California. Occurs primarily in isolated inshore areas such as San Diego Bay. Is also found mixed in mackerel schools in quantities less than 10% and at times is reported in small pure schools in offshore areas.	Pelagic environment; probably spending most of time within 200 to 300 feet of surface. Spawning fish during years of large population found 350 miles offshore. Young found inshore and in bays in shallow water (60 feet).

YEAR	FRESH AND DEAD BAIT	LIVE BAIT**
1966	878,000 lbs	54,000 lbs
1967	149,000 lbs	1,000 lbs
1968	124,000 lbs	57,000 lbs
1969	105,000 lbs	34,000 lbs
1970	442,000 lbs	6,000 lbs

**Minimal figures.

3. Jack and Pacific Mackerel

Jack mackerel are caught in southern California from Point Conception to San Diego, and offshore as far as San Nicolas Island and Tanner and Cortes Banks. Catches in southern California have fluctuated widely due to changing market demand, increased catches of other species such as Pacific mackerel and Pacific sardine, and the scarcity of young fishes on which theydepend for food.

Pacific mackerel, on the contrary, were never abundant north of Monterey Bay, and, in recent years, have become scarce north of Point Conception. The offshore range of Pacific mackerel spawning populations is about 150 miles off southern California, 250 miles off northern Baja California, and 200 miles off central Baja California. The Pacific mackerel resource has experienced seven consecutive years of poor year-classes, indicating that the resource is in a serious state of depletion.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Jack mackerel, *Trachurus symmetricus*	Year-round fishery off southern California utilizing young fish of large offshore population extending to 400 miles offshore. Fishery has been maintaining itself but indications are it may have reached peak production in normal southern California fishing areas. At times large fish may come inshore in significant numbers and be taken by sportsmen.	Generally believed to be large and estimated as 500,000 tons off California.		Occurs within the California Current and out to 500 miles from shore. Area of abundance, consisting primarily of juveniles and young adults, is between Pt. Conception and central Baja, California. Purse seine catches made well within the 200 foot curve around islands and land masses.	Pelagic, within California Current to 500 miles from shore. Inshore distribution of juveniles and young adults. Large, old (30 years) adults exist in offshore (to 500 miles areas much of year, within 200 to 300 feet of surface.

YEAR	CANNERY FISHERY	** LIVE BAIT FISHERY	PARTYBOAT SPORT FISHERY NO. OF FISH**
1966	30,862,000 lbs	25,000 lbs	19,027
1967	38,181,000 lbs	-	16,236
1968	55,668,000 lbs	158,000 lbs	13,588
1969	51,921,000 lbs	103,000 lbs	11,272
1970	47,747,000 lbs	103,000 lbs	15,725

**Minimum Figures

Pacific mackerel, *Scomber japonicus*	Fishery in depressed state because of successive year-class failures from 1962 through 1968 and probably through 1971. A moratorium on fishing (18% tolerance by weight of fish taken incidentally with other species was enacted in 1970).	Spawning population (California and northern Baja, California) declined from estimated 80,000 tons in 1963 to less than 5,000 tons in 1969.		Formerly ranged from the Gulf of Alaska southward into Baja, California. Never abundant north of Monterey Bay and in recent years has become scarce north of Point Conception. Spawns offshore to 150 miles.	Pelagic, probably spending most of time within 200 to 300 feet of surface.

YEAR	CANNERY FISHERY	PARTYBOAT CATCH (NO. OF FISH)
1966	4,630,000 lbs	250,090
1967	1,167,000 lbs	108,366
1968	3,133,000 lbs	78,933
1969	2,357,000 lbs	120,036
1970	620,000 lbs	129,770

4. Flatfishes

Flatfishes are taken by both commercial and sport fishermen in California. Of this group of fish, the California halibut is the most frequently caught and most highly priced by sportsmen. Several years ago, the largest landings were from southern California and Baja California waters, but recently more catches have occurred off northern California and less off the southern coast.

English sole was the leading flatfish landed in California waters until it was replaced by Dover sole in 1949. Commercial English sole fisheries exist between Santa Barbara, California and Hecate Strait, British Columbia. Petrale sole are caught by California fishermen between the Santa Barbara Channel and southern Oregon. Starry flounders range from Japan and Korea north to the Aleutian Islands, and southward along the North American coast to Santa Barbara.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Arrowtooth halibut, *Atheresthes stomias*	Little exploited. Common.	Not known.	Forms a minor proportion of the sole catch.	Central California to Oregon.	Demersal - from 60 to 600 feet.
California halibut, *Paralichthys californicus*	Exploited - not abundant.	Not estimated.	256,898 pounds (1970) commercial; party boat catch 29,968 (1970). 5,000,000 pounds (1919) commercial.	San Francisco to San Diego.	Live in water less than 150 feet deep. Optimum trawling depths range from 60 to 100 feet. Halibut spawn in 18 to 60 feet from February to July. The eggs are demersal, but the larvae and post-larvae are pelagic. The young settle to the ocean floor as early as June.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Pacific halibut, Hippoglossus stenolepis	Either over exploited or current low numbers possibly due to a natural fluctuation.	No estimate given.	127 pounds (1968); no harvest reported in 1969 and 1970.	Central California to Oregon.	Eggs and larvae are pelagic. Adults are demersal. Although found in depths up to at least 3,600 feet, they are usually found in much shallower waters.
Dover sole, Microstomus pacificus	Exploited - abundant.	No estimate available.	13,908,434 pounds (1970) commercial.	California fishermen take Dover sole between Oregon and Central California.	Benthic. Dover sole are found on mud bottoms between 180 and 3,900 feet.
English sole, Parophrys vetulus	Exploited.	Not available.	3,237,364 pounds, commercial (1970).	Oregon border to Santa Barbara.	Demersal. English sole are found from bays and estuaries to depths of 1,200 feet.
Petrale sole, Eopsetta jordani	Exploited. A rising trend in landings and size composition of the catch during the past 10 years indicate the resource is in a fairly good condition.	Not available.	3,344,274 pounds, commercial (1970).	California fishermen take Petrale sole between Oregon and the Santa Barbara Channel.	Demersal. Petrale sole are found from shallow water to depths of 2,100 feet.
Rex sole, Glyptocephalus zachirus	Exploited.	Not available.	1,688,764 pounds, commercial (1970).	Oregon to Santa Barbara. The heaviest catches are in the Eureka-Crescent City area.	Demersal. Rex sole are found from shallow water to 2,100 feet. The depth at which spawning fish are most abundant is from 180 to 300 feet.
Rock sole, Lepidopsetta bilineata	Little exploited due to lack of consumer demand.	Not known.	No estimates given (commercial). Caught fairly often by sportsmen.	Southern California to Oregon.	Found in shallower water and over a more pebbly bottom than most other flatfish.
Sand sole, Paeticichthys melanostictus	Under exploited.	No estimate given.	Commercial: 192,729 pounds (1970) - taken incidentally. An important sportfish.	Along entire coast but uncommon south of Pt. Conception.	Demersal.
Starry flounder, Platichthys stellatus	Exploited	Not available.	Separate catch values for starry flounder are not available. Total flounder catch was 275,585 lbs commercial (1970).	Oregon to Santa Barbara.	Demersal. The starry flounder is caught from shallow flats of brackish bays to 900 feet. Spawning fish seek shallow water near river mouths and sloughs. They have been known to enter rivers and travel as much as 75 miles upstream.

5. Rockfishes

Rockfishes are of major importance to both commercial and sport fishermen. Landings in the Santa Barbara area have remained relatively constant in recent years. Chilipepper, a rockfish species, is commercially important from Fort Bragg to Santa Barbara. They are most abundant from 600 to 1000 feet deep. The catch has remained relatively stable since the area of maximum abundance (Santa Barbara to Fort Bragg) is characterized by a very narrow Continental Shelf with the chilipepper's preferred depth interval generally less than three miles wide.

Olive rockfish occurs in almost every kelp bed along the mainland shore south of Point Conception and around the offshore islands particularly Santa Barbara and San Nicolas.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Cabezon, Scorpaenichthys marmoratus	Over exploited.	No estimate given.	Commercial: 10,698 lbs (1970) - caught incidentally. It is also an important sportfish - the catch being about five times as great as the commercial catch.	Along entire coast.	Adults are demersal in coastal waters, on almost all rocky bottoms from tide pools to depths in excess of 250 feet. The average depth in which they are found is about 35 feet. The larvae and young are pelagic, some having been taken more than 200 miles from shore.
Chilipepper, Sebastes goodei	A major component in the commercial "rockcod" fishery. Seldom enters the sport catch.	Unknown.	The second most important species in the 10.7 million pound (1970) rockfish catch, contributing as much as 45% at Monterey.	Oregon to Mexico. Most abundant from Fort Bragg to Santa Barbara.	Rocky or hard bottom, soft bottom clay, and mud bottom; from 240 to 1,100 feet. Yound found in shallower water inshore.
California corbina, Menticirrhus undulatus	Indications are that the present harvest of this species may be near the maximum sustainable yield level.	Not known.	Has been set aside as a recreational resource. It has been illegal to take corbina with nets since 1909, and illegal to sell or buy it since 1915. Makes up about 17% of the surf fishermen's bag.	Pt. Conception to Mexico.	Usually swim in loose schools at or near the bottom in sandy areas. Sometimes abundant in the surf zone and in shallow bays and lagoons. Found most often in offshore areas at depths of 10 to 100 or more feet. On rare occasions are fairly abundant at depths as great as 300 feet.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Black rockfish, Sebastes melanops	A commercial and sport species of moderate importance.	Unknown.	Comprises a moderate proportion of the 10.7 million pounds (1970) commercial rockfish catch. One of the more important sport species in northern California.	Oregon to San Miguel Island. Most common in northern California.	Over shallow rocky reefs, kelp beds, and occasionally deep reefs to 360 feet.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Bocaccio, Sebastes paucispinis	The most important species of "rockfish" taken by the commercial fishery. A highly prized sport species.	Unknown.	The dominant species in the 10.7 million pound (1970) commercial rockfish catch.	Oregon to Mexico.	Adults on deep rocky reefs and irregular rocky or rubble bottoms, and over mud bottoms. Common from 250 to 1,200 feet Juveniles often concentrate inshore over sandy bottoms in shallow water. Larvae have been taken as far as 300 miles offshore.
Olive rockfish, Sebastes serranoides	One of the more important northern California sport species. Relatively unimportant commercially.	Unknown.	A minor contributor to the 10.7 million pound (1970) commercial rockfish fishery.	Crescent City to Mexico.	Kelp beds as well as rocky reefs to 480 feet. Young have been found 100 miles at sea.

6. Albacore Tuna

Albacore tuna, from major fishing grounds off Baja California, Oregon and Washington, is the only tuna species commercially landed in the Santa Barbara district. These fish are desirable to partyboat fishermen, with the sportfishing season peak during the summer months. Almost all the entire sportfishery is confined to southern and central California waters within 60 to 80 miless of shore. The 1967 commercial landings of this resource in Santa Barbara area was 2.8 million pounds, valued at $522,000.00.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
			FISHES, SHARKS AND RAYS		
Albacore, Thunnus alalunga	Under exploited.	No estimate given.	Commercial: 25,946,105 pounds (1970). Also an important sportfish - the average annual party boat catch for the past 20 years has been around 90,000 fish.	Entire length of coast; offshore to 700 miles.	Pelagic. Prefer deep blue temperate oceanic water. Information on spawning habits is incomplete. Spawning apparently occurs in the vicinity of the subtropical covergence sometime between January and June, most likely peaking about April.

7. Nearshore Game Fishes

California yellowtail, barracuda, and giant sea bass are harvested by both commercial and sportfishermen. The California yellowtail is highly favored by sportfishermen. The present yellowtail sportfishery extends from Santa Barbara to Ensenada, with the Coronado Islands consistently providing the best fishing. The California barracuda is normally found from Point Conception, California, to Punta Canoas, Baja California. It is a schooling fish and remains relatively close to the shore.

Giant sea bass are rarely found north of Point Conception. However, they are relatively abundant seasonally, south of Point Conception to Cape San Lucas and throughout much of the Gulf of California.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
California yellowtail, Seriola dorsalis	The population appears to be healthy.	Not known.	Commercial: 56,275 lbs. (1970). A minor commercial species. An extremely popular Southern California game fish. The present sportfishery extends from Santa Barbara to Mexico.	Oregon to Mexico. Not abundant north of Santa Barbara. Numbers increase northward in years when the ocean temperature is above normal.	A schooling fish usually found around offshore islands. At times are abundant around kelp beds along mainland coast. During summer and early fall, yellow-tail schools are frequently observed at the surface. In winter and early spring they remain deep and seldom show at the surface.
California barracuda, Sphyraena argentea	Over exploited.	1960 est. 2,156,186 individuals.	Commercial: 22,508 pounds (1970). One of the most desirable game fishes - 1.2 million fish taken in 1959.	Along the entire coast; not common north of Pt. Conception.	Coastal - surface to 120 feet. Spawn in the spring and summer.

8. Croakers

The white seabass is highly esteemed by both California sport and commercial fishermen. Commercial landings of this species have fluctuated widely. The Santa Barbara commercial catch of 556,400 pounds in 1959 declined to only 122,400 pounds in 1967. The center of abundance of the species commonly lies between Point Conception and Ballanas Bay, Baja California, shifting from year to year in response to environmental changes.

Spotfin and yellowfin croakers are reserved for sport fishermen. Spotfin croakers range from Point Conception to San Juanico Bay, Baja California, while yellowfin croakers range from San Francisco southward into the Gulf of California. Since croakers inhabit nearshore areas, some species may be adversely affected by environmental changes.

SPECIES	STATUS	POPULATION SIZE	HARVEST	DISTRIBUTION	HABITAT
Spotfin croaker, *Roncador stearnsi*	Indications are that it may not be able to support breater fishing pressures.	Not known.	Illegal to take with nets since 1909 or to buy or sell since 1915. A popular sport fish, especially among surf fishermen.	Pt. Conception to Mexico, most common south of Los Angeles Harbor.	Beaches and in bays over bottoms varying from coarse sand to heavy mud, in depths varying from 4 to 50 or more feet. Prefer depressions and holes near shore.
White croaker, *Genyonemus lineatus*	Under exploited.	No estimate given.	564,871 pounds (1970). Important to pier and skiff fishermen. There is evidence that over 670,000 are taken by sportmen each year.	Along entire coast, but not abundant north of San Francisco.	Usually in loose schools at or near the bottom in sandy areas. Sometimes abundant in surf zone, and in shallow bays and lagoo lagoons. Commonly off-shore at depths of 10 to 100 or more feet. Fairly abundant to depths as great as 300 feet on rare oc asions. Most spawn in early spring but some spawn throughout the year.
Yellowfin croaker, *Umbrina roncador*	Indications are that it may not be able to support greater fishing pressure.	Not known.	Illegal to take with nets since 1909 or to buy or sell since 1915.	San Francisco to Mexico, rare north of Pt.	Beaches, in bays, and shallow sloughs over bottoms varying from coarse sand to havey mud at depths from 4 to 50 or more feet.
Giant sea bass, *Stereolepis gigas*	Any increase in present fishing pressure would result in over exploitation.	No estimate given.	Commercial: 11,940 lbs (1970). A popular game fish - from 1963 to 1966, the annual sport take, other than party boat, was an estimated 200,000 fish.	Humboldt Bay to Mexico. Rare north of Pt. Conception. Numbers increase going southward.	Large fish prefer rocky bottom habitat just outside kelp beds and along drop-off areas where the water is 115-150 feet deep. Small fish (up to 30 pounds) are often found over sandy bottom areas and in and around kelp beds in depths of 40 to 70 feet.
Kelp bass, *Paralabrax clathratus*	No commercial exploitation.	No estimate given.	Not harvested commercially. It is illegal to sell bass taken in California waters since 1953. A desirable sport-fish.	Along entire coast, but primarily a southern California resident.	Environmental situations attractive to kelp bass include sparse *Zostera* beds on sandy bottoms, as well as cobble regions, areas of broken rock, submarine canyons, cliffs, & *Macrocystis* beds with bottoms varying from substrates of mud and sand to highly broken rock. Adults found from surf zone to 130 feet or more. Large adults are common about the submarine canyons near La Jolla from 100 feet downward. Rarely reported below 150 feet. Juveniles and small adults usually abundant in the surf zone.
Pabific bonito, *Sarda chiliensis*	Under xploited.	No estimage given.	Commercial: 8,793,788 pounds (1970). Caught incidentally or in lieu of more desirable species. A very important sportfish annual average from 1961 to 1969 was over 850,000 fish.	Along entire coast. More abundant in southern California.	Pelagic schooling fish. Observed within a few miles of shore. Spawn off southern California between January and May

COMMERCIAL AND SPORT FISHING

There has been commercial fishing in California waters since the early settlements on the coast, but major exploitation of fish and shellfish did not start until the mid-19th century. From the Gold Rush days the demand for fish and shellfish in the San Francisco area resulted in a considerable market for fresh and salted fish. In 1864 the first cannery for salmon was built near Sacramento. Twenty five years later in 1889 a sardine cannery was built in San Francisco. This cannery was moved south to San Pedro in 1893. In 1902 a second sardine cannery was built in Monterey. These canneries also packed "whitefish" (yellowtail, white seabass and barracuda). These canneries also began to experiment with albacore tuna and by 1912 there were five tuna canneries in the San Diego-San Pedro area.

The sardine fishery became, at one time, the largest volume fishery in the U.S. with a peak landing in 1937-1938 of 1,582,668,000 lbs. Landings continued high through 1945 and then there followed a spectacular collapse of the fishery leading to the ruin of Monterey's "Cannery Row".

Following the collapse of the sardine fishery, some of the canners and boats turned to alternative species, chiefly Pacific mackerel and jack mackerel. The Pacific mackerel soon followed the sardine into oblibion leaving only jack mackerel, squid, minor amounts of herring and anchovy to supply a much reduced canning operation.

The tuna industry followed the growth pattern of the sardine industry but with major differences. Tuna resources are global with the bulk of the catch being taken beyond California waters. Also it is profitable to import frozen tuna for the canneries from other nations making the canners independent of local supply and regulations.

Today, California's commercial fishing industry is largely governed by the canners who form the major political block for influencing fishing legislation and research. The canning industry produces three major products: 1) canned tuna and tuna-like fish, 2) wetfish, mainly jack mackerel and squid, and 3) fishmeal and oil, by-products of the cannery or processed from northern anchovy. The reduction fishing for anchovy uses the greatest volume of a single species taken in California waters. The raw material for the tuna industry, except for bluefin tuna, comes mainly from waters other than those which are considered to be "offshore California."

Other important commercial fisheries exist for the fresh fish market. Chief among these species are salmon, flatfish and rockfish. With the exception of salmon these fisheries are centered north of San Francisco.

Recreational fisheries are dependent, to a degree, upon the same species: tuna, bonito, anchovy for bait, salmon, flatfish and rockfish in addition to yellowtail, barracuda, white seabass and kelp bass.

Other commercial fisheries are for the fresh market and include flatfish and rockfish, and specialty items such as lobster, abalone, shrimp and market crab. The flatfish and rockfish fisheries north of San Francisco are beginning to prosper owing to recent rises in prices and the ability to fish deeper. Ocean shrimp and market crab undergo periodic changes in abundance that are environmentally caused. Both of these fisheries occur north of Point Conception.

Since the decline of the sardine fishing, California landings have stabilized to a level of about 700,000,000 lbs. annually. Value, however has risen sharply owing to major price increases for all species. The tunas account for more tha half the volume and value but included are shipments of tunas from elsehwere and landings from vessels fishing off Central and South America and in the Atlantic. The northern anchovy has the potential to be

largest volume fishery for the State but for this potential to be realized a number of institutional problems need be overcome.

Beginning in 1913 organized sportsmen began to compete with commercial fishermen to restrict their operations and to enhance their own recreational opportunities. As a result, legislation was passed closing some areas to commercial fishing, e.g. the waters around Catalina Island, proscribing marlin, basses, some croakers, and pismo clams for commercial use, closing some areas to certain types of fishing gear, etc. Because of declining catches in local waters there has been a trend to construct larger party boats capable of extended trips into distant waters. About 20 of these boats operate out of San Diego and Los Angeles and fish the waters of Baja California and the outer Islands. Current sportsmen's concerns center about the harvest of giant kelp and the taking of northern anchovy for reduction.(19)

FISHING GEAR

Purse Seines and Roundhaul Nets

The major volume and value of fishes are taken with purse seines, or nets for taking surface schooling fish. In operation the school is surrounded by a vertical wall of net supported at the surface by plastic-foam floats and weighted at the bottom by leads or chain. The bottom of the net is equipped with rings through which runs a purse lines. By means of the purse line. By means of the purse line the bottom of the net can be closed and the fish school is trapped. The net is then retrieved aboard by mechanical means until the fish are concentrated in a small area from which they can be scooped or pumped aboard.(19)

Purse seines are of three sorts: tuna nets used by the high seas boats, mackerel nets and anchovy nets. Tuna nets are large, typically 600 fathoms long and 60 fathoms deep. Webbing is heavy nylon 4 1/2 inch to 7 1/2 inch mesh.

Mackerel nets are smaller and shallower. Typically 265 x 30 fathoms of light 1 1/2 to 2 inch web.

Anchovy nets are small mesh, usually 9/16" mesh with approximately the same overall dimensions as a mackerel net.

Purse seines are used in both deep and shallow water. San Pedro wetfish and tuna seiners are particularly adept at fishing shoals.

Trawls

Trawls are used for taking midwater and bottom fish and shrimp. The single boat otter trawl, a sack net spread open by doors (otter boards) and towed along the bottom or in midwater at the end of wire cables, is the most common type trawl in use. Trawlers operate north of San Francisco for the most part and are rare south of Santa Barbara.

Set Lines and Long Lines

This gear consists of a long main-line with numerous short branch lines and baited hooks. The gear may be free floating, long lining for tuna and billfish, or anchored (set) on the bottom for shark, rockfish and halibut. Set lining is uncommon today. Long lining is common with Japanese and Taiwanese boats fishing offshore from Baja south.

Gill Nets

Gill, set and trammel nets are vertical walls of light, large mesh designed to catch fish by entangling. These nets may be allowed to drift near or at the surface but this practice is rare south of Oregon. The common practice is to anchor the nets to the bottom in kelp beds or near points to intercept moving fish. This is the most productive way of taking fish such as baracuda, white sea bass, and halibut for the fresh fish market.

Hand Lines and Pole and Line for Rockfish

During the winter when surface gamefish are scarce off California and at all seasons by commercial boats rockfish are taken using deep hand lines or lines and powered reels. Fishing is to depths of 200 fathoms on reefs and offshore banks.

Trolling

A method of taking larger predators such as tuna, principally albacore, billfish, and salmon. Commercial boats are usually small with one or two men aborad and may troll 10 to 15 lines with artificial lures or baits.

Traps

Lobster, crab and prawns are taken with wood, plastic or wire traps or with ring nets. Fishing is done in shallow (less than 50 fathoms) water. Traps may be buoyed separately or run in strings with up to 10 traps on a single buoyline.

Commercial fishery data and illustration of the fishing zones for the Santa Barbara and San Pedro Districts will be found in Tables 2 to 8 inclusive and Figures 7 to 51 inclusive.

TABLE 2

FISH AND SHELLFISH LANDINGS AND OPERATIONAL UNITS IN SANTA BARBARA DISTRICT, CALIFORNIA

YEAR	FISH 1000 LBS	FISH 1000 $	SHELLFISH 1000 LBS	SHELLFISH 1000 $	TOTAL 1000 LBS	TOTAL 1000 $	NO. FISHERMEN	MOTOR VESSELS NUMBER	MOTOR VESSELS TONNAGE	MOTOR & ACCESSORY BOATS
1951	83,273	1,953	814	290	84,088	2,243	2,444	289	9,736	349
1952	22,906	1,017	1,166	418	24,072	1,435	2,077	266	8,014	266
1953	47,332	1,344	837	315	48,169	1,659	1,304	195	4,510	233
1954	49,130	1,935	671	297	49,801	2,232	1,552	218	5,072	304
1955	58,812	1,270	911	402	59,723	1,672	861	152	4,104	138
1956	46,387	1,101	1,258	524	47,645	1,625	786	108	1,139	191
1957	68,639	2,381	1,147	413	69,786	2,794	1,540	203	2,270	330
1958	64,517	2,059	1,066	393	65,583	2,452	1,525	304	6,364	298
1959	21,503	1,511	1,218	487	22,721	1,998	1,506	317	4,958	258
1960	39,393	1,416	1,076	488	40,469	1,905	1,282	241	8,016	230
1961	32,344	1,181	3,545	588	35,889	1,770	935	199	5,785	177
1962	23,235	902	2,906	573	26,141	1,475	990	198	5,442	229
1963	19,121	1,150	1,600	553	20,720	1,702	1,197	283	7,059	241
1964	22,524	1,273	1,473	528	23,998	1,802	1,423	289	8,157	291
1965	16,940	1,138	2,972	598	19,911	1,736	1,202	232	5,392	297
1966	24,083	1,186	2,224	739	26,307	1,925	1,358	227	6,740	298
1967	21,045	1,282	3,479	749	24,525	2,031	1,416	250	6,912	309
1968	15,372	1,055	3,456	745	18,828	1,802	1,263	197	4,908	321
1969	29,317	1,178	3,829	799	33,146	1,977	1,535	285	6,828	319
1970	33,310	2,356	5,747	882	39,057	3,238	3,056	480	12,968	273
1971	30,232	1,942	8,402	795	38,634	2,736	1,866	409	11,202	231
1972	40,533	2,608	4,433	956	45,966	3,564	2,173	398	11,293	204
1973					41,558					(Prelim)

SOURCE: Fishery Statistics of the United States, 1951-1971[16, 17]
Statistical Digest Publications, NMFS, NOAA.

1972, 1973 data from National Marine Fisheries Service, NOAA.[18]

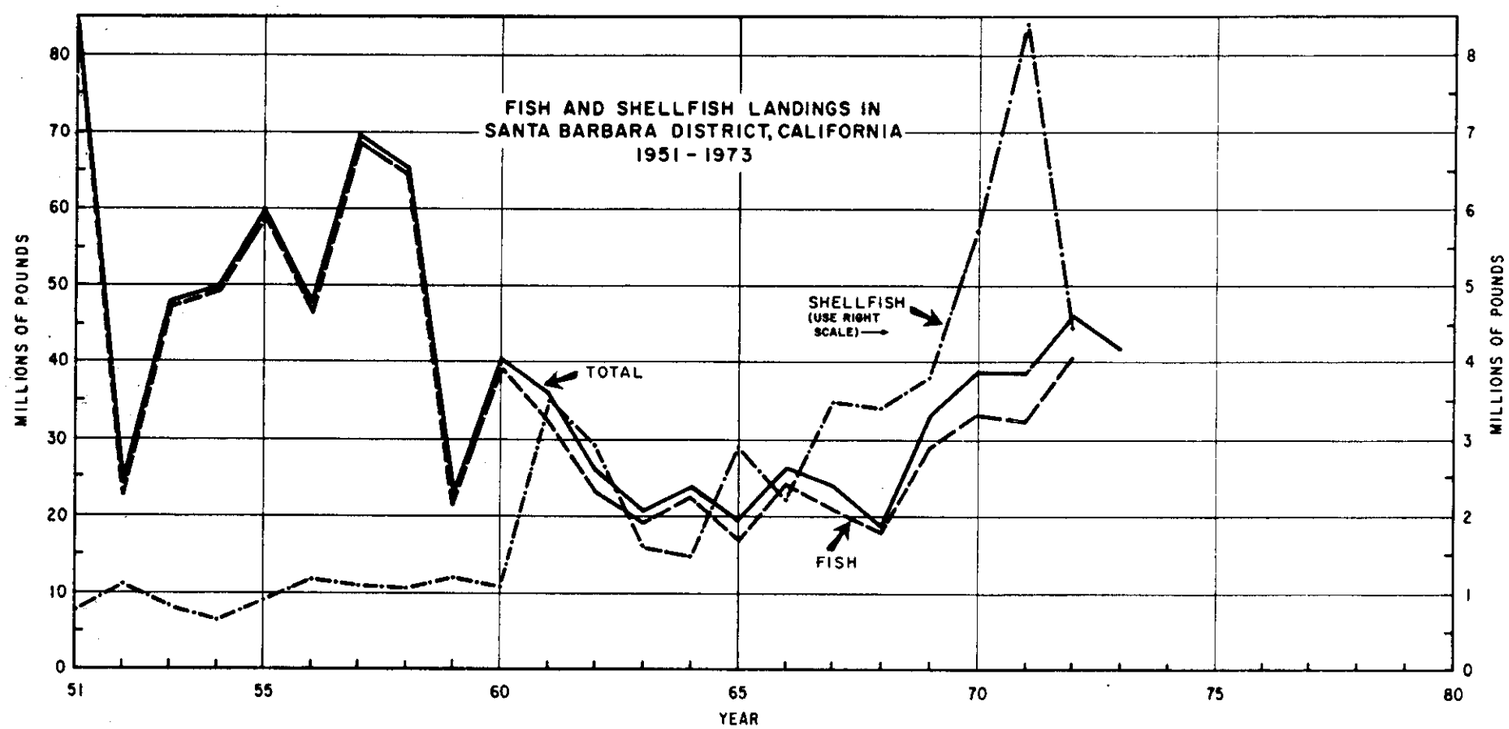

FISH AND SHELLFISH LANDINGS IN
SANTA BARBARA DISTRICT, CALIFORNIA
1951 - 1973
MILLIONS OF POUNDS
MILLIONS OF POUNDS
YEAR
TOTAL
FISH
SHELLFISH
(USE RIGHT SCALE)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8
51
55
60
65
70
75
80

FIGURE 7

TABLE 3

CATCH AND VALUE OF SOME PRINCIPAL FISH SPECIES IN SANTA BARBARA DISTRICT, CALIFORNIA

(THOUSANDS OF POUNDS AND THOUSANDS OF DOLLARS)

	ANCHOVIES		JACK MACKEREL		ROCKFISHES		ALBACORE TUNA		PAC. SARDINE	
YEAR	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1950	292	5	893	15	190	19	2,891	545	-	-
1951	202	3	777	19	268	24	156	21	74,973	1,567
1952	7,034	122	9,407	271	238	20	2,420	396	2,610	113
1953	34,735	590	8,619	297	196	16	1,080	204	972	54
1954	16,807	351	2,762	113	580	31	811	147	24,433	950
1955	3,262	59	9,809	151	3,378	121	119	18	39,732	675
1956	557	10	14,057	212	2,571	96	320	47	15,446	293
1957	125	15	21,493	423	3,357	144	1,254	181	23,978	934
1958	627	7	6,199	130	3,144	121	1,876	357	47,110	1,084
1959	810	11	5,401	118	1,479	66	4,085	765	5,526	137
1960	26	1	13,198	235	2,823	123	1,464	194	15,231	425
1961	54	2	14,795	281	2,321	109	684	109	8,582	243
1962	30	1	9,572	173	2,021	110	984	136	2,175	78
1963	11	1	7,021	128	2,602	144	3,608	511	400	21
1964	1	<1	12,179	239	1,584	91	3,892	538	840	25
1965	47	3	7,134	173	1,733	100	3,149	435	150	11
1966	9,039	89	6,790	222	2,264	134	1,551	281	108	17
1967	8,289	80	4,032	150	2,895	162	2,826	522	7	1
1968	4,007	30	4,251	159	2,544	150	2,131	399	20	4
1969	19,861	202	2,804	105	2,497	161	1,196	246	-	-
1970	19,614	224	3,383	129	2,457	171	5,203	1,362	209	186
1971	19,722	268	2,296	92	1,915	155	3,403	1,004	-	-
1972	27,477	364	772	32	3,293	291	3,928	1,258	-	-
1973	27,367		22		2,424					(Prelim)

SOURCE: Fishery Statistics of the United States, 1950-1971[16, 17]
Statistical Digest Publications.
1972, 1973 data from National Marine Fisheries Service, NOAA.[18]

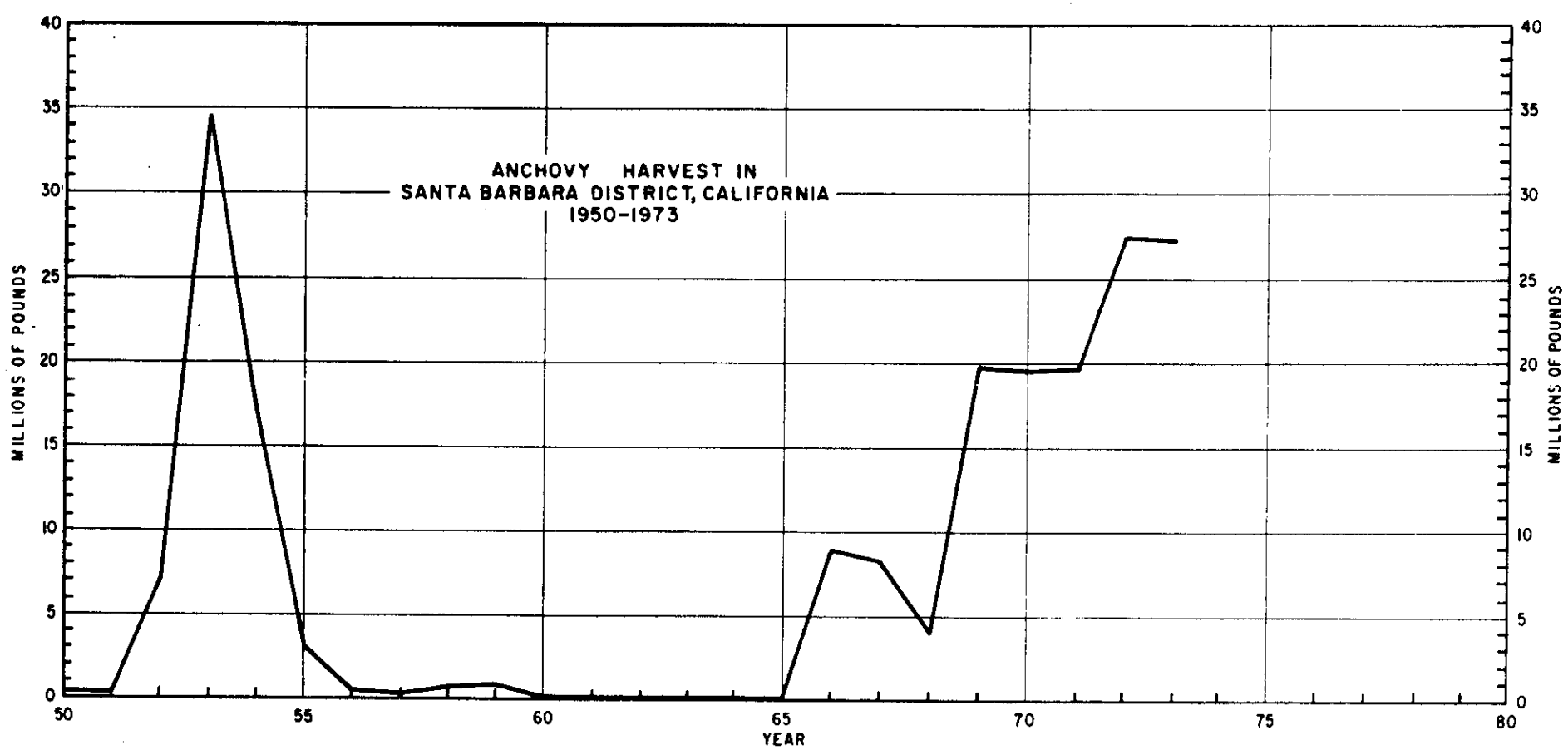

ANCHOVY HARVEST IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
MILLIONS OF POUNDS
YEAR
0
5
10
15
20
25
30
35
40
50
55
60
65
70
75
80

FIGURE 8

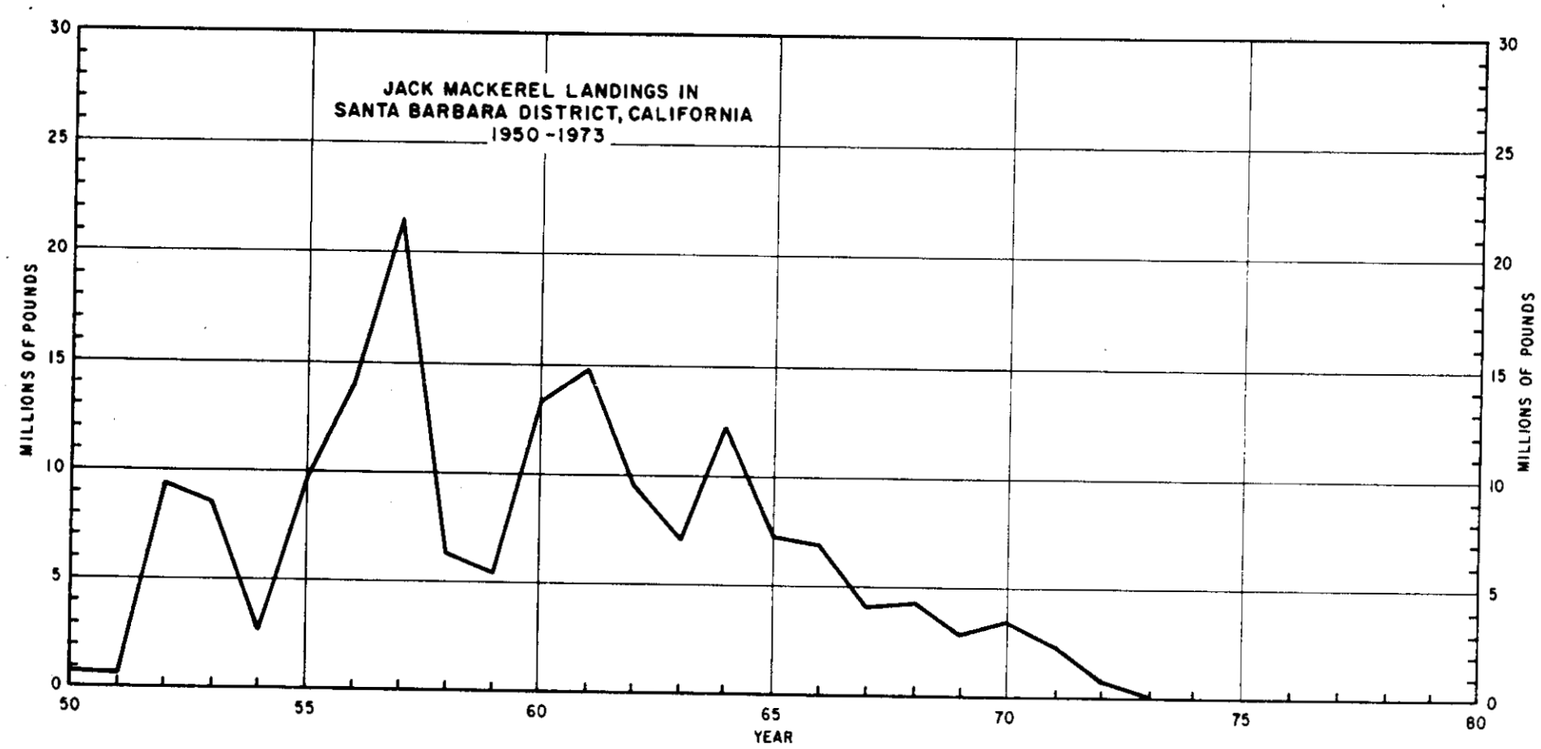

JACK MACKEREL LANDINGS IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950 - 1973
MILLIONS OF POUNDS
YEAR
0
5
10
15
20
25
30
50
55
60
65
70
75
80

FIGURE 9

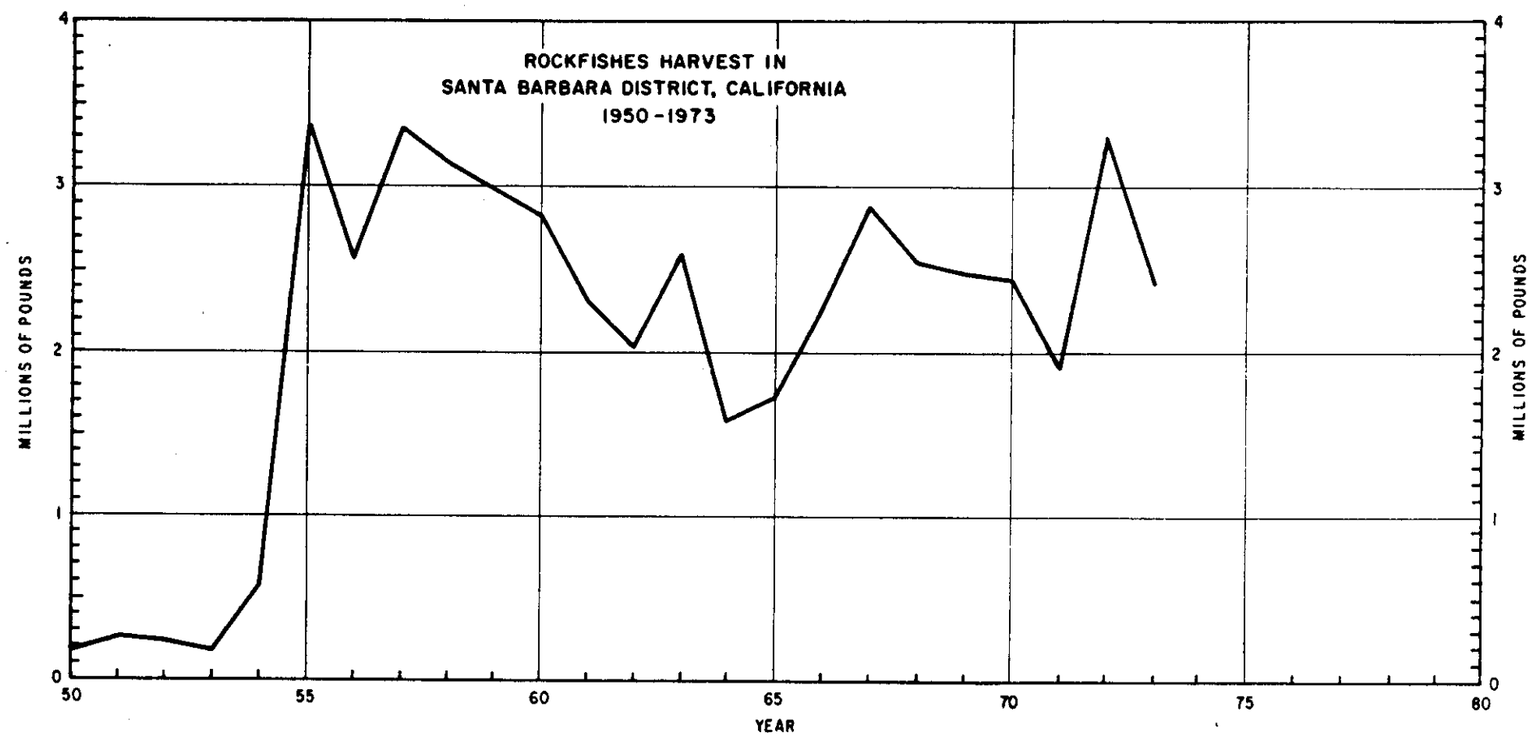

ROCKFISHES HARVEST IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
MILLIONS OF POUNDS
0
1
2
3
4
50
55
60
65
70
75
80
YEAR

FIGURE 10

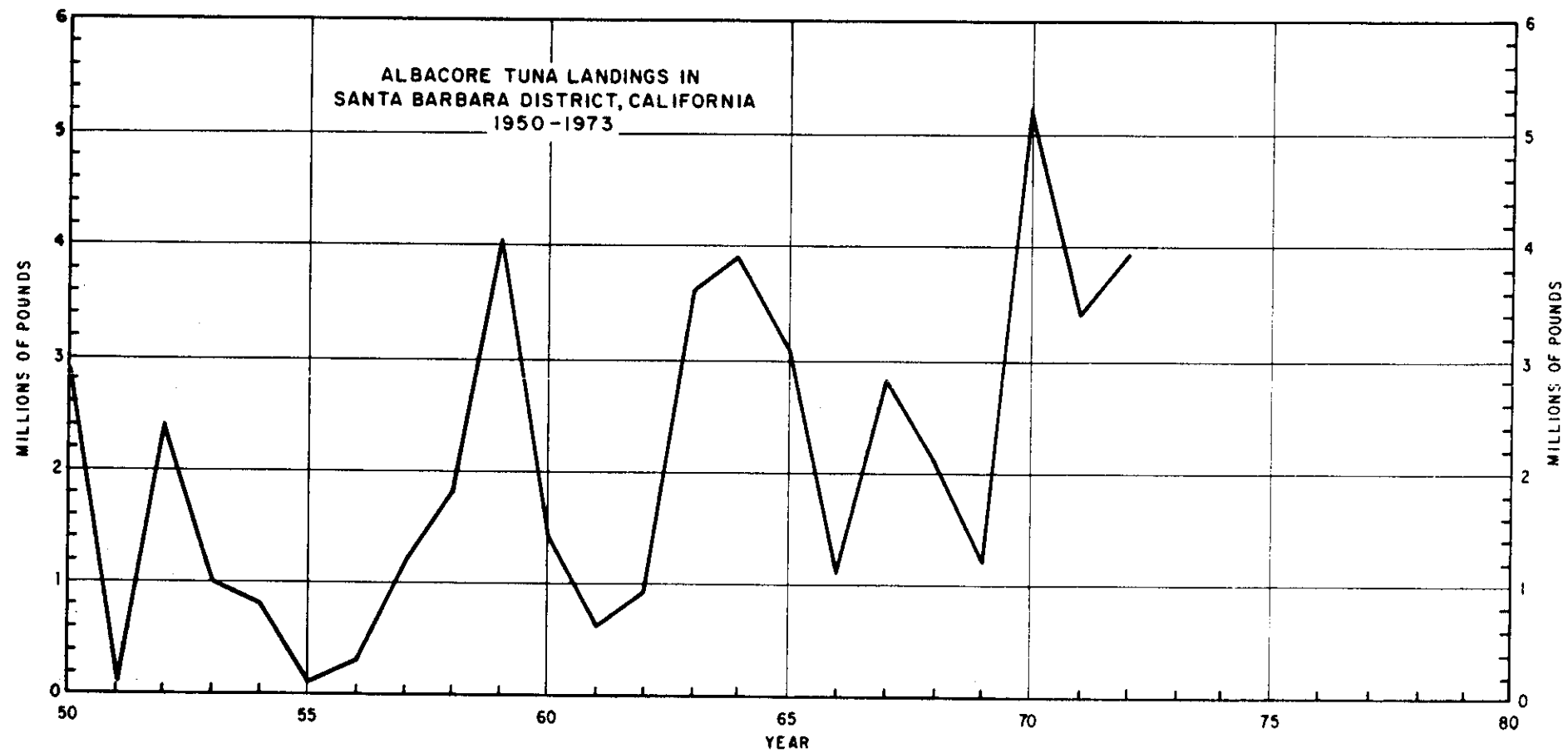

ALBACORE TUNA LANDINGS IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
MILLIONS OF POUNDS
YEAR
0
1
2
3
4
5
6
50
55
60
65
70
75
80

FIGURE 11

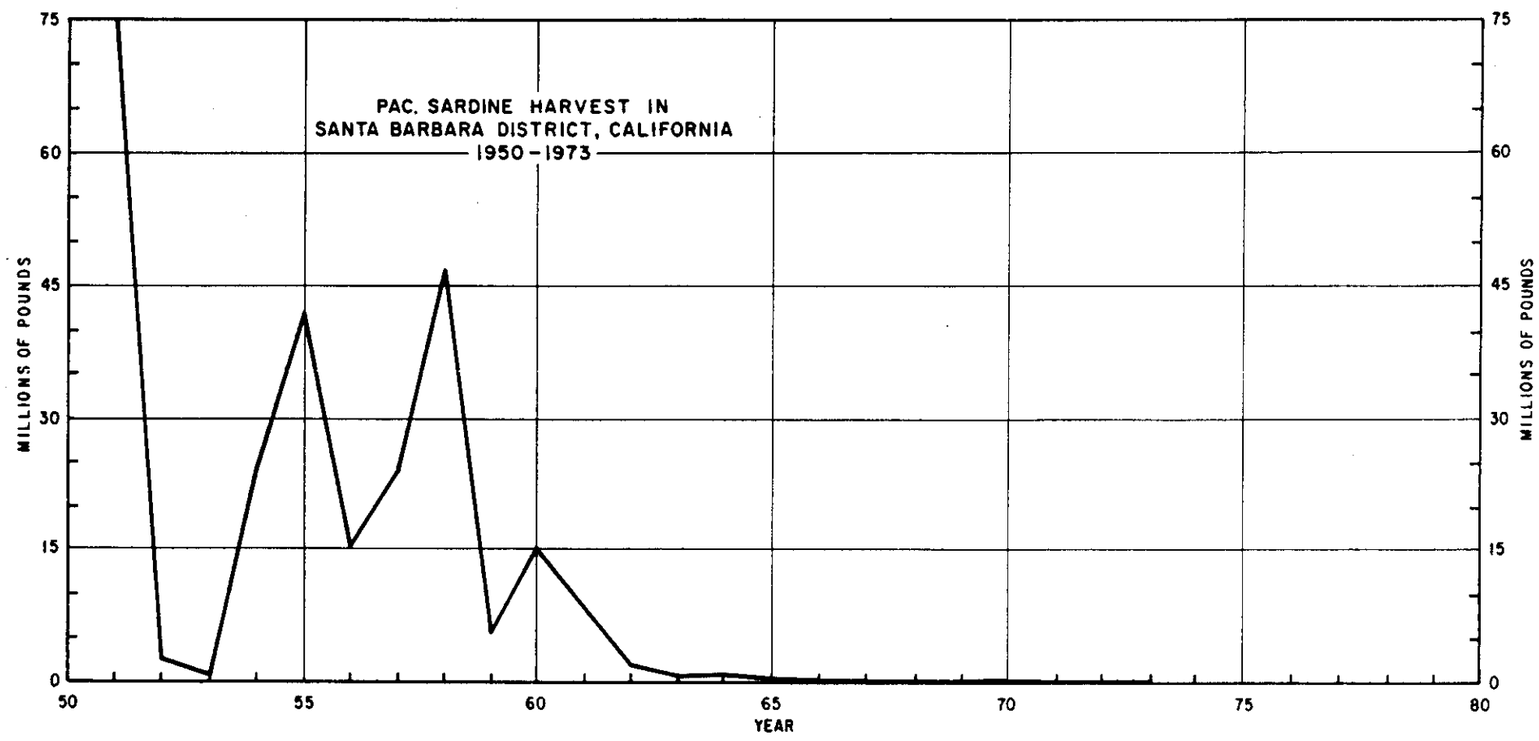

PAC. SARDINE HARVEST IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950 - 1973
MILLIONS OF POUNDS
0
15
30
45
60
75
50
55
60
65
70
75
80
YEAR

FIGURE 12

TABLE 4

CATCH AND VALUE OF THE PRINCIPAL SHELLFISH SPECIES IN SANTA BARBARA DISTRICT, CALIFORNIA

(THOUSANDS OF POUNDS AND THOUSANDS OF DOLLARS)

	DUNGENESS CRAB		ROCK CRAB		SPINY LOBSTER		ABALONE	
YEAR	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1950	-	-	-	-	374	96	361	193
1951	211	32	3	< 1	331	99	268	159
1952	93	17	3	< 1	310	111	246	155
1953	33	7	8	< 1	256	101	326	186
1954	56	12	2	< 1	259	100	307	177
1955	98	19	9	< 1	201	93	409	260
1956	326	47	10	< 1	198	98	542	350
1957	276	24	52	3	101	59	549	297
1958	167	24	59	2	128	71	424	256
1959	315	53	46	2	114	63	542	340
1960	177	36	43	2	62	37	572	381
1961	56	14	77	4	79	51	629	462
1962	10	4	130	9	120	81	561	435
1963	2	1	100	7	123	79	561	432
1964	2	1	117	7	104	66	535	406
1965	4	2	153	10	101	76	551	451
1966	6	3	106	7	124	100	624	598
1967	6	2	79	5	112	92	600	590
1968	2	.8	109	7	112	96	431	572
1969	.1	-	196	17	99	102	368	589
1970	1	.5	207	17	86	104	275	470
1971	4	2	157	14	78	107	1,401	509
1972	21	15	191	20	87	131	388	709
1973	65		195		48		1,699	(Prelim)

SOURCE: Fishery Statistics of the United States, 1950-1971[16, 17]
Statistical Digest Publications.
1972, 1973 data from National Marine Fisheries Service, NOAA.[18]

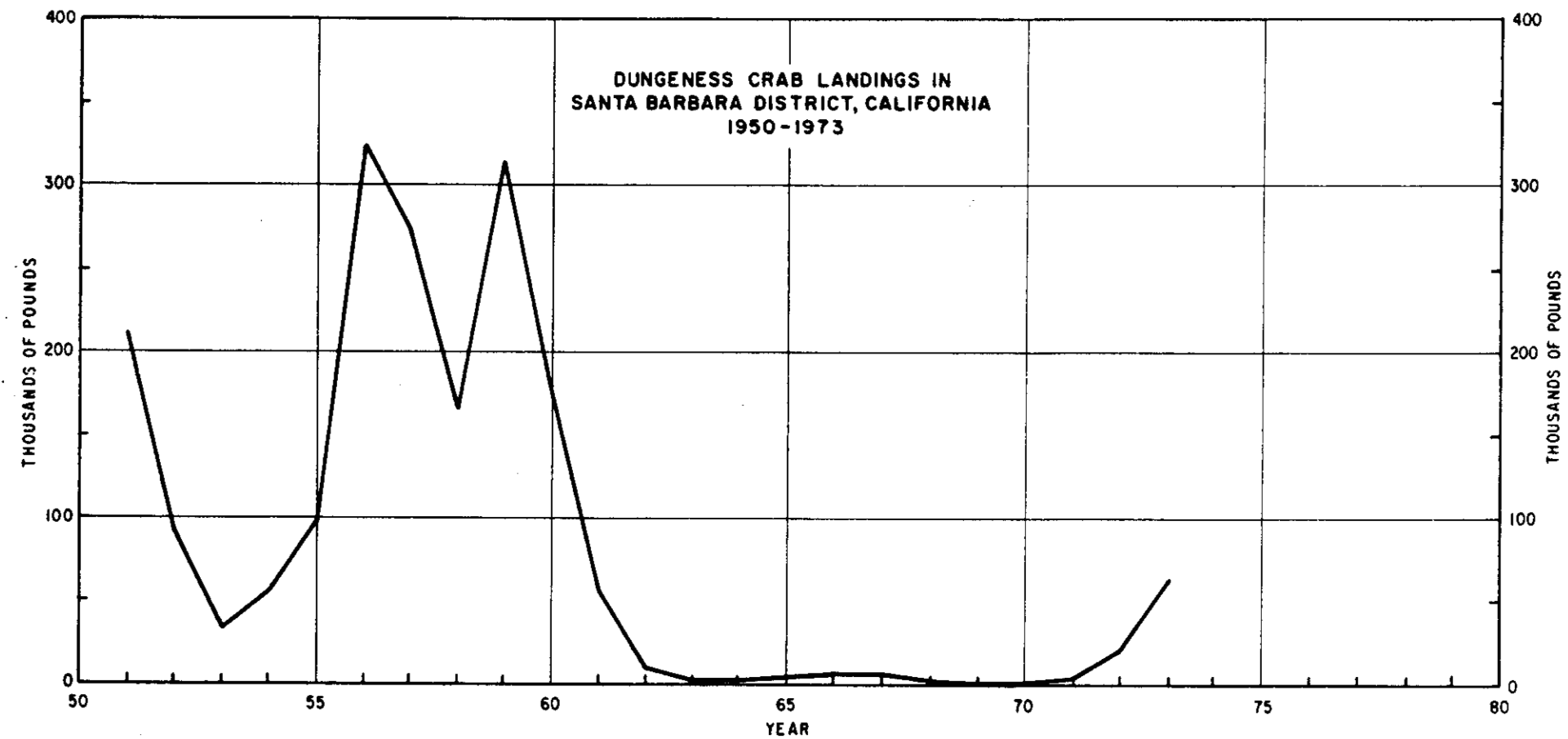

DUNGENESS CRAB LANDINGS IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
THOUSANDS OF POUNDS
400
300
200
100
0
50
55
60
65
70
75
80
YEAR

FIGURE 13

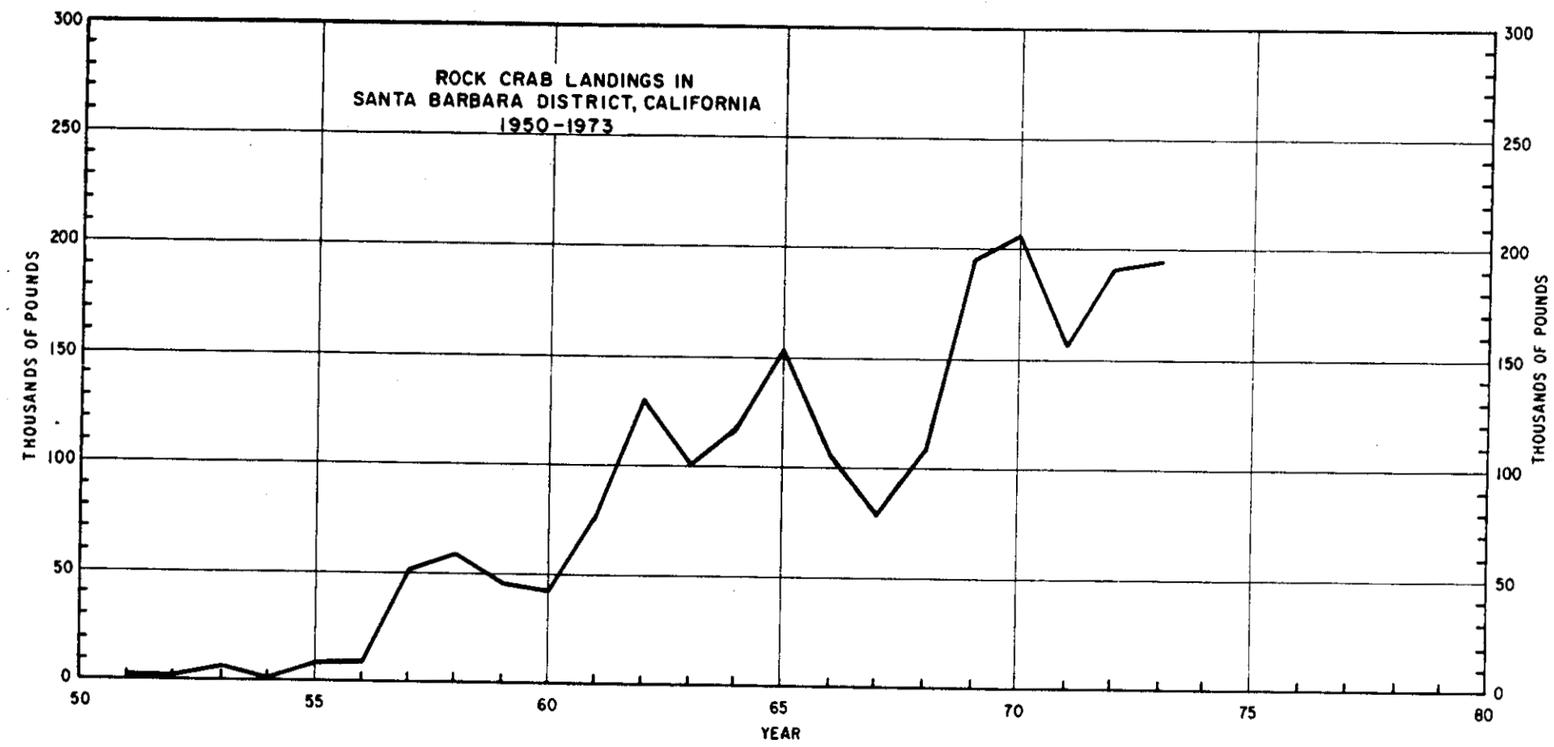

ROCK CRAB LANDINGS IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
THOUSANDS OF POUNDS
YEAR
0
50
100
150
200
250
300
50
55
60
65
70
75
80

FIGURE 14

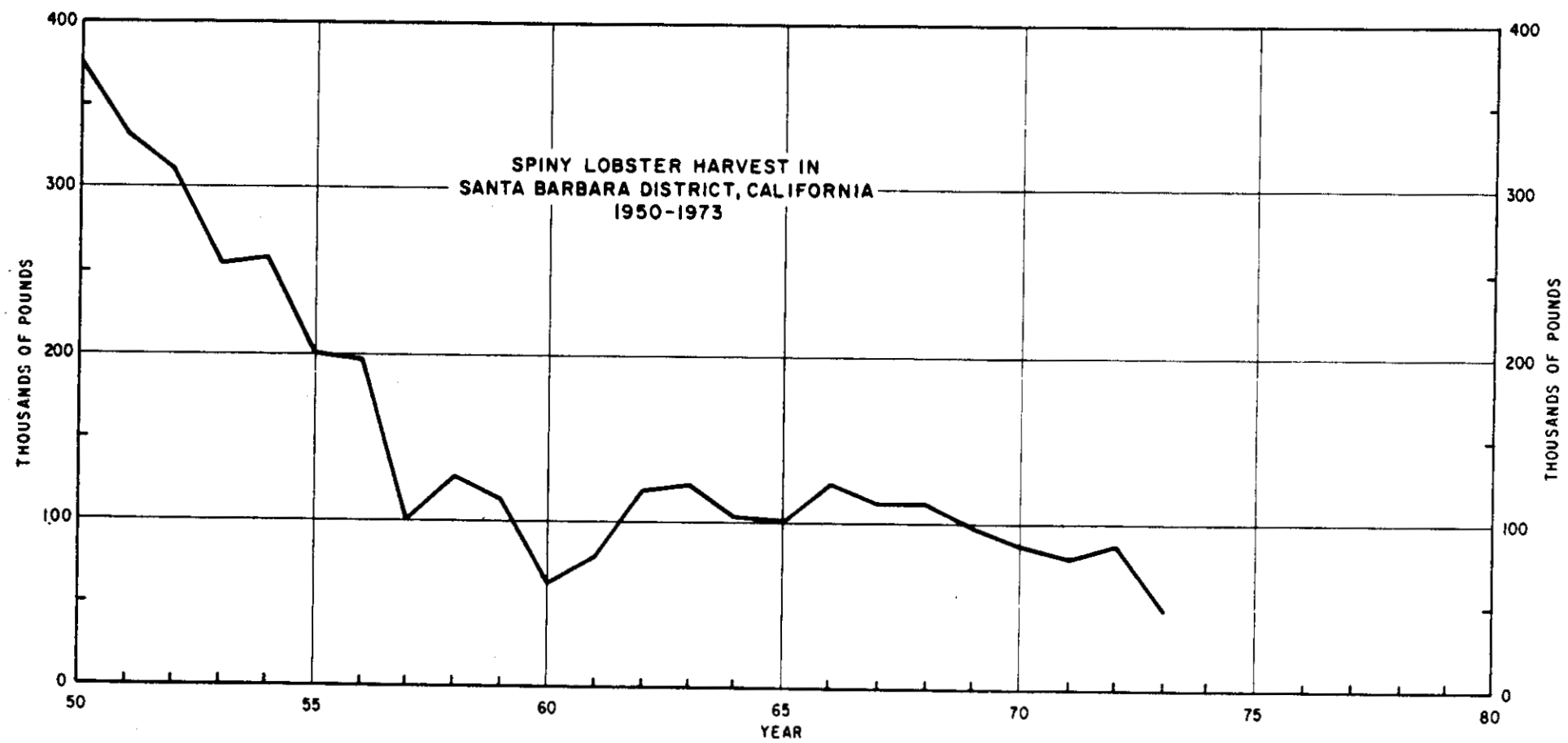

SPINY LOBSTER HARVEST IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
THOUSANDS OF POUNDS
YEAR
0
100
200
300
400
50
55
60
65
70
75
80

FIGURE 15

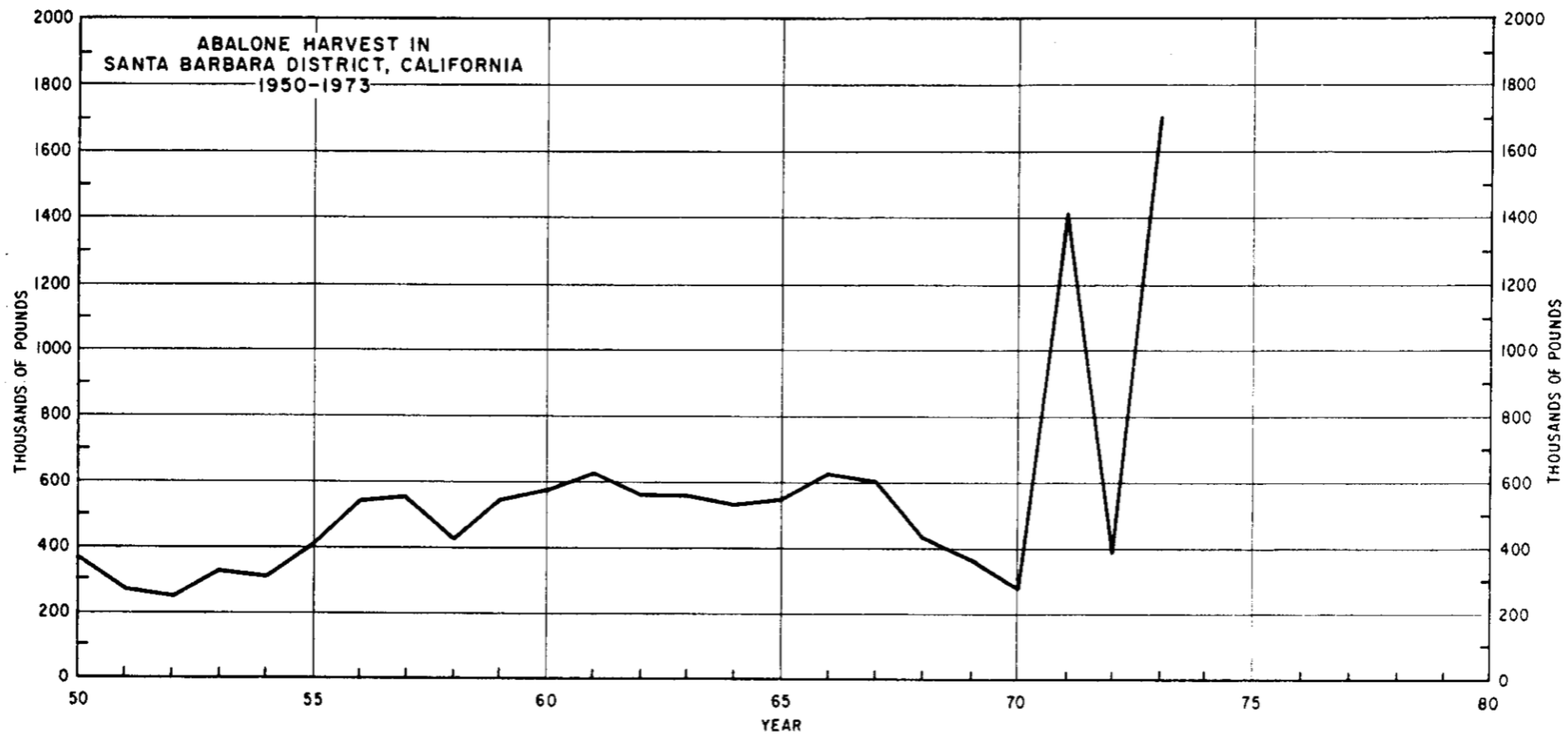

ABALONE HARVEST IN
SANTA BARBARA DISTRICT, CALIFORNIA
1950-1973
THOUSANDS OF POUNDS
YEAR
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50
55
60
65
70
75
80

FIGURE 16

TABLE 5

FISH AND SHELLFISH LANDINGS AND OPERATIONAL UNITS IN SAN PEDRO DISTRICT, CALIFORNIA

YEAR	FISH		SHELLFISH		TOTAL		NO.	MOTOR VESSELS		MOTOR & ACCESSORY
	1000 LBS	1000 $	1000 LBS	1000 $	1000 LBS	1000 $	FISHERMEN	NUMBER	TONNAGE	BOATS
1951	511,958	30,402	1,609	353	513,568	30,755	7,948	901	36,884	1,297
1952	385,419	37,391	1,176	438	386,595	37,829	5,054	794	35,245	720
1953	285,024	31,363	1,333	530	286,357	31,893	6,464	924	38,983	1,119
1954	356,060	34,890	1,532	400	357,583	35,290	5,668	706	33,095	987
1955	353,449	25,156	960	364	354,409	25,520	4,663	931	40,033	808
1956	379,506	27,935	1,507	308	381,014	28,243	4,669	851	30,918	601
1957	331,386	24,254	1,400	475	332,786	24,729	4,612	808	23,860	730
1958	375,560	28,887	4,306	442	379,866	29,299	4,023	625	25,680	684
1959	289,801	25,694	5,941	346	295,742	26,040	4,060	668	27,727	611
1960	374,294	32,354	766	216	375,059	32,570	4,108	719	51,825	521
1961	415,600	35,384	4,504	323	420,103	35,707	3,536	576	47,607	522
1962	360,135	35,315	2,284	332	362,420	35,647	3,537	619	48,946	526
1963	342,989	29,016	4,740	395	347,729	29,411	3,389	578	47,367	543
1964	333,885	30,561	7,377	355	341,262	30,915	3,266	567	48,843	480
1965	295,334	30,887	8,424	470	303,759	31,357	3,425	575	54,156	494
1966	259,884	30,264	7,159	502	267,043	30,766	3,236	518	49,171	486
1967	303,860	28,419	6,832	465	310,242	28,884	3,365	544	52,403	466
1968	263,503	29,635	8,350	624	271,853	30,259	3,436	511	58,867	568
1969	390,911	38,202	6,867	722	397,778	38,924	3,305	543	54,604	485
1970	484,755	50,993	11,686	716	496,441	51,709	4,444	429	63,331	450
1971	363,780	49,643	9,506	553	373,287	50,196	3,139	430	63,407	192
1972	426,218	59,857	5,278	831	431,496	60,688	2,736	388	51,834	134
1973					502,787					(Prelim)

SOURCE: Fishery Statistics of the United States, 1951-1971
Statistical Digest Publications, National Marine Fisheries Service, NOAA.

1972, 1973 data from National Marine Fisheries Service, NOAA.

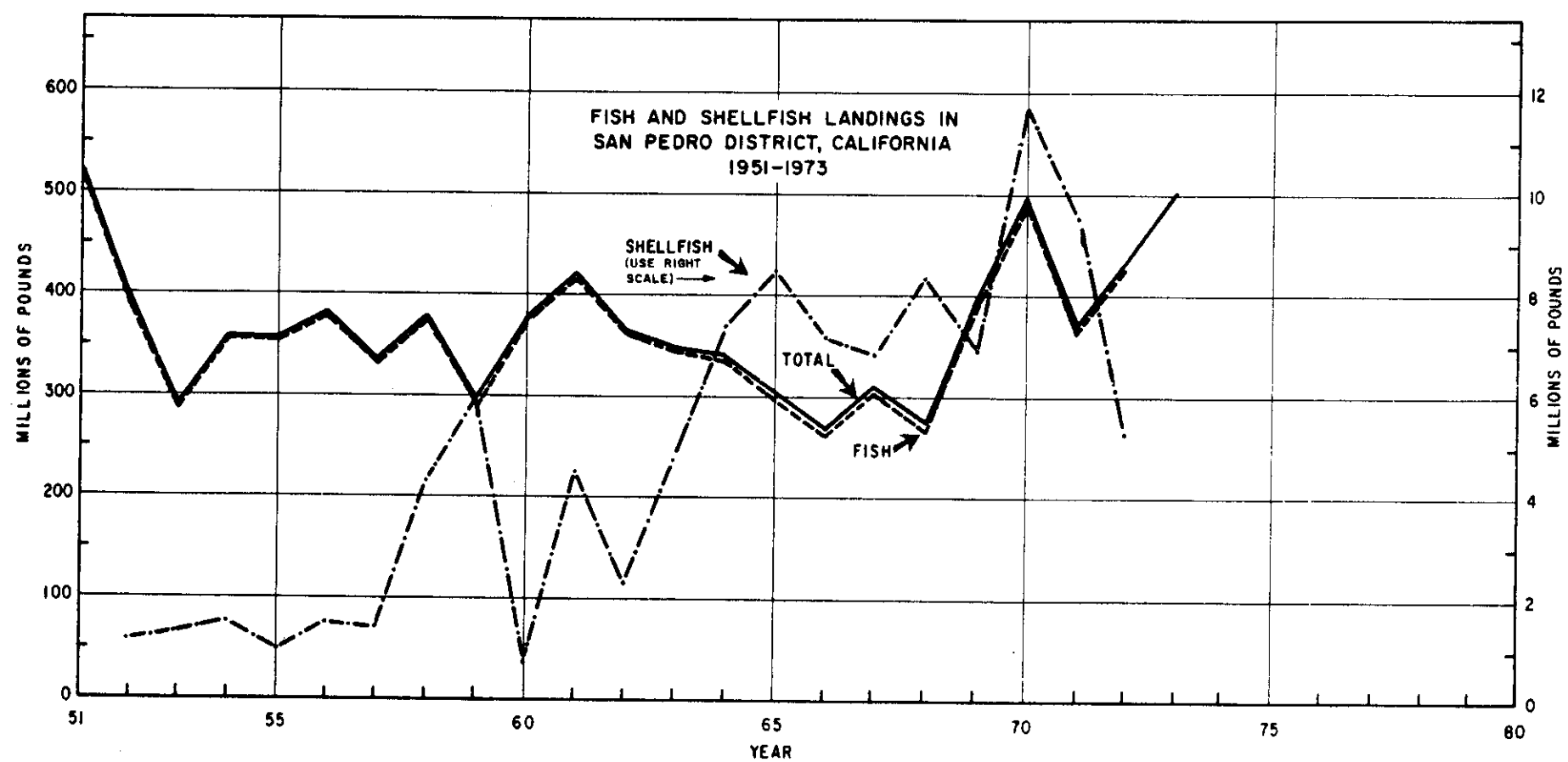

FISH AND SHELLFISH LANDINGS IN
SAN PEDRO DISTRICT, CALIFORNIA
1951-1973
SHELLFISH
(USE RIGHT
SCALE)
TOTAL
FISH
MILLIONS OF POUNDS
MILLIONS OF POUNDS
YEAR
0
100
200
300
400
500
600
0
2
4
6
8
10
12
51
55
60
65
70
75
80

FIGURE 17

TABLE 6

CATCH AND VALUE OF SOME PRINCIPAL FISH SPECIES IN SAN PEDRO DISTRICT, CALIFORNIA

(THOUSANDS OF POUNDS AND THOUSANDS OF DOLLARS)

YEAR	ANCHOVIES		JACK MACKEREL		ROCKFISHES		ALBACORE TUNA		PAC SARDINE	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1951	1,406	31	83,811	1,894	726	74	7,104	1,142	246,573	5,548
1952	3,157	71	136,588	4,466	515	56	13,102	2,362	11,642	407
1953	34,330	756	45,910	1,644	429	50	9,377	1,884	7,849	447
1954	25,092	482	8,325	3,336	672	65	9,934	2,036	111,039	2,732
1955	34,333	439	25,786	552	499	52	6,811	1,128	104,939	2,372
1956	46,276	578	59,067	1,218	598	61	11,625	2,051	54,089	1,379
1957	38,906	472	58,195	1,334	562	24	13,807	2,000	21,837	851
1958	10,426	133	12,629	316	520	57	9,952	2,099	143,541	3,847
1959	5,959	75	21,199	524	631	68	14,325	2,831	38,954	740
1960	3,742	49	59,477	1,297	617	76	21,062	3,235	39,139	693
1961	3,640	50	79,140	1,658	584	74	11,994	2,171	33,430	867
1962	1,534	24	78,353	1,645	559	67	19,370	3,266	10,596	331
1963	1,171	24	86,768	1,822	586	70	23,599	3,757	5,391	215
1964	2,107	35	24,927	1,804	479	61	20,190	3,262	11,687	432
1965	1,586	27	56,779	1,577	594	74	11,405	1,852	1,433	79
1966	36,533	3,756	32,857	1,157	551	78	6,754	1,296	743	130
1967	44,532	455	33,227	1,260	681	100	5,336	1,064	132	27
1968	18,515	168	50,456	1,922	657	96	5,704	1,213	101	11
1969	109,778	1,072	48,669	1,843	624	110	5,818	1,309	83	9
1970	170,746	1,877	43,846	1,728	415	82	5,694	1,568	268	58
1971	67,255	760	57,412	2,314	453	93	6,403	2,018	163	35
1972	114,874	2,540	50,222	2,111	672	141	4,769	1,626	326	49
1973	222,966		19,758		525				118	

TABLE 6 (Cont'd)

CATCH AND VALUE OF THE PRINCIPAL SHELLFISH SPECIES IN SAN PEDRO DISTRICT, CALIFORNIA

(THOUSANDS OF POUNDS AND THOUSANDS OF DOLLARS)

	ROCK CRAB		SPINY LOBSTER		ABALONE	
YEAR	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1951	13	1	361	150	486	184
1952	800	-	381	174	669	260
1953	31	4	355	182	580	232
1954	18	2	436	208	449	175
1955	34	3	466	237	322	120
1956	44	4	347	185	239	100
1957	94	6	388	226	433	234
1958	92	9	349	222	321	124
1959	80	7	236	146	267	114
1960	75	7	183	128	182	73
1961	73	8	304	143	201	104
1962	64	7	252	175	213	57
1963	106	13	252	168	249	159
1964	130	16	164	116	225	137
1965	169	22	208	170	279	191
1966	208	25	200	172	238	213
1967	235	27	209	182	162	157
1968	235	30	109	104	313	372
1969	301	38	127	145	256	415
1970	317	42	80	93	203	331
1971	360	51	73	103	887	247
1972	626	92	174	273	125	267
1973	582		77		603	

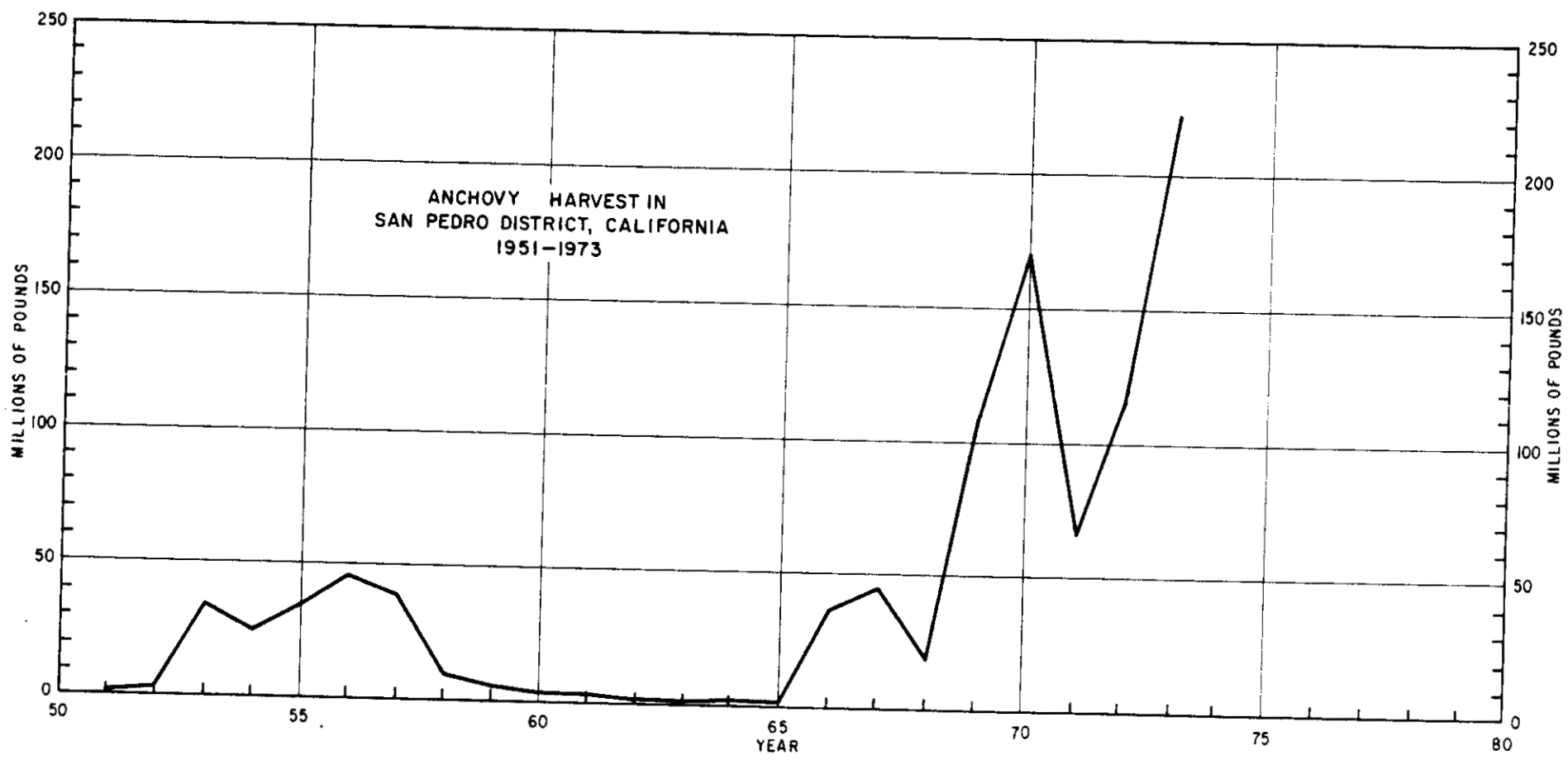

ANCHOVY HARVEST IN
SAN PEDRO DISTRICT, CALIFORNIA
1951–1973
MILLIONS OF POUNDS
YEAR
0
50
100
150
200
250
50
55
60
65
70
75
80

FIGURE 18

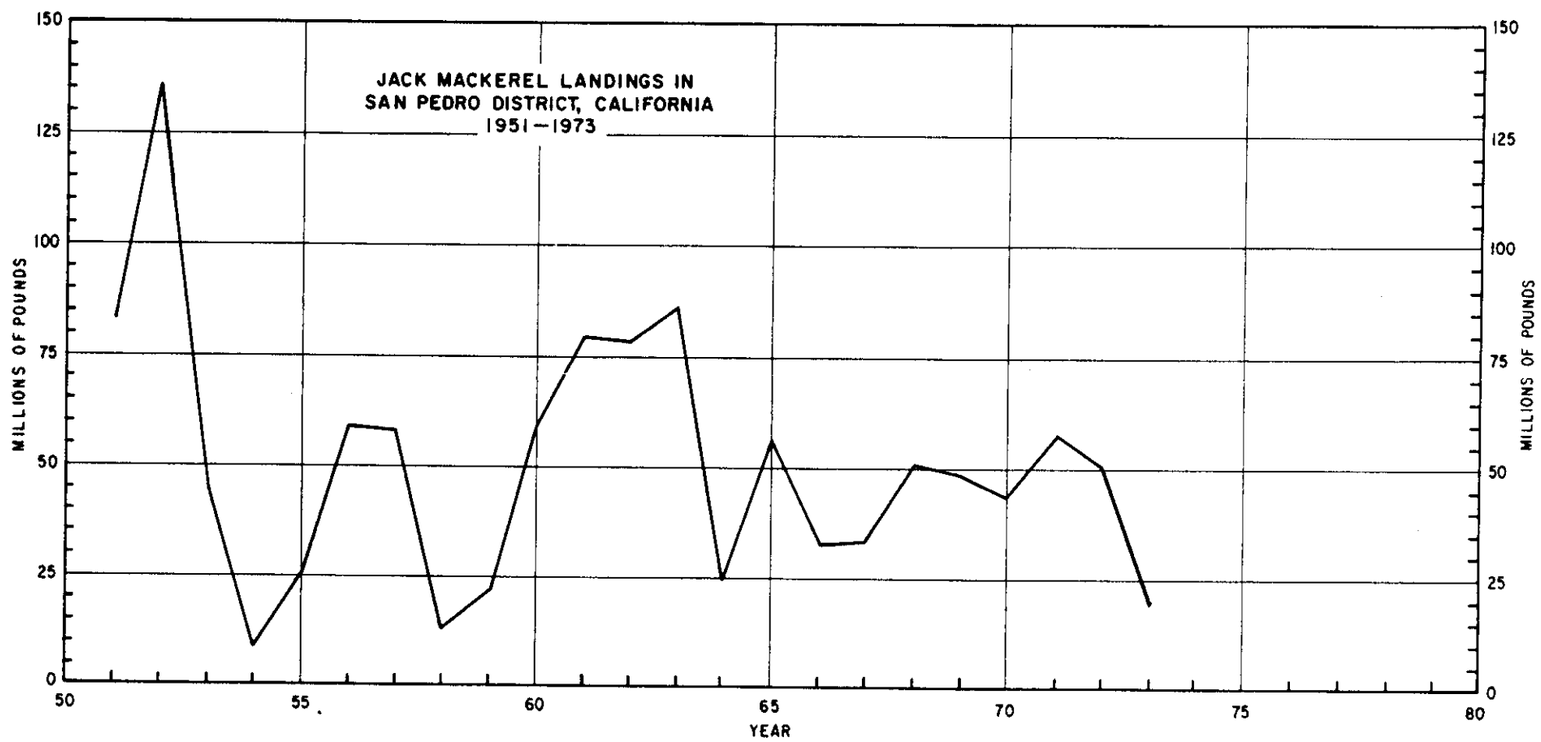

JACK MACKEREL LANDINGS IN
SAN PEDRO DISTRICT, CALIFORNIA
1951—1973
MILLIONS OF POUNDS
YEAR
0
25
50
75
100
125
150
50
55
60
65
70
75
80

FIGURE 19

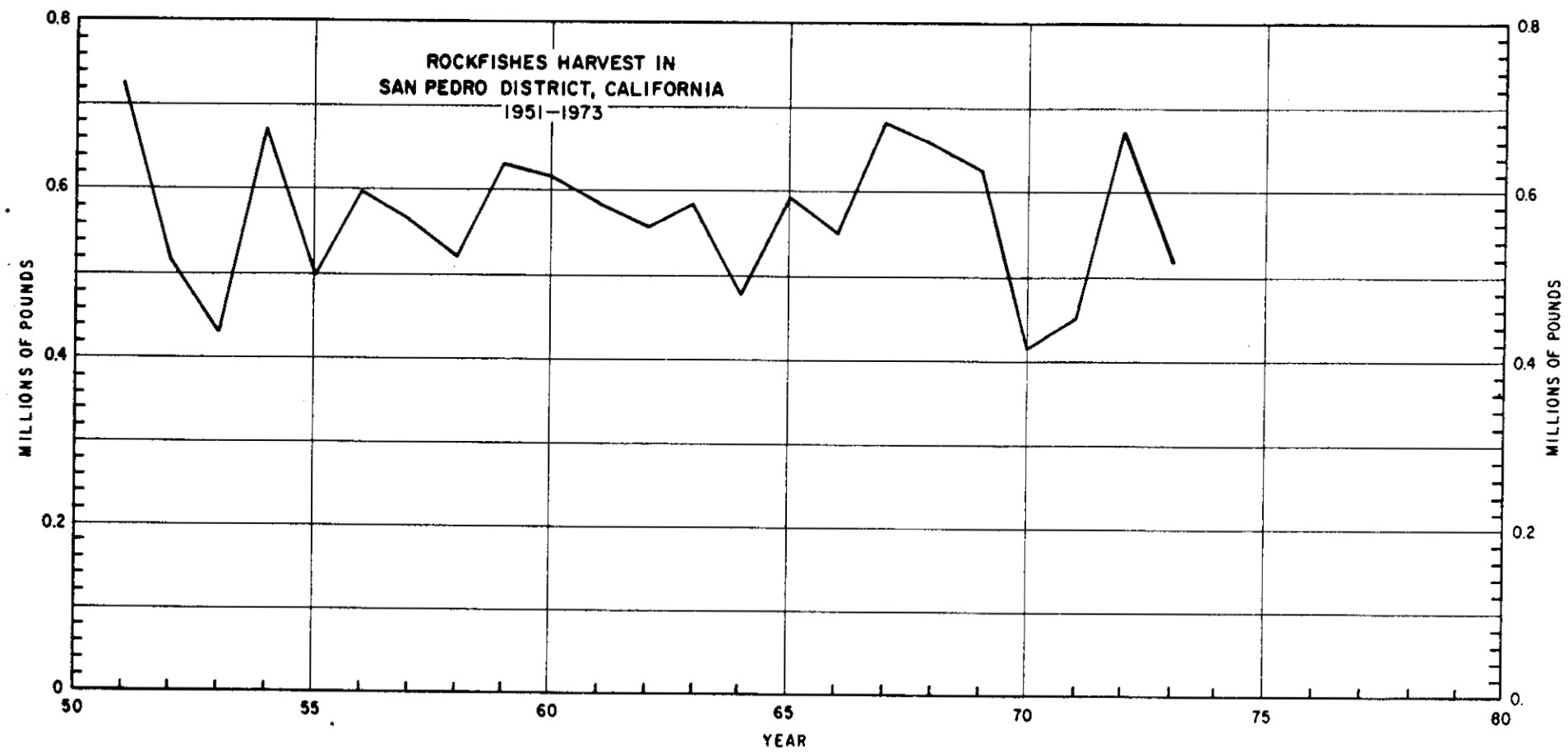

ROCKFISHES HARVEST IN
SAN PEDRO DISTRICT, CALIFORNIA
1951–1973
MILLIONS OF POUNDS
0.8
0.6
0.4
0.2
0
50
55
60
65
70
75
80
YEAR

FIGURE 20

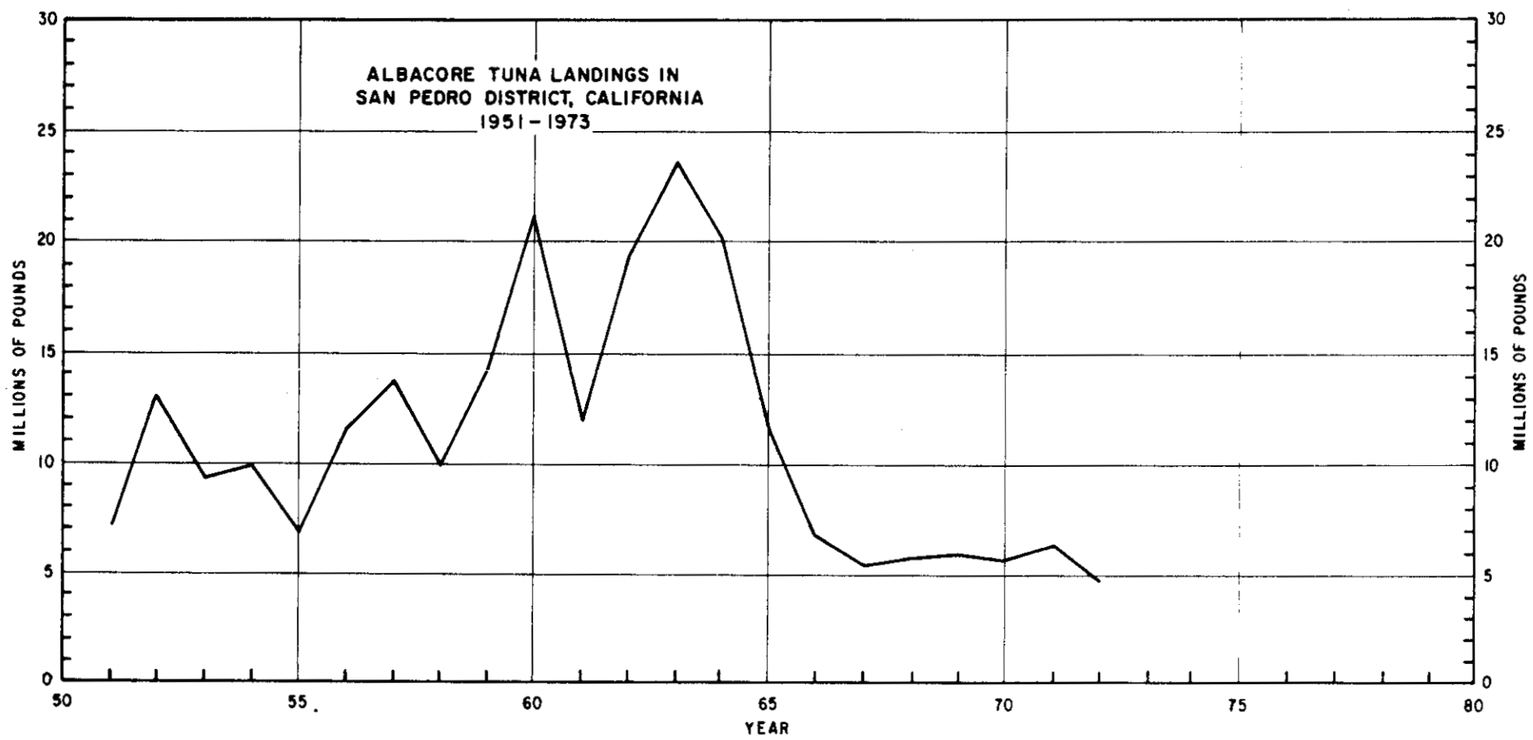

ALBACORE TUNA LANDINGS IN
SAN PEDRO DISTRICT, CALIFORNIA
1951 - 1973
MILLIONS OF POUNDS
YEAR
0
5
10
15
20
25
30
50
55
60
65
70
75
80

FIGURE 21

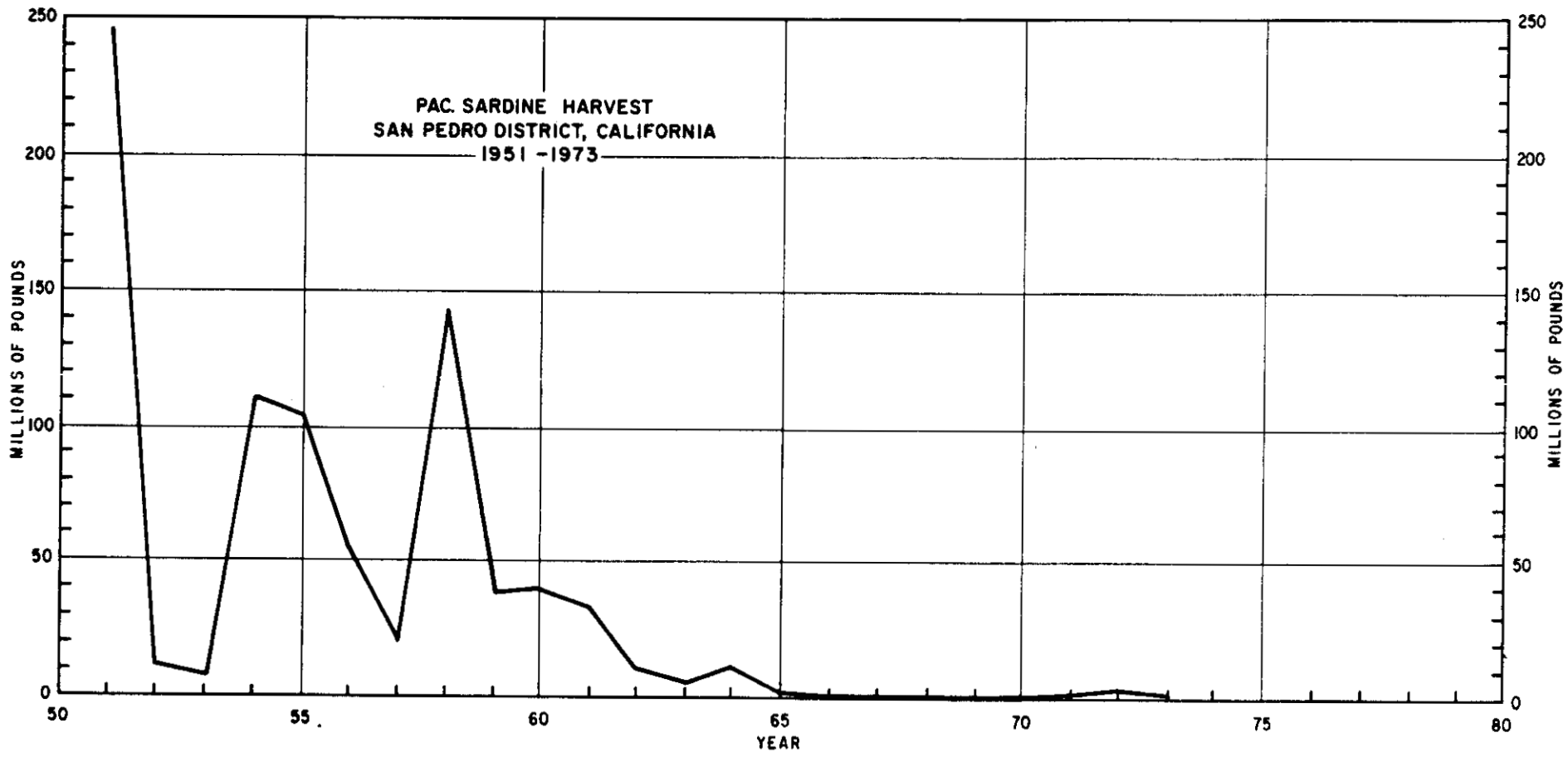

PAC. SARDINE HARVEST
SAN PEDRO DISTRICT, CALIFORNIA
1951 -1973
MILLIONS OF POUNDS
YEAR
0
50
100
150
200
250
50
55
60
65
70
75
80

FIGURE 22

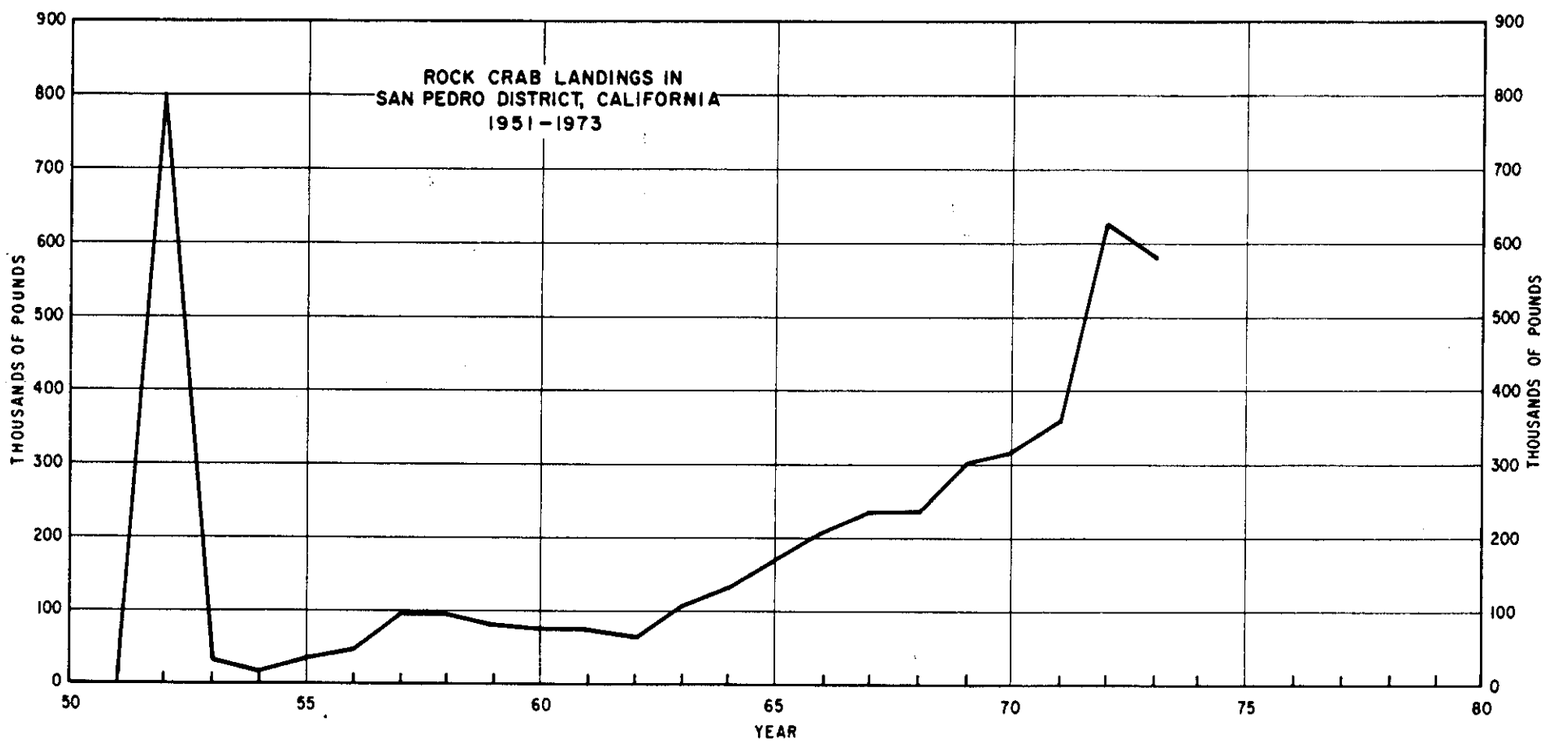

ROCK CRAB LANDINGS IN
SAN PEDRO DISTRICT, CALIFORNIA
1951-1973
THOUSANDS OF POUNDS
YEAR
0
100
200
300
400
500
600
700
800
900
50
55
60
65
70
75
80

FIGURE 23

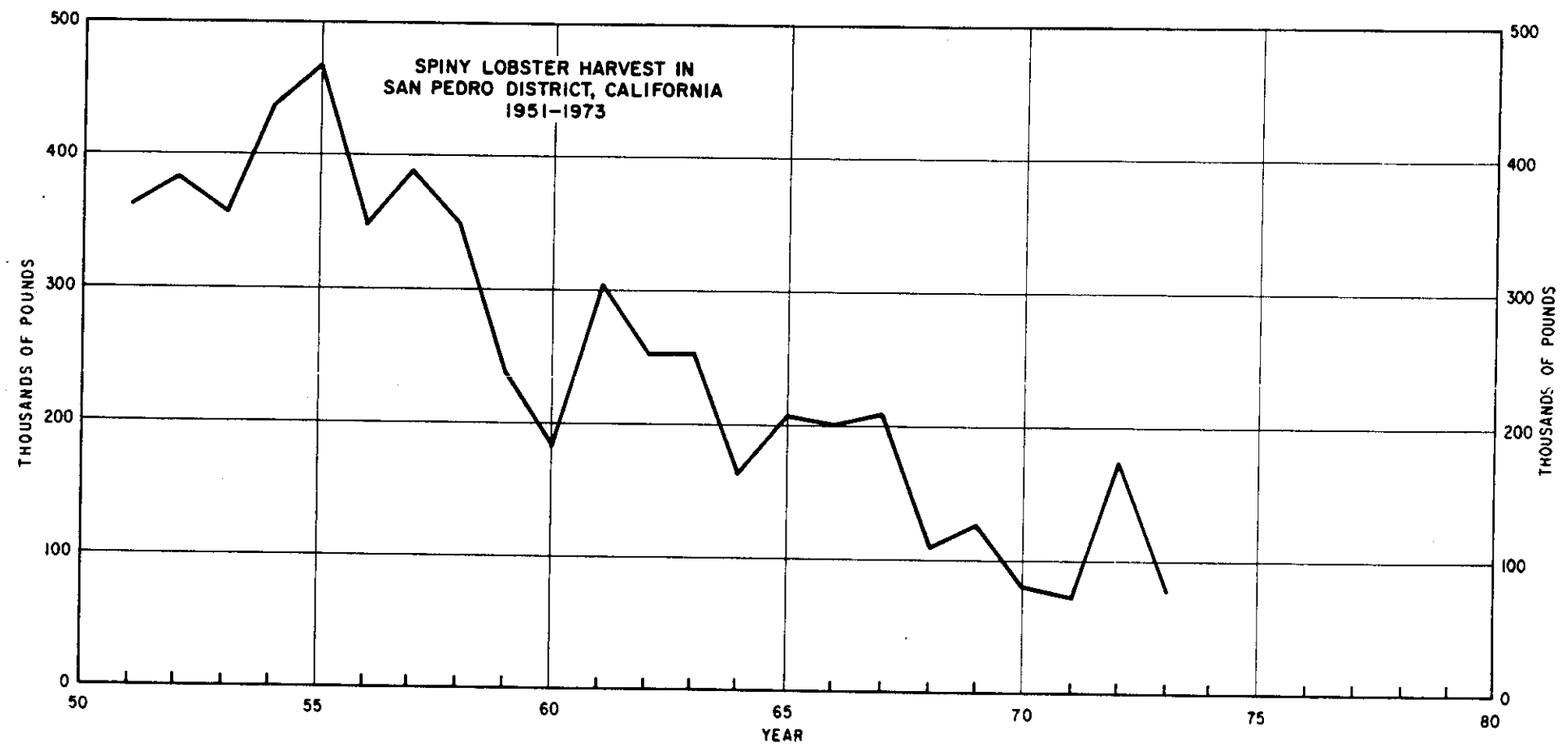

SPINY LOBSTER HARVEST IN
SAN PEDRO DISTRICT, CALIFORNIA
1951–1973
THOUSANDS OF POUNDS
YEAR
0
100
200
300
400
500
50
55
60
65
70
75
80

FIGURE 24

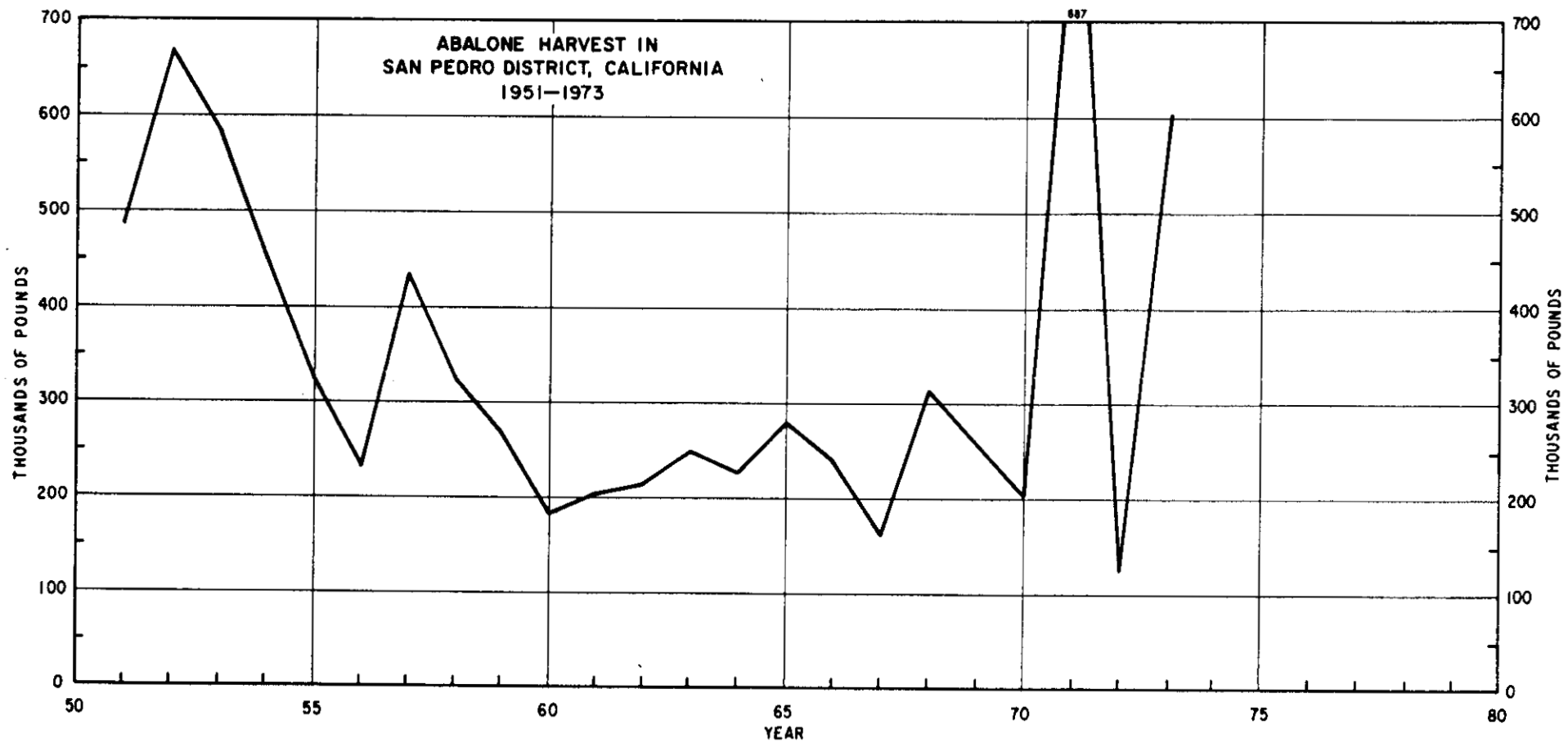

ABALONE HARVEST IN
SAN PEDRO DISTRICT, CALIFORNIA
1951—1973
687
THOUSANDS OF POUNDS
YEAR
0
100
200
300
400
500
600
700
50
55
60
65
70
75
80

FIGURE 25

SUMMARY TABLES

SANTA BARBARA
AND
SAN PEDRO LANDINGS

TABLE 7

YEAR	FISH (Thousand Pounds)			SHELLFISH (Thousand Pounds)			TOTAL (Thousand Pounds)		
	SAN PEDRO	SANTA BARBARA	TOTAL	SAN PEDRO	SANTA BARBARA	TOTAL	SAN PEDRO	SANTA BARBARA	TOTAL
1951	511,958	83,273	595,231	1,609	814	2,423	513,568	84,088	597,656
1952	385,419	22,906	408,325	1,176	1,166	2,342	386,595	24,072	410,667
1953	285,024	47,332	332,356	1,333	837	2,170	286,357	48,169	334,526
1954	356,060	49,130	405,190	1,532	671	2,203	357,583	49,801	407,384
1955	353,449	58,812	412,261	960	911	1,871	354,409	59,723	414,132
1956	379,506	46,387	425,893	1,507	1,258	2,765	381,014	47,645	428,659
1957	331,386	68,639	400,025	1,400	1,147	2,547	332,766	69,786	402,572
1958	375,560	64,517	440,077	4,306	1,066	5,372	379,866	65,583	445,449
1959	289,801	21,503	311,304	5,941	1,218	7,159	295,742	22,721	318,463
1960	374,294	39,393	413,687	766	1,076	1,842	375,059	40,469	415,528
1961	415,600	32,344	447,944	4,504	3,545	8,049	420,103	35,889	455,992
1962	360,135	23,235	383,370	2,284	2,906	5,190	362,420	26,141	388,561
1963	342,989	19,121	362,110	4,740	1,600	6,340	347,729	20,720	368,449
1964	333,885	22,524	356,409	7,377	1,473	8,850	341,262	23,998	365,260
1965	295,334	16,940	312,274	8,424	2,972	11,396	303,759	19,911	323,670
1966	259,884	24,083	283,967	7,159	2,224	9,383	267,043	26,307	293,350
1967	303,860	21,045	324,905	6,832	3,479	10,311	310,242	24,525	334,767
1968	263,503	15,372	278,875	8,350	3,456	1,806	271,853	18,828	290,681
1969	390,911	29,317	420,228	6,867	3,829	9,696	397,778	33,146	430,924
1970	484,755	33,310	518,065	11,686	5,747	17,615	496,441	39,057	535,498
1971	363,780	30,232	394,012	9,506	8,402	17,908	373,287	38,634	411,921
1972	426,218	40,533	466,751	5,278	4,433	9,711	431,496	45,966	477,462
1973 (Prelim)							502,787	41,558	544,345
1974									
1975									
1976									
1977									
1978									
1979									
1980									

SOURCE: Fishery Statistics of the United States, Statistical Digests 1951-1971, National Marine Fishery Service, NOAA
1972, 1973 data from National Marine Fisheries Service, NOAA

TABLE 8

YEAR	ANCHOVIES (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	JACK MACKEREL (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	ROCKFISHES (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	ALBACORE TUNA (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL
1951	1,406	202	1,608	83,811	777	84,588	726	268	994	7,104	156	7,260
1952	3,157	7,034	10,191	136,588	9,407	145,995	515	238	753	13,102	2,420	15,520
1953	34,330	34,735	69,065	45,910	8,619	54,529	429	196	625	9,377	1,080	10,457
1954	25,092	16,807	41,899	8,325	2,762	11,087	672	580	1,252	9,934	811	10,745
1955	34,333	3,262	37,595	25,786	9,809	35,595	499	3,378	3,877	6,811	119	930
1956	46,276	557	46,833	59,067	14,057	73,124	598	2,571	3,169	11,625	320	11,945
1957	38,906	125	39,031	58,195	21,493	79,688	562	3,357	3,919	13,807	1,254	15,061
1958	10,426	627	11,053	12,629	6,199	18,828	520	3,144	3,664	9,952	1,876	11,828
1959	5,959	810	6,769	21,199	5,401	26,600	631	1,479	2,110	14,325	4,085	18,410
1960	3,742	26	3,768	59,477	13,198	72,675	617	2,823	3,440	21,062	1,464	22,526
1961	3,640	54	3,694	79,140	14,795	93,935	584	2,321	2,905	11,994	684	12,678
1962	1,534	30	1,564	78,353	9,572	87,925	559	2,021	2,580	19,370	984	20,354
1963	1,171	11	1,182	86,768	7,021	93,789	586	2,602	3,188	23,599	3,608	27,207
1964	2,107	1	2,108	24,927	12,179	37,106	479	1,584	2,063	20,190	3,892	24,082
1965	1,586	47	1,633	56,779	7,134	63,913	594	1,733	2,327	11,405	3,149	14,554
1966	36,533	9,039	45,572	32,857	6,790	39,647	551	2,264	2,815	6,754	1,551	8,305
1967	44,532	8,289	52,821	33,227	4,032	37,259	681	2,895	3,576	5,336	2,826	8,162
1968	18,515	4,007	22,522	50,456	4,251	54,707	657	2,544	3,201	5,704	2,131	7,835
1969	109,778	19,861	129,639	48,669	2,804	51,473	624	2,497	3,121	5,818	1,196	7,014
1970	170,746	19,614	190,360	43,846	3,383	47,229	415	2,457	2,872	5,694	5,203	10,897
1971	67,255	19,722	86,977	57,412	2,296	59,708	453	1,915	2,368	6,403	3,403	9,806
1972	114,874	27,477	142,651	50,222	772	50,994	672	3,293	3,965	4,769	3,928	8,697
1973(1)	222,966	27,367	250,333	19,758	22	19,780	524	2,424	2,948	N.A.	N.A.	N.A.
1974												
1975												
1976												
1977												
1978												
1979												
1980												

(1)1973 data are preliminary. From National Marine Fisheries Service, NOAA.

TABLE 8 (cont'd)

YEAR	PAC SARDINE (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	ROCK CRAB (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	SPINY LOBSTER (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL	ABALONE (Thousand Pounds) SAN PEDRO	SANTA BARBARA	TOTAL
1951	246,573	74,973	321,546	13	3	16	361	331	692	486	268	754
1952	11,642	2,610	14,252	800	3	803	381	310	691	669	246	915
1953	7,849	972	8,821	31	8	39	355	256	611	580	326	906
1954	111,039	24,433	135,472	18	2	20	436	259	695	449	307	756
1955	104,939	39,732	144,671	34	9	43	466	201	667	322	409	731
1956	54,089	15,446	69,535	44	10	54	347	198	545	239	542	781
1957	21,837	23,978	45,815	94	52	146	388	101	489	433	549	982
1958	143,541	47,110	190,651	92	59	151	349	128	477	321	424	745
1959	38,954	5,526	44,480	80	46	126	236	114	350	267	542	909
1960	39,139	15,231	54,370	75	43	118	183	62	245	182	572	754
1961	33,430	8,582	42,012	73	77	150	304	79	383	201	629	830
1962	10,596	2,175	12,771	64	130	194	252	120	372	213	561	774
1963	5,391	400	5,791	106	100	206	252	123	375	249	561	810
1964	11,687	840	12,527	130	117	247	164	104	268	225	535	760
1965	1,433	150	1,583	169	153	322	208	101	309	279	551	830
1966	743	108	851	208	106	314	200	124	324	238	624	862
1967	132	7	139	235	79	314	209	112	321	162	600	762
1968	101	20	121	235	109	344	109	112	221	313	431	744
1969	83	-	83	301	196	497	127	99	226	256	368	624
1970	268	209	477	317	207	524	80	86	166	203	275	478
1971	163	-	163	360	157	517	73	78	151	887	1,401	2,288
1972	326	-	326	626	191	817	174	87	261	125	388	513
1973(1)	118	-	118	582	195	777	77	48	125	603	1,699	2,302
1974												
1975												
1976												
1977												
1978												
1979												
1980												

(1) 1973 data are preliminary. From National Marine Fisheries Service, NOAA.

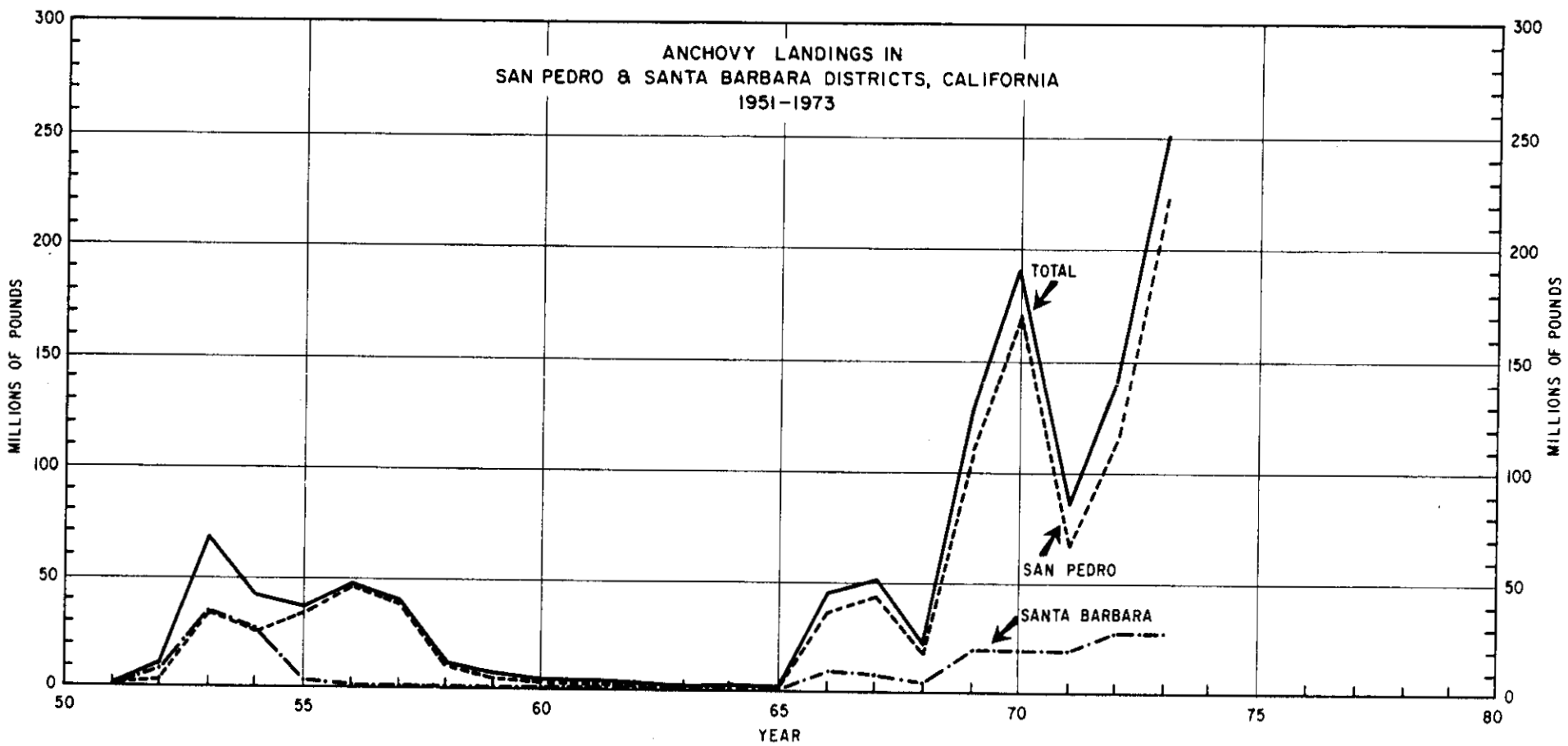

ANCHOVY LANDINGS IN
SAN PEDRO & SANTA BARBARA DISTRICTS, CALIFORNIA
1951-1973
MILLIONS OF POUNDS
YEAR
TOTAL
SAN PEDRO
SANTA BARBARA
0
50
100
150
200
250
300
50
55
60
65
70
75
80

FIGURE 26

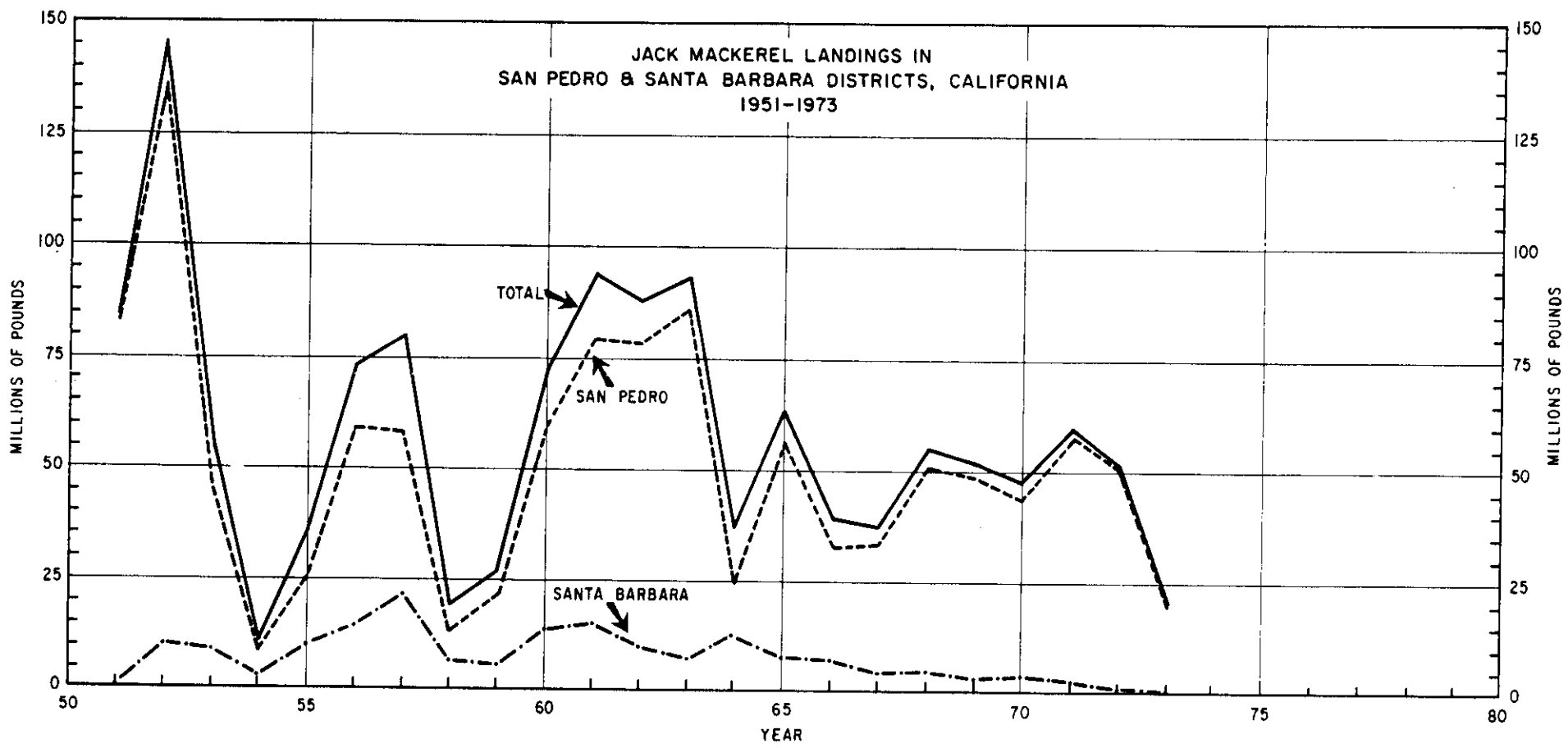

JACK MACKEREL LANDINGS IN
SAN PEDRO & SANTA BARBARA DISTRICTS, CALIFORNIA
1951-1973
TOTAL
SAN PEDRO
SANTA BARBARA
MILLIONS OF POUNDS
YEAR
0
25
50
75
100
125
150
50
55
60
65
70
75
80

FIGURE 27

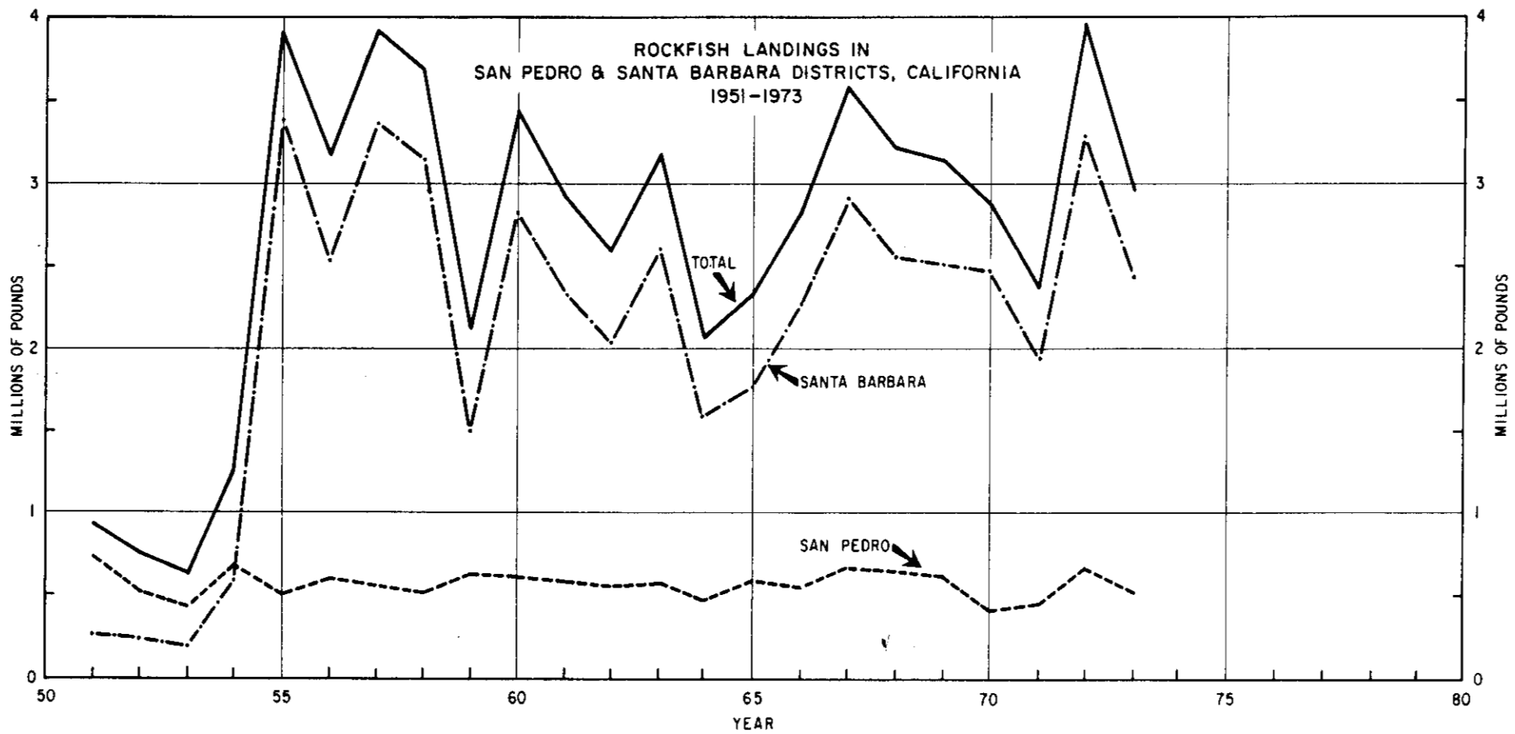

ROCKFISH LANDINGS IN
SAN PEDRO & SANTA BARBARA DISTRICTS, CALIFORNIA
1951-1973
TOTAL
SANTA BARBARA
SAN PEDRO
MILLIONS OF POUNDS
MILLIONS OF POUNDS
YEAR
0
1
2
3
4
50
55
60
65
70
75
80

FIGURE 28

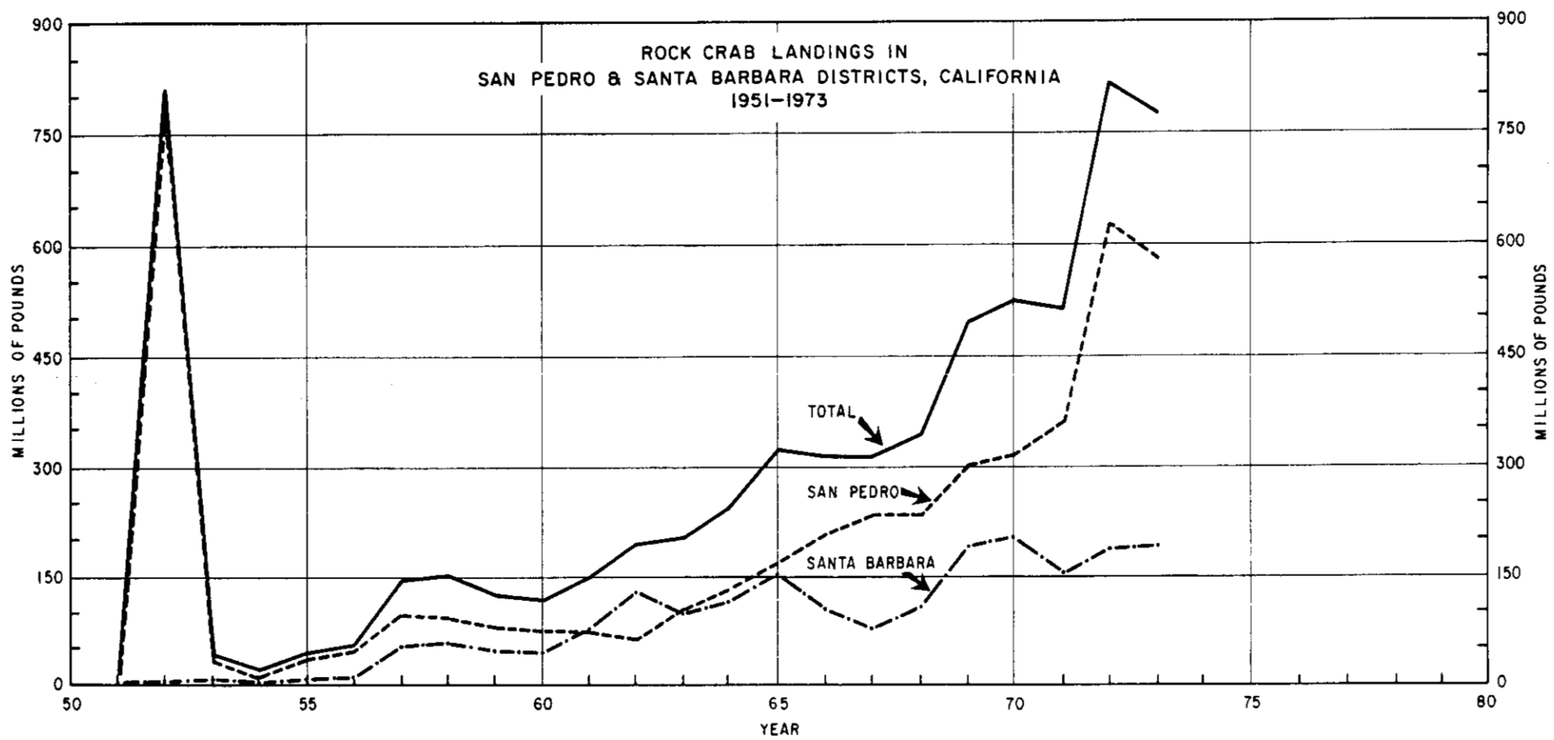

ROCK CRAB LANDINGS IN
SAN PEDRO & SANTA BARBARA DISTRICTS, CALIFORNIA
1951–1973
MILLIONS OF POUNDS
YEAR
TOTAL
SAN PEDRO
SANTA BARBARA
0
150
300
450
600
750
900
50
55
60
65
70
75
80

FIGURE 29

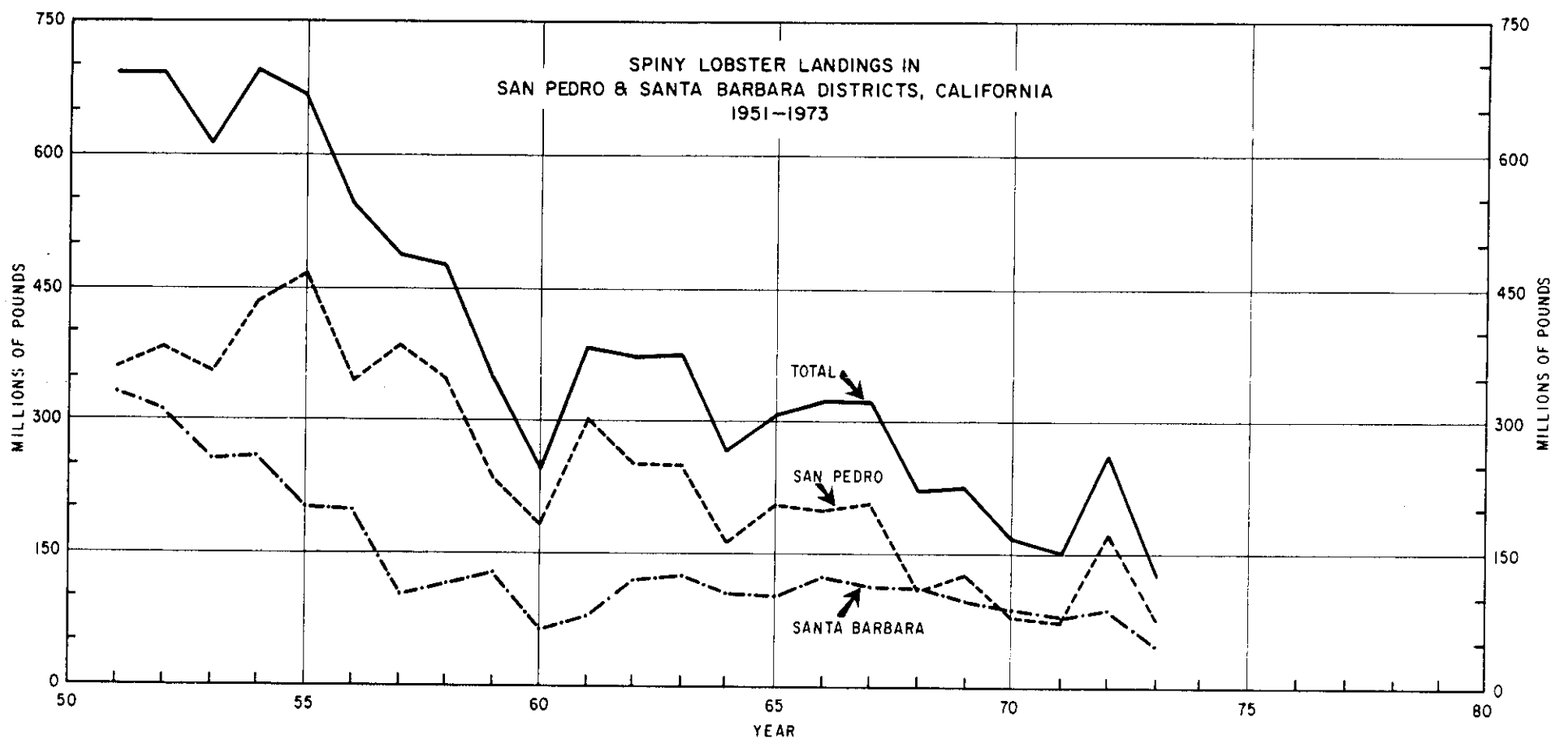
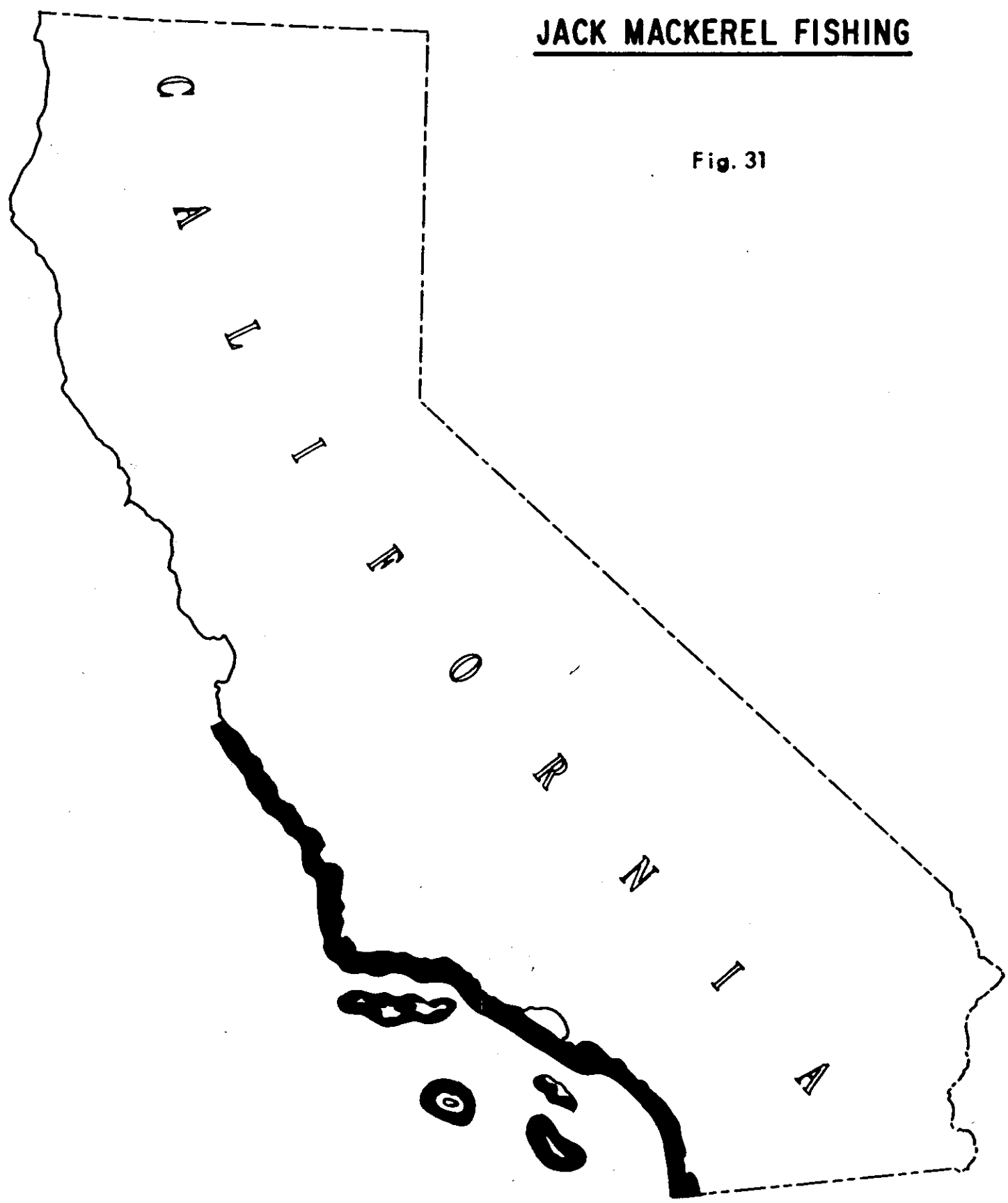

SPINY LOBSTER LANDINGS IN
SAN PEDRO & SANTA BARBARA DISTRICTS, CALIFORNIA
1951–1973
TOTAL
SAN PEDRO
SANTA BARBARA
MILLIONS OF POUNDS
YEAR
0
150
300
450
600
750
50
55
60
65
70
75
80

FIGURE 30

The following maps (Figures 31-42) of the waters and coastline of the Santa Barbara and San Pedro fishing regions in which sport and commercial fishing for various species occur are from Bell and Ally, 1972.[15]

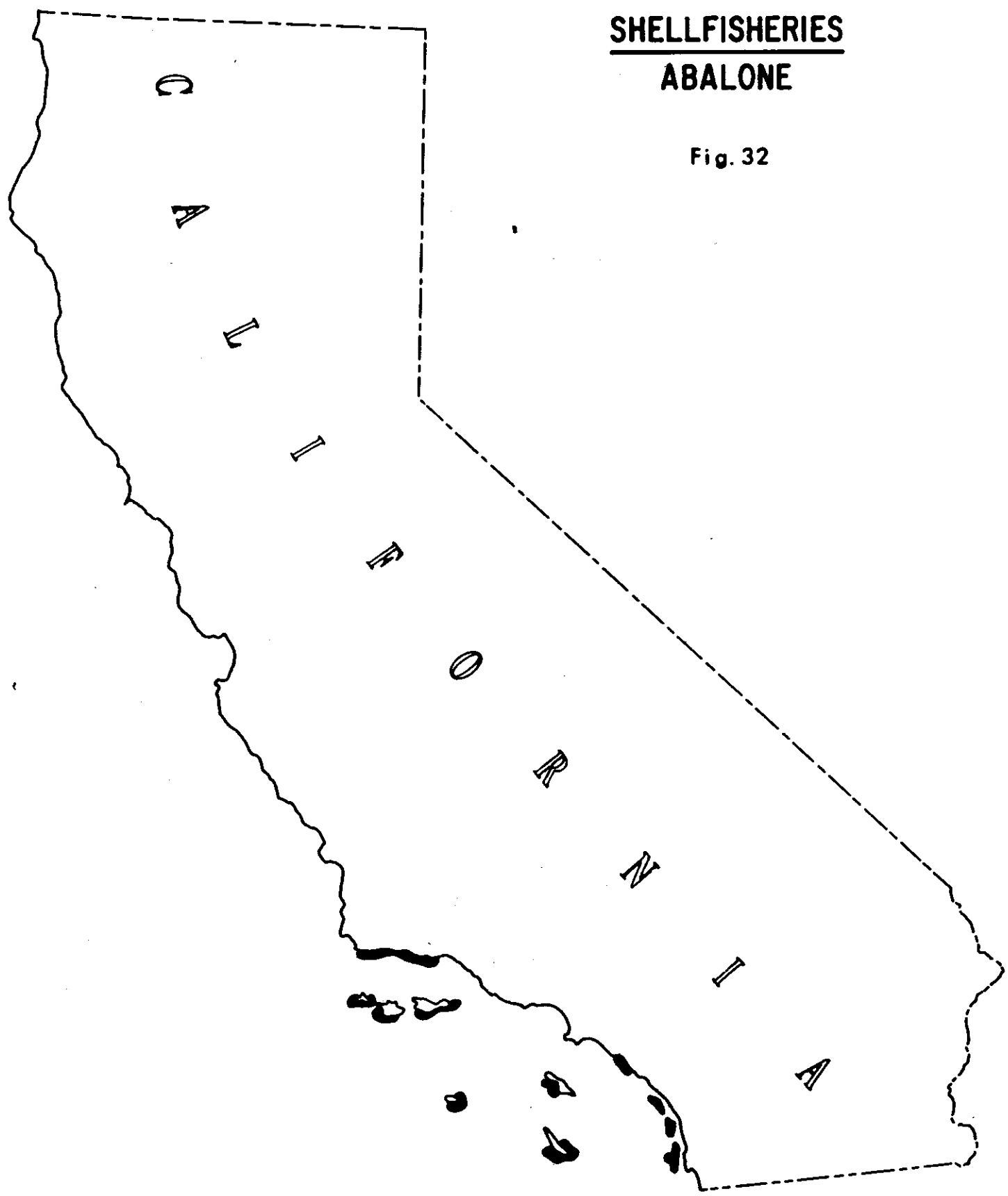
JACK MACKEREL FISHING

Fig. 31



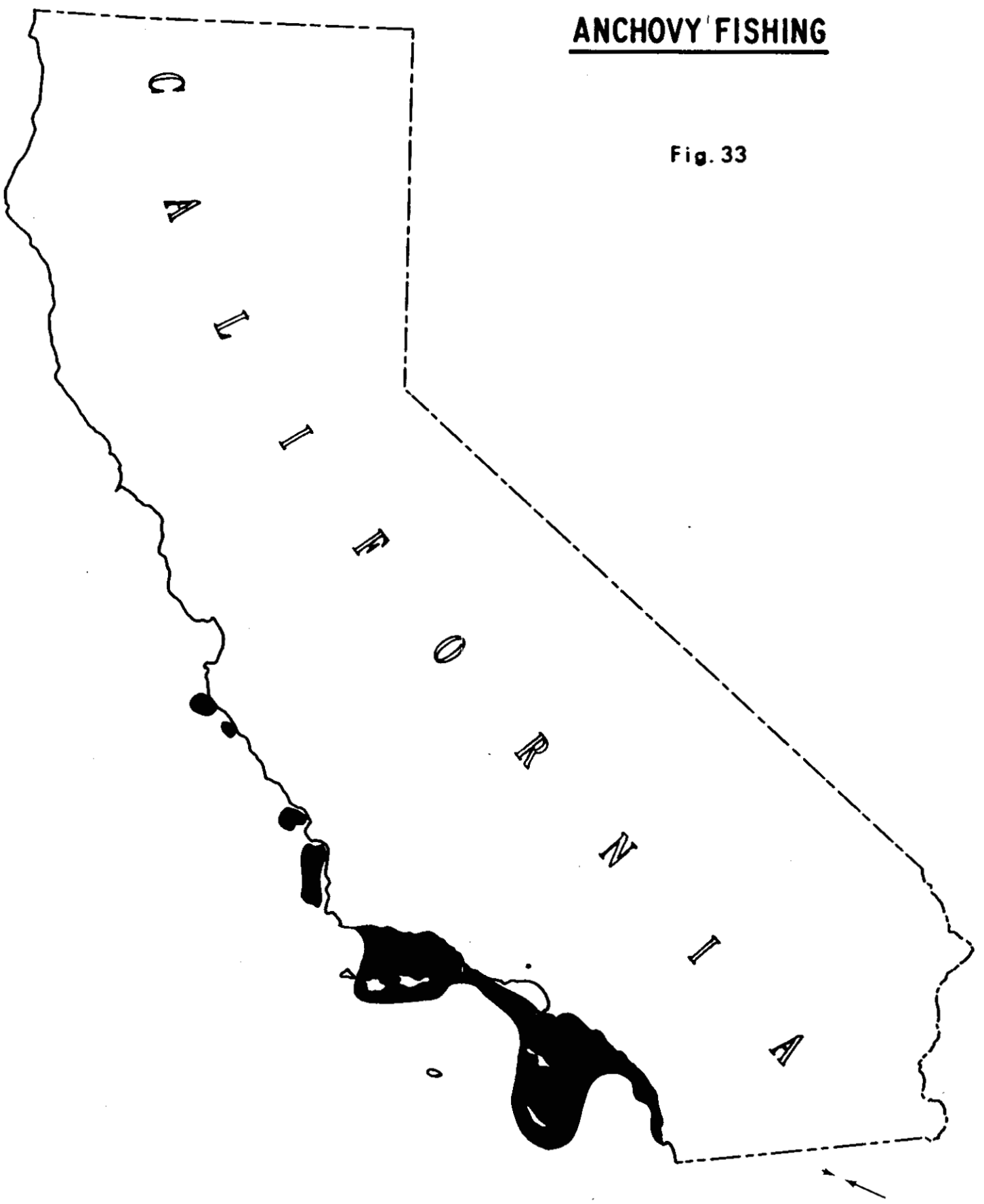
SHELLFISHERIES
ABALONE

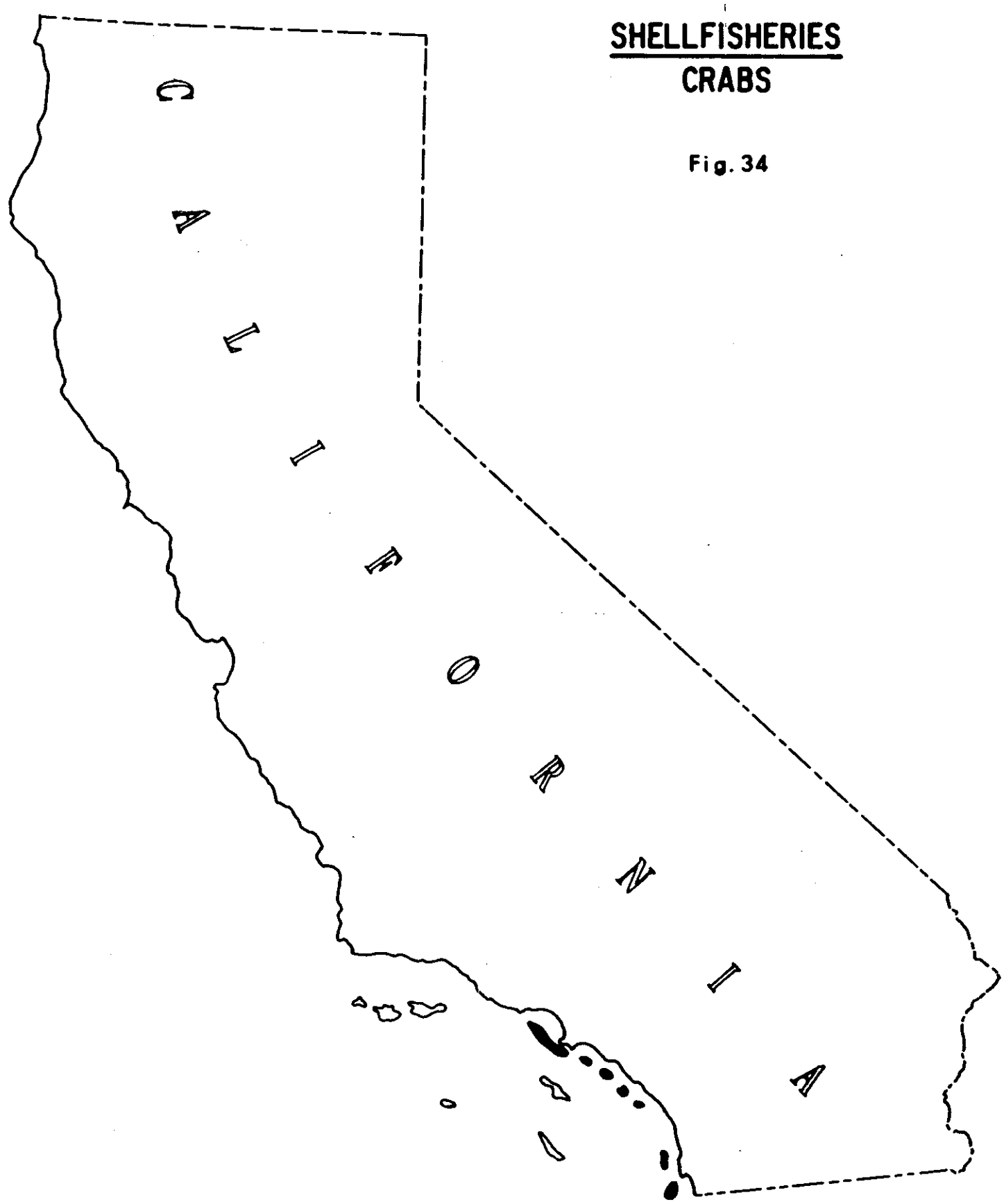
Fig. 32



ANCHOVY FISHING

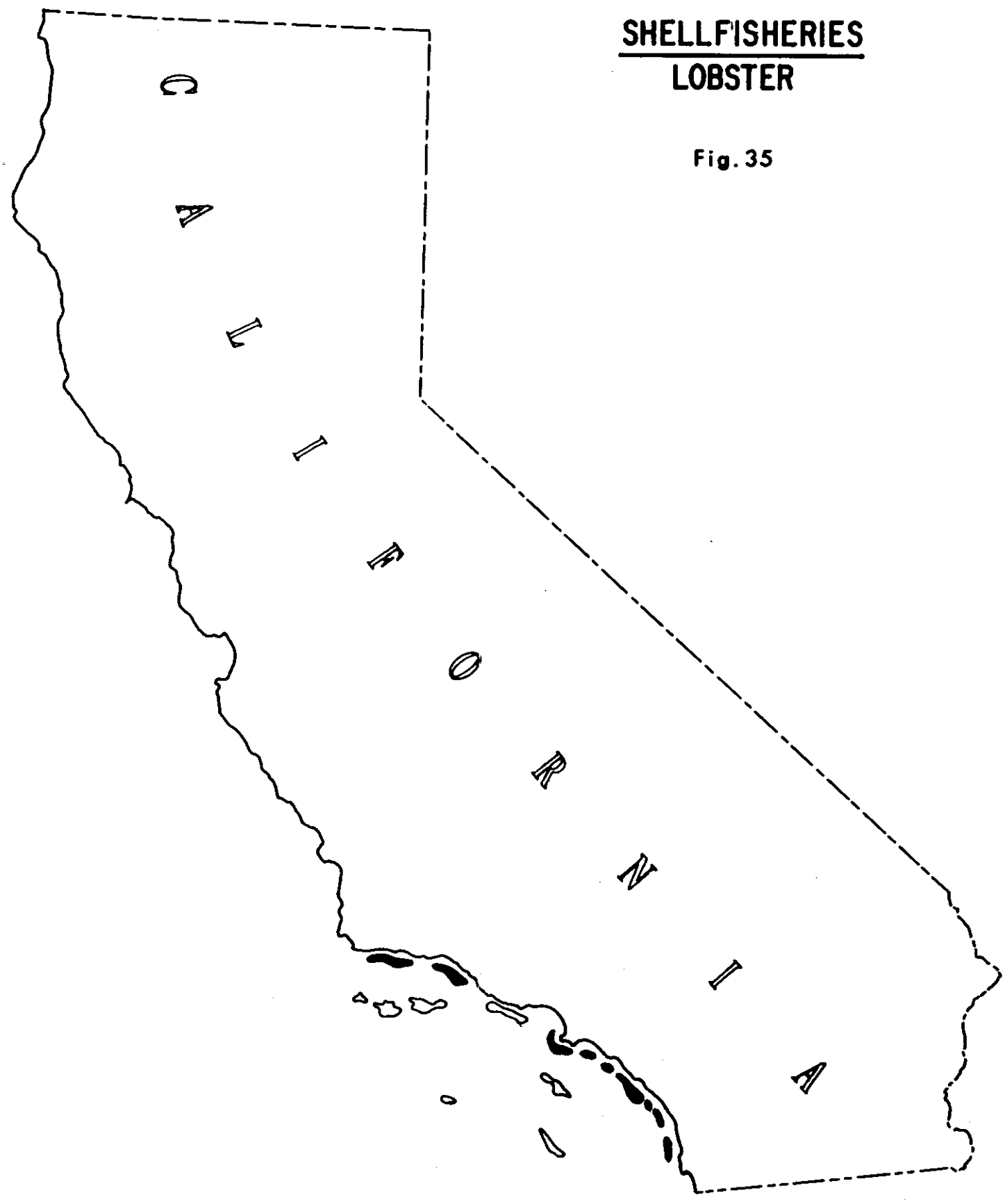
Fig. 33





SHELLFISHERIES
CRABS

Fig. 34

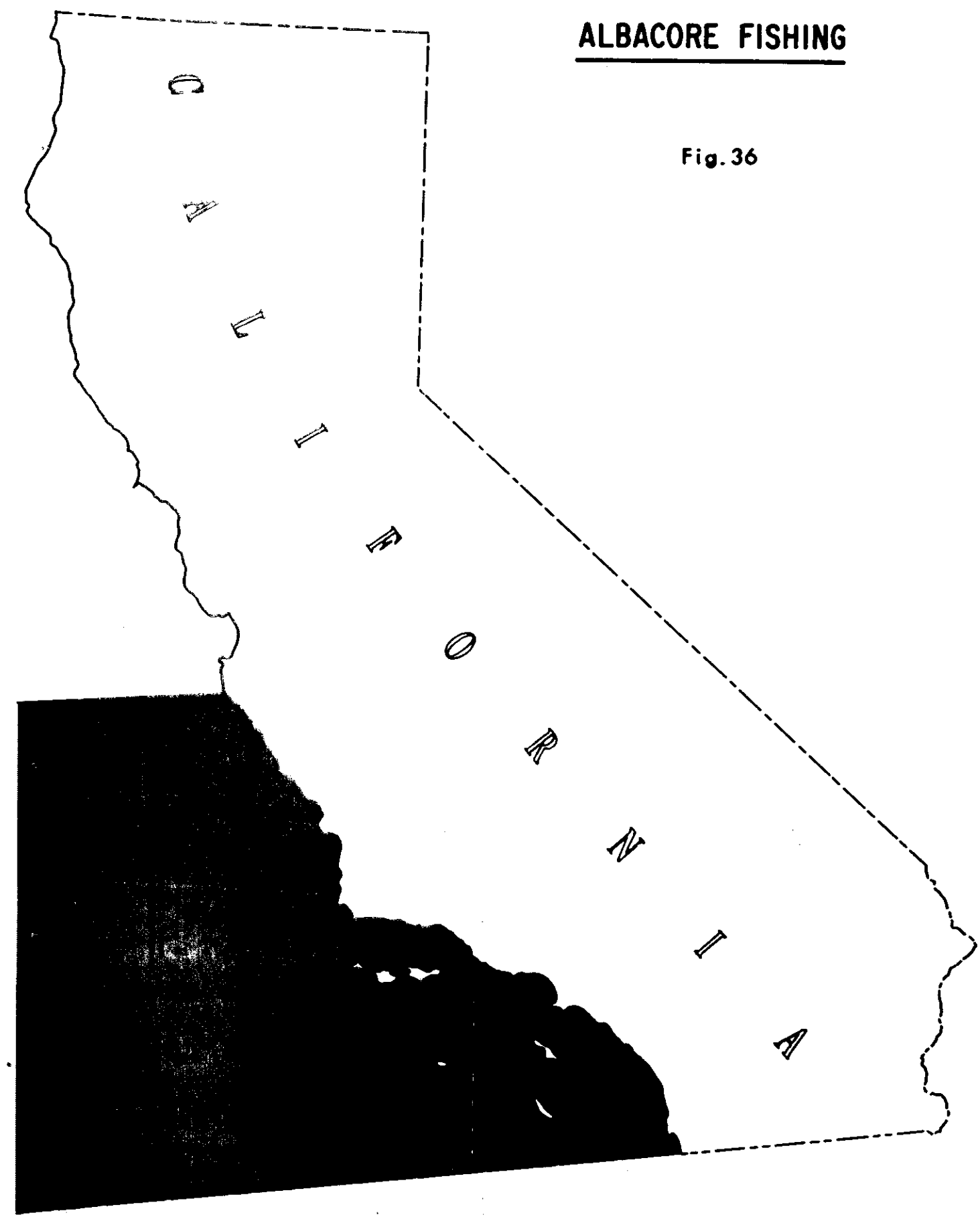


SHELLFISHERIES
LOBSTER

Fig. 35

ALBACORE FISHING

Fig. 36

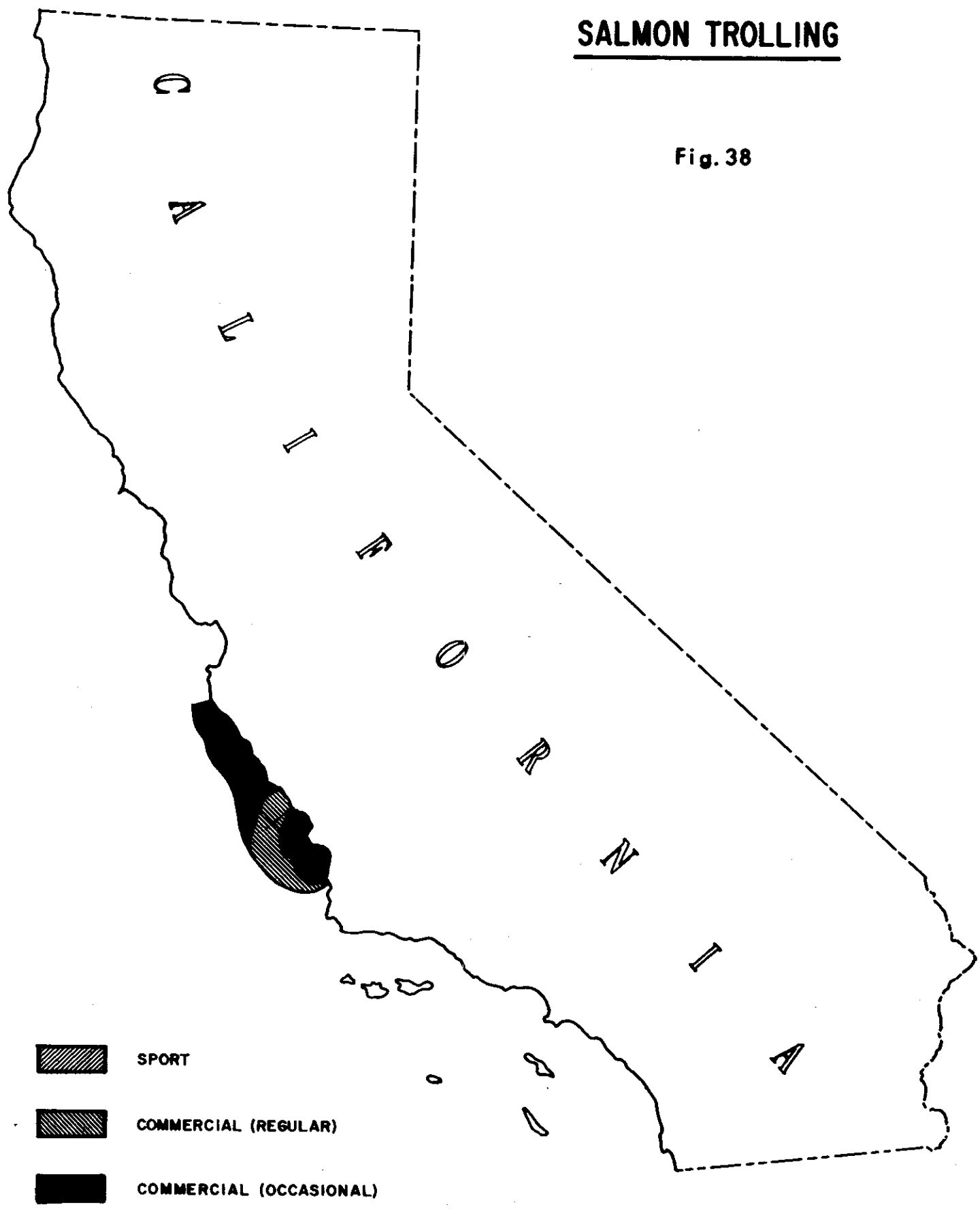


BLUEFIN TUNA FISHING

Fig. 37

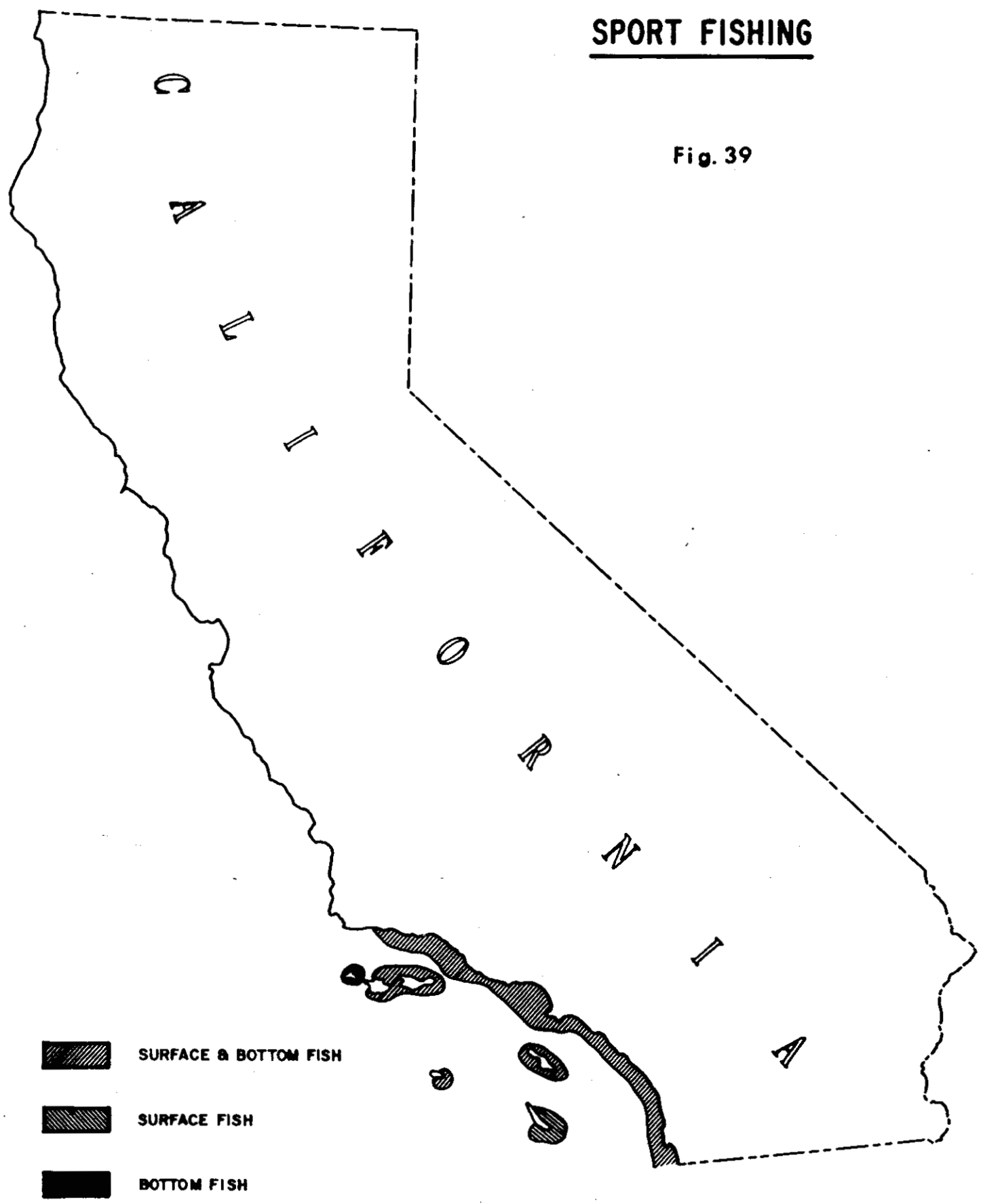
SALMON TROLLING

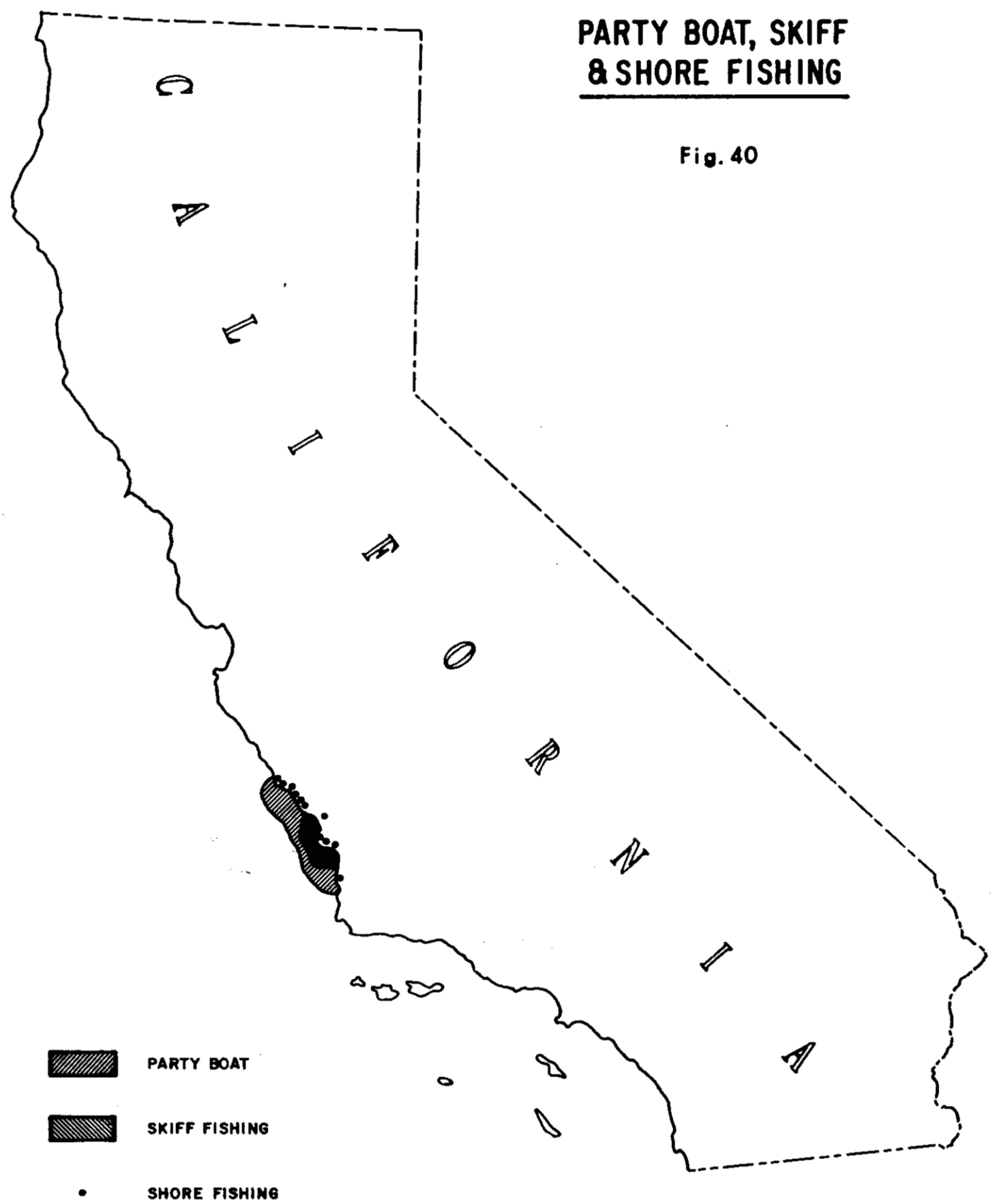
Fig. 38



SPORT FISHING

Fig. 39



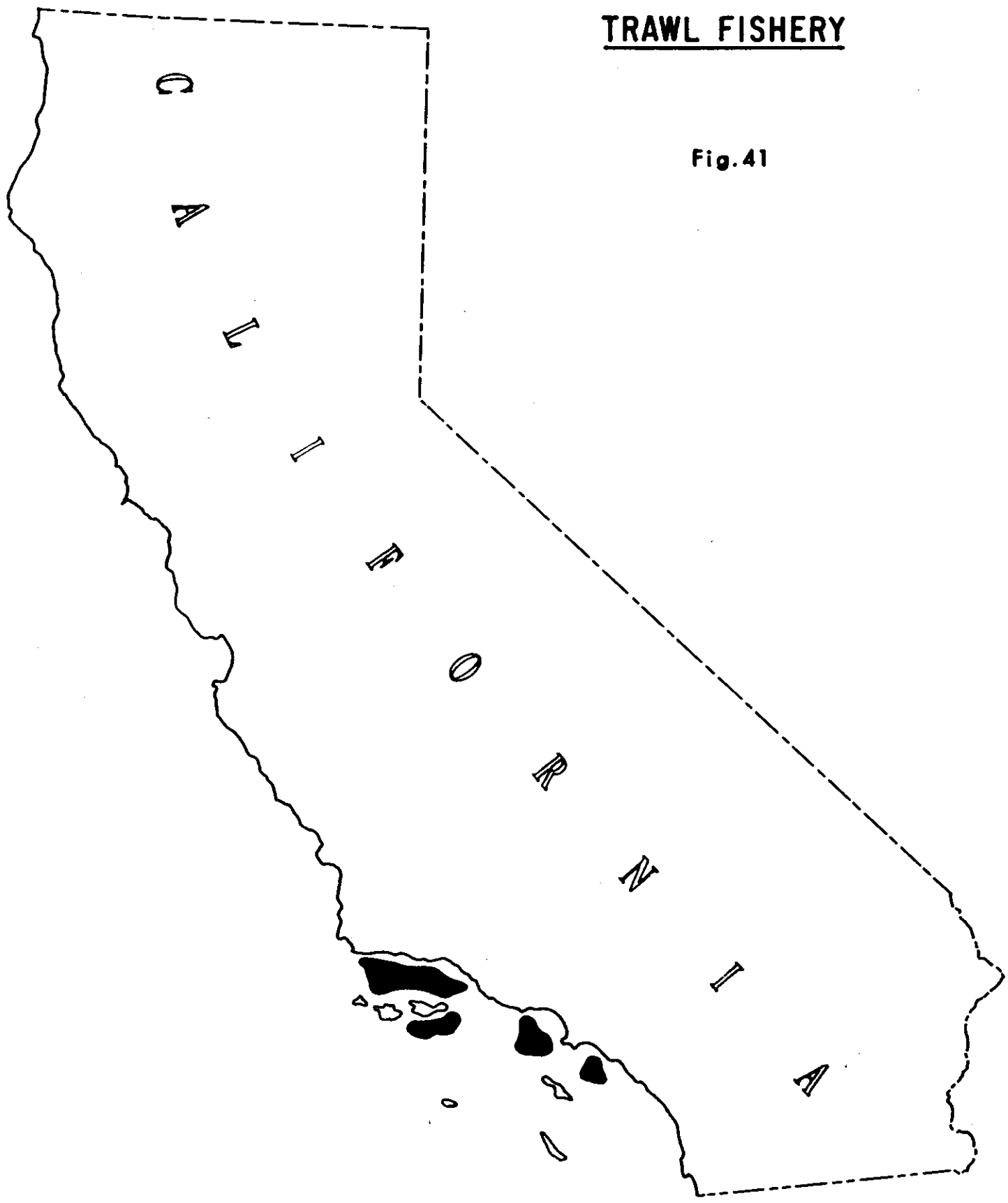


PARTY BOAT, SKIFF & SHORE FISHING

Fig. 40

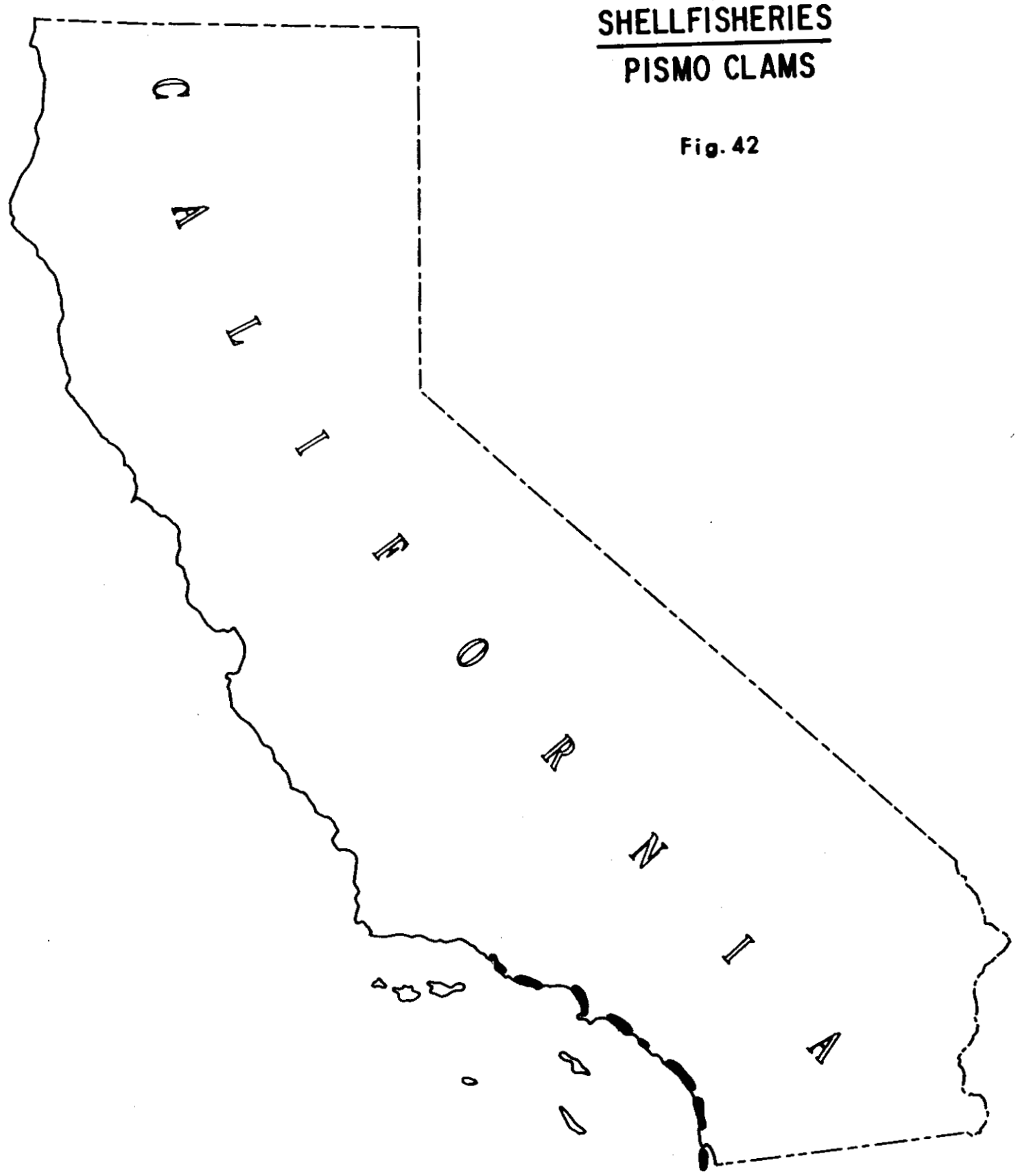
TRAWL FISHERY

Fig.41

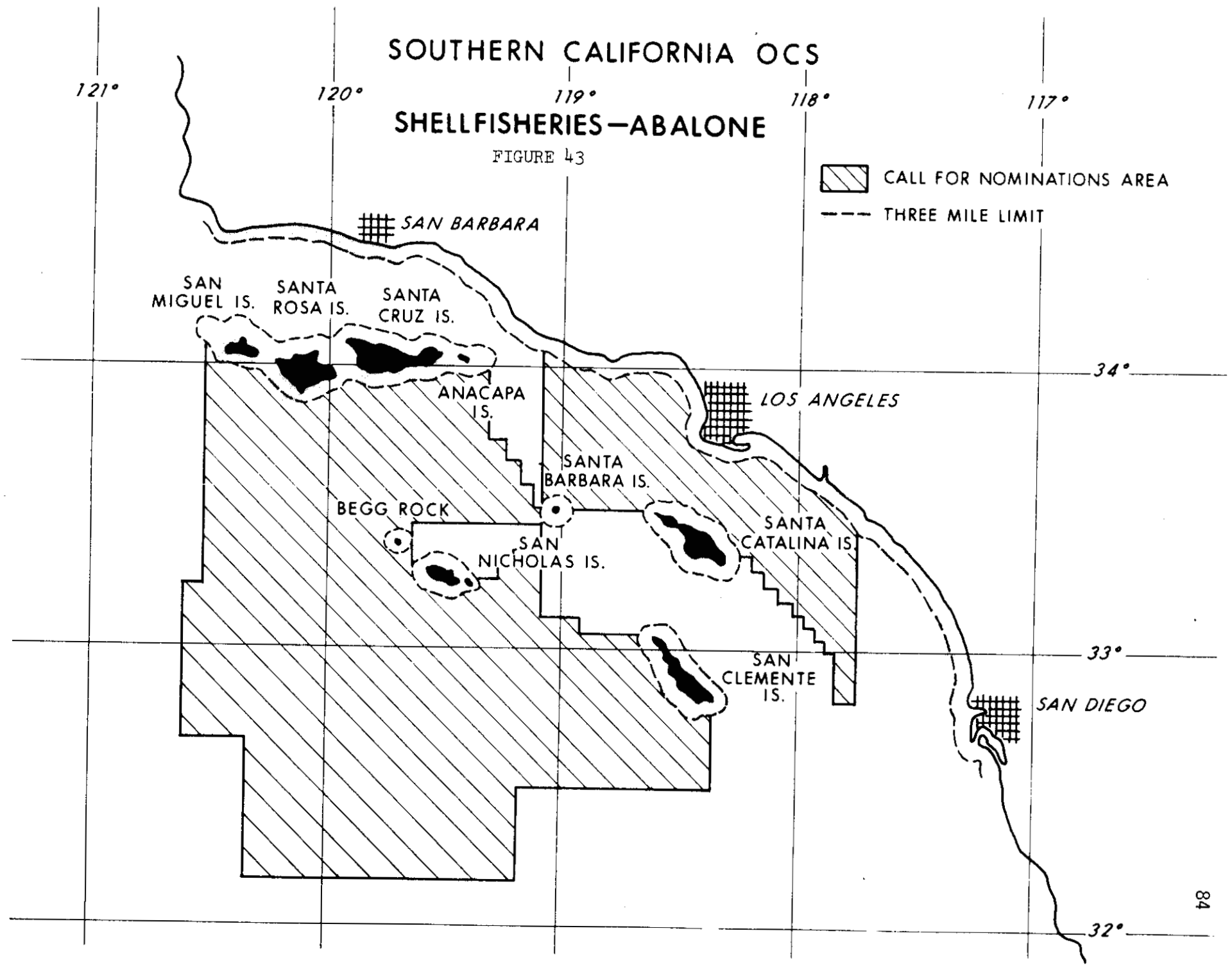


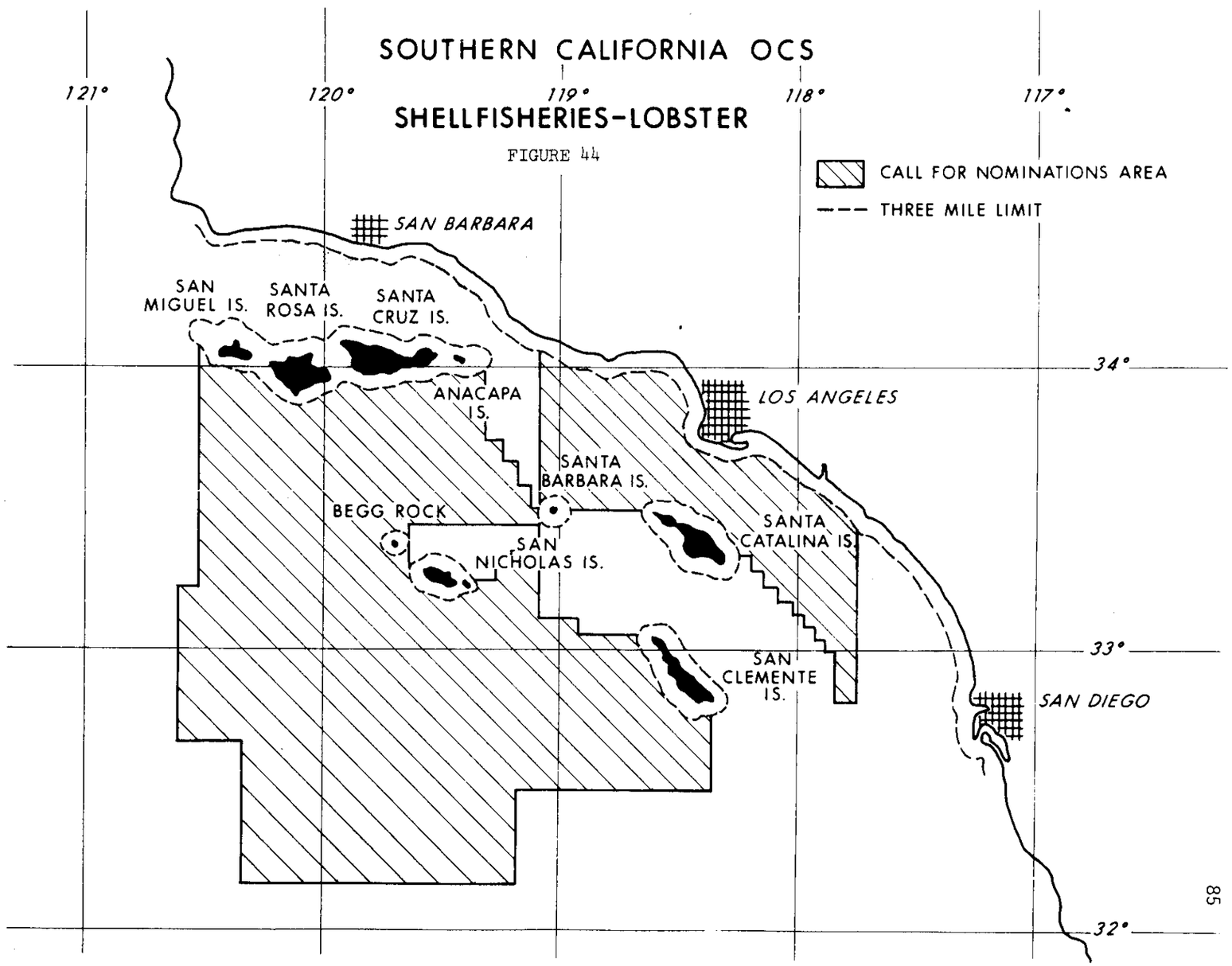
SHELLFISHERIES
PISMO CLAMS

Fig. 42



The relationship of sport and commercial fishing for various species (Bell and Ally, 1972)[15] to the southern California OCS is shown in Figures 43 to 51.


SOUTHERN CALIFORNIA OCS
SHELLFISHERIES—ABALONE
FIGURE 43
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
LOS ANGELES
SAN DIEGO
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.


SOUTHERN CALIFORNIA OCS
SHELLFISHERIES-LOBSTER
FIGURE 44
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO

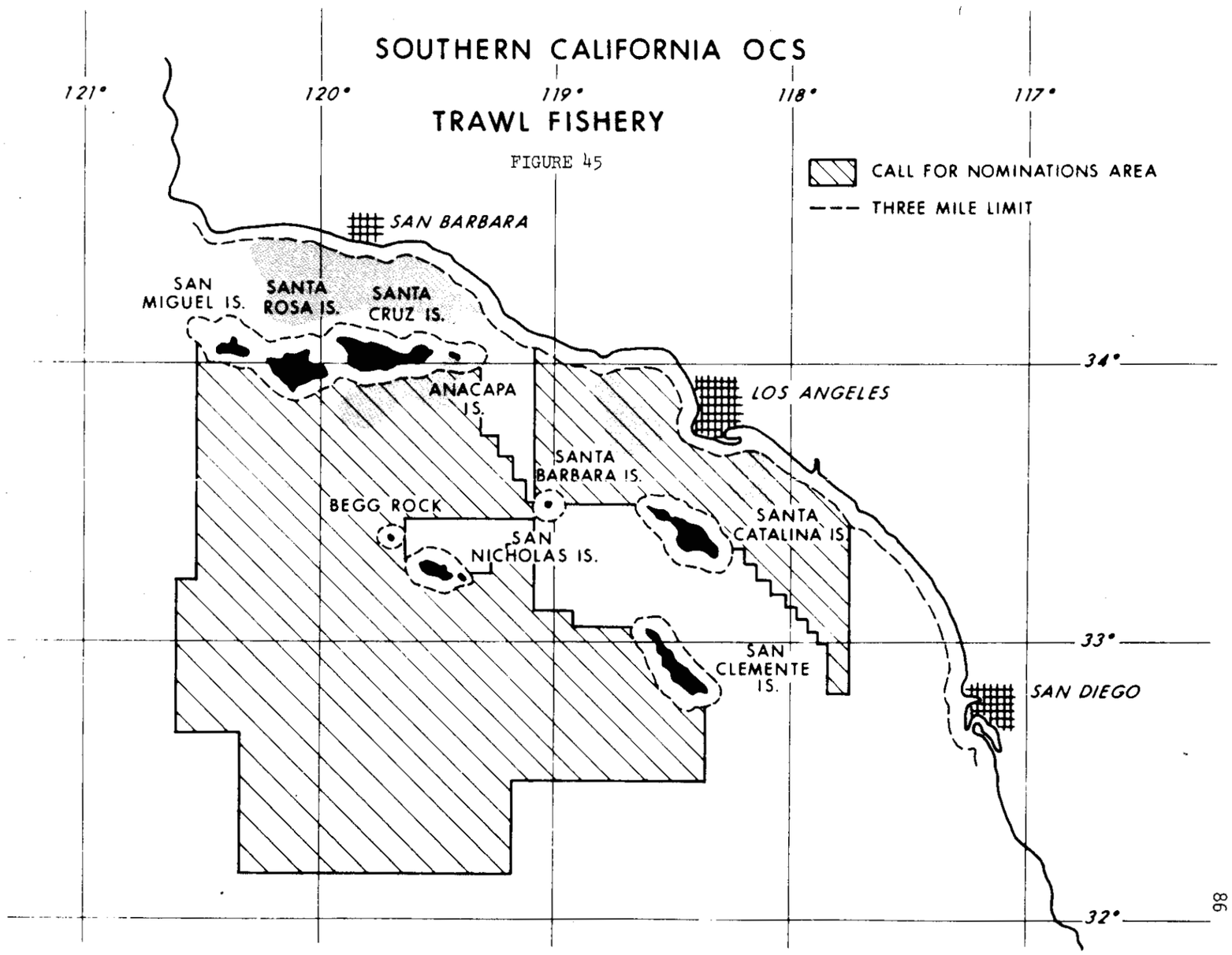
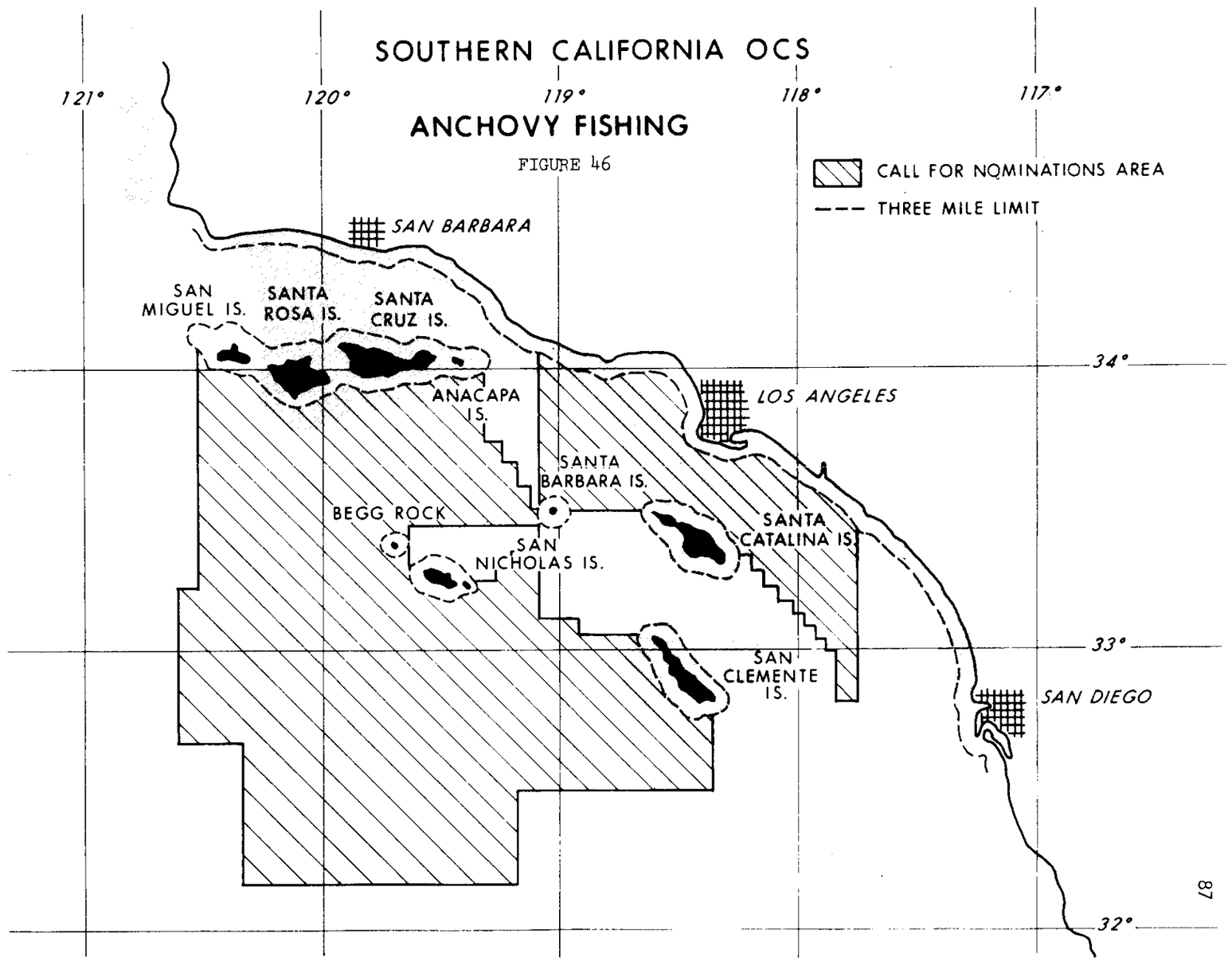
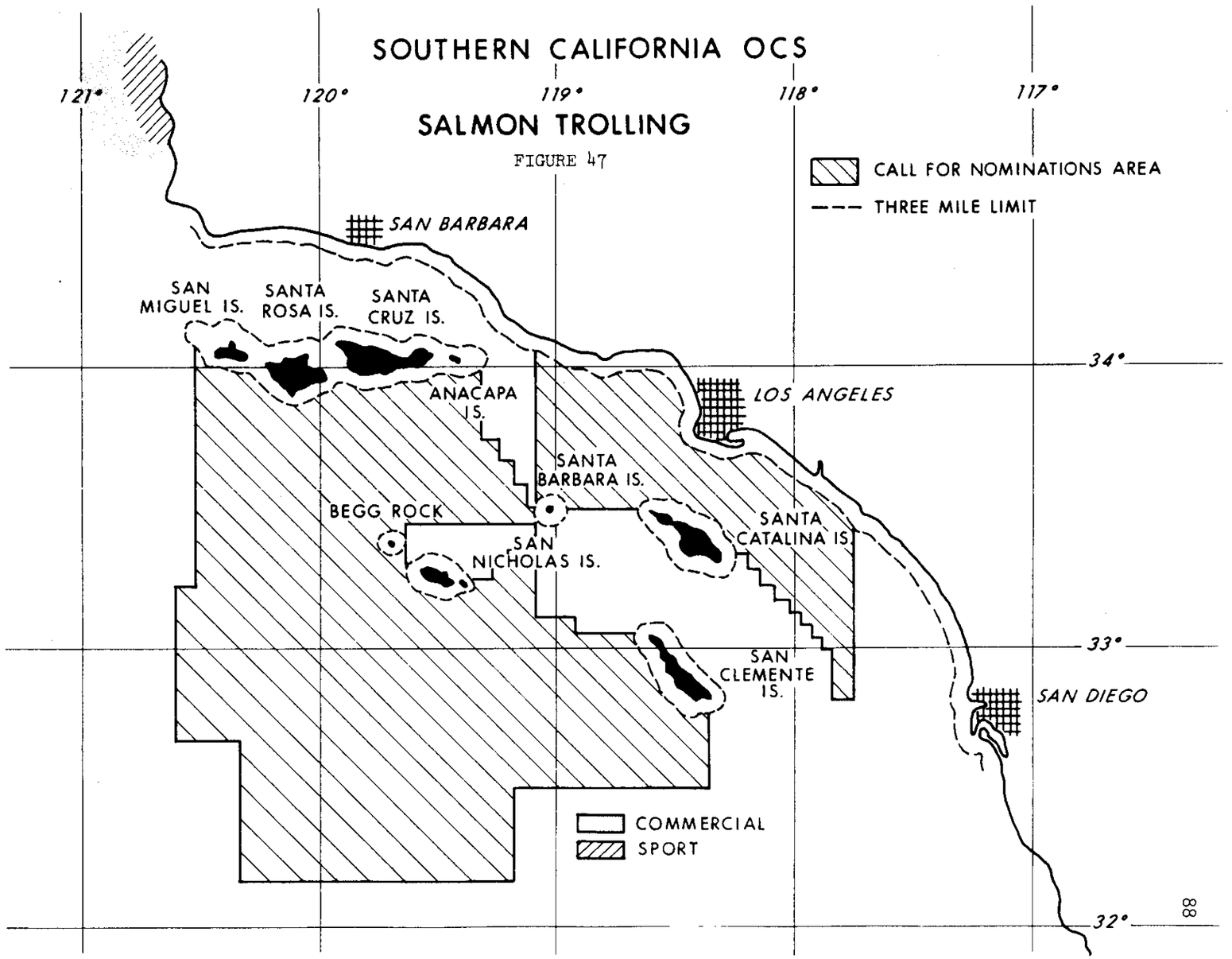
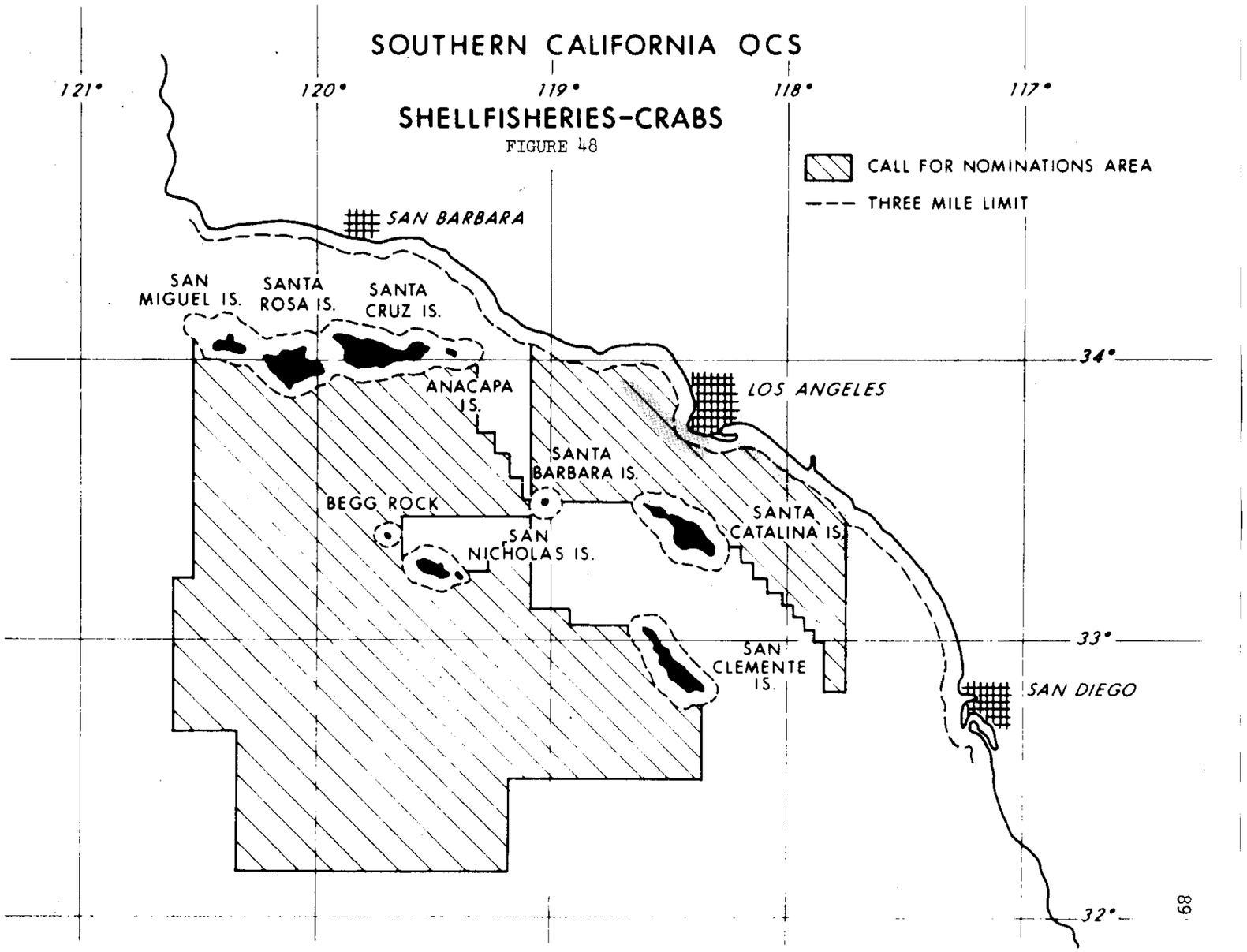

SOUTHERN CALIFORNIA OCS
TRAWL FISHERY
121°
120°
119°
118°
117°
34°
33°
32°
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO

FIGURE 45


SOUTHERN CALIFORNIA OCS
ANCHOVY FISHING
FIGURE 46
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
LOS ANGELES
SAN DIEGO
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.


SOUTHERN CALIFORNIA OCS
SALMON TROLLING
FIGURE 47
121°
120°
119°
118°
117°
34°
33°
32°
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO
COMMERCIAL
SPORT


SOUTHERN CALIFORNIA OCS
SHELLFISHERIES-CRABS
FIGURE 48
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO

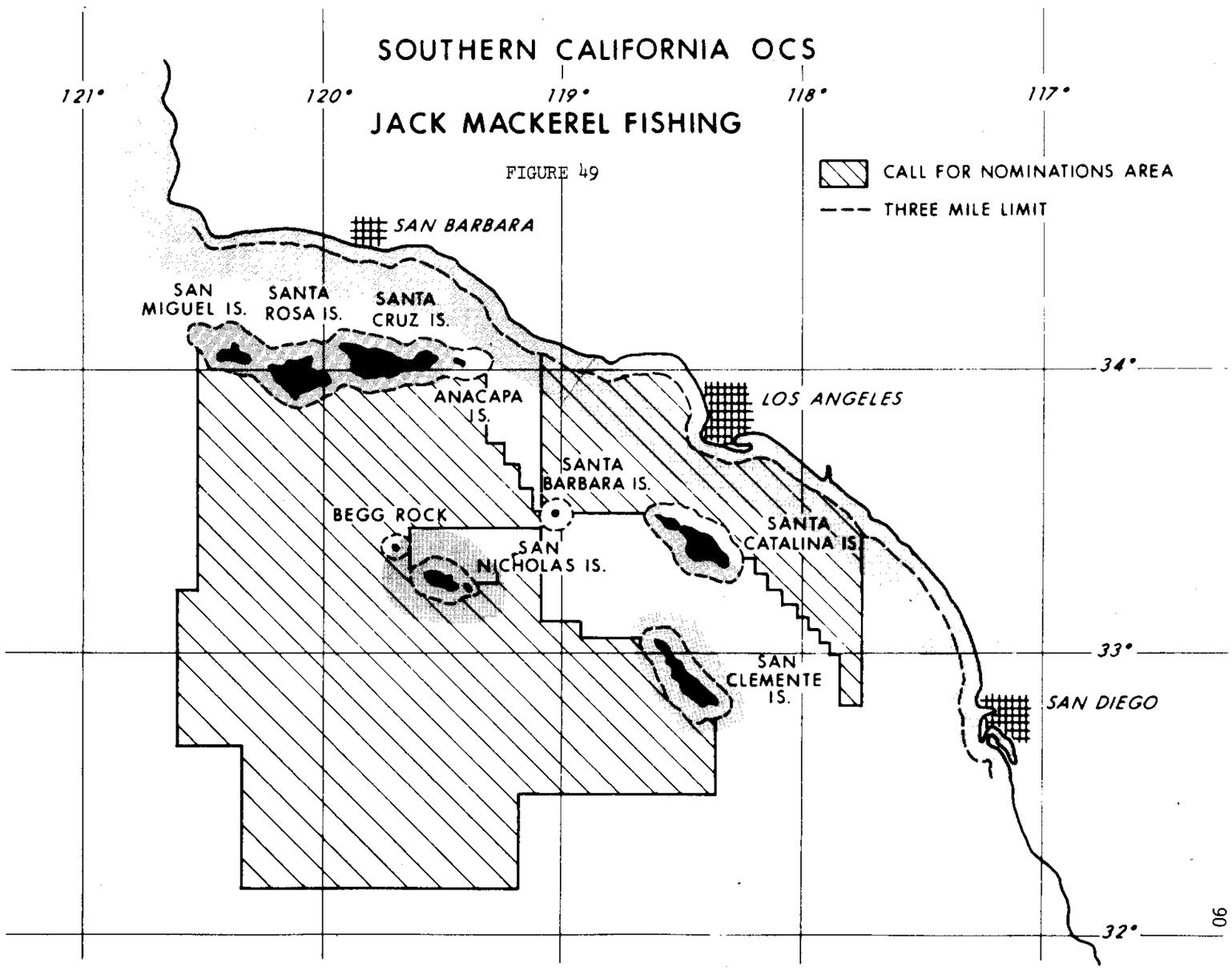

SOUTHERN CALIFORNIA OCS
JACK MACKEREL FISHING
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO

FIGURE 49

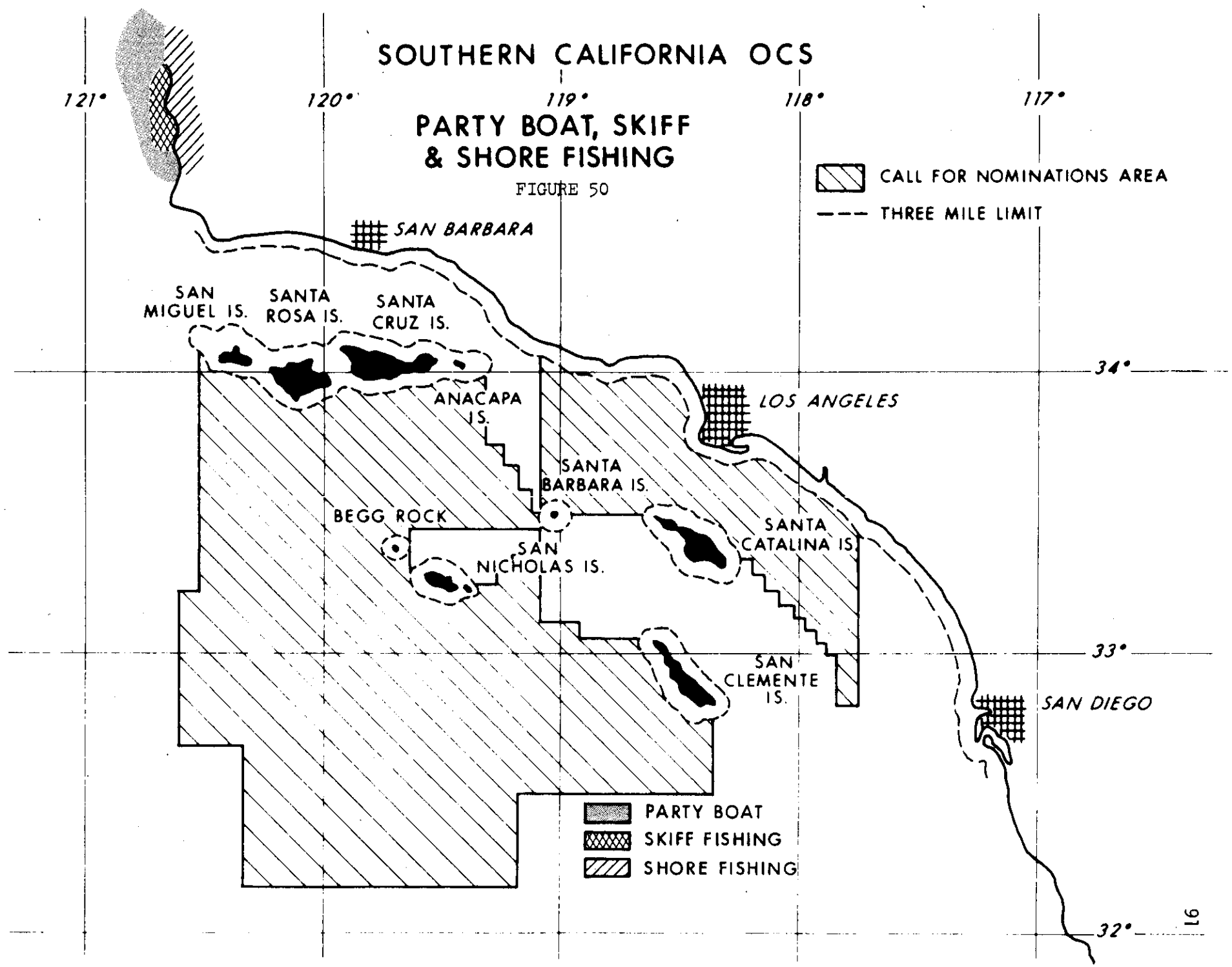
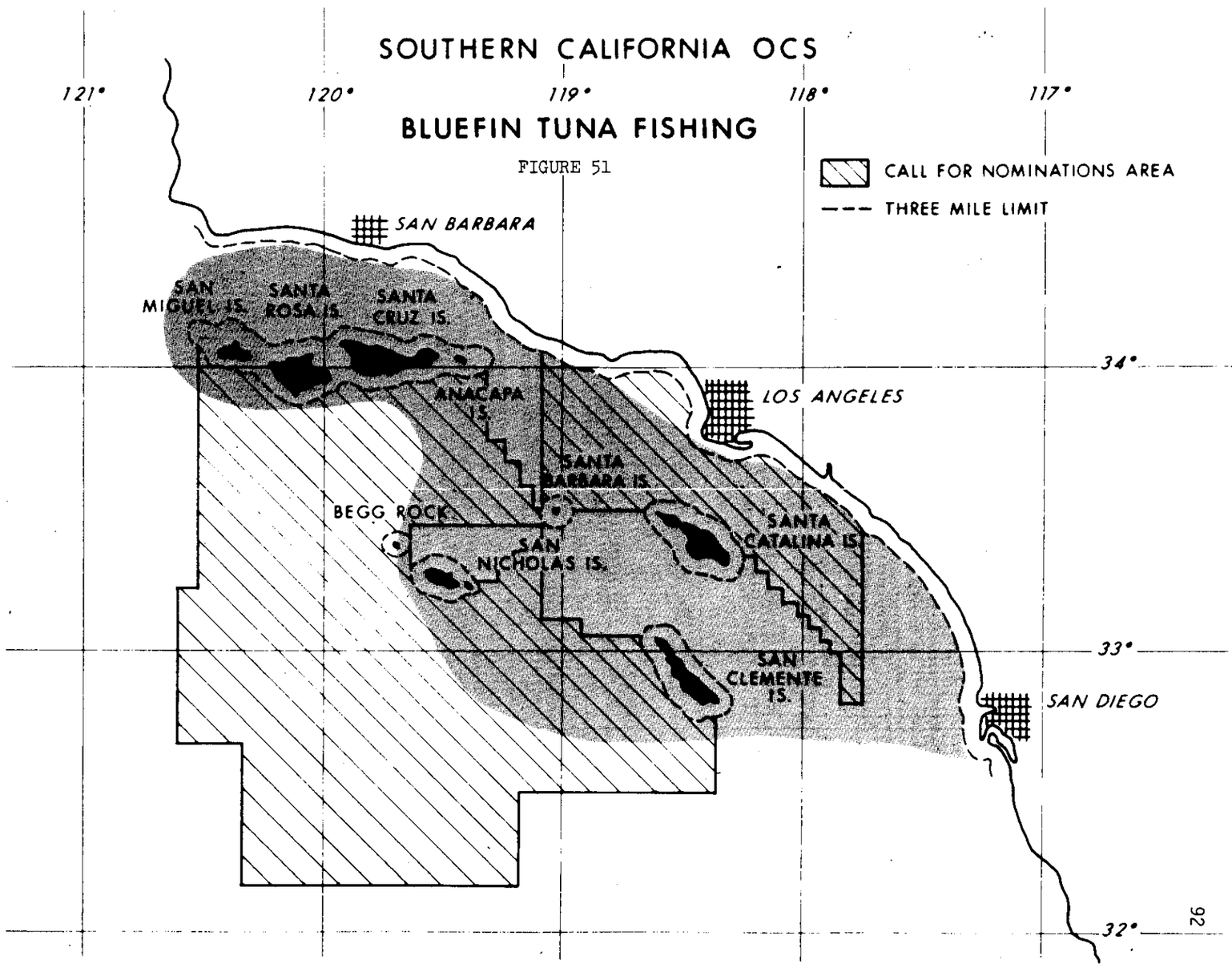

SOUTHERN CALIFORNIA OCS
PARTY BOAT, SKIFF & SHORE FISHING
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
LOS ANGELES
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.
SAN DIEGO
PARTY BOAT
SKIFF FISHING
SHORE FISHING

FIGURE 50


SOUTHERN CALIFORNIA OCS
BLUEFIN TUNA FISHING
FIGURE 51
CALL FOR NOMINATIONS AREA
THREE MILE LIMIT
121°
120°
119°
118°
117°
34°
33°
32°
SAN BARBARA
LOS ANGELES
SAN DIEGO
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
ANACAPA IS.
SANTA BARBARA IS.
BEGG ROCK
SAN NICHOLAS IS.
SANTA CATALINA IS.
SAN CLEMENTE IS.

MARINE MAMMALS

MARINE MAMMAL RESOURCES

General

About 36 species of marine mammals occur in the waters of California and Baja California. Some of these species, the Pinnipeds - seals and sea lions, are land dependent for part of their life cycle. The remainder, the Cetaceans - whales, dolphins and porpoises, and the one member of Carniva, the sea otter, are truly pelagic and can spend their entire lives in the water. Of these, the gray whale, the sea otter, the harbor porpoise and the Pacific bottlenose dolphin, are found inshore, or in bays and rivers.(Table 9)

Along the coastline are outlying rocks and islets and south of Point Conception some major islands. All of these islands and some of the larger rocks are suitable haul out spots for pinnipeds.

Several major bays and lagoons along the coast are inhabited by marine mammals that use them for feeding or calving and breeding areas. Most important of these bays are: San Francisco Bay, Monterey Bay, Morro Bay, the Scammon Lagoon complex, San Ignacio Lagoon, and the Magdalena Bay complex (see Figure 52).

Pinnipeds

Seven members of this Order have been reported from the area. One, the ribbon seal is only a curiosity; and another, the northern fur seal, is uncommon this far south of its normal range. The remainder occur in some number throughout the area with breeding rookeries and haul-out colonies on several of the outlying islands and rocks where they are inaccessible to large terrestrial predators. The most popular spots are the Farallon Islands, the rocks at Point Ano Nuevo, all of the Santa Barbara Channel Islands, the Coronada Island, and Cedros, the San Benitos Islands and Guadalupe Island in Mexico. Major hauling out grounds with non-breeding colonies occur elsewhere along the coast, including Seal Rocks at the entrance to San Francisco Bay, Point Lobos, and Seal Rocks at Santa Catalina Island. [19]

Cetacea

Most cetaceans are creatures of the high seas. Exceptions to this general rule along the California coast are the California gray whale, the harbor porpoise and bottlenose dolphin. The gray whale, which migrates annually from the Bering Sea to Mexico and back, passes close inshore in the area and enters bays and lagoons in Mexico to calve and breed. The harbor porpoise, as the name suggests, is found in bays and river mouths as far south as Los Angeles. The bottlenose dolphin is a tropical species that often occurs inshore and enters bays and lagoons. Its normal rage extends north to at least Point Conception. [19]

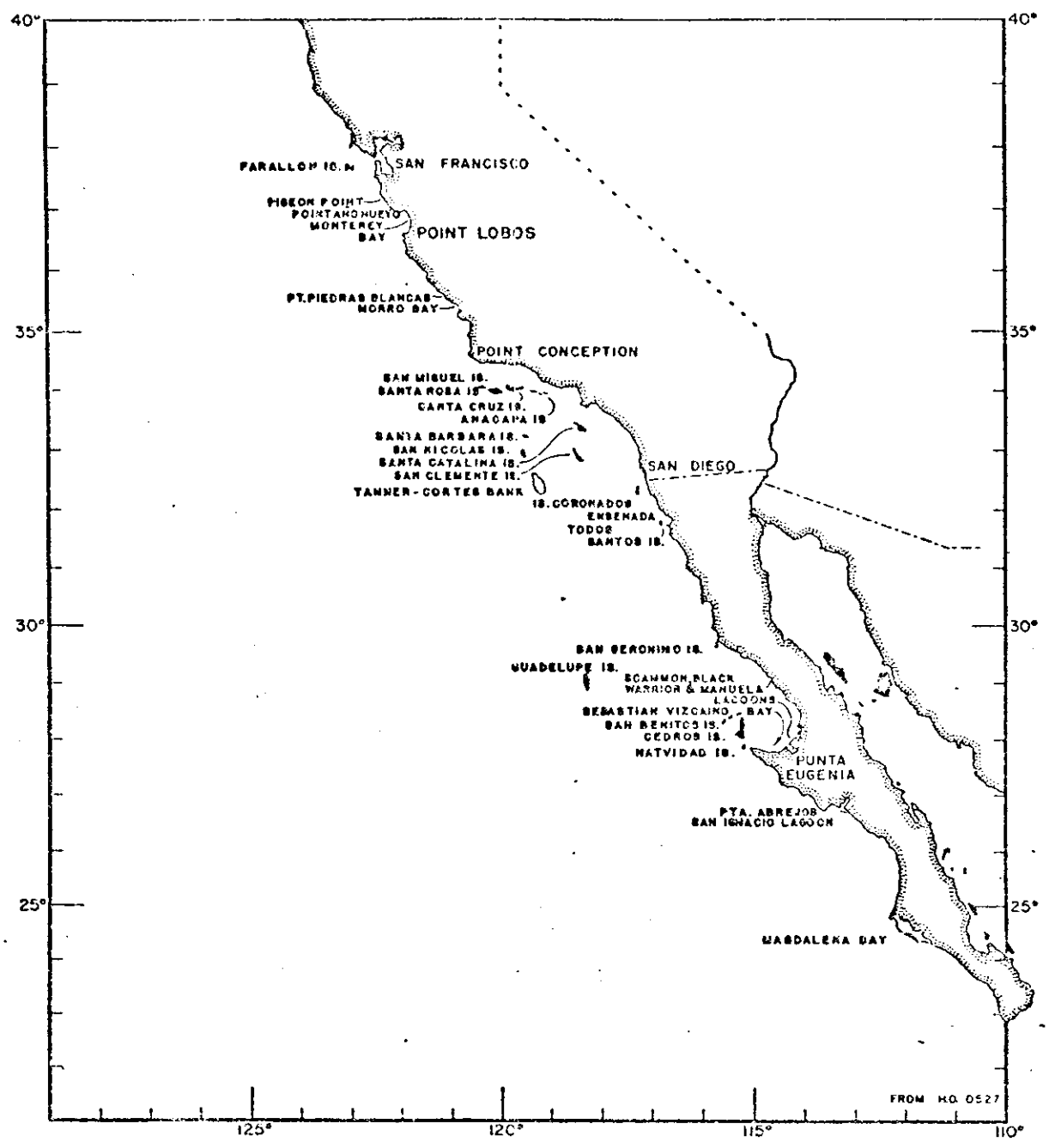
Carnivora

The only marine representative of this Order on the California coast is the California Sea Otter. This animal can be completely independent of the land and seldom, if ever, comes ashore. It is, however, a nearshore creature, usually confined to the coastal kelp beds north of Point Conception.

Offshore Mammals

These are all in the Order Cetacea, the whales, dolphins and porpoises. All of the whales are transitory residents of the area being present at certain times of the year when their migratory paths pass this part of the coast. Most occur well offshore.

In contrast to the great whales, many of the dolphins and porpoises are offshore residents of the area. They occur in herds that may, over the course of the year, move about over an area of several hundred miles but generally do not undertake long migrations.



Source:19

Figure 52

Locations mentioned in this report

Table 9

MARINE MAMMALS OF CENTRAL AND SOUTHERN CALIFORNIA AND THE WEST COAST OF BAJA CALIFORNIA [19]

ORDER CETACEA	
Sub-order Mysticeti	
Balaenidae	Pacific right whale-*Balaena glacialis japonica*
Balaenopteridae	Little piked or minke whale-*Balenoptera acutorostrata*
	Sei whale-*Balaenoptera borealis*
	Bryde's whale-*Balaenoptera edeni*
	Blue or sulphur-bottom whale-*Balaenoptera musculus*
	Fin or finback whale-*Balaenoptera physalus*
	Humpback whale-*Megaptera novaengliae*
Eschrichtidae	California gray whale-*Eschrichtius gibbosus*
Sub-order Odontoceti	
Delphinidae	Common or Baird's dolphin-*Delphinus delphis bairdi*
	Pilot whale or blackfish-*Globicephala macrorhynca*
	Risso's dolphin-*Grampus griseus*
	Pacific striped or white-sided dolphin - *Lagenorhynchus obliquidens*
	Northern right whale dolphin-*Lissodelphis borealis*
	Killer whale-*Orcinus orca*
	Harbor porpoise-*Phocoena phocoena*
	Dall porpoise-*Phocoenoides dalli*
	False killer whale-*Pseudorca crassidens*
	Long-beaked porpoise-*Stenella coeruleoalba*
	Spotted porpoise-*Stenella graffmani*
	Spinner porpoise-*Stenella longirostris*
	Rough-toothed dolphin-*Steno bredanensis*
	Pacific bottlenose dolphin-*Tursiops truncatus gilli*
Physeteridae	Pygmy sperm whale-*Kogia breviceps*
	Dwarf sperm whale-*Kogia simus*
	Sperm whale-*Physeter catodon*
Ziphiidae	Baird's beaked whale-*Berardius bairdi*
	Hubbs's beaked whale-*Mesoplodon carlhubbsi*
	Cuvier's beaked whale-*Ziphius cavirostris*
ORDER PINNIPEDIA	
Otariidae	Guadalupe fur seal-*Arctocephalus philippii townsendi*
	Northern (Alaska) fur seal-*Callorhinus ursinus*
	Steller sea lion-*Eumetopias jubatus*
	California sea lion-*Zalophus californianus*
Phocidae	Ribbon seal-*Histriphoca fasciata*
	Northern elephant seal-*Mirounga angustirostris*
	Harbor seal-*Phoca vitulina*
ORDER CARNIVORA	
Mustelidae	Sea otter-*Enhydra lutris*

Pinnipeds

Four principal pinnipeds inhabit the California coast and Santa Barbara Channel islands: California sea lions, *Zalophus californianus;* Steller sea lions, *Eumetopias jubata;* harbor seals, *Phoca vitulina;* and northern elephant seals, *Mirounga angustirostris.* A small breeding colony of northern fur seals, *Callorhinus ursinus,* has become established on San Miguel Island, and occasionally a Guadalupe fur seal, *Arctocephalus townsendi,* may be seen on the Channel Islands. The periods of activity in the Channel Island area are shown on Table 10.

The feeding habits of sea lions and harbor seals throughout the year is not well known. The total poundage of food they consume has not been assessed completely, though it is probably less than claimed by fishermen. The percentage of fish eaten which are of value to commercial and sport fishermen compared with the percentage of those with little or no value, or those which might actually be harmful, is not known.

California sea lions and Steller sea lions are found in the temperate North Pacific; harbor seals range the temperate North Pacific and temperate North Atlantic; northern elephant seals are found occasionally as far north as Vancouver Island, British Columbia, and south to about Sebastian Viscaino Bay, Baja California. Free movement is common among the California pinnipeds, especially on and off the breeding grounds, where great differences in population size occur at differt seasons. The California Department of Fish and Game conducts aerial censuses in early June when most animals are on the rookeries.

Except in the very young, natural mortality is apparently low; and pinnipeds are long lived. Some individuals survive to 30 or 40 years. In some years, more than 50 percent of the sea lion pups may not survive to leave the rookeries. Sea lion pups are born in June and July, harbor seals give birth to their pups from May through July, while northern elephant seal pups are born from December through March. Breeding, depending upon the species, may take place from a few days after the female gives birth to 4 months after parturition.

Food habits of the pinnipeds are not very well known. Most of the animals that are on land have empty stomachs, and the bodies of those killed in the water are difficult to recover. Steller sea lions eat flatfish, rockfish, salmon, and squid. While valuable fish such as salmon and halibut are occasionally taken, most of the fish they eat are commercially unimportant. Two killed near the mouth of the Columbia River during a salmon run had their stomachs filled with lampreys only.

The food of the California sea lion consists largely of squid, octopus, and a variety of fish (chiefly non-commercial). A study of 300 sea lion stomachs found 24 contained fish remains in the form of otoliths. Hake otoliths were present in 17 of these stomachs and represented well over half the fish eaten. In all, 24 species of fish were identified, of which 8 were of commerical value. California sea lions probably are opportunistic feeders.

Examination of northern elephant seal stomachs has revealed the presence of fishes (not identified) squid, ratfish, skate, and shark; it is theorized that because of the very large eye size this seal dives deep on occasion for its food.

Of 50 harbor seals examined, 20 had some food in their stomachs. Food items included rockfish, octopus, and salmon; as well as smaller amounts of shrimp, small crabs, and lamprey.

Before 1946, the California Department of Fish and Game had conducted censuses only of animals on larger rookeries, hauling grounds and nearby areas. Similar aerial census methods have been used since 1958, so counts may be compared (Table 11). No attempt was made to separate the two sea lion species; however, those north of Point Conception are considered Stellers and those south, California sea lions. The two overlap only to a limited degree off central California during June, the month the censuses are conducted because it coincides with the breeding season. [4]

Table 10

PINNIPED POPULATIONS OF CALIFORNIA

Species	YEAR 1958	1961	1965	1969
Sea lions				
Northern California (Steller sea lion)	7,053	6,675	4,998	7,156
Southern California (California sea lion)	12,619	18,363	17,169	17,451
Total	**19,672**	**25,038**	**22,167**	**24,607**
Harbor seals	—	—	1,062	2,139
Northern elephant	—	—	3,563	*1,642

**Apparently, the animals left the rookery early since an April, 1969 census revealed approximately 3,000 animals on San Miguel Island.*

Source 20

Table 11

ANNUAL ACTIVITY OF PINNIPED POPULATIONS ON THE ISLANDS OFF CALIFORNIA AND BAJA CALIFORNIA

	ACTIVITY			
Species	**On Land**	**Pupping**	**Breeding**	**Nursing**
Northern fur seals	May to about 15 Nov. *	Late May to mid-Aug.	Late May to late Aug.	Late May to about 15 Nov.
Northern sea lion	May through November *	June	June	June-Nov. Few may nurse all year
California sea lion	All Year	June	June-July	June-Nov. Few all year
Northern elephant seal	All year, peaks during winter.	Late Dec. to late Feb.	Jan. to mid-March	Late Dec. to mid-March
Harbor seals	All year *	May to July	May to July	May to Oct.
Guadalupe	All year*	Probably May to August	Probably May to August	Probably late May to Nov.

** A few may be on land at any time.*

Source 20

Members of the *Order Pinnipedia* are dependent upon the land for breeding and pupping. Thus, they are more accessible for study and generally better known than the whales and dolphins. They mainly occur on the offshore islands of the area. These islands are privately owned or controlled by the Federal governments and access to the breeding and haul-out areas is limited.

The Order comprises three families. One, the*Odobenidae* (walruses), does not occur in the area and are not considered here. The other two families are the *Otariidae*, the sea lions and fur seals, and the *Phocidae*, the hair or true seals.

Family Otariidae - Sea lions and fur seals

The animals of this family are characterized by having an external ear and by having rear flippers that can be turned forward providing fair mobility on land. The seals and fur seals breed in organized colonies, usually on offshore islands or rocks. The males are territorial and may return to and defend the same territory season after season. Each successful male accumulates a harem of several females, which he guards from other males during the breeding and pupping season. As with all marine mammals, the female typically gives birth to a single young.

1. California sea lion. *Zalophus californianus*

   Description: Males - dark brown, 500-1,000 lbs., head with a marked sagittal crest. Females smaller, 200-500 lbs., often lighter colored.
   Distribution: Canada to Cape San Lucas and Tres Marias Islands at the entrance to the Gulf of California. Breeds June-July mainly on the islands from San Miguel Island to San Benito Island. Hauls out throughout range on rocks and islets and the offshore islands particularly during winter months.
   Reproduction: Males begin to occupy territories about May. Females arrive and pupping begins soon after. Mating begins a few days following pupping and continues into July. Harem size 8-10. Sexual maturity reached at 3 or later, active for probably 8-10 seasons.
   Food Habits: Squid and many species of fish.
   Factors controlling population size: Density dependent mortality with pups from squashing and parasites. Occasional sea lion control measures proposed to reduce herd size, frequently at the urging of fishermen. Herd soon recovers. Natural enemies include killer whales and sharks.
   Status of stocks: May be stabilized at about 35,000 animals from San Francisco to Cape San Lucas. (Table 12)

2. Steller sea lion. *Eumetopias jubatus*

   Description: Larger than California sea lion, males to 1,800 lbs., females to 600, color yellow-brown, no head crest on males, haul out colonies quiet compared with California sea lion.
   Distribution: Alaska to southern California. Breeds from Point Conception and Channel Islands north. Major breeding grounds in area at Ano Nuevo and San Miguel Island.
   Reproduction: Season and habits about same as California sea lion, harems a bit larger, 10-20 females.
   Food habits: Fish and squid.
   Factors controlling population size: Same as California sea lion. Channel Island area is southern limit of range and it is probable that any decrease in numbers here would be quickly replaced from the north.

Status of stocks: Estimated that a fairly stable population of from 4-8,000 animals in California, about 2/3 of these occur between Point Conception and San Francisco, 1/3 from San Francisco to Oregon.(Table 12)

Table 12

COUNTS OF SEA LIONS - 1970

Local	Steller Number	California Number
Farallon Is.	585	—
Ano Nuevo	1,542	—
to Point Lobos	265	—
to Point Conception	1,104	—
San Miguel I	68	9,835
Santa Rosa I		220
Santa Cruz I		201
Anacapa I		40
San Clemente I		949
Santa Barbara I		484
Santa Catalina I		39
San Nicolas I		6,240
Coast to San Diego		39
Guadalupe I		585
Cedros I		8,407
San Benitos Is.		7,158
	3,564	34,177

3. Guadalupe fur seal. *Arctocephalus townsendi*

Description: Smaller than California sea lion, males to perhaps 400 lbs., females to 200. Color, dark with a silver mane of hair on neck. Long, pointed nose and concave profile.
Distribution: Ranges from Magdalena Bay to San Francisco and offshore. Breeds on Cedros, Guadalupe, Los Coronados, and perhaps San Miguel Island, San Nicholas and Santa Barbara Islands where they have been seen hauled out.

Reproduction: Breeding season and behavior about the same as the sea lions.
Factors controlling population size: This species was believed extinct until 1926. Since then the population has been slowly increasing and probably numbers about 500 individuals. Once numerous, it has not expanded to former range. May be expected to increase unless competition with other species for breeding room interferes.

Estimated Population of the Guadalupe Fur Seal in 1965

Guadalupe I	Resident	285
Cedros I	1965	3
		288

4. Alaska Fur seal. *Callorhinus ursinus*

Description: Similar in appearance to Guadalupe fur seal but larger, males to 700 lbs. Females very similar to the other species. Males have a very short snout.
Distribution: Ranges from Alaska to Guadalupe Island but does not haul out. Occurs 30 to 100 miles offshore as a pelagic visitor during the winter. One breeding colony (one male, 40 females and 60 pups) reported on San Miguel Island.

Family Phocidae - The true seals

The animals in this family lack external ears and cannot turn their hind flippers forward forcing them to hunch about on land. The front flippers are small. In the water they swim with the hind flippers. Breeding habits vary.

1. Northern elephant seal. *Mirounga angustirostris*

Description: A large seal, males to 16 feet and 4,500 lbs., females smaller. Dark or brown, males have a large, fleshy snout.
Distribution: Alaska to Magdalena Bay. Breeds on Cedros, San Benitos, Guadalupe, Los Coronados, San Nicholas, San Miguel, Santa Barbara and San Clemente Islands and perhaps Ano Nuevo. Hauls out November through April, mostly pelagic remainder of year.
Reproduction: Breeding season December to March, male establishes a loose harem of 8 to 40 females. Males dominate by fighting and display to establish a peck order. The harem arrangement is not formal nor is control of territory.
Food habits: Fish and squid, frequently feeds at night.
Factors controlling population size: This is another animals that was almost hunted to extinction and is now recovering. Population still increasing. Natural mortality still low but will increase from same causes as the sea lions. The big bulls are without concern for the pups and squash them quite regularly. As a breeding area becomes densely populated this becomes a major cause of mortality.
Status of stocks: Probably about 25,000 animals in 1973.[19]

Estimated Populations of the Northern Elephant Seal in 1965

Local	Year Reoccupied	Population Size Including Pups
Guadalupe I	Resident	10,389
San Benito Is.	1918	2,860
Cedros I	1965	47
Los Cronados Is.	1948	1
Santa Barbara I	1948	4
San Nicolas I	1949	197
San Miguel I	1925	1,922
Santa Rosa I	1965	14
Anacapa I	1958	6
Ano Nuevo Is.	1955	194
		15,634

2. Harbor seal. *Phoca vitulina*

Description: Small, 5-6 feet, chunky seal with spotted coat.
Distribution: There are two populations, a northern population from the Bering Sea to Monterey and a southern population from Santa Barbara to San Geronimo Island, Mexico.
Reproduction: Breeds May to July, no organized harem, mating may take place in the water. Pups may be born in the water and can swim at or soon after birth. Breeds on sandy spots on the islands and in bays.
Food habits: Fish, squid, octopus.
Factors controlling population size: Same as sea lion with which it may compete for space. Does not seem to compete well for space with other species.
Status of stocks: Southern population perhaps 500 to 1,000 individuals, northern population, 1,500 in California, 50-200,000 in rest of range.[19]

Life History, Distribution, Ecology and Status of Stocks
Order Cetacea - Whales, Dolphins and Porpoises

The *Cetacea* includes the whales, dolphins and/or porpoises. (The choice between the term dolphin and porpoise as used in this report is a matter of custom not convention.) This order comprises two suborders: *Mysticeti*, the baleen or shalebone whales and *Odontoceti*, the toothed whales, dolphins and porpoises.

The whalebone whales have mouths equipped with bony plates of baleen or whalebone whales and *Odontoceti*, the toothed whales, dolphins and porpoises.

The whalebone whales have mouths equipped with bony plates of baleen which is used to strain plankton and small organisms from the water. All these whales follow a north-south migratory pattern, which moves them into the north Pacific or Bering Sea in the summer for breeding and into the tropics in the winter for calving and breeding. Social structure is generally loose and they are solitary or occur in small groups.

The toothed whales are particulate carnivores feeding on cephalopods, fish or other mammals and birds. Some migrate, some occupy local territories. Most are social and travel in herds. Typically Cetacea in common with all marine mammals give birth to a single offspring although multiple births do occur.

Many species of whales are found along the California coast in limited numbers. The gray whale is most important as a recreational asset to the state. At least 162,000 people watch gray whales every year. This activity is becoming increasingly important, and "lookers" annually spend an estimated $70,000 in California to see these marine mammals. The finback is also of the more commonly seen in California waters since it occurs year round. Killer whales are occasionally seen by coastal inhabitants and visitors.

Considerable data are available on the biology of the various whales that occur off the California coast. Since the California gray whale is the best known and most often seen of the great whales in California, consideration here is limited to this species.

In the eastern Pacific California gray whales occur from the Arctic Ocean southward along the coast of North America to the Gulf of California. They also occur in the western Pacific. Gray whales feed in summer in the western Bering Sea and adjacent Arctic Ocean. In winter, particularly in December through February, they may be seen traveling south along the California coast in small groups, usually two to five, on their way to Mexico. There in various bays and lagoons, females have their calves and breed. In spring, particularly in March and April, they travel north again along the coast. They travel fairly close to shore, often coming within a few hundred yards of some points or even into the surf zone. These whales travel some 6,000 to 7,000 miles each way, and the trip takes 2.5 to 3 months. (Figure 53)

California gray whales reach 35 to 50 feet in length and a weight of 20 to 40 tons. The calf is 15 to 16 feet long at birth. This is a baleen whale and feeds mainly on small crustaceans (krill) and to some extent on fish. Feeding takes place largely, it is believed, during 4 months of the year spent in the north, though there is some evidence of feeding during the 8 months spent in migration and in lagoons.

There is considerable contention about the population of the California gray whale. Estimates of stock size vary from 3,000 to 15,000. In any event, the International Whaling Commission has permitted an experimental harvest of this species during the last few years. [20]

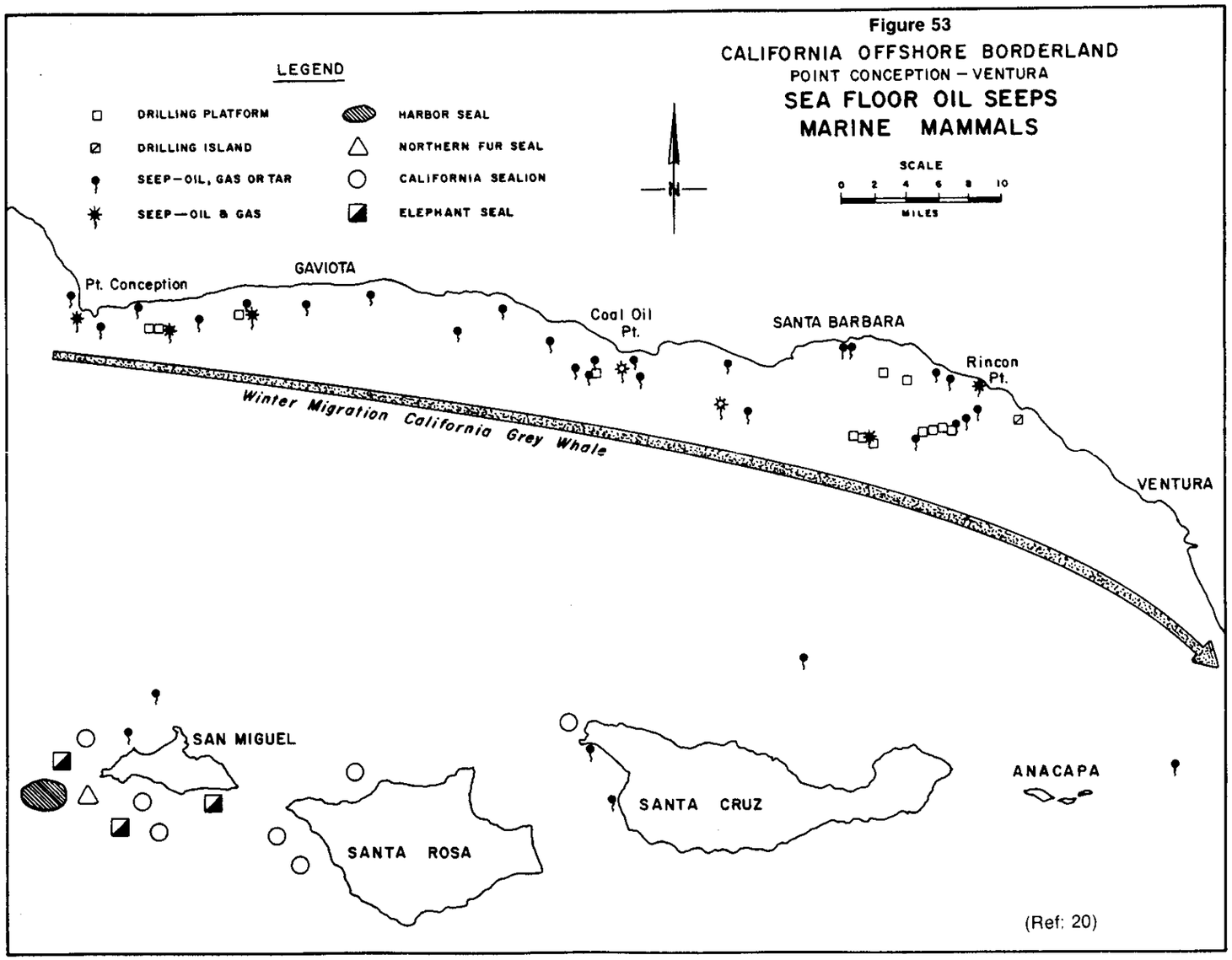


Figure 53

CALIFORNIA OFFSHORE BORDERLAND

POINT CONCEPTION – VENTURA

SEA FLOOR OIL SEEPS

MARINE MAMMALS

(Ref: 20)

BIBLIOGRAPHY

(1) Drinkwater, Barbara; Leonard, Maurine and Black, Susan, "Santa Barbara's Oiled Birds", *Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill 1969-1970,* 1: 313-324 (Publ. Allan Hancock Foundation).

(2) Cubit, J., "The Effects of the 1969 Santa Barbara Oil Spill on Marine Intertidal Invertebrates", *Santa Barbara Oil Symposium,* Dec. 16-18, 1970: 131-137 (Marine Science Institute, University of California, Santa Barbara).

(3) Foster, M., Neushul, M., and Zingmark, R., "The Santa Barbara Oil Spill, Part 2: Initial Effects on Intertidal and Kelp Bed Organisms", *Environmental Pollution,* 2: 115-134.

(4) Nicholson, N. and Cimberg, R., "The Santa Barbara Oil Spills of 1969: a Post-spill Survey of the Rocky Intertidal: *Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill 1969-1970,* 1: 325-400 (Publ. Allan Hancock Foundation).

(5) Cimburg, Robert; Mann, Steven and Straughan, Dale, "A Reinvestigation of Southern California Rocky Intertidal Beaches Three and One-Half Years after the 1969 Santa Barbara Oil Spill: A Preliminary Report", *Proceedings Joint Conference on Prevention and Control of Oil Spills 1973* (American Petroleum Institute, Environmental Protection Agency and United States Coast Guard).

(6) Straughan, Dale, "Factors Causing Environmental Changes After an Oil Spill", Paper SPE 3644, Society of Petroleum Engineers of AIME, Fall Mtg., Oct. 1971.

(7) Straughan, Dale, "What has been the Effect of the Spill on the Ecology in the Santa Barbara Channel?", *Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill, 1969-1970,* 1: 401-426 (Publ. Allan Hancock Foundation.)

(8) California Department of Fish and Game, *Report No. 60,* 1969.

(9) Pacific Northwest Laboratories, Division of Batelle Memorial Institute, *Review of the Santa Barbara Channel Oil Pollution Incident,* p. 12-14 (U.S. Dept. of the Interior, Federal Water Pollution Control Administration, Publication No. 15080 EAG 07/69).

(10) Oguri, M. and Kanter, R., "Primary Productivity in the Santa Barbara Channel", *Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill 1969-1970,* 1: 17-48 (Publ. Allan Hancock Foundation).

(11) McGinnis, Diane R., "Observations on the Zooplankton of the Eastern Santa Barbara Channel from May, 1969, to March, 1970", *Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill 1969-1970,* 1: 49-60 (Publ. Allan Hancock Foundation).

(12) Straughan, Dale and Abbott, Bernard C., "The Santa Barbara Oil Spill: Ecological Changes and Natural Oil Leaks", *Water Pollution by Oil, Proceedings of a Seminar at Aviemore, Scotland, May 4-8, 1970,* (Institute of Petroleum, London, 1971).

(13) Straughan, Dale, "Biological Effects of Oil Pollution in the Santa Barbara Channel", University of Southern California, Paper presented at the FAO Technical Conference on Marine Pollution, Rome, Italy, December 9-18, 1970.

(14) Turner, C. H., J. E. Carlisle, Jr., and E. E. Ebert. 1971. "Offshore Oil Drilling - Its Effect Upon the Marine Environment." In Installation of Platforms 'C' and 'Henry' on Federal Oil and Gas Leases OCS-P 0241 and 0240 Issued Under the Outer Continental Shelf Lands Act, Santa Barbara Channel Area Off the Coast of California (EIS)," prepared by the U.S. Geological Survey, Washington, D.C., August 26, 1971.

(15) Bell, R. R. and J. R. R. Ally. 1972. Fish & Wildlife Resources Relationships and Water Quality Requirements, California Dept. of Fish & Game.

(16) Fishery Statistics of the United States, U.S. Dept. of the Interior, Bureau of Commerical Fisheries. Statistical Digests from 1939-1967.

(17) Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

(18) Wheeland, Hoyt G., Chief, Statistics and Market News, Division NMFS, NOAA, Personal Communications, Feb. 28, 1973, March 1974.

(19) Hester, Frank J., The Living Marine Resources of Central and Southern California and Baja California. Report for Western Oil and Gas Assn., January 1974.

(20) Frey, Herbert W., California's Living Marine Resources and their Utilization (State of California, The Resources Agency, Department of Fish and Game) 1971.

UNITED STATES AND REGIONAL FISHERY STATISTICS

1939 - 1974

William F. Gusey
Senior Staff Wildlife Specialist

APPENDIX 7

Shell Oil Company
Environmental Affairs
Houston, Texas

April, 1975

CONTENTS

PREFACE	1
UNITED STATES FISHERY REVIEW, 1968-1974.	2
NEW ENGLAND FISHERIES	16
INTERNATIONAL COMMISSION FOR THE NORTH ATLANTIC FISHERIES	28
ATLANTIC COAST FISHERIES	36
GULF OF MEXICO FISHERIES	46
PACIFIC COAST FISHERIES	73

TABLES

TABLE 1	U.S. CATCH OF FISH AND SHELLFISH, 1939-1974.	8
2	U.S. FISH AND SHELLFISH HARVEST IN THE COASTAL REGIONS AND PERCENT OF U.S. CATCH, 1939-1974.	11
3	A SUMMARY OF SHELLFISH LANDINGS IN THE UNITED STATES.	13
4	FISH AND SHELLFISH HARVEST - NEW ENGLAND STATES, 1939-1974.	18
5	NEW ENGLAND FISHERY OPERATING UNITS, 1951-1972.	20
6	COMMERCIAL FISH AND SHELLFISH LANDINGS, ALL SPECIES, ALL NATIONS, ALL ICNAF CONVENTION AREAS AND SUB-AREAS, 1951-1973.	30
7	INTERNATIONAL COMMISSION FOR THE NORTH ATLANTIC FISHERIES - NOMINAL CATCH, ALL SPECIES, CERTAIN CONVENTION AREAS AND SUB-AREAS, 1953-1973	32
8	FISH AND SHELLFISH HARVEST - ATLANTIC COAST, 1939-1974.	37
9	ATLANTIC COAST FISHERY OPERATING UNITS, 1951-1972.	39
10	FISHERY STATISTICS OF THE GULF STATES, 1939-1974.	49
11	OYSTER HARVEST IN THE GULF STATES, 1880-1973.	59
12	SHRIMP HARVEST IN THE GULF STATES, 1880-1973.	60
13	CRAB HARVEST IN THE GULF STATES, 1880-1973.	61
14	FISH AND SHELLFISH HARVEST - PACIFIC COAST 1939-1974.	74
15	PACIFIC COAST FISHERY OPERATING UNITS 1951-1971.	76

FIGURES

FIGURE 1	U.S. CATCH OF FISH AND SHELLFISH, 1939-1974.	9
2	CATCH OF FISH AND SHELLFISH, 1939-1974.	10
3	U.S. FISH-SHELLFISH HARVEST IN THE COASTAL REGIONS BY PERCENT OF U.S. CATCH.	12
4	FISH AND SHELLFISH HARVEST - NEW ENGLAND STATES, 1939-1974.	19
5	INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES, CONVENTION AREAS AND SUB-AREAS.	29
6	COMMERCIAL FISH AND SHELLFISH LANDINGS, ALL SPECIES, ALL NATIONS, ALL ICNAF CONVENTION AREAS AND SUB-AREAS, 1951-1973.	31
7	INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES - NOMINAL CATCH, ALL SPECIES, CERTAIN CONVENTION AREAS AND SUB-AREAS.	35
8	FISH AND SHELLFISH HARVEST - ATLANTIC COAST, 1939-1974.	38
9	FISHERY STATISTICS FOR THE GULF STATES, 1939-1974.	56
10	FISHERY STATISTICS FOR LOUISIANA, 1939-1974.	57
11	GULF STATE FISHERIES IN PERCENT OF TOTAL U.S. CATCH, VARIOUS YEARS, 1930-1973.	58
12	FISH AND SHELLFISH HARVEST - PACIFIC COAST, 1939-1974.	75

PREFACE

This compilation of fishery data is not intended to serve as a historical digest of U.S. commercial fishing interests or efforts. Its prime function is to highlight trends during the past 30 years in the commercial harvest of fish and shellfish from waters off the New England, Atlantic and Pacific coasts, and in the Gulf of Mexico and Alaska.

The U.S. fishery has been maintained in spite of heavy utilization of the resource, but stresses exist on some species, particularly oysters, crabs, lobsters and shrimp, from estuarine and offshore pollution.

United States commercial fishermen took 4,732,000,000 pounds of fish and shellfish in 1973, an increase of more than 41 percent over 1926, the earliest year for which total U.S. data are available. Nationally, the U.S. harvest of fish and shellfish has been declining since 1962 (Table 1). However, the decline in Pacific coast fisheries began in about 1951, from a high of nearly two billion pounds, to about 874 million pounds in 1972.

The decline in the New England fishery began in 1958, from a peak of slightly more than one billion pounds of fish and shellfish in 1957 to about 524 million pounds in 1972.

The peak year for the Atlantic Coast fishery was 1956, with a harvest of one billion, eight hundred seventy-four million pounds, declining to a low of approximately eight hundred million pounds in 1969. The harvest increased to nearly one billion, two hundred million pounds in 1972.

On the other hand, the fish and shellfish harvest in the Gulf states has increased from slightly more than two hundred million pounds in 1939 to more than one billion, seven hundred million pounds in 1974, an increase from 5 percent of the total U.S. catch in 1939 to 36 percent in 1974. A peak harvest in excess of two billion pounds was achieved in 1971 — 42 percent of the nation's total.

Some of the factors will be described which have been identified as causes of increases or declines in the availability or harvest of particular marine species or of the total fish or shellfish resource in any given coastal region. These include those which conspicuously influence a particular species such as toxic municipal or industrial discharges, sewage with high biological oxygen demand, or silting. At present, there is no evidence that pesticides or crude oil constitute a portion of this burden. Such influences also include less obvious elements such as increased salinity of fresh or brackish wetland nursery areas, with possible accompanying higher predation, higher water temperatures near or in estuaries associated with municipal or industrial growth, water control programs which may affect the chemistry of a particular body of water, hurricanes and wage and price disputes.

UNITED STATES FISHERY REVIEW

1968

United States fishermen caught 4.1 billion pounds of fishery products in 1968 that sold for $471.5 million, nearly equal to the record $472.4 million paid for the larger 1966 catch (4.4 billion pounds).

There were sharp declines in landings of anchovies, haddock, Pacific hake, tuna, blue crabs, and king crabs; and reductions in the catch of alewives, Pacific halibut, and shrimp. The overall productivity of the domestic fisheries would have been even lower than in 1967 except for increases in landings of menhaden, Pacific salmon, sea herring, jack mackerel, and yellowtail flounders. There were record catches of Maine and Oregon shrimp, albacore tuna in Oregon, and both northern and spiny lobsters.

At year end, certain segments of the fishing industry still faced economic and other problems. However, many segments were in excellent condition. Fishermen received a high dollar value for their catch and excellent gains were made in the fishery processing industry.

Other Important Facts

- Domestic shrimp fishermen were paid a record $113.3 million for their catch. For the second consecutive year, this fishery exceeded $100 million. Shrimp accounted for 24 percent of the total United States value paid for all species.
- The menhaden catch of 1.4 billion pounds accounted for 34 percent of the total United States catch of all species.
- Louisiana led all states in volume of catch — 747.5 million pounds — followed by California, 446.1 million pounds — Alaska, 433.7 million pounds — Virginia, 388.5 million pounds — and Massachusetts, 337.4 million pounds.
- Alaska led all states in value of catch — $71.6 million — followed by California, $53.3 million — Texas, $44.2 million — Massachusetts, $41.6 million — and Louisiana, $40.6 million.
- For the 20th consecutive year, San Pedro, California led all other domestic fishing ports in value of the catch ($29.1 million).
- A new and potentially important Alaska sea scallop fishery began in 1968 and nearly 2 million pounds of sea scallop meats were landed.
- Construction of shrimp trawlers continued at a record pace with at least 350 newly constructed vessels joining the Gulf shrimp fleet in 1968.
- In 1968, about 2.3 billion pounds of the domestic catch of fishery products was used directly as human food. It was estimated that the 1968 domestic catch was marketed as follows: 1,503 million pounds (round weight) as fresh and frozen, 970 million pounds for canning, 76 million pounds for cured products, and 1,567 million pounds for reduction to meal, oil, etc.

Congressional actions that became public law during the second session of the 90th Congress included the following:

Public Law 90-420 amended the Northwest Atlantic Fisheries Act to change the definition of fish to include mollusks and mammals.

Public Law 90-454 provides a means of considering the need to conserve and restore estuarine areas of the United States in a manner tnat reasonably maintains a balance between natural resources and the development of the Nation.

1969

United States fishermen caught 4,292 million pounds of fish and shellfish in 1969 that sold for $518 million—the highest dollar value received to date by the commercial fishing history. The value of the catch was $47.0 million more than in 1968 and 31 percent above the previous 10-year average. The volume taken was about 4 percent more than in 1968 and the largest catch since 1966.

There were record landings of Gulf menhaden, Pacific anchovies, yellowfin tuna, shrimp, spiny lobsters, tanner crabs, dungeness crabs, and surf clam meats in 1969; and sharp increases in the catches of Atlantic cod, Pacific halibut and blue crabs. Landings of Atlantic flounders, pollock, and soft clams were also higher in 1969 than in 1968. On the other side of the ledger, offsetting any real large gain in the overall productivity of the domestic fisheries, were serious declines in landings of haddock, Atlantic sea herring, Pacific salmon, whiting, otter-trawl caught industrial fish, sea scallop meats, and king crab. Production of jack mackerel, Atlantic ocean perch, and oyster meats were also below the 1968 levels.

At year end, some segments of the industry were facing declines in resource availability caused by both natural causes and heavy fishing but other segments remained highly competitive with foreign fleets and production. With only few exceptions, prices for fishery products generally increased at all levels: ex-vessel, wholesale, and retail. Fishermen got a high dollar ex-vessel value in 1969 and the fishery processing industry generally made excellent gains in production. Many canned items, fish sticks and portions, fillets and steaks, shellfish (lobsters, crab, shrimp) products, and other fish and shellfish products were in good demand throughout 1969 and many of these items made new inroads in foreign countries.

Other Important Facts

- The menhaden catch of 1,548 million pounds accounted for 36 percent of the total United States catch of all species.
- Shrimp accounted for 24 percent of the total United States ex-vessel value paid for all species.
- louisiana led all states in volume of fish and shellfish catch — 1,016 million pounds — followed by California, 575.9 million pounds — Alaska, 346.8 million pounds — Mississippi, 310.0 million pounds — and Massachusetts, 280.0 million pounds.
- Alaska led all states in value of catch — $71.1 million — followed by California, $62.1 million — Louisiana, $56.7 million — Texas, $46.9 million — and Massachusetts, $41.9 million.
- San Pedro, California led all other domestic fishing ports in volume and value of the catch.

1970

United States fishermen caught 4,884 million pounds of fish, shellfish, and other aquatic plants and animals that sold for $602 million—the highest dollar value in the history of the fisheries. The value of the catch was 16 percent more than in 1969 and 36 percent above the 1964-68 average. The volume taken was 14 percent more than in 1969 and the largest catch taken since the all-time record catch of 5.4 billion pounds in 1962. The 1970 catch was the seventh largest on record.

There were record landings of tuna, Gulf menhaden, California anchovies, shrimp, dungeness crabs, snow crabs, surf clam meats, northern lobsters, and spiny lobsters in 1970; and sharp increases in the landings of Atlantic menhaden and Pacific salmon. Landings of Atlantic flounders and blue crabs also were higher in 1970 than in 1969. There were marked declines in the catches of Atlantic alewives and haddock, and landings of Atlantic cod, bonito, jack mackerel, king crab, sea scallop meats, and oyster meats were somewhat lower than landings in 1969.

At year end, there were some problems associated with pollutants in the environment, high inventories of some frozen products, and declines in resource availability due to both natural causes and heavy fishing. However, many segments of the industry remained highly competitive with foreign fleets and production, and operated at record volume. With only few exceptions, prices for fishery products generally increased at all levels - ex-vessel, wholesale, and retail. Demand for fishery products was strong in 1970 as evidence by rising consumption and rising prices.

Other Important Facts

- The menhaden catch of 1,814 million pounds accounted for 37 percent of the total United States catch of all species.
- Shrimp accounted for 22 percent of the total United States ex-vessel value paid for all species.
- Louisiana led all states in volume of catch — 1,110 million pounds — followed by California, 694.2 million pounds — Virginia, 583.2 million pounds — Alaska, 528.6 million pounds — and Mississippi, 301.3 million pounds.
- Alaska led all states in value of catch — $89.7 million — followed by California, $84.5 million — Louisiana, $62.0 million — Texas, $53.5 million — and Massachusetts, $45.8 million.
- San Pedro, California led all other domestic fishing ports in volume and value of the catch.

1971

U.S. commercial fishery landings in 1971 were 5.0 billion pounds valued at dockside (ex-vessel) at $643 million—the fifth largest landing and the highest dollar value in the history of U.S. fisheries. The quantity landed was 1 percent greater than in 1970 and was exceeded by landings only in 1956, 1959, 1961, and 1962. The value was 5 percent greater than in 1970, the previous record year. The average value per pound of 12.94 cents in 1971 also was a record high.

Total U.S. landings were heavier in 1971 than in 1970 principally because of large landings of menhaden, a fish used almost exclusively for processing fish meal and oil. Among the other important fisheries, shrimp landings set a new record but total landings of tuna (excluding landings in Puerto Rico) were down 12 percent and salmon landings were down 24 percent as compared with the

previous year. The increase in value of the total U.S. catch of all species was due largely to higher ex-vessel prices for most species in 1971 as compared with 1970.

Landings of menhaden in the Gulf States and landings of shrimp in the Pacific Coast States (mainly Alaska) were the largest on record. Landings of bonito and Pacific cod increased several fold and landings increased sharply for the following species: croaker, sea trout, bluefin and skipjack tuna, king crabs, and shrimp landed in the South Atlantic States. Landings declined markedly for a number of species including anchovies, haddock, halibut, Pacific ocean perch, pink salmon, red salmon, silver salmon, swordfish, yellowfin tuna, whiting, surf clams, and dungeness crabs.

Other Important Facts

- Menhaden landings of 2.2 billion pounds accounted for 44 percent of the total United States landings of all species.
- Shrimp accounted for 8 percent of the quantity and 26 percent of the value of the total United States landings.
- Louisiana led all states in volume of landings — 1,396.2 million pounds — followed by California, 585.5 million pounds — Virginia, 489.0 million pounds — Alaska, 449.1 million pounds — and Mississippi, 397.6 million pounds.
- California led all states in value of landings — $87.2 million — followed by Alaska, $84.5 million — Louisiana, $72.6 million — Texas, $70.0 million — Massachusetts, $46.0 million, and Florida, $45.2 million.
- Cameron, Louisiana led all other U.S. fishing ports in quantity landed and San Pedro, California led all other domestic fishing ports in value of landings.
- The Secretary of Commerce halted the taking or processing of whales on the Department of the Interior's Endangered Species List — blue, bowhead, finback, gray, humpback, right, sei, and sperm — after December 31, 1971. The importation of these whales or products thereof also was halted after that date.

1972

In 1972, commercial fishery landings at U.S. ports by U.S. fishermen were 4.7 billion pounds valued at a record $703.6 million at the ex-vessel level. The quantity landed was 5 percent less than in 1971, but, because of higher ex-vessel prices, the value was 9 percent greater than in 1971. The 1972 average value per pound of 14.9 cents was a record high.

Total U.S. landings were smaller in 1972 than in 1971, principally because of marked decreases in landings of menhaden and salmon. The 1972 salmon landings were 31 percent less than 1971, and menhaden landings decreased 11 percent. Significant decreases occurred in other species including alewives, Atlantic cod, haddock, Pacific hake, halibut, jack mackerel, whiting, dungeness crabs, and soft clams. Skipjack landings of 46.8 million pounds in 1972 represented a decrease of 59 percent compared with 1971, but total tuna landings of 377.6 million pounds at ports in the United States were 8 percent above 1971 because of increased landings of yellowfin tuna. The following species had significant increases in landings in 1972 compared with 1971: anchovies, flounders, sea herring, rockfishes, surf clams, king crabs, and snow crabs.

The domestic shrimp industry was the most valuable fishery in the country. The 1972 catch, valued at a record $193.2 million, accounted for 27 percent of the total U.S. ex-vessel value for all species. Landings of shrimp in the United States in 1972 were 385.0 million pounds—down 1 percent from 1971.

Other Important Facts

- Menhaden landings of 1.9 billion pounds accounted for 41 percent of total landings of all species in the United States.
- Shrimp was the leading species landed in terms of value of total landings in the United States and second in quantity.
- Tuna was the second most important species landed in the United States in terms of value and third in quantity.
- Louisiana led all the states in volume of landings with 1,071 million pounds — followed by Virginia, 664 million pounds — California, 640 million pounds — and Alaska, 390 million pounds.
- For the second year, California led all states in value of landings, $92 million — followed by Texas, $85 million — Alaska, $81 million — and Louisiana, $72 million.
- San Pedro, California with landings of 452 million pounds valued at $59 million, was the leading commercial fishing port in 1972.
- A permanent moratorium was placed on the taking and importation of any marine mammal or marine mammal product, effective December 21, 1972, under the Marine Mammal Protection Act of 1972. The management of whales, porpoises (dolphins), seals, and sea lions are the responsibility of the Department of Commerce, while all other marine mammals are the responsibility of the Department of the Interior. The Alaska fur seal is exempt from the moratorium. Marine mammals taken incidentally in commercial fishing operations are exempt for 2 years after the date of enactment, October 21, 1972.

1973

In 1973, the U.S. commercial harvest of fish, shellfish, and other aquatic life was 4.7 billion pounds worth a record $907.4 million to the fishermen. The landings improved slightly compared with 1972, and the value increased 29 percent - principally because of higher ex-vessel prices. The average value in 1973 was a record 19.2 cents per pound. The slight gain in landings was caused principally by record harvests of anchovies, Pacific shrimp, surf clam meats, and snow crabs. Increased landings of bonito, Atlantic cod, croaker, Pacific sea herring, striped bass, pollock, rockfishes, scup, and whiting also contributed to the greater volume. Sharp declines occurred, however, in landings of flounders (principally yellowtail and Pacific); Atlantic sea herring; jack mackerel; albacore, bluefin, and skipjack tuna; pink salmon; hard blue crabs; dungeness crabs; Gulf shrimp; and squid. Slighter decreases occurred in landings of haddock, Pacific halibut, menhaden, red salmon, and oysters.

The domestic shrimp industry was the most valuable fishery in the country. Landings of 372.2 million pounds worth $219.4 million declined 3 percent in volume but increased 14 percent in value compared with 1972. Shrimp accounted for 24 percent of the total ex-vessel value of U.S. landings.

Tuna landings of 342.1 million pounds at U.S. ports were 35.5 million (9 percent) less than in 1972.

Other Important Facts

- Menhaden landings of 1.9 billion pounds accounted for 40 percent of total landings of all species in the United States.
- Shrimp was the leading species in terms of value of total landings in the United States and was second in quantity.
- Salmon was the second most important species landed in the United States in terms of value of landings.
- Tuna was the third most important species landed in the United States in both quantity and value.
- Louisiana led all states in volume of landings with 1,036 million pounds — followed by California with 669 million — Virginia, 631 million — and Alaska, 456 million pounds.
- Alaska led all states in value of landings with $162 million — followed by California with $103 million — Louisiana, $98 million — and Texas, $91 million.
- San Pedro, California, with landings of 474 million pounds worth $66 million, was the leading commercial fishing port in 1973 in terms of value.
- The United States early in 1973 declared a moratorium on seal harvests on St. George Island in the Pribilofs. Scientists will now be able to compare the protected seal population with the harvested one on nearby St. Paul Island.

Records Established

Total value - $907.4 million — (previous high, 1972 - $703.6 million).

Anchovies - 229.3 million pounds — (previous high, 1970 - 192.9 million pounds).

Bonito - 28.4 million pounds — (previous high, 1972 - 22.9 million pounds).

Striped bass - 13.5 million pounds — (previous high, 1969 - 12.4 million pounds).

Total clams (meats) - 106.3 million pounds — (previous high, 1970 - 99.2 million pounds).

Clams, surf (meats) - 82.3 million pounds — (previous high, 1970 - 67.3 million pounds).

Crabs, snow - 61.2 million pounds — (previous high, 1972 - 29.0 million pounds).

Lobsters, spiny - 11.4 million pounds — (previous high, 1972 - 11.2 million pounds).

Shrimp, Pacific (heads-on) - 144.3 million pounds — (previous high, 1970 - 92.9 million pounds).

1974

Commercial fishery landings at U.S. ports by U.S. fishermen were 4.9 billion pounds worth $898.5 million — an increase of 4 percent in volume, but a decline of 1 percent in value from 1973. Greater landings of menhaden, alewives, jack mackerel, and sea herring, and such foodfish and shellfish as tuna, Atlantic cod, pollock, scup, squid, clams, and crabs accounted largely for the volume gain. On the other hand, landings of anchovies, bonito, flounders (blackback, yellowtail, and Pacific), halibut, ocean perch, rockfishes, salmon, whiting, shrimp, and oysters declined from 1973.

The shrimp industry accounted for 20 percent of the total exvessel value of U.S. landings, and was the Nation's most valuable fishery.

Other Important Facts

- Menhaden landings of 1,979 million pounds accounted for 40 percent of total landings of all species in the United States.
- Shrimp was the leading species in terms of value of landings in the United States.
- Salmon was the second most valuable species landed in the United States.
- Tuna was the second largest species in terms of landings and was third in terms of value.
- Louisiana led all states in volume of landings with 1,229 million pounds — followed by California with 745 million; Virginia, 507 million; and Alaska, 457 million pounds.
- Alaska led all states in value of landings with $141 million — followed by California with $130 million; Louisiana, $87 million; and Texas, $72 million.
- San Pedro, California, with landings of 438.9 million pounds with a record $78.8 million was the leading commercial fishing port in 1974.

Records Established

Total tuna value - $117.8 million — (previous high, 1972 - $92.5 million).

Total clams (meats) - 119.9 million pounds — (previous high, 1973 - 106.3 million pounds).

Crabs, snow - 64.1 million pounds — (previous high, 1973 - 61.2 million pounds).

Lobsters, spiny - 12.9 million pounds — (previous high, 1973 - 11.4 million pounds).

Sources: *Fisheries of the United States,* National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March 1973, C.F.S. No. 6400, March 1974, and C.F.S. No. 6700, March 1975.

Fishery Statistics of the United States, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 63, 1900; No. 65, 1971.

Table 1
U. S. CATCH OF FISH AND SHELLFISH
1939 - 1974
(Million Pounds)

Year	Shellfish*	Fish	Total Fish & Shellfish Harvest
1939	397		4,445
1940	386		4,060
1945	444		4,598
1950	493		4,901
1951	518		4,433
1952	512		4,432
1953	553		4,487
1954	554		4,762
1955	524		4,809
1956	512		5,268
1957	523		4,789
1958	513		4,747
1959	557		5,122
1960	615		4,942
1961	550		5,187
1962	569		5,345
1963	649		4,847
1964	642		4,541
1965	741		4,777
1966	771		4,366
1967	858**	3,190	4,055
1968	791	3,363	4,160
1969	813	3,519	4,337
1970	898	4,017	4,917
1971	918	4,099	5,018
1972	895	3,813	4,710
1973	907	3,825	4,732
1974			4,939
1975			
1976			
1977			
1978			
1979			
1980			

*Shellfish data are for crabs, lobsters, shrimps, clams, & oysters. Other shellfish species are included in total fish and shellfish harvest.

**Includes all shellfish after 1967.

SOURCES:
Historical Catch Statistics (Shellfish), U. S. Dept. of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 5007, July, 1969.

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March, 1974, and C.F.S. No. 6700, March, 1975.

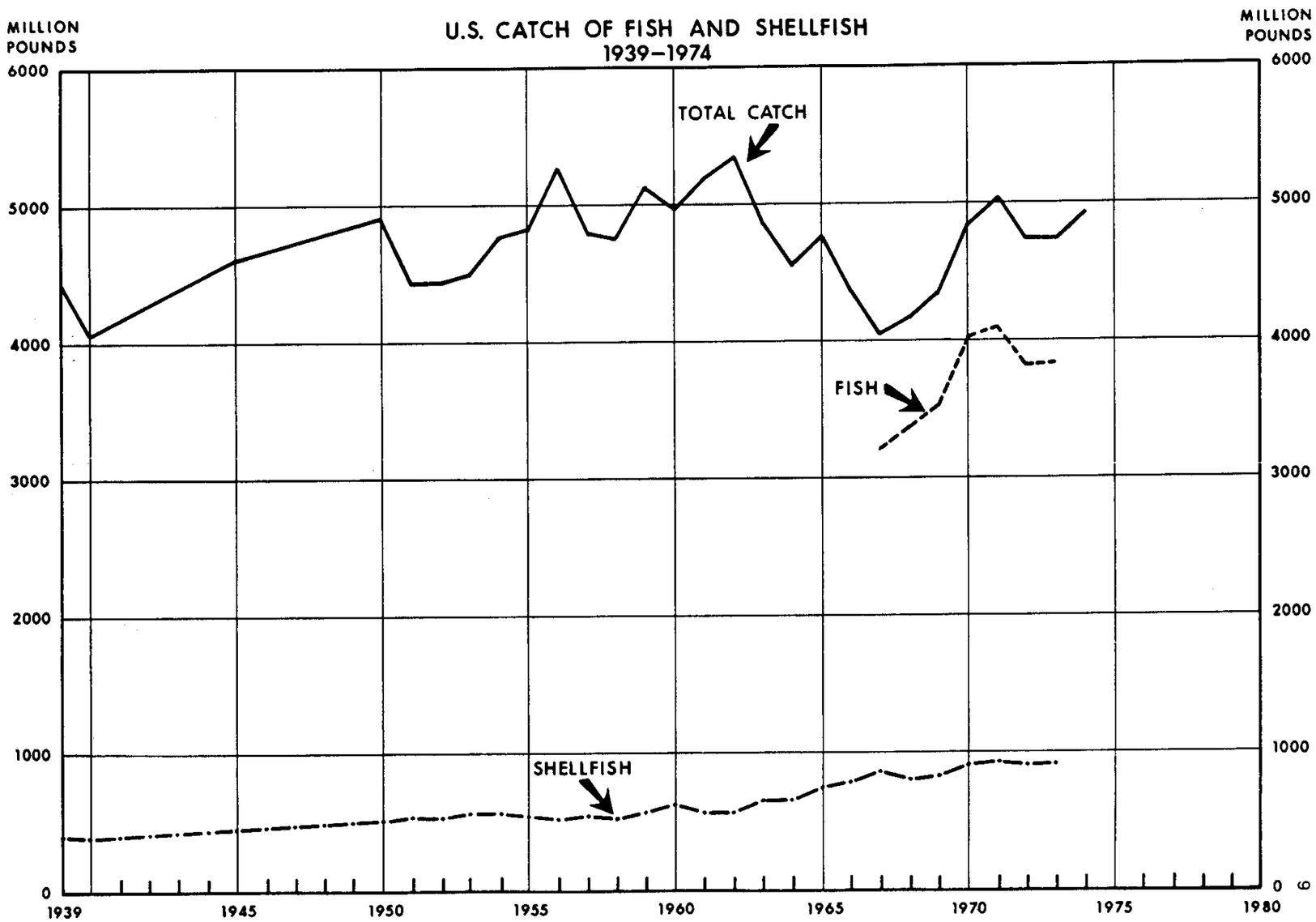

U.S. CATCH OF FISH AND SHELLFISH
1939–1974
MILLION POUNDS
MILLION POUNDS
6000
5000
4000
3000
2000
1000
0
TOTAL CATCH
FISH
SHELLFISH
1939
1945
1950
1955
1960
1965
1970
1975
1980

Figure 1

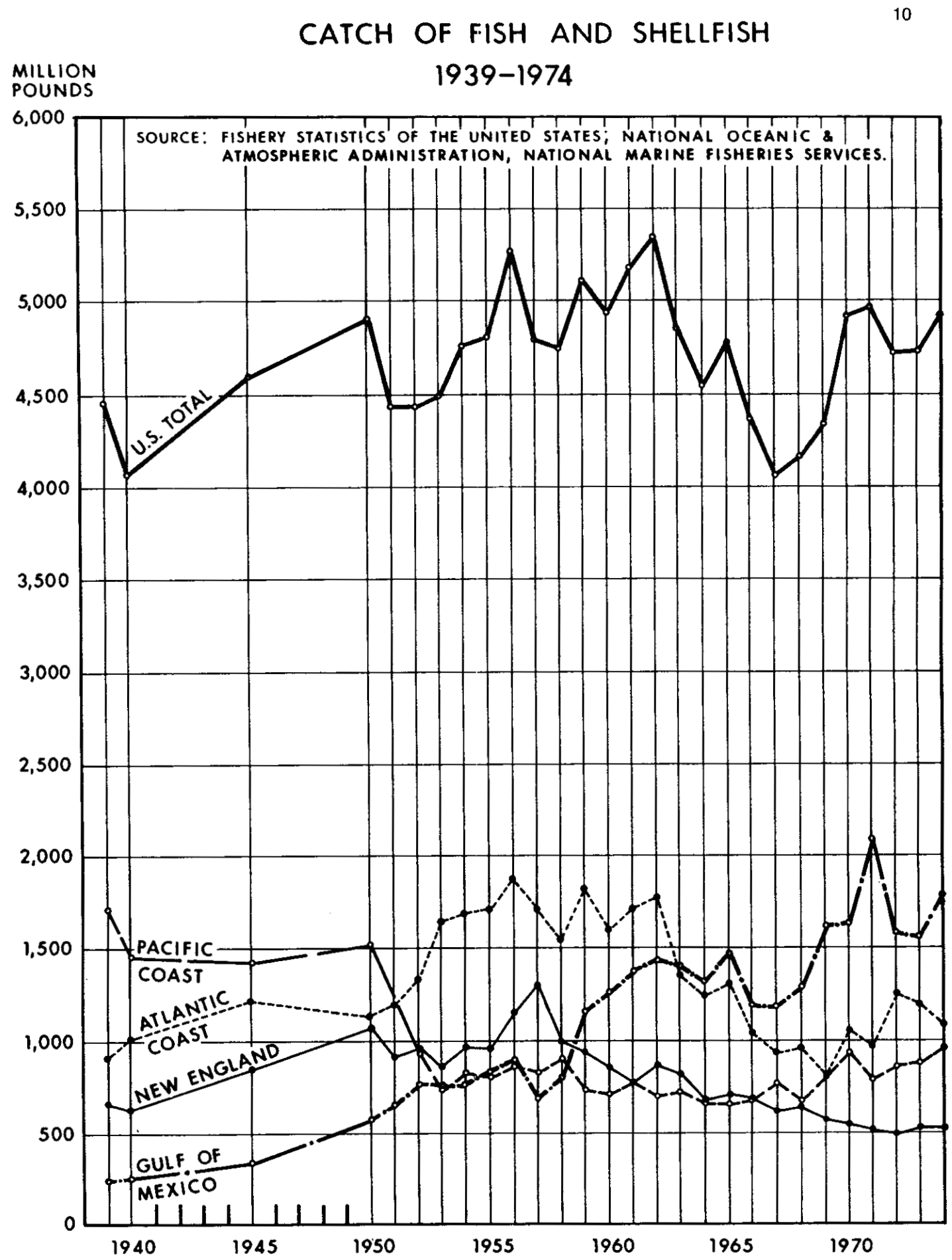

CATCH OF FISH AND SHELLFISH
1939–1974
MILLION POUNDS
SOURCE: FISHERY STATISTICS OF THE UNITED STATES; NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICES.
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
U.S. TOTAL
PACIFIC COAST
ATLANTIC COAST
NEW ENGLAND
GULF OF MEXICO
1940
1945
1950
1955
1960
1965
1970

Figure 2

Table 2
U. S. FISH AND SHELLFISH HARVEST IN THE COASTAL REGIONS
and
Percent of U. S. Catch
(Million Pounds)

Year		New England	Atlantic	Gulf	Pacific[1]
1939	Quantity	664	992	240	1,714
	Percent	15	22	5	39
1940	Quantity	626	1,002	250	1,456
	Percent	15	25	6	36
1945	Quantity	845	1,204	341	1,428
	Percent	18	26	7	31
1950	Quantity	1,007	1,133	571	1,515
	Percent	21	23	12	41
1955	Quantity	955	1,713	830	800
	Percent	20	36	17	17
1960	Quantity	852	1,599	1,266	703
	Percent	17	32	26	14
1965	Quantity	702	1,304	1,463	654
	Percent	15	27	31	14
1967	Quantity	625	937	1,180	773
	Percent	15	23	29	19
1968	Quantity	635	956	1,298	666
	Percent	15	23	32	16
1969	Quantity	559	802	1,622	801
	Percent	13	19	38	19
1970	Quantity	531	1,039	1,698	934
	Percent	11	24	35	19
1971	Quantity	509	976	2,097	792
	Percent	10	19	42	16
1972	Quantity	490	1,254	1,585	853
	Percent	11	27	33	18
1973	Quantity	524	1,196	1,584	874
	Percent	11	25.2	32.7	18.4
1974	Quantity	521,565	1,080,293	1,772,531	956,562
	Percent	10.5	21.8	35.8	19.3

SOURCES:
Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March, 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 63, 1900; No. 65, 1971.

[1] Does not include Alaska.

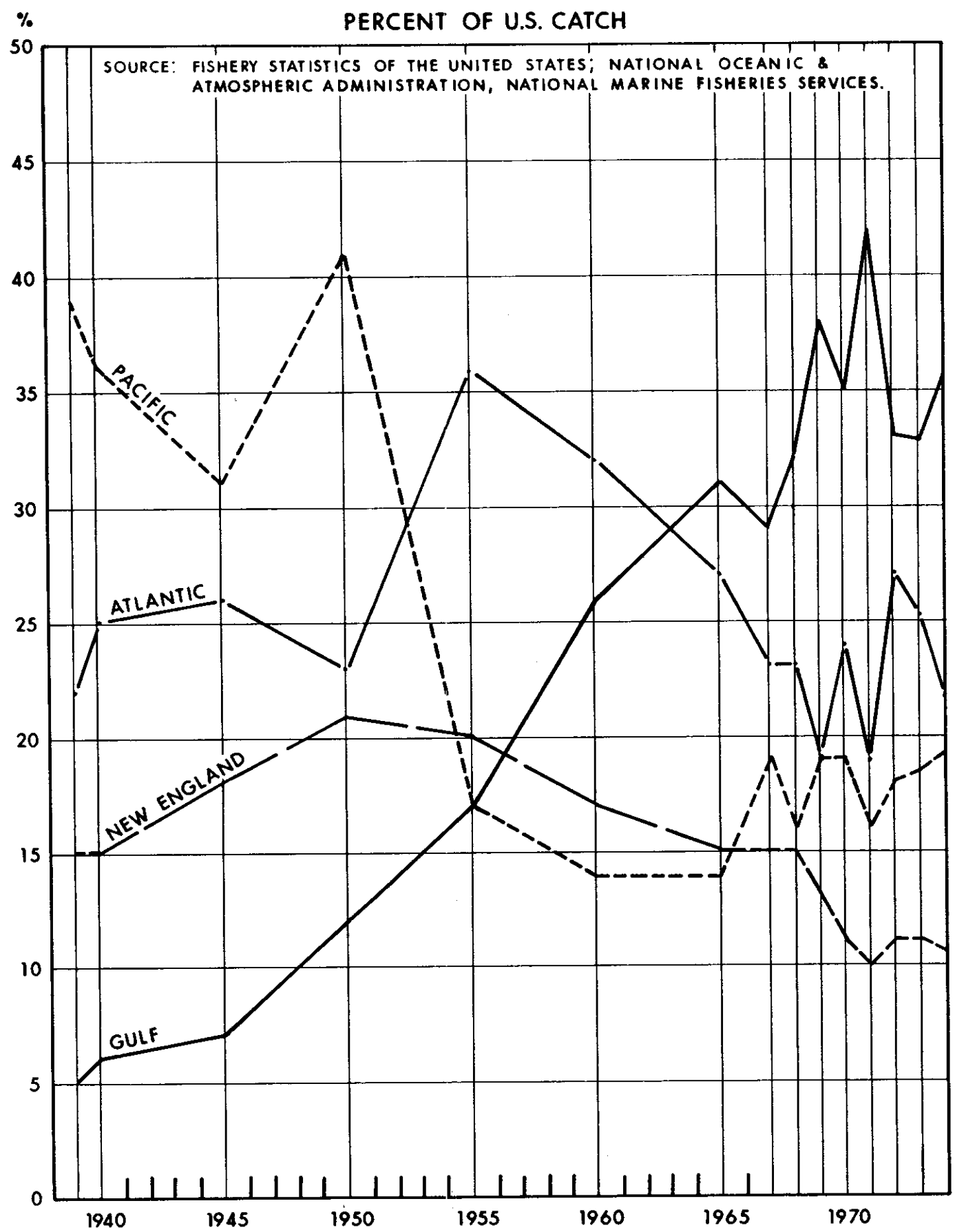

U.S. FISH—SHELLFISH HARVEST IN THE COASTAL REGIONS
BY
PERCENT OF U.S. CATCH
%
SOURCE: FISHERY STATISTICS OF THE UNITED STATES; NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICES.
PACIFIC
ATLANTIC
NEW ENGLAND
GULF
50
45
40
35
30
25
20
15
10
5
0
1940
1945
1950
1955
1960
1965
1970

Figure 3

Table 3

A SUMMARY OF SHELLFISH LANDINGS IN UNITED STATES*

1890-1974

(Thousands of Pounds and Thousand of Dollars)

YEAR	CRAB		NORTHERN LOBSTER		SPINY LOBSTER		SHRIMP		ABALONE		CLAM		OYSTER	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1890	-	-	-	-	-	-	-	-	204	6	-	-	-	-
1895	-	-	-	-	-	-	-	-	126	5	-	-	-	-
1900	-	-	15,768	1,391	-	-	-	-	-	-	-	-	-	-
1905	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1910	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1915	-	-	-	-	-	-	-	-	731	17	-	-	-	-
1920	-	-	-	-	-	-	-	-	180	-	-	-	-	-
1925	-	-	-	-	-	-	-	-	471	262	-	-	-	-
1930	83,332	2,568	13,916	3,586	1,682	289	-	-	647	130	-	-	86,874	11,965
1931	78,596	1,833	12,461	3,010	1,796	265	-	-	678	125	-	-	74,210	7,525
1932	77,951	1,495	11,157	2,079	1,463	174	-	-	563	77	-	-	68,467	5,974
1933	-	-	9,812	1,745	-	-	-	-	551	80	-	-	-	-
1934	-	-	-	-	1,534	197	-	-	645	105	-	-	-	-
1935	-	-	11,496	2,659	-	-	-	-	774	115	-	-	-	-
1936	-	-	-	-	1,662	168	-	-	660	93	-	-	-	-
1937	92,564	2,914	11,576	2,437	1,615	185	-	-	573	93	-	-	95,627	8,703
1938	98,661	2,714	11,984	2,245	1,526	202	-	-	424	92	-	-	86,932	8,458

*Source: Historical Catch Statistics, July 1969, USDI Fish & Wildlife Service, Bureau of Commercial Fisheries. Statistics on the landings of clam abalone and oysters are reported in weight of total meats and shrimps on a heads-on basis.

A Summary of Shellfish Landings in United States

YEAR	CRAB		NORTHERN LOBSTER		SPINY LOBSTER		SHRIMP		ABALONE		CLAM		OYSTER	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1939	106,535	2,806	11,985	2,079	1,649	231	152,151	-	361	77	31,871	-	93,006	8,190
1940	96,140	2,734	11,761	2,131	1,561	200	155,013	-	345	93	32,470	-	89,382	8,467
1941	-	-	-	-	-	-	-	-	200	59	-	-	-	-
1942	-	-	12,300	2,852	-	-	-	-	33	13	-	-	-	-
1943	-	-	-	-	-	-	-	-	136	55	-	-	-	-
1944	-	-	17,929	4,430	-	-	-	-	326	145	-	-	-	-
1945	121,049	9,379	22,728	9,461	1,256	272	191,378	-	486	272	31,866	-	75,627	25,145
1946	-	-	-	-	-	-	-	-	419	254	-	-	-	-
1947	-	-	23,927	8,992	-	-	-	-	534	307	-	-	-	-
1948	-	-	20,987	8,728	-	-	-	-	646	371	-	-	-	-
1949	-	-	24,656	8,903	-	-	-	-	714	398	-	-	-	-
1950	159,281	9,232	23,198	8,345	2,493	577	192,295	43,450	791	369	39,571	10,741	76,415	29,597
1951	148,138	9,770	25,946	9,379	3,921	891	225,188	-	817	365	41,831	11,520	72,990	29,070
1952	135,126	9,051	25,032	10,556	2,420	740	228,210	-	957	431	38,996	11,702	82,242	32,339
1953	144,154	10,203	28,115	10,870	2,745	752	261,504	-	944	439	36,544	11,470	79,718	29,051
1954	140,658	9,715	27,481	10,486	2,849	837	269,517	60,831	820	377	31,536	9,887	81,921	32,795
1955	135,751	10,103	28,954	11,302	3,154	962	245,779	61,782	837	423	33,032	9,963	77,518	30,474
1956	143,418	11,730	26,520	11,908	3,849	1,210	224,557	70,895	857	481	38,099	10,739	75,132	30,886
1957	171,357	12,255	30,155	11,512	4,687	1,500	205,618	73,148	1,084	587	39,782	11,258	71,654	29,405
1958	166,389	12,391	27,227	13,218	2,588	1,226	213,842	72,930	845	423	36,364	10,527	66,395	30,441
1959	174,630	14,804	29,085	14,468	3,686	1,260	240,182	58,133	913	497	44,916	11,504	64,709	29,484

A Summary of Shellfish Landings in United States

YEAR	CRAB		NORTHERN LOBSTER		SPINY LOBSTER		SHRIMP		ABALONE		CLAM		OYSTER	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
1960	221,681	17,068	31,168	14,251	3,199	1,337	249,452	66,932	853	496	49,483	12,049	60,007	29,240
1961	231,606	17,337	27,998	14,572	3,222	1,254	174,530	51,688	910	607	50,265	11,661	62,304	33,204
1962	234,340	18,708	29,497	14,953	3,656	1,556	191,106	73,236	837	593	54,169	11,762	56,037	29,139
1963	252,334	21,354	30,274	16,769	4,170	1,790	240,478	70,044	869	626	63,403	14,202	58,443	27,106
1964	270,442	23,813	30,958	19,856	4,078	1,872	211,821	70,376	817	574	64,464	14,890	60,532	27,924
1965	335,407	30,792	30,246	21,957	6,229	3,619	243,645	82,409	915	698	70,849	16,733	54,686	27,865
1966	372,425	33,037	29,541	22,266	5,839	2,878	239,046	96,296	998	920	72,751	18,551	51,216	27,367
1967	322,184	32,321	26,745	22,389	4,864	3,121	307,779	103,466	888	866	71,500	20,486	59,912	32,318
1968	238,500	44,500	32,300	25,200	7,500	5,200	291,600	113,300	-	-	66,200	20,100	55,600	29,800
1969	234,800	39,400	31,600	26,600	7,900	5,800	317,100	122,900	-	-	75,500	23,900	51,900	28,200
1970	277,218	39,235	34,152	33,463	10,346	6,334	367,469	129,738	-	-	99,202	28,789	53,603	29,483
1971	276,374	51,656	33,347	35,066	8,439	7,907	387,932	166,610	-	-	82,659	30,540	54,585	30,426
1972	281,077	58,610	29,278	36,052	11,199	11,582	384,952	193,188	-	-	89,100	31,859	52,546	33,819
1973	291,882	88,086	29,035	41,917	11,375	12,007	372,190	219,420	-	-	106,293	34,730	48,553	35,191
1974	329,282	83,090	28,266	42,352	12,854	15,322	369,601	177,860	-	-	119,909	39,004	44,873	33,570
1975														
1976														

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March 1973, C.F.S. No. 6400, March 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

FISH AND SHELLFISH HARVEST - NEW ENGLAND STATES

This synopsis of the New England fishery includes the annual landings of fish and shellfish in all seaports of the New England states, and the annual harvests of principal fish and shellfish species as reported by the International Commission for the North Atlantic Fisheries (ICNAF).

The New England commercial fisheries yielded a five-year (1964-1968) average catch of 666 million pounds of fish and shellfish worth 73.3 million dollars to fishermen. Harvests from the ICNAF Convention Areas constituted about 30 percent of the New England catch.

The groundfish species (haddock, ocean perch, cod, cusk, hake, and pollock) are the principal fin-fish group taken from these grounds; however, the groundfishery is largely dependent on the catch of only two species—haddock and ocean perch. The five-year average harvest of fish and shellfish from these areas indicated that 63 percent of the catch was composed of groundfish and 33 percent of the flounder group.

Since the early 1950's, the groundfish fishery has experienced severe difficulties, reflected in declining catches are: 1) overfishing by both domestic and foreign fishermen, 2) continued heavy imports of groundfish fillets and steaks which lowered the prices of the local products prompting some fishermen to abandon this fishery, 3) the inability of the New England fishermen to adjust to declines in abundance of a particular species since they tend to specialize in fishing for one species, 4) mounting vessel insurance rates, 5) lack of long-term credit for vessel construction and modernization, and 6) stiff competition from foreign fleets.

Table 4
FISH AND SHELLFISH HARVEST - NEW ENGLAND STATES
1939 - 1974
(Thousand Pounds)

Year	Shellfish	Fish	Total Fish & Shellfish Harvest
1939	49,653		663,866
1940	46,298		626,054
1945	48,930		845,471
1950	60,815		1,006,590
1951	59,385		916,807
1952	57,936		954,563
1953	65,694		864,005
1954	56,749		966,481
1955	58,910		955,418
1956	54,764		1,015,246
1957	60,973		1,030,883
1958	54,109		997,749
1959	58,290		933,206
1960	63,681		851,964
1961	60,945		760,078
1962	61,079		871,681
1963	58,309		828,889
1964	54,333		681,857
1965	52,742		702,181
1966	54,233		684,375
1967	49,842		625,340
1968	62,764		634,748
1969	76,086		568,266
1970	73,037		531,272
1971	79,951		513,521
1972	77,642	411,610	489,252
1973	73,774	450,091	523,865 (Prelim.)
1974			521,565 (Prelim.)
1975			
1976			
1977			
1978			
1979			
1980			

(1) Shellfish data are for crabs, northern lobsters, shrimp, clam meats, sea mussels, oysters, and scallops.

SOURCES:

Historical Catch Statistics (Shellfish), U. S. Dept. of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 5007, July, 1969.

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March, 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States, U. S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

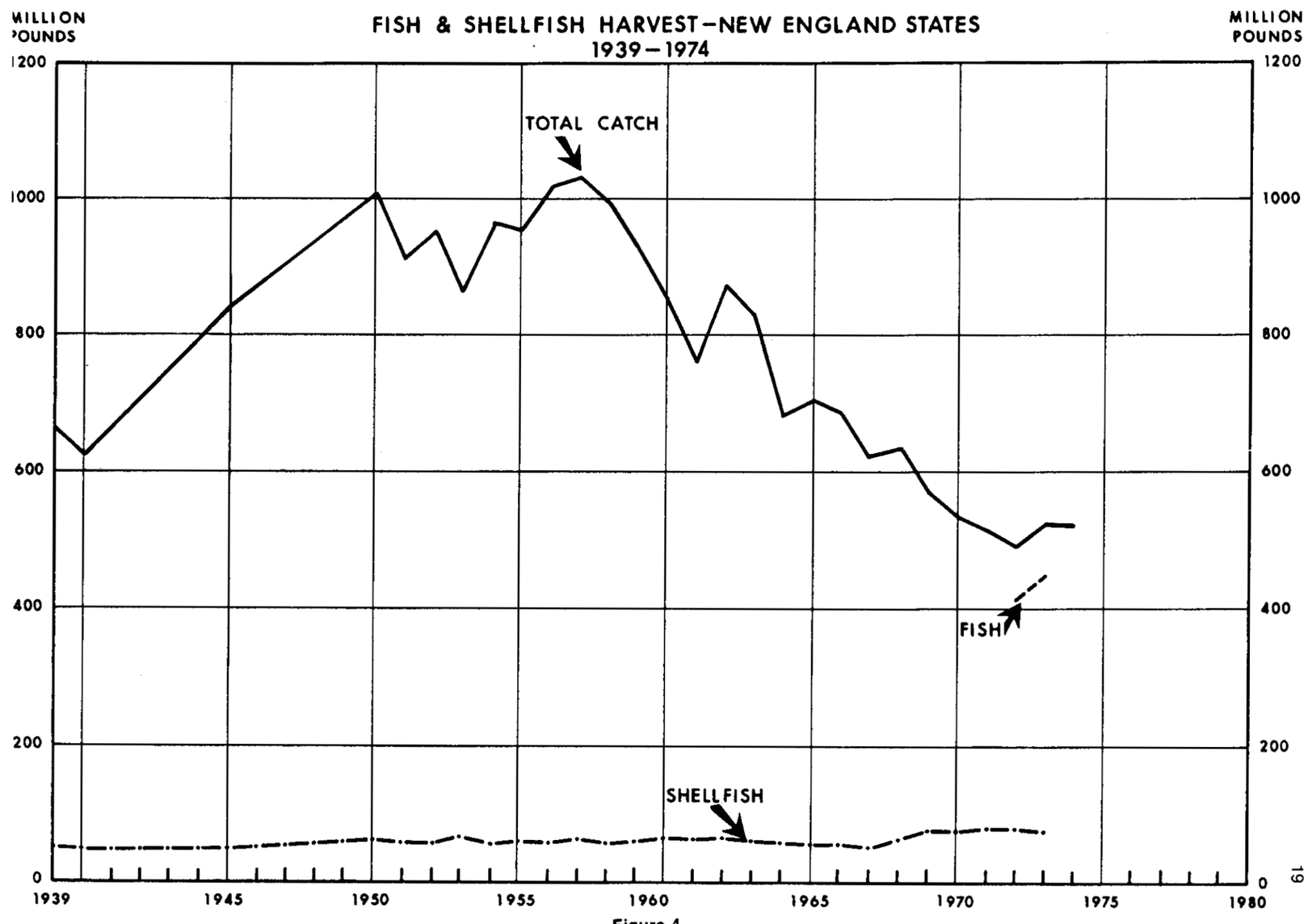

FISH & SHELLFISH HARVEST–NEW ENGLAND STATES
1939–1974
MILLION POUNDS
MILLION POUNDS
1200
1000
800
600
400
200
0
TOTAL CATCH
FISH
SHELLFISH
1939
1945
1950
1955
1960
1965
1970
1975
1980

Figure 4

Table 5

NEW ENGLAND FISHERY OPERATING UNITS
1951-1972

Year	No. Fishermen	Vessels No.	Vessels Total Net Tonnage	Boats Motor	Boats Other
1951	23,639	881	29,694	8,792	4,249
1952	23,497	916	31,056	9,092	3,707
1953	26,392	1,072	36,799	10,491	2,938
1954	23,348	886	30,138	11,711	2,305
1955	22,566	847	28,712	11,946	1,806
1956	21,376	832	28,141	11,280	1,375
1957	22,288	800	27,346	10,972	828
1958	21,789	773	26,479	10,868	921
1959	21,051	758	26,282	10,703	674
1960	22,200	742	44,514	11,356	572
1961	21,737	738	44,242	11,15	709
1962	21,536	727	45,476	10,414	699
1963	21,428	733	47,501	10,070	676
1964	20,194	721	47,084	10,128	465
1965	19,435	703	46,929	10,412	405
1966	18,518	704	48,416	9,555	344
1967	18,043	714	48,350	9,294	354
1968	18,180	695	46,433	,9429	297
1969	19,949	695	48,655	10,549	251
1970	22,218	686	43,798	11,703	252
1971	22,761	699	44,544	11,535	172
1972	28,960	687	45,546	14,475	249
1973					
1974					
1975					
1976					
1977					
1978					
1979					
1980					

SOURCES:

Fishery Statistics of the United States, U. S. Dept. of the Interior, Bureau of Commercial Fisheries, and National Marine Fisheries Service, Statistical Digests from 1951-1971.

Data for 1973 from National Marine Fisheries Service, NOAA.

FISH AND SHELLFISH HARVEST — NEW ENGLAND STATES

1951-1952

The New England ocean perch landings of 258.3 million pounds in 1951 were a record high. Based on catches by Massachusetts fishermen, about 32 percent of the total ocean perch harvest was from fishing grounds in the outer fishing areas of the New England coast, especially off Nova Scotia. A hurricane struck the fishing areas in north Atlantic waters in October 1951 causing damage to some fishing craft.

In 1952, the ocean perch catch decreased, while haddock and herring catches increased.

1953-1954

The 1953 fishery landings were down primarily as a result of the decline in sea herring and ocean perch harvests. Labor tie-ups and migration of some fishing fleets to the shrimp fishery in the Gulf of Mexico were factors contributing to the decline. Some fishermen observed scarcity of fish in 1953, especially on fishing grounds off Nova Scotia.

In 1954, the total regional landings increased by 102 million pounds. Catches in sea herring and haddock gained. Scrod haddock was abundant early in the year off Browns Bank.

1955-1956

The New England catch declined by 1 percent in 1955. However, there were increased catches of menhaden, whiting, industrial fish, and sea scallops. Decreases in some landings, including haddock and ocean perch, were primarily due to economic problems in the processing, distribution, and marketing of fishery products rather than to declining stocks on the fishing grounds.

The landings in 1956 increased by almost 60 million pounds. Major contributing factors were larger catches of alewives, greater landings of haddock, and a sharp increase in production of sea herring from waters off the Maine coast. Ocean perch landings were down by six million pounds from the previous year. The groundfish industry continued to suffer from the severe competitive pressure of imports of foreign fish fillets, an influence which affected the New England groundfish and packaged-fish processing industry for several years.

1957-1958

The record catch of 1,030 million pounds of fish and shellfish in 1957 resulted from the largest production of industrial fish in New England history in addition to increased catches of alewives, sea herring, and whiting. The groundfish catch declined. Aside from scarcity of groundfish on fishing grounds, low prices and fewer vessels working the distant banks were responsible for the decrease. Catch of haddock, the principal groundfish species taken, was down. This species was less abundant on the fishing grounds off Georges Bank, and inclement weather during the last few months of 1957 resulted in fewer landings at haddock ports. Sea scallop production was high in the Georges Bank area.

In 1958 regional landings of cod, ocean perch, and pollock were up, while haddock catch was down. Stocks of haddock on Georges Bank were considerably reduced and biological research indicated that no relief could be expected before 1960. Greater fishing effort resulted in increased catches for pollock and ocean perch. Whiting production dropped, especially on Georges Bank fishing grounds.

1959

Starting in 1959, there was a poor demand for otter-trawl caught industrial fish. Local production of fish meal and solubles was heavy and imports of these products were at their highest level since 1954.

The groundfish fishery continued to operate under severe difficulties caused by competition from foreign imports of groundfish fillets and steaks. Lower ex-vessel prices of groundfish species brought this fishery to a poor financial condition. In addition, scrod-sized haddock were scarce on Georges and Browns Banks.

There was a substantial rise in ocean perch production in the Grand Banks and fishing grounds in outer sub-areas off Nova Scotia.

Scallop grounds on Georges Bank were so productive that 5-10 minute tows filled dredges.

This year considerable progress was made in establishing a New England tuna fishery that started in 1951. Bluefin tuna was observed in commercial numbers in waters southeast of New England.

1960

The low 1960 regional catch was due to decreased landings of industrial fish. The poor demand for otter-trawl caught industrial fish continued in 1960 with the result that industrial fish landings plunged from 153 million pounds in 1959 to 34 million pounds in 1960. Bad weather also contributed to the low 1960 harvest. By the first week of March 1960, the worst blizzard in New England's history brought the fishing industry to a standstill, and a hurricane in September and another blizzard in December further suspended fishing activities.

The lobster catch, however, approached the 1889 record harvest. There was a steady downward trend in the catch of large haddock from 1938 through 1960 indicating fewer large fish available on the grounds. Heavy landings of scrod haddock in 1960 were due to good spawning and survival of the 1958 year class.

Catch of groundfish species increased on Georges Bank and fishing banks from the outer sub-areas off Nova Scotia. Sea scallop production at Georges Bank was at record level. Their abundance was the result of an unusually heavy set in 1955. Yellowtail flounder, the leading flounder species, was abundant on Georges Bank, Nantucket Shoals, Lightship Grounds, and East Side of the Channel. An increased catch of whiting was also observed on Georges Bank, Inner Grounds, Nantucket Shoals, and Lightship Grounds.

In August 1960, Russian trawlers, which previously confined their fishing activities to waters off Newfoundland, were observed for the first time fishing on Georges Bank.

1961

A sharp decline in the landings of sea herring (sardine) from Maine ports was experienced. Regional catch of sea herring was 97 million pounds less than in 1960. There was no clear-cut explanation for the shortage of this fish in inshore waters, as there were indications of an adequate supply offshore throughout the season. Regional landings of menhaden, ocean perch,

whiting, and lobsters were also lighter. Fishing time was lost to blizzard conditions in early 1961 and hurricane warnings in the fall.

Groundfish production was up on Grand Banks, Georges Bank, and Inner Grounds. The whiting catch increased markedly on Nantucket Shoals and Lightship Grounds. There was a record catch of sea scallop meats — with the harvest of 21 million pounds of scallops on Georges Bank accounting for about 87 percent of the total sea scallop harvest in the New England states. Yellowtail flounders were larger this year, due to a strong 1958 year class.

At least 100 Russian and Polish vessels were sighted fishing on Georges Bank.

1962

The larger sea herring harvest was the main contributor to the increased landings in 1962. Ocean perch, pollock, and sea scallop catches declined. Severe weather during the last quarter of the year reduced fish catches through loss of fishing time.

Ocean perch production on the Grand Banks and outer sub-areas off Nova Scotia declined. The scarcity of fish in local and Canadian waters and the additional profit to be derived from fishing for other groundfish species, such as cod and haddock, contributed to the decline in the ocean perch harvest.

The sea scallop harvest was down from the previous year's record production. Catches of all flounder species, especially yellowtail, increased.

Fishing by Russian vessels and other European fleets in waters adjacent to New England increased during 1962.

1963

A 43 million pound harvest decline in 1963, as compared with the previous year, was due largely to the decrease in the landings of groundfish, menhaden, whiting, and sea scallops. A severe storm in November climaxed a year of unusually high winds and poor fishing weather, and competition with a large fleet of Russian trawlers contributed significantly to the lower landings.

Flounder and whiting catches increased on Georges Bank, Inner Grounds, Nantucket Shoals, and Lightship Grounds. Sea scallops continued to decline from their peak in 1961. The older and marginally profitable scallop fleets were converted to otter-trawling or longlining.

A record high of 984,000 pounds of swordfish was caught on Georges Bank in 1963, a year after the longline method of fishing for swordfish was introduced.

1964

The New England landings of sea herring, industrial fish, ocean perch, scallops, cod, pollock, and whiting declined.

Catches of ocean perch off Grand Banks declined by 16.3 million pounds from 1963. This phenomenal decline continued in the succeeding years.

Groundfish production, especially haddock and ocean perch, increased in the outer sub-areas off Nova Scotia but decreased on Georges Bank. Harvest of whiting on Georges Bank was minimal, a decline of 12.5 million pounds from the previous year. The continued large-scale whiting fishing by the Russian fleet on the offshore banks affected the productivity of some of the whiting grounds.

The catch of flounders, especially yellowtail, was a record for the fourth consecutive year. The species was especially abundant on Georges Bank, Inner Grounds, and Nantucket Shoals. The 52% drop of catch of industrial fish was almost entirely due to closing of the industrial plant at Point Judith, Rhode Island. Tuna seiners avoided landing at New England ports due to additional costs of handling, storage, and transportation required before tuna could reach canneries which are located outside New England.

Sea scallops continued to decline on Georges Bank.

1965

Increased fishery landings were due to larger harvests of sea herring, haddock, shrimp, and blackback flounder. Catches of ocean perch, yellowtail flounder, whiting, sea scallops, and lobsters declined.

The groundfish catch on Georges Bank and Nantucket Shoals increased but declined on fishing grounds off Nova Scotia and the Inner Grounds.

Sea scallop production declined for the fourth consecutive year. The grounds at Georges Bank did not yield normal large catches. Consequently, more than 60 percent of the scallops landed at New Bedford, Massachusetts, the leading sea scallop port, were taken from new grounds off the Middle Atlantic and Chesapeake States.

The whiting fishery was no longer productive in the Inner Grounds; however, a comeback for this species was observed on Nantucket Shoals and Lightship Grounds. The New England catch for this species was the smallest since 1950, with competition from foreign vessels, primarily Russian fleets, the leading factor in the decline.

Ocean perch, although declining, were plentiful on the fishing grounds. However, their small size or infestation of a copepod parasite, *Sphyrion lumpi*, made processors reluctant to purchase this species.

1966

Landings of groundfish declined from the 1965 harvest. Violent storms with strong winds and rough seas hampered fishing. Further, imports of groundfish fillets were still high, about 7 percent more than in 1965. The haddock catch was low, with scrod haddock dominating the catch. The haddock fishery had three successive poor year classes beginning in 1964. The major haddock fishing grounds off Georges Bank decreased production by 9 million pounds. Nantucket Shoals, however, experienced a record-breaking haddock catch of 5.2 million pounds.

Ocean perch landings were the lowest since 1939 and far less than the 1951 peak production of 258.3 million pounds. Processing plants for ocean perch declined sharply as most of the vessels that formerly fished for this species turned to other fisheries.

The swordfish fishery was a disappointment. About five vessels in New England were employed in the longline fishery for swordfish. Aside from low catches, cost and losses of gear were high and processing for swordfish unprofitably low.

Catches of flounder species, especially yellowtail, were down. Size composition of landings indicated that this species was becoming less available due to overfishing. Georges Bank and Nantucket Shoals, the two major fishing grounds for yellowtail flounder, declined production by 11.2 million pounds.

Sea scallop production on Georges Bank, long the source of most sea scallops landed in New England states, decreased by 1.0 million pounds — resulting in one of the lowest catches since data were collected in 1951. Most of the scallops landed in the New England ports

were taken from fishing grounds off the coast of the middle Atlantic states, since the stocks on Georges Bank could no longer support a large fishery.

1967

Fish and shellfish landings were 9 percent lower than in 1966 due to unusually severe weather. Groundfish production on Georges Bank declined by 3.4 million pounds.

Ocean perch production continued a downward trend in all outer sub-areas except Browns Bank, Misaine Bank, Banquero, Inner Grounds, and Nantucket Shoals. Ocean perch were plentiful in both the Gulf of St. Lawrence and the Gulf of Maine, but the Nova Scotia banks were not as productive as in former years.

The haddock catch declined in all areas except on the Nova Scotia banks. The decline resulted from four successive poor year classes and increasing competition from foreign vessels fishing on Georges Bank.

Production of all flounder species declined by 22.6 million pounds from 1966 on Georges Bank and Nantucket Shoals.

The whiting catch decline resulted from a delayed 1967 fishing season. Fishing was spotty most of the year and poor in some formerly productive areas. Whiting production off Georges Bank declined by almost 3.0 million pounds as compared with 1966. With a large inventory of frozen processed whiting, catch limitations were imposed. Also, the industry faced the competition of whiting imported from Argentina.

Sea scallop production improved on Georges Bank with 546,000 pounds more scallop meats taken from this area.

1968

Severe weather at the beginning and end of the year caused a production decline. However, New England landings of cod, yellowtail flounder, sea herring, whiting, lobsters, and sea scallops increased. Groundfish catches declined and record imports of groundfish fillets (390.2 million pounds) reduced the demand for local groundfish products.

Haddock production continued a severe decline. Fishing banks in sub-area Western Browns Bank off Nova Scotia were the only fishing grounds that showed catch increases of this species. Because of five successive poor year classes and intensive fishing by foreign vessels, the supply of small, younger fish was depleted, with the fishery becoming more dependent upon older stocks.

Ocean perch catches also declined, notably in Browns Bank and Inner Grounds fishing areas. Ocean perch were taken mostly from the Gulf of St. Lawrence, with most of the remaining catches occurring in the Gulf of Maine.

Catches of cod increased on Georges Bank and Nantucket Shoals. All other fishing areas showed a decline in production. Low prices for cod discouraged fishermen from intensively seeking this species.

Yellowtail flounders increased during the year. Most of the largest yellowtail were observed along southeast Georges Bank where a catch of 216 million pounds in Central and Southeast Georges Bank was up by 10.7 million pounds over the previous year's harvest.

Sea scallops continued to decline. Georges Bank, formerly a productive scallop ground, declined in production by nearly 20 million pounds of meats from its 1961 record catch.

Fishermen and biologists expressed concern that the supply of sea scallops was facing depletion from the middle Atlantic grounds to Georges Bank.

1969

Haddock landings declined by 25.1 million pounds in 1969, the smallest catch since the turn of the century. The decline was due to decreased abundance, not only from natural causes, but also from heavy fishing by foreign fleets in 1965-66 when almost 950 million pounds were caught by Russia, Canada and the United States—nearly double the average annual landings by all nations in previous years.

The quantity of yellowtail flounders landed remained at about the 1968 level. The whiting catch dropped in 1969 as whiting failed to appear in large commercial numbers on any of the popular New England fishing grounds.

The sea scallop harvest continued to decline. With poor fishing off the middle Atlantic states, the scallop fleet concentrated more on Georges Bank and the Channel areas.

1970

The New England haddock fishery continued to decline with landings falling from 46.2 million pounds in 1969 to 26.9 million pounds in 1970. There has not been a successful year-class of haddock since 1963. In addition, continuous heavy fishing by domestic and foreign fleets resulted in serious depletion of the resource. Consequently, quotas for haddock were set and complete closure of the spawning grounds in March and April was enforced.

The yellowtail flounder catch improved over 1969. The scallop catch continued to decline with most of the catch coming from the Georges Bank and Channel areas. The scarcity of scallops resulted in fishermen continuing to cut small shellstock which in past years would have been returned to the ocean for another seasons growth.

1971

New England yellowtail landings decreased in 1971, partially attributable to quotas set in taking yellowtails from fishing grounds east and west of 69° longitude.

Haddock production declined. However, the 1971 year-class improved slightly as compared with 1970. Many foreign vessels fished for haddock off the New England Coast during the year.

The sea scallop fishery continued decline, a result of reduced catches from major sea scallop grounds off the New England Coast.

1972

New England shrimp landings of 24.5 million pounds worth $4.6 million were comparable to 1971. Maine landings of 16.6 million pounds declined moderately because of smaller catches during the peak season from January to April. Massachusetts landings were 29 percent greater than in 1971. Gloucester has become the leading port for New England shrimp landings, and shrimp has become economically important to fishermen operating out of that port.

Landings of *American* (northern) lobsters were 29.3 million pounds worth a record $36.1 million—a decline of 12 percent in volume, but a gain of 3 percent in value compared with 1971. Landings in the New England and middle Atlantic states declined, but in the Chesapeake states, principally in Virginia, they increased moderately. All along the Atlantic Coast fishermen turned increasingly to the offshore lobster pot fishery. In Massachusetts this fishery was based in the Cape Cod-Westport area.

Total U.S. landings of flounders were 168.8 million pounds valued at $28.8 million, an increase of 8 percent in quantity and 30 percent in value. Increased landings of Pacific flounders in California and *yellowtail* flounders in Massachusetts and Rhode Island were responsible for the increase in the total quantity landed. Landings in Massachusetts and Rhode Island, the leading yellowtail flounder producing states, increased owning to increased catches made in Subarea 6 (middle Atlantic area) of the Statistical Area of the International Commission for the Northwest Atlantic Fisheries (ICNAF). Catches in Subarea 5 (New England area) were subject to an international quarterly quota, and the quota was reached in each quarter of the year. By informal agreement, only U.S. fishermen were allowed to fish specifically for yellowtail flounder in 1972.

Landings of the leading groundfish species declined in 1972, and landings of the less important groundfish species increased. In 1972, *haddock* was the only Atlantic groundfish subject to a catch quota by the International Commission for the Northwest Atlantic Fisheries (ICNAF). The total quota of 41.9 million pounds for Subarea 4 (Nova Scotia area) and Subarea 5 (New England area) was an international quota in which the United States and Canada, by informal agreement, were the only countries allowed to fish specifically for haddock.

Total landings of sea herring were 102.0 million pounds valued at $3.5 million in 1972, up 17 percent in quantity and 85 percent in value compared to 1971. Landings of Atlantic sea herring comprised the bulk of total sea herring landings. The increase in value of Atlantic sea herring landings was due to an increase in the use of sea herring for food purposes, principally for canning and for frozen fillets for export to Europe.

The U.S. catch of Atlantic sea herring beyond the 3-mile limit was subject to a quota of 55.1 million pounds in Subareas 5Y (Gulf of Maine) and 5Z (Georges Bank) under regulations of the International Commission for the Northwest Atlantic Fisheries (ICNAF). According to preliminary figures, U.S. fishermen caught about 90 percent of this quota.

Total scallop landings were 8.8 million pounds valued at $14.3 million—down 5 percent in quantity but up 18 percent in value. The decline was attributable to a drop in landings of *bay* and *calico* scallops which more than offset a 12 percent increase in *sea* scallop landings. Landings of sea scallops rose in Maine, but declined in Massachusetts, the principal producing state. At New Bedford, Massachusetts, the nation's leading scallop port, the average ex-vessel price in 1972 was $2.00 per pound compared to $1.48 per pound in 1971.

1973

For the first time in many years, menhaden were plentiful in waters off the New England coast. Landings at Maine ports of nearly 7 million pounds were in the first sizeable production since 1956, although small amounts were taken in 1957 and 1960. Massachusetts landings of 43.2 million pounds exceed that of 1972, and is the best since the record 66.4 million pounds taken in 1956. More fish could have been taken had the industry been prepared. The reasons for menhaden returning to cold northern waters, after a virtual absence of many years, have not yet been determined.

Landings of groundfish and similar species were 181.7 million pounds valued at more than $22 million—an increase of 8% in quantity and 12% in value compared with 1972. Most of this increase was attributable to larger landings of whiting, which rose from 26.7 million pounds in 1972 to 42.7 million pounds in 1973. Despite this increase, whiting landings were below the annual average for the previous five years. Landings were also up slightly for cod, cusk, red hake and pollock, but landings of haddock and ocean perch declined.

1974

Southern New England flounder stocks are under quota regulation by the International Commission for the Northwest Atlantic Fisheries (ICNAF). The United States has been allocated a 1975 quota of 23,900 metric tons (52.7 million pounds) out of a total quota for all countries of 25,000 metric tons (59.8 million pounds) for the southern New England stock of flounders (except yellowtail) and 19,890 metric tons (47.5 million pounds) out of a total quota for all countries of 20,000 metric tons (47.8 million pounds) for yellowtail flounder stocks in the same area.

Landings of soft clams yielded 8.6 million pounds of meats — a decline of 4 percent compared with 1973, and one of the smallest harvests in the last decade. The decline was largely in the New England States where Maine landings of 5.9 million pounds were 19 percent less than in 1973. Fishermen found a poor market for soft clams, possibly because consumers remembered the "red tide" of highly toxic organisms that had caused officials to close many clamming areas in 1972. The production decline in New England was partially offset by the resurgence of the soft clam fishery in Maryland, formerly the leading state in soft clam landings.

Landings of American lobsters were 28.3 million pounds worth $42.4 million — a decline of 3 percent in volume. Fishermen received an average price of nearly $1.50 per pound in 1974 — compared with $1.44 in 1973. Landings declined moderately in the New England States. In Maine, the principal producing area, landings of 16.5 million pounds were 587,000 pounds less than in 1973, and one of the smallest in 30 years.

Sea scallop landings of 6.5 million pounds of meats worth $9.9 million increased 4 percent in volume, but declined 7 percent in value. New England landings accounted for 71 percent of the production. In Massachusetts, the major producing state, landings of slightly more than 4 million pounds were about 1 million pounds greater than in 1973. Several factors contributed to the greater landings. Fishermen had a full fishing season without work stoppages, and more vessels made more trips to the scallop grounds off the New York and Virginia coasts. In this area the scallops, though small, are more abundant than on the Georges Bank grounds. Bay scallop landings yielded 2.1 million pounds of meats — 14 percent more than in 1973.

The shrimp harvest of 17.6 million pounds was 15 percent less than in 1973. However, the value ($5.6 million) declined only 1 percent -- reflecting an increase in the average price per pound from about 27 cents in 1973 to nearly 32 cents in 1974.

INTERNATIONAL COMMISSION FOR THE NORTH ATLANTIC FISHERIES

CONVENTION AREAS AND SUB-AREAS WITH SPECIAL REFERENCE TO THE GRAND BANKS AND GEORGES BANK

Figure 5

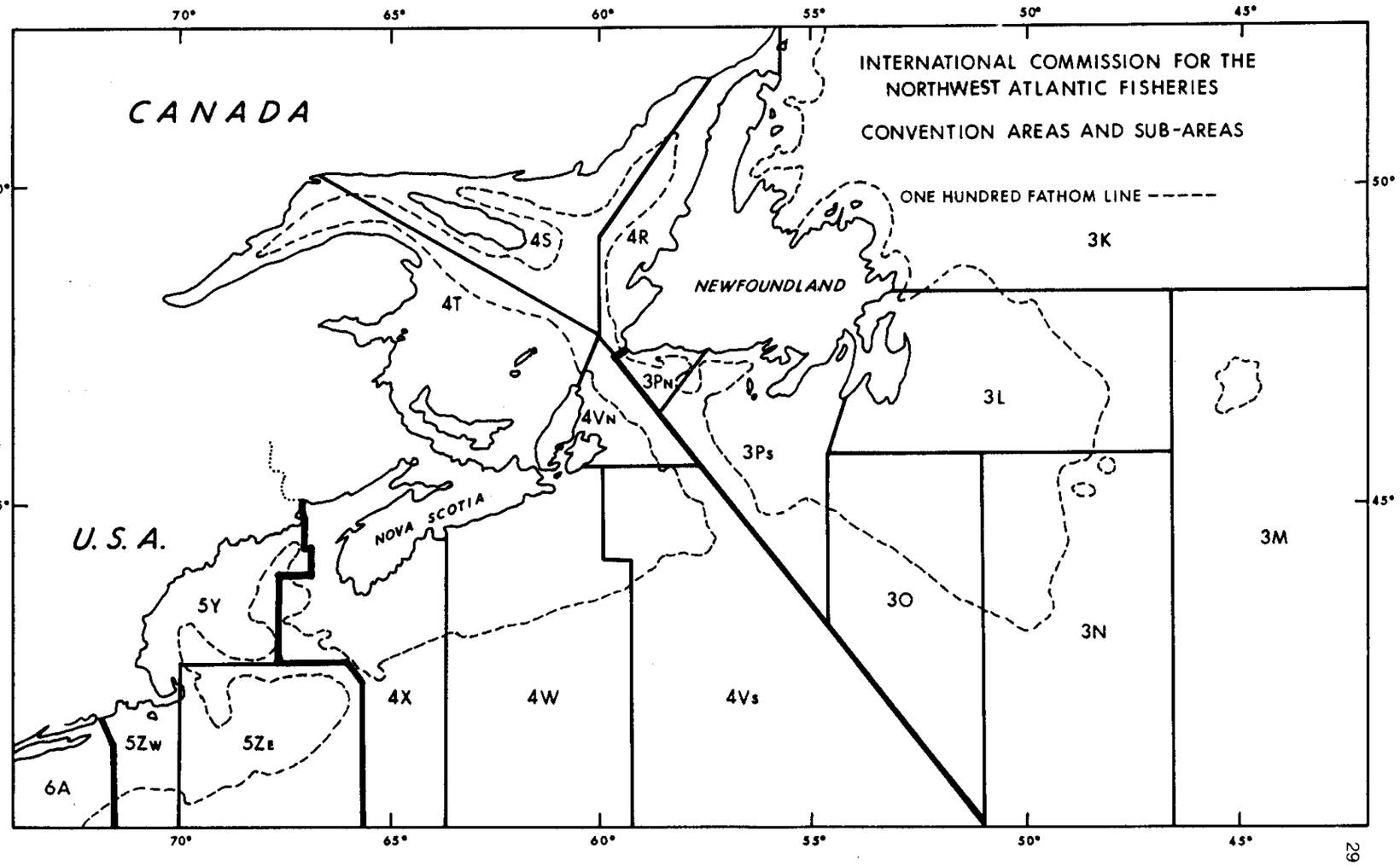

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES
CONVENTION AREAS AND SUB-AREAS
ONE HUNDRED FATHOM LINE
CANADA
U. S. A.
NEWFOUNDLAND
NOVA SCOTIA
70°
65°
60°
55°
50°
45°
4S
4R
4T
3PN
4VN
3K
3L
3Ps
3M
3O
3N
4X
4W
4Vs
5Y
5ZW
5ZE
6A

Table 6

COMMERCIAL FISH AND SHELLFISH LANDINGS
ALL SPECIES, ALL NATIONS, ALL ICNAF CONVENTION
AREAS AND SUB-AREAS
(DOES NOT INCLUDE STATISTICAL
AREAS 0 AND 6)

YEAR	POUNDS LANDED (IN THOUSANDS)
1800	220,460
1951	2,774,561
1952	2,879,719
1953	2,659,248
1954	4,072,652
1955	4,071,153
1956	4,264,509
1957	4,363,258
1958	4,411,404
1959	4,726,662
1960	5,024,283
1961	5,293,244
1962	5,740,778
1963	6,091,309
1964	6,507,979
1965	7,052,515
1966	7,030,469
1967	7,389,819
1968	8,646,441
1969	8,198,907
1970	7,215,655
1971	7,231,088
1972	6,981,968
1973	7,630,120

Source: International Commission for the Northwest Atlantic Fisheries, Statistical Bulletin, Volume 23, 1973; 1975.

COMMERCIAL FISH AND SHELLFISH LANDINGS
ALL SPECIES, ALL NATIONS, ALL ICNAF CONVENTION
AREAS AND SUB-AREAS
1951-1973

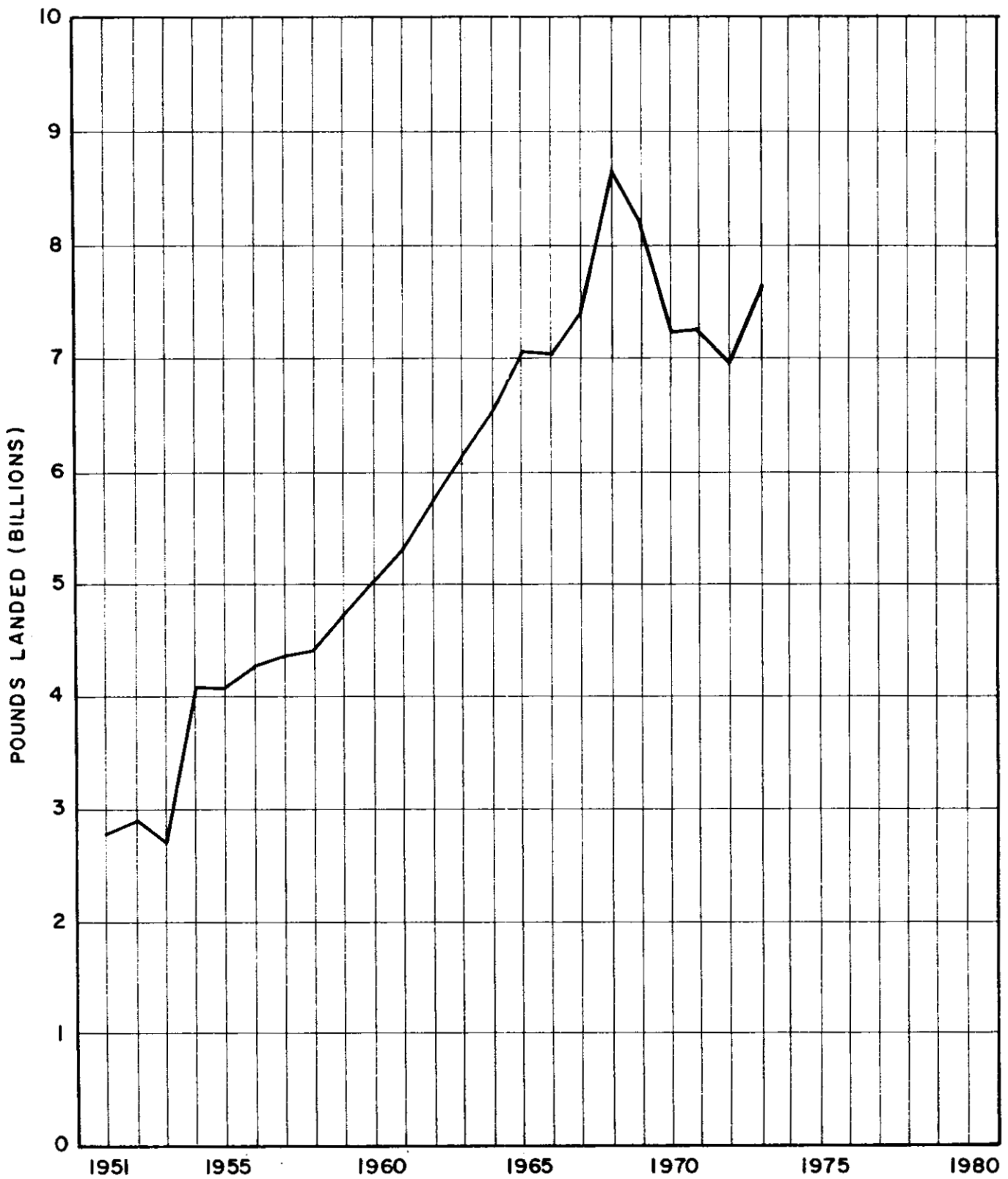


Figure 6

Table 7

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES - NOMINAL CATCH, ALL SPECIES, CONVENTION AREAS AND SUB-AREAS

POUNDS LANDED (IN THOUSANDS)

YEAR		3L	3N	30	3PN	3PS	4VN	4VS	4W	4X	5Y	5ZE	5ZW			
1953	Foreign	121,866	61,742	63,592	(Comb. N&S)	32,430	(Comb. N&S)	43,032	56,171	99,829	1,684	(Comb. E&W)	342,240	TOTAL F.	821,070	
	U.S.	-	-	-	-	-	-	-	-	-	-	-	-	TOTAL U.S.	519,990	(Areas unidentified)
	TOTAL	121,866	61,742	63,592	-	32,430	-	43,032	56,171	99,829	1,684	-	342,240	GRAND TOTAL	1,341,058	
1954	Foreign	401,032	214,763	166,200	(Comb. N&S)	201,925	(Comb. N&S)	120,080	79,028	228,211	-	(Comb. E&W)	2,531	TOTAL F.	1,413,773	
	U.S.	-	-	-	-	-	-	29,561	19,160	54,343	143,731	-	190,111	TOTAL U.S.	1,083,958	(Includes 646,665 lbs, Area 5, sub-
	TOTAL	401,032	214,763	166,200	-	201,925	-	150,036	98,188	282,555	143,731	-	192,642	GRAND TOTAL	2,497,730	area unknown)
1955	Foreign	380,322	248,974	117,596	(Comb. N&S)	324,350	(Comb. N&S)	117,492	94,472	199,547	1,067	(Comb. E&W)	4,127	TOTAL F.	1,487,946	
	U.S.	220	8,724	18,060	-	2,952	-	15,148	12,452	35,611	237,826	-	812,064	TOTAL U.S.	1,259,045	(Includes 115,998 lbs shellfish, not
	TOTAL	380,543	257,698	135,656	-	327,302	-	132,640	106,923	235,158	238,893	-	816,191	GRAND TOTAL	2,746,991	assigned to sub-division)
1956	Foreign	439,591	176,979	94,366	(Comb. N&S)	207,947	(Comb. N&S)	57,558	109,017	239,777	1,143	(Comb. E&W)	7,476	TOTAL F.	1,333,412	
	U.S.	-	16,003	12,509	-	1,332	-	13,225	15,318	49,469	147,389	-	540,947	TOTAL U.S.	1,136,685	(Includes 340,493 lbs, Area 5, sub-
	TOTAL	439,591	192,982	106,875	-	209,278	-	70,783	124,335	289,246	143,742	-	548,423	GRAND TOTAL	2,470,157	area unknown)
1957	Foreign	429,161	199,071	151,077	(Comb. N&S)	218,579	(Comb. N&S)	122,774	113,266	265,030	20,684	(Comb. E&W)	-	TOTAL F.	1,519,642	
	U.S.	-	5,518	4,513	-	571	-	13,157	29,202	29,200	195,616	-	571,276	TOTAL U.S.	1,195,257	(Includes 346,203 lbs, Area 5, sub-
	TOTAL	429,161	204,589	155,590	-	219,150	-	135,931	142,468	294,230	216,300	-	571,276	GRAND TOTAL	2,714,899	area unknown)
1958	Foreign	310,059	134,745	82,379	(Comb. N&S)	141,646	(Comb. N&S)	116,597	114,441	267,583	1,795	(Comb. E&W)	27,103	TOTAL F.	1,196,348	(Includes 295,818 lbs, Area 5, sub-
	U.S.	-	13,148	8,968	-	315	-	17,405	34,822	56,061	207,129	-	479,304	TOTAL U.S.	1,112,961	area unknown)
	TOTAL	310,059	147,893	91,348	-	141,961	-	134,002	149,262	323,637	208,923	-	506,408	GRAND TOTAL	2,309,310	
1959	Foreign	421,396	127,926	100,415	15,827	171,015	62,225	115,589	129,161	290,112	3,743	(Comb. E&W)	43,422	TOTAL F.	1,480,832	
	U.S.	633	17,835	16,076	-	1,986	4,548	12,269	43,539	30,983	221,293	-	524,095	TOTAL U.SL	1,093,435	(Includes 220,187 lbs, Area 5, sub-
	TOTAL	422,029	145,762	116,491	15,827	173,002	66,773	127,858	172,700	321,096	225,037	-	567,517	GRAND TOTAL	2,574,267	area unknown)

Table 7 (Continued)

POUNDS LANDED (IN THOUSANDS)

YEAR		3L	3N	3O	3PN	3PS	4VN	4VS	4W	4X	5Y	5ZE	5ZW			
1960	Foreign	455,578	231,260	130,034	26,149	210,724	84,134	74,729	142,086	319,795	6,116	(Comb. E&W)	63,724	TOTAL F.	1,744,330	
	U.S.	2	17,595	10,176	-	5,836	11,479	17,566	25,311	54,224	165,422	-	467,384	TOTAL U.S.	1,049,423	(Includes 274,436 lbs, Area 5, sub-area unknown)
	TOTAL	455,581	248,855	140,210	26,149	216,560	95,614	92,296	167,397	374,019	171,538	-	531,108	GRAND TOTAL	2,793,753	
1961	Foreign	402,203	155,318	224,655	87,856	231,318	58,693	88,155	179,543	233,163	880	(Comb. E&W)	236,922	TOTAL F.	1,898,705	
	U.S.	-	19,010	17,031	-	-	7,269	8,245	20,620	57,939	169,207	-	496,826	TOTAL U.S.	971,539	(Includes 175,391 lbs, Area 5, sub-area unknown)
	TOTAL	402,203	174,329	241,686	87,856	231,318	65,962	96,401	200,162	291,102	170,087	-	733,748	GRAND TOTAL	2,870,244	
1962	Foreign	413,094	53,340	159,177	69,154	146,474	69,434	73,949	226,948	322,985	1,206	(Comb. E&W)	582,749	TOTAL F.	2,118,508	
	U.S.	18	23,212	745	-	7,513	3,071	7,549	27,211	49,634	154,417	-	524,446	TOTAL U.S.	1,062,013	(Includes 264,207 lbs, Area 5, sub-area unknown)
	TOTAL	413,111	76,553	159,922	69,154	153,987	72,505	81,497	254,160	372,619	155,623	-	1,107,194	GRAND TOTAL	3,180,521	
1963	Foreign	422,622	102,007	130,395	51,475	151,690	88,878	84,635	505,103	402,278	13,973	(Comb. E&W)	649,696	TOTAL F.	2,602,751	
	U.S.	20	17,990	6,561	-	2,368	2,690	11,801	18,419	44,026	324,451	-	529,723	TOTAL U.S.	1,013,393	(Includes 55,344 lbs, Area 5, sub-area unknown)
	TOTAL	422,642	119,997	136,956	51,475	154,057	91,568	96,436	523,522	446,304	338,424	-	1,179,420	GRAND TOTAL	3,616,144	
1964	Foreign	567,572	91,683	144,051	45,820	165,901	90,289	88,175	336,400	517,953	1,933	(Comb. E&W)	908,353	TOTAL F.	2,955,925	
	U.S.	-	6,162	3,743	-	505	2,357	14,160	7,727	35,285	245,143	-	509,977	TOTAL U.S.	825,058	
	TOTAL	567,572	97,845	147,794	45,820	166,405	92,646	102,335	344,127	553,238	247,076	-	1,418,330	GRAND TOTAL	3,780,984	
1965	Foreign	567,931	173,689	188,328	57,999	161,959	89,225	116,943	426,960	472,153	1,221	(Comb. E&W)	1,269,565	TOTAL F.	3,525,973	
	U.S.	137	578	-	236	809	701	4,455	12,698	23,228	246,234	-	444,895	TOTAL U.S.	733,971	
	TOTAL	568,068	174,267	188,328	58,235	162,768	89,926	121,399	439,659	495,380	247,455	-	1,714,460	GRAND TOTAL	4,259,944	
1966	Foreign	508,659	297,736	153,306	42,507	248,181	96,692	99,868	263,403	696,881	4,407	(Comb. E&W)	1,257,179	TOTAL F.	3,669,136	
	U.S.	-	328	15	179	282	862	1,252	15,754	28,783	270,698	-	378,173	TOTAL U.S.	696,327	
	TOTAL	508,659	298,064	153,321	42,686	248,463	97,554	101,121	279,157	725,664	275,105	-	1,635,342	GRAND TOTAL	4,365,463	
1967	Foreign	733,572	395,393	389,315	66,963	399,921	69,888	103,625	121,604	622,639	14,974	(Comb. E&W)	994,731	TOTAL F.	3,912,618	
	U.S.	-	53	-	212	64	1,971	-	5,196	41,623	270,729	-	333,287	TOTAL U.S.	653,135	
	TOTAL	733,572	395,446	389,315	67,175	399,985	71,859	103,625	126,800	664,262	285,703	-	1,328,018	GRAND TOTAL	4,565,753	
1968	Foreign	731,698	332,127	219,190	113,682	476,886	88,713	191,946	273,257	725,467	48,071	913,273	252,883	TOTAL F.	4,331,197	
	U.S.	-	-	26	434	-	7,434	37	1,693	11,288	309,173	199,430	110,473	TOTAL U.S.	640,386	
	TOTAL	731,698	332,127	219,217	114,117	476,886	96,147	191,983	238,950	736,757	357,244	1,113,100	363,356	GRAND TOTAL	4,971,583	

Table 7 (Continued)

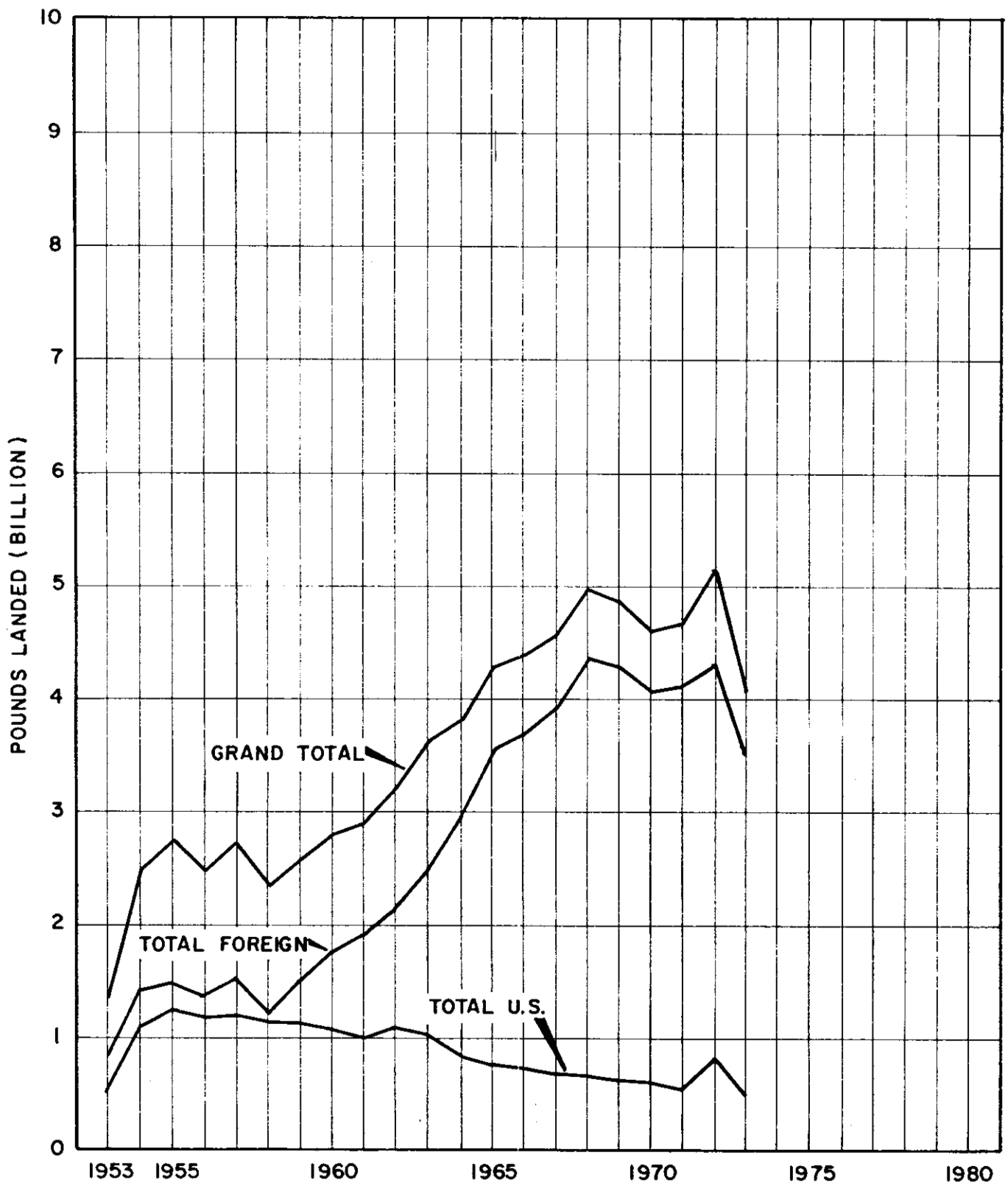
3

POUNDS LANDED
(IN THOUSANDS)

		3L	3N	30	3PN	3PS	4VN	4VS	4W	4X	5Y	5ZE	5ZW		
1969	Foreign	662,892	218,560	221,289	230,742	340,569	92,044	264,746	369,577	546,465	43,812	647,218	631,726	TOTAL F.	4,269,640
	U.S.	117	-	-	-	51	328	-	1,336	7,370	302,374	184,353	92,135	TOTAL U.S.	588,064
	TOTAL	663,009	218,560	221,289	230,742	340,620	92,373	264,746	370,913	553,835	346,186	831,571	723,861	GRAND TOTAL	4,857,704
1970	Foreign	572,277	253,670	170,230	229,177	374,224	113,863	145,867	731,958	462,247	31,978	730,042	184,505	TOTAL F.	4,000,039
	U.S.	121	-	-	-	-	419	-	4,845	7,132	305,544	175,429	87,108	TOTAL U.S.	580,599
	TOTAL	572,398	253,670	170,230	229,177	374,224	114,282	145,867	736,804	469,379	337,522	905,471	271,613	GRAND TOTAL	4,580,639
1971	Foreign	387,085	337,227	225,817	174,926	327,198	118,012	165,734	744,198	389,381	56,248	964,056	227,923	TOTAL F.	4,117,805
	U.S.	-	-	-	-	-	1,424	968	5,930	10,040	319,488	166,974	56,111	TOTAL U.S.	560,935
	TOTAL	387,085	337,227	225,817	174,926	327,198	119,436	166,602	750,128	399,421	377,736	1,131,030	284,034	GRAND TOTAL	4,680,640
1972	Foreign	489,013	306,680	221,042	720,000	254,506	106,006	105,205	369,782	388,651	76,118	1,242,766	306,091	TOTAL F.	4,331,354
	U.S.	-	-	-	-	-	26,235	43,431	152,999	157,056	258,364	136,008	49,099	TOTAL U.S.	823,192
	TOTAL	489,013	306,680	221,042	720,000	254,506	132,241	148,636	522,781	545,707	334,482	1,378,775	355,190	GRAND TOTAL	5,154,547
1973	Foreign	391,078	533,249	168,462	37,531	226,990	155,202	127,379	880,918	559,531	30,904	1,200,600	613,247	TOTAL F.	3,541,134
	U.S.	-	-	-	-	-	154	862	11,336	14,609	270,350	154,068	73,869	TOTAL U.S.	525,111
	TOTAL	391,078	533,249	168,462	37,531	226,990	155,356	128,241	892,254	574,140	301,254	1,354,668	687,116	GRAND TOTAL	4,066,245

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES—NOMINAL CATCH, ALL SPECIES, CERTAIN CONVENTION AREAS AND SUB-AREAS

Figure 7



ATLANTIC COAST FISHERIES

Table 8

FISH & SHELLFISH HARVEST - ATLANTIC COAST[1]
1939 - 1974
(Thousand Pounds)

Year	Shellfish[2]	Fish	Total Fish & Shellfish Harvest
1939	166,876		991,792
1940	151,673		1,001,781
1945	170,133		1,203,603
1950	226,825		1,133,458
1951	213,119		1,196,765
1952	202,744		1,313,123
1953	213,028		1,632,925
1954	199,691		1,685,506
1955	189,987		1,712,878
1956	189,576		1,874,741
1957	202,639		1,710,633
1958	187,680		1,504,275
1959	194,851		1,818,497
1960	230,777		1,598,524
1961	219,376		1,705,595
1962	234,374		1,771,265
1963	218,978		1,351,414
1964	239,883		1,242,816
1965	396,681		1,304,137
1966	260,234		1,037,378
1967	242,817		937,723
1968	206,023		963,826
1969	240,290		810,655
1970	259,666		1,056,608
1971	262,341		986,495
1972	257,568	996,144	1,253,712
1973	256,261	939,357	1,195,618 (Prelim.)
1974			1,080,293 (Prelim.)
1975			
1976			
1977			
1978			
1979			
1980			

(1) Excludes New England States.
(2) Shellfish data are for crabs, lobsters, shrimp, clam meats, sea mussels, oysters, and scallops.

SOURCES:

Historical Catch Statistics (Shellfish), U. S. Dept. of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 5007, July, 1969.

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March, 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States, U. S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

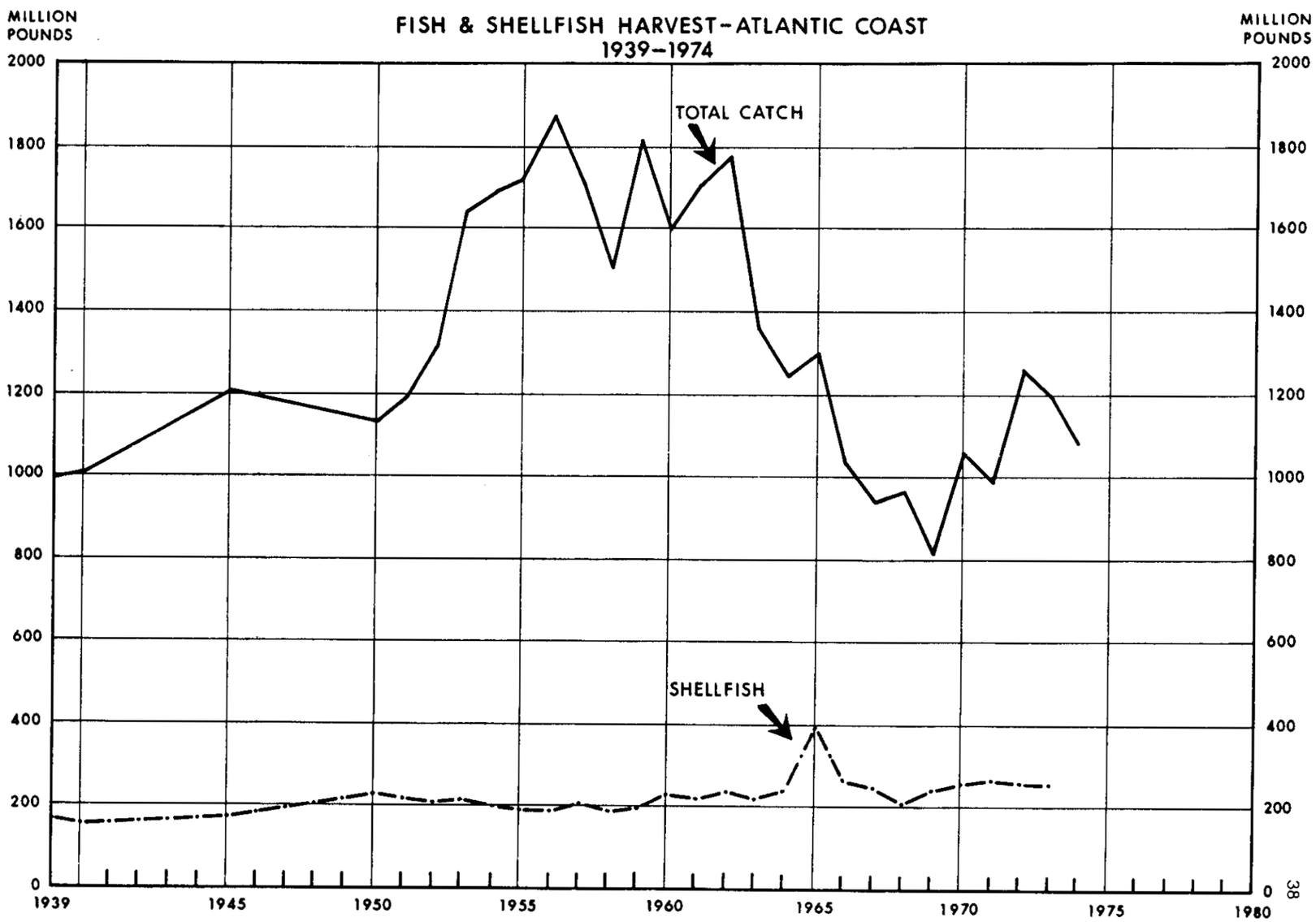

FISH & SHELLFISH HARVEST-ATLANTIC COAST
1939-1974
MILLION POUNDS
MILLION POUNDS
2000
1800
1600
1400
1200
1000
800
600
400
200
0
TOTAL CATCH
SHELLFISH
1939
1945
1950
1955
1960
1965
1970
1975
1980

Figure 8

Table 9

ATLANTIC COAST FISHERY OPERATING UNITS
(Middle Atlantic, Chesapeake and Southern Atlantic States)

YEAR	NO. FISHERMEN	VESSELS NUMBER	VESSELS TONNAGE	BOATS MOTOR	BOATS OTHER
1951	44,518	2,073	36,164	15,654	7,485
1952	43,463	2,098	38,824	14,855	7,125
1953	44,021	2,194	42,581	15,284	5,731
1954	43,802	2,065	40,620	15,907	5,395
1955	46,165	2,442	46,320	17,637	5,348
1956	46,630	2,570	50,087	18,145	4,941
1957	45,892	2,664	53,900	18,177	4,343
1958	42,238	2,703	53,905	18,629	3,558
1959	42,328	2,930	53,099	18,287	3,009
1960	40,732	2,962	93,697	18,476	2,702
1961	39,423	3,072	95,601	18,446	2,458
1962	37,569	2,871	94,768	18,326	2,385
1963	38,277	2,945	101,761	19,291	1,988
1964	38,953	2,900	103,345	19,359	1,999
1965	38,523	3,068	102,347	19,276	1,811
1966	38,090	3,123	104,152	20,214	1,320
1967	36,658	3,078	101,816	20,760	1,282
1968	34,110	3,166	108,011	19,150	997
1969	35,012	3,160	105,352	18,785	1,061
1970	36,348	3,193	101,373	20,246	1,021
1971	36,544	3,335	107,333	21,891	649
1972	36,331	3,481	105,707	21,108	572

SOURCES:

Fishery Statistics of the United States, U. S. Department of the Interior, Bureau of Commercial Fisheries and National Marine Fisheries Service, Statistical Digests from 1951-1971.

Data for 1972 from National Marine Fisheries Service, NOAA.

FISH AND SHELLFISH HARVEST — ATLANTIC STATES
MIDDLE ATLANTIC, CHESAPEAKE AND SOUTH ATLANTIC

1957

The decline in the 1957 Atlantic catch was due primarily to a severe setback in the landings of menhaden in North Carolina, down by 109 million pounds from the previous year. Factors contributing to this decline were smaller fish caught due to unfavorable climatic conditions, widely dispersed schools of fish that avoided massive catches in short periods of time, and violent storms at the peak of the season that allowed the menhaden purse seiners only 8 days of actual fishing time. The oyster harvest continued a downward trend which started in 1951. Severe mortality of oysters was observed in the mid-Atlantic states, and oyster beds in Long Island Sound became infested with starfish.

1958

The decline of harvest in 1958 was attributed mainly to decreased landings of menhaden in the mid-Atlantic states — 296 million pounds less than 1957. The oyster harvest also declined, principally in Delaware Bay, where extensive oyster mortality was observed. The cause was unknown.

1960-1961-1962

The lower catch in 1960 was due to a continuing reduction in menhaden landings. Although menhaden were abundant in Chesapeake and south Atlantic waters, operations were restricted because of the low price of fish meal and solubles, products of the menhaden fishery. For two successive years (1961-62), severe weather conditions curtailed fishing operations along the North Carolina coast, also accounting for the low menhaden catch in this area. Oyster production in Chesapeake reached its lowest since 1951. *Dermocystidium*, predators, oxygen deficiencies, poor setting of seed and an MSX organism found in many sick and dead oysters contributed to the oyster mortalities.

1963

The almost continuous unfavorable weather in winter and spring of 1963 drastically lowered menhaden and blue crab landings in the mid-Atlantic and Chesapeake states.

1964

The menhaden catch again declined in 1964 in the middle and south Atlantic states. Adverse weather reduced the harvest not only of menhaden, but also of alewives, mullet, and oysters in the south Atlantic. The five hurricanes (Cleo, Dora, Gladys, Hilda, and Isabel) that stuck the south Atlantic states adversely affected the setting of oyster spat. Secondly, there was a weak demand for oysters.

1966

The diminishing catch of menhaden along the Atlantic coast continued in 1966, attributed largely to overfishing. A curtailment of fishing to permit replenishment of the resource was recommended. Industrial fish landings decreased. Red hake, the staple of the otter-trawl industrial fishery, were fished by Russians along the continental shelf during winter and early

spring thereby reducing migration of fish inshore. As a result, processing plants closed because neither menhaden nor other industrial fish were sufficiently abundant to ensure profitable operation. Oyster producing areas in middle Atlantic and Chesapeake states showed signs of recovery from MSX infestation.

1967

Fish and shellfish landings again declined in 1967. Menhaden landings continued to decline in the Chesapeake and South Atlantic. There was also a marked decline in the price of menhaden meal due to record imports from Peru. Sea scallop landings declined in middle Atlantic ports inasmuch as fewer New England vessels landed in these ports than in the previous year. Local fishermen are not involved in the offshore sea scallop fishery. A heavy rainfall, with subsequent heavy runoff from the Potomac River, may have caused excessive mortality amont young blue crab populations. An extensive kill of blue crabs that occurred in June affected the entire crab population from South Carolina to Georgia. The cause of the kill was never determined.

1968

Commercial landings of fish and shellfish in the middle Atlantic states (New York, New Jersey and Delaware) were 186.5 million pounds, a gain of 24.5 million pounds over 1967. The greater volume resulted principally from a sharp increase in menhaden landings. Landings of 86.3 million pounds of menhaden were 85 percent greater than in 1967. The catch was the best in three years, but there was no evidence that the fish were returning in their former abundance. Partly as a result of the declining catch, the menhaden fleet diminished.

In January and February, bitterly cold weather froze bays and harbors. Many shellfish beds were inaccessible to fishermen, and most craft were confined to port. The weather hampered the otter trawl fishery, usually at its peak during these months, and prevented full production. November and December were also marked by storms of unusual severity that limited landings and caused fishermen to stop fishing earlier than usual.

Plentiful and comparatively low-priced, scup has been the mainstay of the New Jersey otter trawl fleet for more than two decades. However, landings in the middle Atlantic area began to decline in 1961, and the downward trend has continued. No biological reason has been found for the decline; some fishermen tend to blame foreign fleets that fish along the New Jersey coast.

The harvest of 35.2 million pounds of surf clam meats declined 8.7 million pounds compared with 1967. Landings in New Jersey declined 9.4 million pounds compared with 1967. Major factors contributing to the decline were adverse weather during the first three months of the year, several vessels inactive because they lacked captain or crew, and some New Jersey plants temporarily closed.

The catch of 9.8 million pounds of hard clam meats was nearly 500,000 pounds less than in the previous year, declining for the first time since 1962. Major factors contributing to the decline were: unfavorable weather in January and February, closure of certain productive clamming areas to fishermen, and fewer year-round fishermen.

Landings of hard blue crabs in the Chesapeake were 54.2 million pounds—a decline of 25.2 million pounds compared with 1967. Principal cause of the decrease was the high mortality among crabs hatched in the previous year.

In Maryland, oyster landings dropped to 14.9 million pounds. The decline was caused chiefly by adverse weather in the spring.

The soft clam fishery, centered in the Maryland portion of the Chesapeake Bay, has remained fairly stable during the past few years in both volume and value of the catch. Unfortunately, a mortality of soft clams occurred during the year in the Potomac River—apparently because of high water temperatures accompanied by low levels of dissolved oxygen.

Commercial landings of fish and shellfish at ports of the south Atlantic states (North Carolina, South Carolina, Georgia, and the east coast of Florida) including the commercial catch from fresh water areas of Florida were 339.4 million pounds, a decline of 13.9 million pounds compared with 1967. The volume decline resulted principally from smaller catches of alewives, flounders, menhaden, spot, blue crabs, and miscellaneous species used for animal food and for reduction into meal and oil.

Landings of menhaden of 191.4 million pounds were 2.4 million less than in 1967. Fishermen had anticipated a much greater production because landings through October increased 54 percent compared with 1967. However, catches made during November and December, the months of peak production, did not maintain this lead because stormy weather hampered fishing effort. As in 1967, the 1966-year class was nearly one-half the catch. A small menhaden catch was landed in South Carolina in 1968.

1969

Commercial landings of fish and shellfish in the middle Atlantic states were 137.9 million pounds, a decline of 48.7 million pounds compared with 1968. A sharp decrease in menhaden landings and smaller catches of flounders, scup, whitting, sea scallops, and miscellaneous species used for animal food and for reduction into meal and oil accounted largely for the volume decline. Catches of such high-priced fish and shellfish as bluefish, butterfish, gray sea trout, crabs, lobsters, and surf clams improved substantially during 1969 and contributed to a gain in value.

Severe winter weather caused small landings and hampered fishermen generally in the early months of 1969. The inshore fishermen contended with frozen bays and inlets; the offshore fleet was harassed by high winds and stormy weather.

Menhaden landings of 43.8 million pounds were 42.5 million less than in 1968, and the second smallest harvest since 1932. The catch continued the downward trend that began less than 10 years ago. Only two reduction plants for processing the fish into meal and oil operated in 1969.

The catch of 1.8 million pounds of blue fish was 34 percent more than in 1968. New York landings were the greatest since 1933 and almost twice the 1968 production. An increase in gill netting (especially in Long Island Sound) accounted largely for the improved harvest.

Landings of 1.3 million pounds of oyster meats in the mid-Atlantic states represented a decline of 216,000 pounds compared with 1968. New Jersey oyster planters and dealers had a difficult year because unseasonably warm weather during the early fall resulted in a slow market and unsettled prices. Unfortunately, by the time the market had improved, most of the marketable oysters had already been harvested.

The Chesapeake menhaden catch of 181.7 million pounds declined 34 percent compared with 1968, and was the smallest harvest since 1953. The smaller catch reflected the sharp decline in menhaden landings that has prevailed generally along the entire east coast in recent years. Most of the catch was from the Chesapeake Bay.

The hard blue crab harvest during the first seven months of 1969 was down sharply because the fishery depended on the 1967 year class, which had a poor survivor rate in the winter of 1967-1968. (Production in the second half of 1968 had been affected adversely for the same reason.) The 1969 landings improved during the last five months of the year when the crabs of the 1968 year class were large enough to be caught legally by fishermen.

The Virginia oyster catch declined for the fifth consecutive year because the *Minchinia nelsoni* (MSX) organism continued to decimate the oyster beds. Virginia landings of 7.4 million pounds were the smallest on record.

Commercial landings of fish and shellfish at ports of the south Atlantic states were 318.7 million pounds, a decline of 20.7 million pounds compared with 1968. The volume decline resulted principally from smaller landings of menhaden and miscellaneous species used for animal food and for reduction into meal and oil.

Only 6,659 regular fishermen were employed in the south Atlantic area—576 less than in 1968. The number of vessels used in the commercial fishery declined from 1,253 in 1968, to 1,186 in 1969.

No crab "kills" of any significance were reported during the year—unlike the previous 3-year periods when disastrous "kills" occurred in South Carolina and Georgia waters. Unfortunately, the cause of the "kills" was never clearly identified.

Interest in the commercial potential of the North Carolina calico scallop grounds was stimulated by BCF explorations in 1959. Since that time, BCF scientists have searched successfully for other scallop beds suitable for commercial fishing. In 1968, construction began on four new factory-type scallop vessels, and in early 1969 the vessels entered the fishery. Initially, operations were limited largely to fishing gear and processing trials with modifications required on a continuing basis. The more successful vessels worked a 24-hour day, and by September maximum production had reached 4,000 pounds of processed meats per day. The largest single vessel landings of 12,000 pounds occurred in October. In November, two vessels working together landed about 20,000 pounds of processed meats during four fishing days for an average of 2,500 pounds per vessel day.

Landings of 1.8 million pounds of oyster in south Atlantic states were 38 percent less than in 1968, and the second smallest catch on record. A sharp decline in South Carolina landings from 2.1 million pounds in 1968 to 964,000 pounds in 1969 was the principal cause of the decrease. Many industry members in South Carolina believed that oysters were plentiful on most grounds and that the catch decline was caused not by a lack of oyster stocks but by a shortage of oyster fishermen.

1970

Fishing for menhaden in the Atlantic was much better in 1970 than in 1969. For the first time in many years, menhaden were reported in commercial quantities as far north as Massachusetts.

The Atlantic fishery for groundfish (cod, cusk, haddock, ocean perch, pollock, and white hake) yielded a catch of only 149.3 million pounds—the lowest on record. However, while the catch was 23.8 million pounds less than in 1969, average ex-vessel prices paid to fishermen in 1970 were much higher and fishermen received $15.5 million compared with $15.4 million in 1969. Of the six species, only cusk and white hake showed increases.

Fishermen along the south Atlantic Coast had a poor year. Total shrimp landings were only 20.9 million pounds valued at $11.4 million compared with the 1969 production of 27.4 million pounds valued at $16.4 million.

The blue crab harvest in the Chesapeake Bay area was short of the pre-season prediction—supposedly the result of adverse weather conditions. The outlook for the Chesapeake Bay area will remain poor during most of 1971 according to the Virginia Institute of Marine Science.

Oyster production in and around Chesapeake Bay was a little better than in 1969 but declined in South Carolina and in all of the Gulf states.

1971

Fishermen along the south Atlantic Coast had improved shrimp landings over the poor year experienced during 1970. Record values at all levels contributed to a more successful year financially than volume data would indicate.

The 1971 U.S. oyster catch yielded 54.6 million pounds of meats slightly above the previous year's volume of 53.6 million pounds. Largely responsible for the increase was improved landings from middle Atlantic, Chesapeake and Gulf states; all other areas registered declined. Maryland with 16.7 million pounds, Louisiana with 9.9 million pounds, and Virginia with 8.5 million pounds accounted for 64 percent of total U.S. oyster landings.

1972

In the south Atlantic states, the shrimp fishery declined from 30.6 million pounds worth $20.6 million in 1971 to 25.9 million pounds worth $18.5 million in 1972.

Hard blue crab landings in the middle Atlantic and Chesapeake states were adversely affected by hurricane Agnes, a tropical storm that devastated parts of the northeastern coastal and inland areas in June 1972. The storm curtailed crab landings by causing loss of gear and fishing effort, but by July and August the fishery had reached its normal production. The 1972 year-class of young crabs, however, may be small because the storm came when the crabs were spawning, thus affecting the 1972 hatch.

Total landings of menhaden, the leading species used for industrial purposes, were 1.9 billion pounds in 1972, a decrease of 251 million pounds compared to the previous year. Although landings at Gulf ports declined, landings at Atlantic Coast ports increased by 248 million pounds in 1972.

Lobster landings in the middle Atlantic states declined, but in the Chesapeake states, principally in Virginia, they increased moderately. All along the Atlantic Coast fishermen turned increasingly to the offshore lobster pot fishery.

Landings of 89.1 million pounds of clam meats worth a record $31.9 million increased 8 percent in volume and 4 percent in value compared with 1971. The principal reason for the greater volume was a near-record harvest of 63.4 million pounds of *surf* clam meats. Record landings of 23.4 million pounds of surf clams in Virginia were 419 percent greater than in 1971 and contributed substantially to the increase. Many vessels from other states began working out of Virginia ports because the clamming was in areas off the Virginia Coast. New Jersey, formerly the leading state in surf clam landings, accounted for 21.3 million pounds—a decline of 26 percent compared with 1971. Together New Jersey and Virginia accounted for 70 percent of the total U.S. surf clam harvest.

Maryland, long the leading state in soft clam production, had landings of only 1.9 million pounds—the smallest since 1955. The Maryland soft clam resource was severely depleted in June by an influx of fresh water and high water temperatures, which followed hurricane Agnes. State officials closed the fishery until such time as the resource had recovered from the effects of the hurricane.

Oyster landings increased slightly in the middle Atlantic and south Atlantic states, but declined in the Chesapeake. Landings in the Chesapeake states (22.1 million pounds) were 12 percent less than in 1971; however, the Chesapeake and Gulf states landings comprised 76 percent of the total U.S. oyster harvest.

The Atlantic and Pacific fishery for groundfish (Atlantic and Pacific cod, cusk, haddock, white hake, pollock, and Atlantic ocean perch) yielded 148.8 million pounds valued at $18.1 million—down 6 percent in quantity but up 8 percent in value compared to 1971.

Landings of the leading groundfish species declined in 1972: *Atlantic cod* landings were down 12 percent compared to 1971; *haddock* landings were down 46 percent; and Atlantic *ocean perch* landings were down 2 percent. Landings of the less important groundfish species increased: *Pacific cod* landings were 10.4 million pounds, up 61 percent compared to 1971; *pollock* landings were 12.8 million pounds, up 18 percent; and *white hake* landings were 6.6 million pounds, up 16 percent. In 1972, *haddock* was the only Atlantic groundfish subject to a catch quota by the International Commission for the Northwest Atlantic Fisheries (ICNAF).

1973

Shrimp landings in the South Atlantic states of 25.1 million pounds were slightly less than 1972, but the value of $26.6 million reflected an increase of 44% over 1972.

Chesapeake States hard blue crab landings of 55.7 million pounds were 22% less than in 1972. Fishery officials blamed a poor year class in both 1971 and 1972, as well as the after-effects of Hurricane Agnes in 1972 for the production declines.

For the second consecutive year, Virginia led in surf clam landings with 43.2 million pounds - 85% more than in 1972. Together, Virginia and New Jersey accounted for 79% of the total U.S. surf clam landings. Maryland, a long-time leader in soft clam production, had landings of only 700 thousand pounds - a decline of 64% compared with 1972. Fishery authorities attributed the decline to the continuing after effects of Hurricane Agnes.

1974

Landings of flounders in the Atlantic states led all other areas and accounted for 69 percent of the total. The chief reason for the decline in U.S. landings of flounders was a decline in landings of the principal flounder species, yellowtail flounder. Landings of yellowtail dropped from 65.4 million pounds in 1973 to 55.3 in 1974, a decline of 16 percent.

Landings of Atlantic groundfish and similar species (cod, cusk, haddock, hakes, Atlantic ocean perch, pollock, and whiting) were 171.3 million pounds valued at $23.6 million in 1974, down 6 percent in quantity but up 5 percent in value compared to 1973. Most of the decrease was attributable to decreased landings of Atlantic ocean perch and whiting. Landings of cod, which have increased in recent years, were 58.8 million pounds valued at $11.3 million in 1974. Cod landings accounted for almost half of the total value of all groundfish landings. Landings of haddock were only 8.2 million pounds valued at $3.0 million, down slightly in volume and value from 1973. From 1924 to 1966 the haddock fishery never yielded less than 100 million pounds a year. To prevent further depletion, the Atlantic groundfish is under international regulation.

Atlantic sea herring landings were 71.9 million pounds, up sharply from the previous year and close to the 1969-73 average of 72.2 million pounds. Atlantic sea herring landings are subject to the International Commission for the Northwest Atlantic Fisheries country quotas.

Menhaden landings along the Atlantic coast declined for the third consecutive year. Atlantic Coast landings of 683.2 million pounds were 134.3 million less than in 1973. Despite the downward trend of landings on the Atlantic seaboard, the New England harvest of 78.5 million pounds increased 14 percent, and was the best since 1956. In the Middle Atlantic and Chesapeake States, however, landings declined sharply. This decline occurred when large numbers of juvenile menhaden

migrated from New Jersey, Delaware, Maryland, and Virginia waters to the North Carolina coast, where they increased the North Carolina fall fishery landings significantly.

For the third consecutive year, Virginia led in surf clam production with 58.2 million pounds of meats — up 35 percent over 1973. The greatest fishing effort was expended off the Virginia coast where clammers worked extensive beds of small clams. New Jersey, the former surf-clam-production leader, was second with 22.7 million pounds of meats. The two states together accounted for 84 percent of the total surf clam harvest. Landings of hard clams yielded 15 million pounds of meats — 3 percent more than in 1973. The New York production was the third best in the state since the record 10.3 million pounds landed in 1947. New Jersey with 1.7 million pounds of meats and Virginia with 1.1 million pounds were the other principal producing states. Landings of soft clams yielded 8.6 million pounds of meats — a decline of 4 percent compared with 1973, and one of the smallest harvests in the last decade. The Maryland fishery was hit hard by Hurricane Agnes in 1972. Maryland landings in 1974 were 1.8 million pounds — up sharply from the 700,000 pounds taken in 1973.

Landings of hard blue crabs were 142.5 million pounds — 6 percent more than in 1973. Landings in the Chesapeake States (64.0 million pounds) increased 15 percent in the South Atlantic States (34.3 million), 6 percent.

Landings of American lobsters were 28.3 million pounds worth $42.4 million — a decline of 3 percent in volume. Fishermen received an average price of nearly$1.50 per pound in 1974 — compared with $1.44 in 1973. Landings declined moderately in the Middle Atlantic States, but increased slightly in the Chesapeake States.

Oyster landings yielded 44.9 million pounds of meats worth $33.6 million — a decline of 8 percent in volume and 5 percent in value compared with 1973. Production declined in the Middle Atlantic States, but increased slightly in the Chesapeake and South Atlantic States. The Chesapeake States led in production with 22.9 million pounds of meats. In the Chesapeake fishery, Maryland was first in production with 17.3 million pounds — down slightly from 1973. Recruitment in the Maryland fishery has been poor during recent years. In 1974 state officials opened areas that previously had been closed. This action is expected to increase production substantially in the future. In Virginia, landings of 5.7 million pounds increased 60 percent — compared with the all-time low of the previous year. Landings of 26.9 million pounds of shrimp in the South Atlantic States increased 7 percent, but the value of $18.1 million decreased 32 percent. Most fishermen in this area faced a difficult economic situation in 1974. Although shrimp landings generally increased, the record high prices of the previous year declined sharply. At the same time, vessel operating costs soared because of increased cost of fuel, gear, and other essentials. By year's end, many fishermen were in a precarious financial condition.

GULF OF MEXICO FISHERIES

THE GULF OF MEXICO COMMERCIAL FISHERY

For the past 10 years the fish and shellfish resources of the Gulf of Mexico have furnished more than 25% of the tonnage required for United States consumption as food and for industrial purposes. In 1971, the Gulf states led all regions of the United States in quantity (2,096,926,000 pounds) and value ($199,851,000) of fish and shellfish harvested, accounting for 42% and 31% respectively of the total United States catch. This was greater than the Gulf states record set in 1970.

Gulf states fisheries have increased from only 4% of the total U. S. catch in 1930 to 42% in 1971 due largely to growth in menhaden and shrimp fisheries. The 1.6 million pound menhaden harvest in 1971 set a new record for the Gulf of Mexico. Fishery statistics from 1939 to the present illustrate the growth in the Gulf fishery, with estuarine-dependent species such as shrimp, oysters, and menhaden accounting for approximately 90% of the annual fisheries value.

With a harvest of 1,396 million pounds in 1971, Louisiana ranked first in the 50 states. Louisiana landings ranked third in value at 72.6 million dollars, behind first place California and second ranked Alaska.

Commercial fishing occurs along approximately 1,500 miles of Gulf coastline but more than 20 percent of the country's total fishery products are landed from a 425 mile coastal strip between Pascagoula, Mississippi, and Port Arthur, Texas, a region referred to as the "Fertile Fisheries Crescent". The high poundage production in these waters lies in "industrial" fish and menhaden, while high value lies in shrimp, oysters, and crab. The area encompasses both sides of the mouth of the Mississippi River, the largest estuarine region of the North American continent, except possibility for Hudson Bay. In world production it is second only to the Peruvian coast.

Although during the last century redfish, black drum, speckled trout, and flounder were the principal commercial fish harvested from bays and estuaries of the Gulf coast, few of them have been widely accepted as food fish along the Gulf. The sport fishery may produce several times more tonnage of fish for human consumption in the Gulf region than does the commercial fishery.

The most important fin-fish harvested in recent years have been menhaden and "industrial" fish. The latter, often referred to as "trash fish," comprise a substantial portion of the Gulf fishery, with approximately 100 million pounds caught and processed on the Mississippi and Louisiana coasts annually. Common and flat croaker constitute about half the weight. A portion of the industrial fish harvest is shipped frozen to northern mink farms while the balance is processed and canned for the pet food industry.

The menhaden fishery, beginning but not developing during World War II, was revived in 1948 and grew until Gulf production exceeded 1 billion pounds in 1964 and 1966. Menhaden oil finds a market in paints, waxes, cleansers, lipstick, margarine, lubricants, and leather dressing. The meal and protein derivatives are commonly used in animal feeds, especially for poultry.

The numbers of people and vessels occupied in Gulf commercial fishing has increased slightly during the past 20 years. However, the gross tonnage of the vessels has increased substantially, and harvesting operations have been altered materially with changes in fishing gear.

Despite the impact commercial fishing exerts upon Gulf marine resources, there is no evidence that any species is being overharvested. At the same time, it must be acknowledged that the climbing rate of harvest does not reflect a continuing increase in the populations of the harvested species. Rather, the ascending scale tends to imply that fishery stocks are maintaining a reproductive rate adequate to sustain populations greater than are being harvested annually. There is no evidence to the contrary. Further, based upon experimental trawls in the Gulf by the National Marine Fisheries Service, it has been estimated that the catch could be increased substantially without affecting the base of the fishery resource.

However, added to the harvest by American commercial fishing interests is the inestimable toll by Russian, Japanese, and Cuban vessels beyond the 12 mile territorial limit. It is known that fishing fleets from these countries are substantially utilizing blue and white marlin, swordfish, tuna, and sailfish, but the impact on total resources is unknown.

Table 10

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1939	Florida, West	56,987	3,833	60,820	9,349[2]	226[2]	3,979[2]	2,798[2]	3,587[2]
	Alabama	5,077	4,042	9,120	1,229	43	476	303	434
	Mississippi	9,874	14,852	24,726	2,692	192	2,340	631	579
	Louisiana	2,080	125,646	127,725	5,362	246	2,125	1,683	1,313
	Texas	4,840	12,585	17,425	1,920	69	715	573	354
	GULF TOTAL	78,858	160,958	239,816	20,552	776	9,635	5,988	6,267
1940	Florida, West	5,052	4,174	54,676	8,902[2]	199[2]	3,505[2]	2,597[2]	2,967[2]
	Alabama	4,462	6,882	11,344	1,134	41	517	379	534
	Mississippi	25,678	12,324	38,002	1,877	243	2,962	389	238
	Louisiana	914	125,713	126,627	4,858	288	2,449	1,490	1,173
	Texas	3,037	16,332	19,369	1,538	69	715	475	185
	GULF TOTAL	39,143	165,425	250,018	18,309	840	10,148	5,330	5,097
1945	Florida, West	63,551	5,771	69,322	8,902[2]	199[2]	3,505[2]	2,597[2]	2,967[2]
	Alabama	6,884	8,252	15,136	1,167	66	906	375	434
	Mississippi	58,288	12,499	70,787	1,669	215	2,701	602	127
	Louisiana	3,434	160,468	163,902	6,253	486	5,933	1,779	2,600
	Texas	5,153	16,780	21,933	1,635	203	2,215	427	265
	GULF TOTAL	137,310	203,770	341,080	19,626	1,169	15,260	5,780	6,393
1950	Florida, West	45,989	16,024	62,013	7,352	674	8,726	996	3,145
	Alabama	3,313	7,675	10,988	1,300	86	1,355	508	256
	Mississippi	70,130	14,008	84,138	2,594	321	5,357	690	163
	Louisiana	216,143	100,107	316,250	8,206	882	12,267	2,245	1,382
	Texas	50,926	46,326	97,251	4,315	741	15,176	931	255
	GULF TOTAL	386,501	184,140	570,641	23,767	2,704	42,881	5,370	5,201

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.
2) Total for both east and west coasts of Florida.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1951	Florida, West	–	–	88,271	–	–	–	–	–
	Alabama	–	–	13,643	–	–	–	–	–
	Mississippi	–	–	134,830	–	–	–	–	–
	Louisiana	220,778[3]	103,005[3]	323,738[3]	–	–	–	–	–
	Texas	–	–	98,290	–	–	–	–	–
	GULF TOTAL	428,829	220,839	649,668					
1952	Florida, West	–	–	101,135	–	–	–	–	–
	Alabama	–	–	13,506	–	–	–	–	–
	Mississippi	–	–	137,485	–	–	–	–	–
	Louisiana	292,405[3]	102,029[3]	394,734[3]	–	–	–	–	–
	Texas	–	–	122,725	–	–	–	–	–
	GULF TOTAL	532,623	226,884	759,507	–	–	–	–	–
1953	Florida, West	50,249	57,778	108,027	6,426	600	–	678	2,047
	Alabama	3,621	8,343	11,964	1,412	134	–	412	350
	Mississippi	67,493	10,247	77,740	2,674	404	–	393	157
	Louisiana	314,411	105,318	419,729	7,294	777	–	2,204	964
	Texas	70,020	1,514	141,962	4,595	851	–	820	411
	GULF TOTAL	505,794	253,628	759,422	21,359	2,359	47,476	4,507	3,929
1954	Florida, West	47,079	50,442	97,521	8,024	952	–	2,120	1,181
	Alabama	4,287	7,937	12,224	1,243	124	–	512	198
	Mississippi	106,250	10,494	116,744	1,943	288	–	554	194
	Louisiana	276,594	100,006	376,600	7,494	866	–	2,751	170
	Texas	57,269	94,343	151,612	5,696	995	–	1,251	252
	GULF TOTAL	491,479	263,222	754,701	23,498	2,948	60,917	7,188	1,992

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.
3) Fish and Shellfish data for 1951 & 1952 were furnished by the State of Louisiana, hence, Gulf total may not tally.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1955	Florida, West	49,827	55,929	105,756	8,094	1,107		2,087	903
	Alabama	3,571	9,870	13,441	1,297	139		465	194
	Mississippi	166,019	17,118	183,137	2,084	319		506	215
	Louisiana	303,942	93,261	397,203	7,419	884		2,702	107
	Texas	57,680	72,421	130,101	4,601	872		1,035	122
	GULF TOTAL	581,039	248,599	829,638	22,821	3,081	65,937	6,795	1,541
1956	Florida, West	50,973	56,621	107,594	8,483	1,050		2,682	1,059
	Alabama	3,158	9,162	12,320	1,269	158		469	187
	Mississippi	219,197	13,743	232,940	2,799	552		521	173
	Louisiana	327,444	81,216	408,660	7,716	1,004		2,609	27
	Texas	71,943	66,317	138,260	4,761	990		1,106	55
	GULF TOTAL	672,715	227,059	899,774	23,318	3,092	67,267	7,387	1,501
1957	Florida, West	57,291	51,984	109,275	8,070	1,126		2,437	739
	Alabama	3,100	8,788	11,888	1,209	177		453	194
	Mississippi	194,811	12,849	207,660	3,100	555		522	163
	Louisiana	168,651	54,149	222,800	7,444	946		2,437	37
	Texas	62,327	77,983	140,310	5,360	1,300		754	58
	GULF TOTAL	486,180	205,753	691,933	22,591	3,201	73,445	6,603	1,191
1958	Florida, West	68,407	58,178	126,585	7,502	1,194		2,219	719
	Alabama	3,395	6,948	10,343	1,268	206		445	169
	Mississippi	196,623	9,199	205,822	3,094	558		563	122
	Louisiana	257,163	59,887	317,050	8,330	1,214		2,719	73
	Texas	73,197	75,840	149,037	6,375	1,672		811	39
	GULF TOTAL	598,785	210,052	808,837	22,294	3,507	82,627	6,757	1,122

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1959	Florida, West	81,267	50,620	131,887	7,748	1,748		2,908	453
	Alabama	4,016	10,006	14,022	1,377	234		486	161
	Mississippi	238,281	14,666	252,947	3,032	558		624	158
	Louisiana	468,230	77,528	545,758	8,784	1,362		2,733	64
	Texas	123,164	87,173	210,337	6,068	1,628		747	12
	GULF TOTAL	914,958	239,993	1,154,951	22,955	3,678	88,774	7,468	818
1960	Florida, West	67,815	67,720	135,535	7,613	1,111		3,001	402
	Alabama	3,268	8,838	12,106	1,448	234		502	154
	Mississippi	297,975	16,239	314,214	2,987	505		937	153
	Louisiana	485,011	81,400	566,411	9,379	1,415		3,292	65
	Texas	151,203	86,481	237,684	5,929	1,591		765	13
	GULF TOTAL	1,005,272	260,678	1,265,950	23,077	3,429	145,952	8,285	787
1961	Florida, West	66,231	59,148	125,379	7,389	1,141		2,946	229
	Alabama	3,582	4,876	8,458	1,439	200		525	176
	Mississippi	381,528	10,161	391,689	3,080	567		998	147
	Louisiana	593,591	54,743	648,334	8,417	1,131		3,563	60
	Texas	140,501	62,751	203,252	5,845	1,594		791	28
	GULF TOTAL	1,185,433	191,679	1,377,112	22,244	3,267	140,456	8,571	640
1962	Florida, West	68,600	51,007	119,607	7,874	1,116		3,361	222
	Alabama	4,253	4,828	9,081	1,375	183		545	119
	Mississippi	360,988	9,086	370,074	3,196	554		1,013	123
	Louisiana	702,062	64,478	766,540	8,613	1,117		3,796	130
	Texas	110,248	61,860	172,108	5,332	1,324		1,168	45
	GULF TOTAL	1,246,151	191,259	1,437,410	26,390	3,219	137,368	9,639	638

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1963	Florida, West	68,500	56,183	124,683	7,835	1,148		3,072	224
	Alabama	4,832	10,056	14,888	1,791	268		632	117
	Mississippi	326,143	15,170	341,313	3,121	593		1,940	129
	Louisiana	650,672	101,612	752,284	10,205	1,498		4,212	114
	Texas	90,476	75,868	166,344	6,005	1,419		1,276	42
	GULF TOTAL	1,140,623	258,889	1,399,512	24,483	3,369	142,809	9,992	626
1964	Florida, West	69,040	60,619	129,659	8,584	1,278		3,391	187
	Alabama	5,081	9,986	15,067	1,733	251		564	113
	Mississippi	319,365	12,533	331,898	3,068	585		899	120
	Louisiana	618,080	78,060	696,140	10,407	1,602		4,289	128
	Texas	73,152	71,918	145,070	5,997	1,479		1,056	47
	GULF TOTAL	1,084,718	233,116	1,317,834	25,171	3,582	151,665	10,149	595
1965	Florida, West	69,854	66,452	135,866	8,342	1,255		3,307	114
	Alabama	5,854	11,935	17,789	1,854	316		552	107
	Mississippi	355,763	12,622	368,385	2,874	552		972	52
	Louisiana	704,845	82,242	787,087	10,556	1,585		4,495	144
	Texas	68,839	85,509	154,348	6,210	1,499		1,228	36
	GULF TOTAL	1,204,715	258,760	1,463,475	25,571	3,683	162,820	10,536	453
1966	Florida, West	71,696	54,279	125,975	7,997	1,279		3,079	65
	Alabama	6,459	14,103	20,562	2,084	389		583	95
	Mississippi	258,603	11,250	269,853	2,987	568		1,973	41
	Louisiana	580,315	76,519	656,834	10,523	1,616		4,506	38
	Texas	45,512	77,432	122,944	6,273	1,552		1,245	43
	GULF TOTAL	962,585	233,583	1,196,168	25,309	3,782	177,124	10,366	282

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1967	Florida, West	68,224	46,184	114,408	7,788	1,277		3,143	26
	Alabama	7,511	18,901	26,412	2,130	418		566	99
	Mississippi	247,632	14,427	262,059	3,140	545		1,197	34
	Louisiana	547,255	92,420	639,675	11,062	1,698		4,626	40
	Texas	29,162	109,065	138,227	6,741	1,794		1,073	49
	GULF TOTAL	899,784	280,997	1,180,781	25,923	3,968	200,916	10,600	248
1968	Florida, West	71,750	47,543	119,293	7,319	1,394		2,606	38
	Alabama	8,010	18,650	26,660	2,195	480		561	82
	Mississippi	225,539	15,113	240,652	3,306	665		1,249	16
	Louisiana	662,220	93,749	755,969	11,000	1,734		4,520	40
	Texas	56,989	90,732	147,721	6,989	1,903		1,219	46
	GULF TOTAL	1,024,508	265,787	1,290,925	25,470	4,237	226,255	10,131	222
1969	Florida, West	70,319	46,206	116,525	7,223	1,299	64,268	2,685	28
	Alabama	11,131	17,384	28,515	2,290	520	28,233	570	93
	Mississippi	294,860	12,076	306,936	2,900	551	30,370	1,199	12
	Louisiana	896,231	106,929	1,003,160	10,929	1,766	107,224	4,837	52
	Texas	78,561	80,809	159,370	6,681	1,917	120,717	953	50
	GULF TOTAL	1,351,102	263,404	1,614,506	25,048	4,316	234,993	10,222	235
1970	Florida, West	61,830	54,659	116,489	6,933	1,209	58,852	2,599	18
	Alabama	12,895	16,725	29,620	2,042	461	25,615	609	84
	Mississippi	210,634	12,392	223,026	2,848	536	29,762	996	1
	Louisiana	995,946	111,306	1,107,252	11,228	1,956	122,282	4,341	40
	Texas	48,459	98,537	146,996	6,311	1,819	116,994	845	22
	GULF TOTAL	1,329,763	293,618	1,623,381	29,362	5,981	353,505	9,390	165

1) Starting in 1953, the Gulf Total represents the number exclusive of duplication, i.e., a vessel or fisherman counted only once if operating in both states.

Table 10 (Continued)

FISHERY STATISTICS OF THE GULF STATES
VARIOUS YEARS, 1939—1973

YEAR	STATE	FISH 1,000 LBS.	SHELLFISH 1,000 LBS.	TOTAL 1,000 LBS.	NO.[1] FISHERMEN	OPERATING UNITS[1] VESSELS MOTOR	VESSELS GROSS TONNAGE	BOATS MOTOR	BOATS OTHER
1971	Florida, West	63,204	44,282	107,486	6,798	1,189	59,881	2,517	10
	Alabama	15,136	19,101	34,237	1,958	470	27,185	598	82
	Mississippi	384,467	12,436	396,903	2,657	443	27,623	1,022	3
	Louisiana	1,273,944	116,888	1,390,832	11,088	1,808	125,414	4,426	36
	Texas	69,715	97,468	167,183	7,076	2,046	135,689	881	10
	GULF TOTAL	1,806,465	290,641	2,096,641	24,810	4,315	253,863	9,410	141
1972	Florida, West	63,966	44,235	108,201					
	Alabama	15,768	20,274	36,042					
	Mississippi	245,948	10,724	256,672					
	Louisiana	962,719	109,536	1,072,255					
	Texas	6,756	107,982	114,738					
	GULF TOTAL	1,295,157	292,751	1,587,908	NA	NA	NA	NA	NA
1973	Florida, West	64,801	44,399	109,200					
	Alabama	22,026	14,723	36,749					
	Mississippi	261,002	6,692	267,694					
	Louisiana	936,003	99,956	1,035,959					
	Texas	7,341	90,528	97,869					
	GULF TOTAL (Prelim)	1,291,173	256,298	1,547,471	NA	NA	NA	NA	NA
1974	Florida, West			104,666					
	Alabama			36,962					
	Mississippi			304,794					
	Louisiana			1,228,906					
	Texas			97, 203					
	GULF TOTAL (Prelim)			1,772,531	NA	NA	NA	NA	NA

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States. U.S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Statistical Digests No. 62, 1968, No. 63, 1969, No. 64, 1970, No. 65, 1971

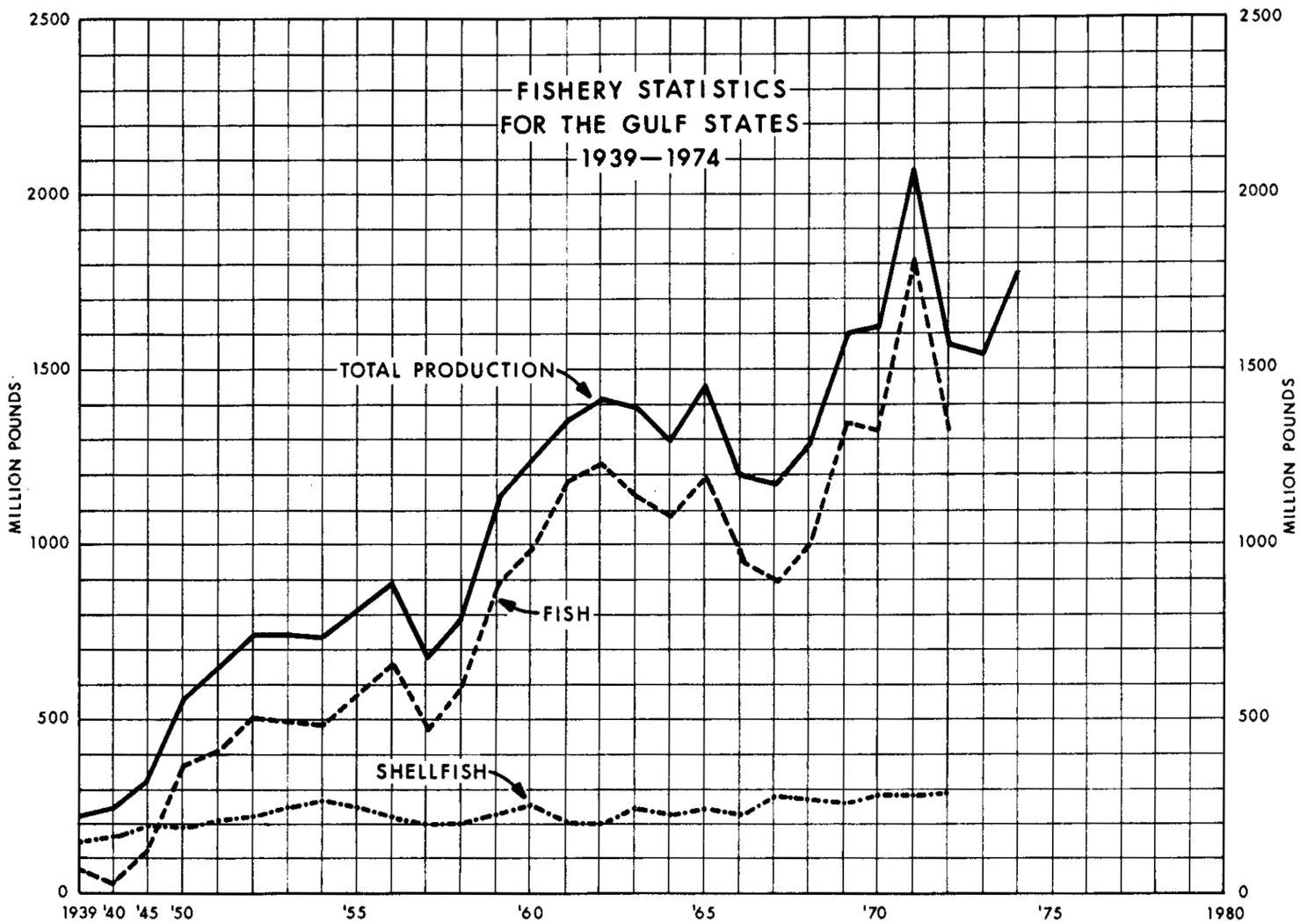

FISHERY STATISTICS
FOR THE GULF STATES
1939—1974
TOTAL PRODUCTION
FISH
SHELLFISH
MILLION POUNDS
2500
2000
1500
1000
500
0
1939 '40 '45 '50
'55
'60
'65
'70
'75
1980

Figure 9

Figure 10

FISHERY STATISTICS
FOR LOUISIANA
1939—1974

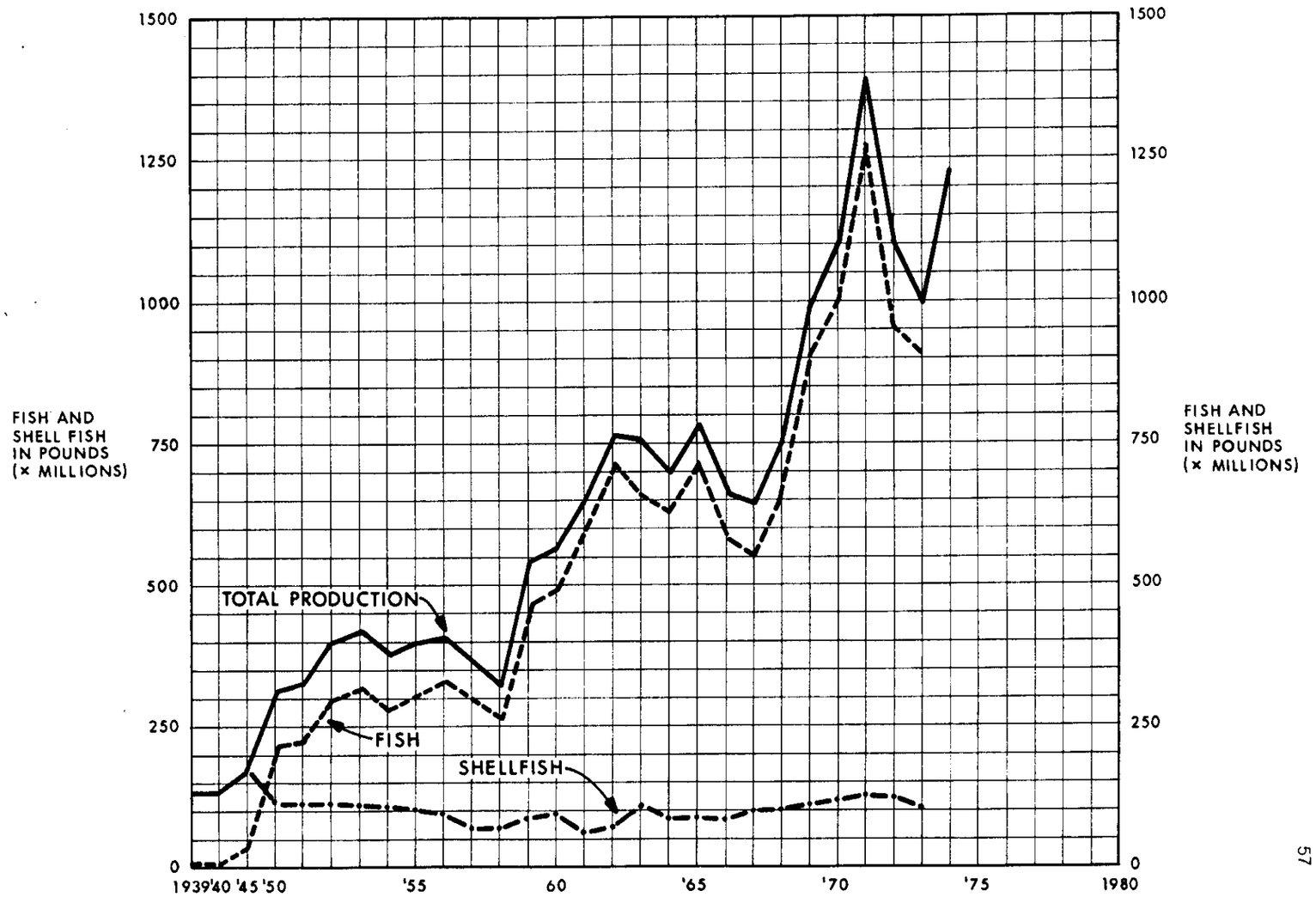


Figure 11
GULF STATE FISHERIES IN PERCENT OF TOTAL U.S. CATCH
VARIOUS YEARS, 1930-1974

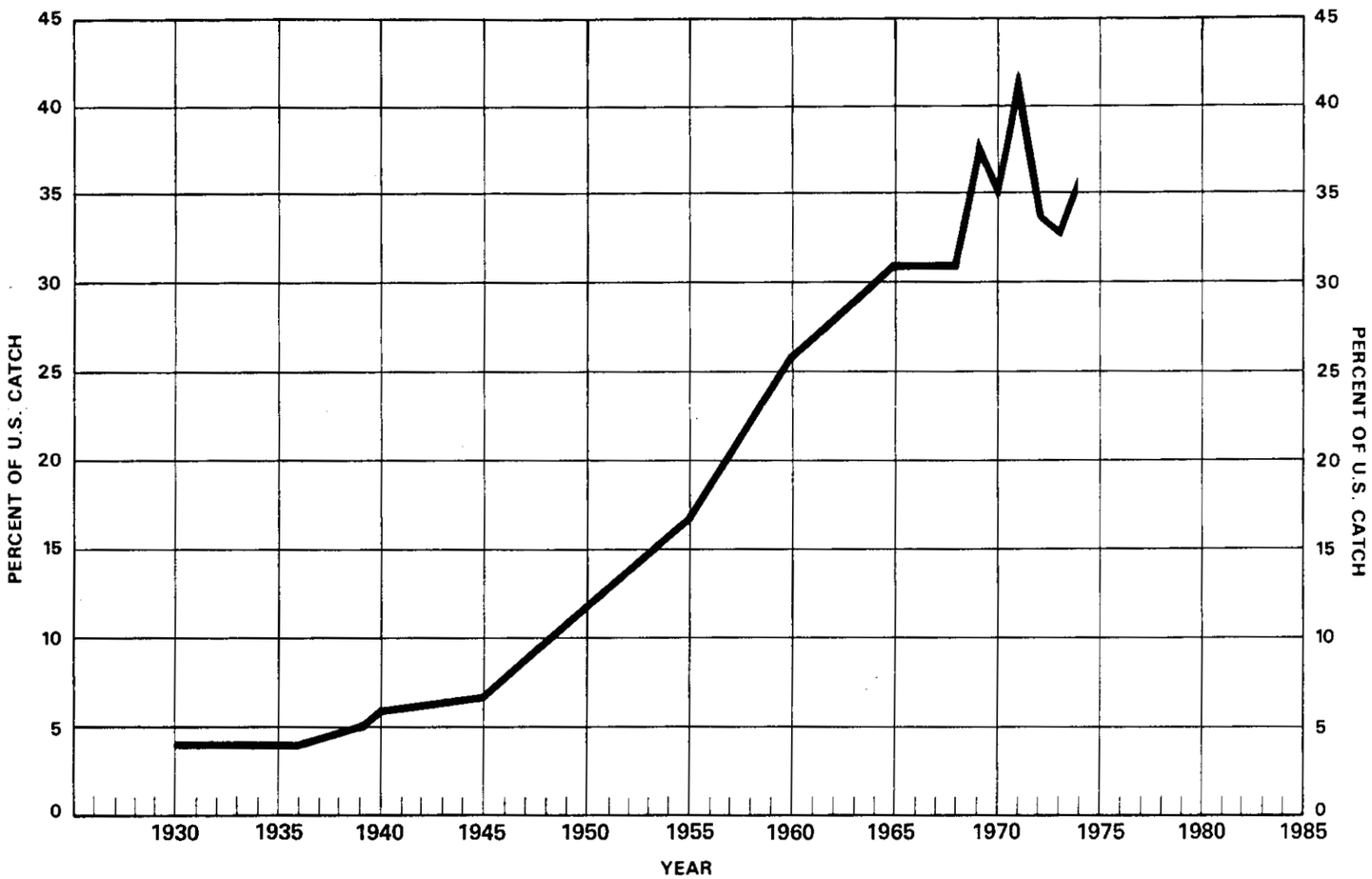


Table 11

OYSTER HARVEST IN THE GULF STATES[1])
VARIOUS YEARS, 1880-1973
(In Thousands of Pounds)

YEARS	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	270	327	62	1,189	325	2,173
1890	1,611	1,506	2,008	3,392	2,133	10,658
1902	3,057	1,088	5,989	4,830	1,661	16,624
1911	1,140	1,162	1,621	12,419	1,766	18,108
1923	1,053	730	4,224	4,119	1,742	11,868
1930	1,501	287	4,896	4,846	1,157	12,688
1931	1,406	769	3,438	3,590	982	10,185
1932	1,109	859	5,222	2,978	981	11,149
1934	1,357	392	4,904	5,592	1,312	13,556
1936	917	992	5,771	5,743	823	14,246
1937	817	1,235	12,894	8,048	1,190	24,184
1938	858	1,359	2,241	10,222	1,356	16,036
1939	742	1,358	7,706	13,586	987	24,380
1940	669	936	2,270	12,412	1,297	17,584
1945	1,496	1,606	265	9,884	719	13,970
1950	873	2,070	508	8,715	125	12,292
1951	681	2,191	28	8,164	456	11,519
1952	542	1,842	23	11,402	828	14,637
1953	564	1,450	318	9,435	1,068	12,835
1954	668	739	976	8,361	699	11,444
1955	630	1,581	1,731	9,396	543	13,881
1956	856	770	846	10,056	986	13,514
1957	710	1,291	862	10,489	953	14,306
1958	795	458	579	8,265	311	10,407
1959	1,415	895	333	9,667	1,411	13,721
1960	1,931	1,169	2,391	8,311	2,296	16,098
1961	3,255	509	3,241	10,139	1,096	18,240
1962	4,952	443	3,073	10,160	1,210	18,838
1963	4,282	995	4,679	11,563	2,618	24,138
1964	2,793	1,005	4,829	11,401	3,357	23,385
1965	2,789	492	2,695	8,343	4,836	19,155
1966	4,157	1,304	2,232	4,764	4,725	17,183
1967	4,578	2,087	3,786	7,742	3,553	21,747
1968	5,317	1,212	3,786	13,121	3,302	26,738
1969[2)]	4,912	481	1,430	9,178	3,764	19,765
1970	3,573	279	548	8,639	4,675	17,714
1971	3,529	250	1,215	10,528	4,744	20,266
1972(Prelim)	3,288	1,064	1,265	8,417	3,857	17,891
1973 (Prelim)	2,409	590	611	8,954	2,348	14,912

(1) Source: *Historical Catch Statistics (Shellfish)*
USD1 Fish and Wildlife Service Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969. Statistics for 1968 are from the State Landings published annually by each respective state.

(2) Data for 1969 & 1973 from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Oysters are reported in weights of total meats.

Table 12

SHRIMP HARVEST IN THE GULF STATES[1]) VARIOUS YEARS, 1880-1973 (In Thousands of Pounds)

YEAR	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	1,172	–	–	534	638	
1890		–	614	6,662	176	7,452
1897		41	1,903	4,487	361	6,792
1902	17	<1	4,424	7,635	291	12,367
1918	3,250	12,661	9,147	18,520	164	32,347
1923	2,881	3,182	9,879	27,753	3,422	47,117
1930	1,589	2,982	8,489	38,664	10,189	61,913
1931	1,803	2,475	17,716	35,148	13,814	70,956
1932	1,068	3,382	14,010	38,096	9,244	65,800
1934	1,539	4,557	15,330	55,572	16,359	93,357
1936	1,789	1,869	17,493	53,430	9,962	84,543
1937	1,490	3,104	33,558	68,781	16,905	113,838
1938	1,296	3,644	9,902	81,379	16,365	112,586
1939	800	2,124	5,676	100,612	11,173	120,385
1940	942	4,565	8,566	98,986	14,779	127,838
1945	1,783	4,439	6,595	116,904	15,722	145,443
1950	13,639	5,007	9,460	77,835	45,812	151,753
1951	29,756	6,356	7,475	85,718	64,346	193,651
1952	37,130	6,208	6,800	83,104	65,026	198,268
1953	52,804	5,806	8,517	86,941	70,435	224,503
1954	45,800	6,226	8,261	83,608	93,258	237,153
1955	48,598	6,676	13,617	71,994	71,517	212,402
1956	49,115	7,668	10,912	60,792	65,134	193,621
1957	41,921	6,035	9,569	34,103	76,825	168,453
1958	45,606	5,308	6,476	41,008	74,956	173,354
1959	32,252	8,018	11,319	57,353	84,561	193,503
1960	44,464	7,169	11,031	61,758	81,303	205,725
1961	36,069	3,525	4,408	31,027	58,766	133,795
1962	32,146	3,748	6,104	43,585	56,143	141,726
1963	34,941	7,760	9,375	80,809	70,231	203,116
1964	39,966	7,215	6,416	59,382	66,053	179,032
1965	37,759	9,624	8,233	62,593	77,028	195,237
1966	28,879	10,608	7,560	62,276	69,907	197,230
1967	23,449	14,456	9,625	75,325	102,876	225,731
1968	27,277	15,450	10,189	67,769	83,336	204,021
1969[2)]	22,964	14,976	8,906	82,888	70,695	200,429
1970	26,564	15,031	9,604	90,948	88,327	230,474
1971	21,622	16,709	9,469	92,379	86,904	227,083
1972 (Prelim)	22,770	17,542	7,791	83,000	97,385	228,488
1973 (Prelim)	26,137	12,019	3,605	58,641	81,720	182,122

(1) Source: Historical Catch Statistics (Shellfish) USDI Fish and Wildlife Service, Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969.

(2) Data for 1969-1973 are from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Shrimp are reported in round weight (heads-on).

Table 13

CRAB HARVEST IN THE GULF STATES[1]) VARIOUS YEARS, 1880-1973 (In Thousands of Pounds)

YEAR	FLORIDA, WEST	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	GULF TOTAL
1880	324	–	–	288	36	–
1890	–	–	47	981	191	1,219
1902	13	75	265	1,312	43	1,708
1908	64	246	427	322	200	1,259
1918	24	96	225	282	194	821
1923	7	84	443	316	109	959
1930	209	81	679	4,332	29	5,330
1931	124	80	459	5,106	49	5,818
1932	116	71	324	5,977	45	6,532
1934	616	259	607	12,328	258	14,068
1936	856	998	2,014	12,941	320	17,129
1937	816	757	1,437	15,046	922	18,978
1938	1,138	511	1,016	10,781	971	14,417
1939	750	558	1,469	11,443	406	14,626
1940	1,201	1,381	1,489	14,314	252	18,637
1945	1,145	2,207	5,639	33,650	339	42,980
1950	722	599	4,040	13,470	387	19,218
1951	2,139	1,109	1,630	9,060	280	14,218
1952	2,089	655	1,741	7,782	338	12,605
1953	3,263	1,087	1,412	8,619	432	14,813
1954	3,159	972	1,256	7,540	379	13,306
1955	5,206	1,613	1,770	11,392	356	20,337
1956	4,003	725	1,985	10,002	195	16,910
1957	5,545	1,462	2,417	9,110	201	18,735
1958	8,981	1,182	2,144	9,913	570	22,790
1959	14,154	1,093	3,014	10,175	1,192	29,628
1960	19,018	499	2,817	10,564	2,870	35,768
1961	17,588	838	2,512	12,530	2,877	36,345
1962	10,913	634	909	9,867	4,479	26,802
1963	13,812	1,297	1,115	8,311	2,982	27,517
1964	14,833	1,762	1,288	5,892	2,484	26,259
1965	21,264	1,812	1,693	9,488	3,622	37,879
1966	17,431	2,183	1,458	8,114	2,778	31,964
1967	14,830	2,353	1,016	7,705	2,625	28,529
1968	10,293	1,980	1,138	9,835	4,084	27,330
1969[2])	11,584	1,920	1,740	11,602	6,343	33,189
1970	14,786	1,407	2,027	10,254	5,525	33,999
1971	12,279	1,997	1,259	12,186	5,810	33,531
1972 (Prelim)	13,000	1,581	1,360	12,432	6,557	34,930
1973 (Prelim)	11,632	2,098	1,814	22,850	6,881	45,275

(1) Source: Historical Catch Statistics (Shellfish)
USDI Fish and Wildlife Service,
Bureau of Commercial Fisheries, C.F.S. No. 5007, July 1969.

(2) Data for 1969-1972 are from National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Crabs are reported in live weight. (1969-72 includes hard blue crabs only).

COMMERCIAL FISHING HIGHLIGHTS - GULF OF MEXICO

The following 30-year resumé highlights commercial fishery trends in the Gulf of Mexico and identifies some factors which relate to an increase or decline in availability and harvest of fish and shellfish resources. It also provides a basis for comparing fish and shellfish production and harvest in the Gulf, where a massive gas and oil industry exists as a part of the marine environment, with other coastal regions of the United States where similar, offshore industrial operations are not present. This is not intended to suggest, however, that a causal relationship exists. Data for Pacific, Atlantic and New England fisheries are appended.

The data do not indicate the nature and magnitude of all environmental factors which bear on the productivity of any fish or shellfish resource. These factors range from those which conspicuously affect a particular species such as toxic municipal or industrial discharges, sewage with high biological oxygen demand, or silting, to less obvious factors such as increased salinity in fresh or brackish water nursery areas (with possible accompanying higher predation), elevated water temperatures near estuaries associated with municipal or industrial growth, and water manipulation programs which may affect the total chemistry and movement of a water body. Further, such widely divergent factors as hurricanes and wage and price disputes affect harvest rates. Lastly, these factors include those which may be beneficial to some marine resources. Offshore gas and oil platforms, which, in the Gulf of Mexico are intimately related to and have a strong influence on sport fishing, are a case in point.

In summary, it is evident that the Gulf marine ecosystem, coincidentally with massive industrial development in offshore waters, is capable of supporting a domestic commercial fishery harvest which exceeds the domestic landings from any other coastal region of the United States.

The growth, particularly in the harvest of fin-fish, corresponds with the development and expansion of the offshore petroleum industry, and a high degree of compatability is strongly suggested.

1951

The fish and shellfish harvest increased by 14% in tonnage and 26% in value compared with 1950. Shrimp landings were up throughout the entire Gulf coast area, while hard crab landings declined by 27%. Menhaden and Spanish mackerel landings registered appreciable gains.

Many new vessels entered the shrimp fishery during the year, gear became more efficient, and there was greater mechanization in the landing and processing of shrimp.

Numerous major shrimp trawler tie ups occurred during the year as a result of disputes among fishermen over exvessel prices. Also, some union versus non-union disputes suppressed shrimping operations during the year.

The Fish and Wildlife Service exploratory vessel the M/V OREGON caught deep water red shrimp (Royal Reds) throughout the year over a wide range of the Gulf in depths from 180 fathoms to 305 fathoms. Best catches were made near the mouth of the Mississippi River. Commercial fishing for Royal Reds will ultimately prove feasible when problems of fishing at extreme depths are solved.

Large numbers of tuna were observed by the M/V OREGON in the central Gulf, with some indication that the quantity might be sufficient to assure commercial production in future years if methods could be found for taking them.

1952

Fish and shellfish landings were up, with shrimp receipts representing 26% of the total poundage and accounting for 71% of the total value — an all time high. Although no significant changes were made in shrimp fishing operations, improvements in shore operations and methods of handling and processing continued. Major tie-ups occurred in Mississippi due to price disagreement. Several new and converted vessels entered the shrimp fishery during the year. On the average, these were larger and better equipped to operate at greater depths and distances than those previously used.

Extensive new brown-grooved shrimp grounds were located by the M/V OREGON near the Mississippi delta which were immediately utilized by the fishing fleet. Royal Red shrimp were located in depths up to 375 fathoms between Tampa, Florida, and Aransas Pass, Texas.

1953

The value of the 1953 harvest was up to 25%. Landed tonnage was down less than 1%.

The shrimp fishery continued to flourish with records established in quantity and value. Several trawlers operated in previously unexplored areas of the Gulf. Fishing vessel construction in the Gulf was confined mainly to shrimp trawlers with the average size of new trawlers slightly larger than those previously constructed.

Storm warnings were displayed over a major portion of the Gulf coast on 34 occasions for approximately 52 days. Shrimp fishing was somewhate curtailed by seizure of a number of U. S. trawlers by Mexican officials for reportedly operating in Mexican territorial waters. No general fishing vessel tie-ups over price disagreements occurred during the year.

Explorations continued for new shrimping grounds and all major areas of possible production on the Continental Shelf were defined. No new stocks of white shrimp were found, but several important areas for brown and pink shrimp were located.

1954

Total fish and shellfish landings were down slightly in volume and value. The shrimp industry was confronted with serious financial problems during the year, resulting principally from shrimp prices lower than the previous year with no reduction in labor costs, supplies, and operating materials.

The high rate of shrimp trawler construction continued into early 1954, but due to financial difficulties many orders for new vessels were canceled by late March.

Price disputes between fishermen and dealers did not significantly reduce the fishing efforts, nor did weather conditions materially affect fishing during the year. However, a storm off lower Texas in early June did moderate damage to fishing vessels. Storm warnings were up for a total of 43 days during the season.

Appreciable catches of yellow fin tuna by long lines were experienced by the M/V OREGON during the year.

1955

Total landings increased by 10% in volume and 5% in value. Shrimp continued to be the most valuable fishery resource in the Gulf states, although landings of menhaden comprised 55% of the total poundage. Nearly 23,000 fishermen operated more than 11,000 fishing craft during the year.

The shrimp harvest was down by 10% from the previous year due to several late summer tropical storms. Despite this, the value of the catch was 2% greater than 1954.

Additional funds were made available during the year for an expanded shrimp biological research program in order to enhance better scientific management of the shrimp resource.

Several vessels entered the tuna fishery during the year, basing their operations on new data from the U. S. Fish and Wildlife Service.

1956

Louisiana led all Gulf states in fisheries during 1956 accounting for 45% of the total harvest. A record 900 million pounds of fish and shellfish, valued at over 85 million dollars were taken by the fishermen in all Gulf states. The record catch resulted from the largest menhaden production in the history of the Gulf area and an increase in the croaker and mullet harvest.

The shrimp harvest was 9% less than the previous year, but the value 15% greater. Adverse weather contributed to lighter landings. Also, these shellfish were less plentiful in north-central and western Gulf areas. A market growth for shrimp products was largely responsible for the value increase for shrimp during the year.

Early attempts at commercial exploitation of yellow fin tuna were handicapped by the absence of a local market. Fishermen discontinued operations due to costs of shipping tuna to west coast and Puerto Rico processing facilities. It is anticipated that yellow-fin tuna canning operations in Mississippi, completed during 1956, will restore the value of this species.

1957

Landings were down by 23% in volume but only about 1% in value. The catch was the lowest in over 5 years, although Florida west coast and Texas landings showed slight increases. Louisiana landings declined by 45%, and menhaden and shrimp landings, mainstays of the Gulf fisheries, declined to their lowest level since 1951.

Shrimp landings declined in all states except Texas where moderate increases were reported. The greatest decline was in Louisiana, where adverse weather and hurricanes caused excessive damage in Louisiana areas. Texas landings were similarly affected by weather although to a lesser degree.

The industry engaged in widespread conversion of conventional trawlers from single trawl to double rig trawling. First attempted in 1955 in Texas, the rig was seen over the entire Gulf coast area by 1957. (Figure 8)

Landings of yellow fin tuna, 666,000 pounds, were double that taken in 1956. New tuna canning installations were largely responsible for the revival of this industry.

1958

Fish and shellfish landings were up by 117 million pounds in volume and more than 2 million dollars in value from 1957, with Louisiana leading all other states in volume. Landings increased by 42%.

The menhaden fishery gained ncticeably during the year due to better weather and greater availability of fish. A trend to larger vessels equipped with refrigeration resulted in longer trips and a greater cruising range.

The 1958 shrimp catch reversed a downward trend which had been in progress for the previous three years, and although decreases were registered in Texas, Alabama, and Mississippi, the landings in Louisiana and the west coast of Florida offset the decline.

The greater landings in Louisiana resulted from an increased availability of white shrimp, although this species did not appear in its former abundance. Failure of the North Carolina shrimp run forced vessels to venture into the Gulf, with consequent greater fishing effort during the year. Texas received most of the migrant trawlers. Despite this, the harvest was down slightly.

Oyster landings were down by almost 4 million pounds from 1957, due principally to the decrease in Alabama where the pack was 82% less than the previous year. Poor oyster reef conditions in the state were responsible.

1959

Commercial fisheries landings amounted to 1.2 billion pounds, a new record. Louisiana led all other states in the volume of the catch, and accounted for 47% of the total Gulf landings. Favorable weather and an abundance of fish contributed to the record harvest. While there was an increase in rainfall along most of the Gulf coast, only one hurricane developed during 1959. Deborah struck the Texas coast west of Galveston causing an interruption of fishing activities for several days. Four tropical storms with accompanying heavy rainfall also temporarily halted fishing activities, but the added rainfall may have been beneficial to oyster growth.

The oyster industry fared well, with unusually heavy landings in Texas. Texas oyster reefs, that had not been productive in years, began to yield large catches of fine oysters. The increased rainfall and runoff of rivers along the Texas coast are credited with much of the volume increase.

The shrimp industry suffered a severe reversal, stimulated by declining prices caused by heavy imports and landings of more than usual amounts of small shrimp.

The blue crab fishery prospered due in part to a scarcity of crabs in Chesapeake Bay. Total landings in the Gulf states reached a record of 752 million pounds, a gain of 70% over the previous year's harvest.

1960

The harvest of menhaden, shrimp, crabs, and oysters was significantly greater than 1959. Weather conditions along the Gulf coast were about normal, although hurricane Donna struck the Florida Keys early in September, inflicting heavy damage to the spiny lobster fishery. A second hurricane, Ethel, struck the Mississippi coast near Biloxi in late September, but there was little damage to the fleet or shore installations. Fishing craft made 6% more trips and fished 6% more days than in 1959.

Spanish mackerel were plentiful along the west coast of Florida and a late run of king mackerel proved to be excellent, with prices holding up. Menhaden were present in large numbers, and the weather was favorable during most of the fishing season.

There was more demand for Gulf oysters because of oyster mortality in the middle Atlantic states. Texas oyster reefs produced a bumper crop and production soared to a near-record high.

1961

The commercial catch of fish and shellfish of 1.4 billion pounds was a new record. However, weather conditions in most of the area did not follow normal seasonal patterns and heavy rains, with accompanying floods, were experienced in most states during early spring. On September 11, hurricane Carla destroyed shore plant installations and craft at Palacios and Port O'Connor on the Texas coast and heavily damaged similar facilities at Freeport and Port Lavaca. Fishing along the Texas coast was curtailed for approximately ten days but a heavy shrimp run off Port Isabel, Texas, and unprecedented high catches of red snapper off the Texas and Louisiana coasts following the hurricane offset many fishing losses.

Shrimp landings declined although exvessel prices increased moderately. However, the decline in volume was so great that vessel operators experienced financial difficulty by mid-year. Shrimp research had not identified factors causing the population decline, although abnormal water temperature and salinities may have been prime factors. The decline was apparent in nearly all major Gulf coastal and offshore waters.

The menhaden fishery recorded a record one billion pounds landed. Texas landings decreased, probably because of the disruption of fishing activities and scattering of menhaden schools due to hurricane Carla. The use of striker boats in this fishery was abandoned as aircraft spotters began the function of locating schools of fish.

Over 18 million pounds of oysters were landed, the highest recorded since 1939, with substantial increases in all Gulf states except Alabama and Texas. The shortage of oysters in the Chesapeake and middle Atlantic states provided the incentive. In Alabama, a drastic decline in oysters occurred due to a heavy influx of fresh water in February floods. Pollution, both industrial waste and sewage, increased as a result of currents generated by these floods — leading to the closing of over 90% of the oyster reefs in early spring. Texas oyster reefs experienced difficulties similar to those in Alabama, with fresh water intrusion and contamination resulting from hurricane Carla.

1962

The volume and value of the fish and shellfish landings set new highs. Record menhaden landings and the highest exvessel shrimp prices in history were the major factors.

More than 23,000 commercial fishermen were employed, an increase of almost 1,000 over 1961.

Total oyster landings increased by 600,000 pounds and 3/4 of a million dollars. Alabama and Mississippi landings were less than 1961, while those for Texas and Louisiana were slightly higher. Florida continued its growth as a major Gulf producer with landings exceeding the previous year.

Crab landings were the smallest for the Gulf area since 1958, due primarily to a shortage of crabs.

Total landings of fish used for human consumption were up by 6 million pounds over 1961. Red snapper landings were about the same as in 1961, although there has been a gradual upgrading of the red snapper fleet as a result of new construction entering the fishery. Of interest, the oldest commercial fishing vessel in the nation, the "Virginia", built in 1965 at Fish River, Alabama, is active in this fishery.

1963

For the first time, over half the U. S. supply of fish and shellfish was received from foreign countries. During the year, several larger U. S. shrimping firms set up companies in Latin American countries and moved a part or all of the fleet to those countries. In the Gulf, Louisiana led all states in the volume of the fisheries harvest, at 754 million pounds. Landings of menhaden were 8% less than in 1962. Despite lower landings, the harvest in the Gulf area was the third highest recorded, and considerably above the average for the previous five years.

The harvest of blue crabs declined by nearly 3 million pounds, while the harvest of nearly 23 million pounds of oysters was 23% greater than the 1950-1962 average.

Shrimp landings at Gulf ports were about 62 million pounds more than in 1962 with substantial increases in white and brown shrimp and a small increase in pink shrimp.

1964

Louisiana led all states in volume of fishery harvest at 705 million pounds.

Total Gulf landings of menhaden declined 64 million pounds, but still comprised 35% of the total U. S. landings and the greatest volume for any single species. Much of the decline was due to hurricanes which limited fishing near the close of the season. Also, storms evidently so dispersed the schools that fishable concentrations were not found for several days after the storms had passed.

Blue crab production declined in Louisiana although generally throughout the Gulf states the harvest was substantially above 1963.

Russian fishing fleets intensified their operations, with more than 300 Russian fishing vessels fishing from Georges Banks to the Gulf of Mexico, discharging all or part of their cargo in Cuba.

Four hurricanes, Cleo, Dora, Hilda, and Isabelle threatened the Gulf fishing industry, and although some plants were damaged by water and a few nets and traps were lost, fishing craft received little or no damage.

Although not a record year for any major fishery, favorable prices attracted additional fisherman.

Shrimp catches were down by 12%. Louisiana, Alabama, and Mississippi landings of brown shrimp declined due to a scarcity of the species.

Honduran authorities seized ten Tampa based shrimp trawlers but craft and crews were released after payment of substantial fines.

The total volume and value of edible fin fish changed little from the previous year. Declines in king mackerel and Spanish mackerel were experienced, apparently the result of exceptionally heavy concentrations of sharks in Florida waters which severely damaged fishing gear.

1965

Landings were 145.6 million pounds greater than 1964 and the value increased more than 14 million dollars. Most of this was due to excellent conditions that prevailed in four of the area's major fisheries — shrimp, menhaden, blue crab, and red snapper. In addition to the abundance of these, the market was strong and exvessel prices were high throughout the year. Louisiana landings constituted 54% of the catch. Texas landings were up 9.3 million pounds.

Two hundred and ninety-eight vessels of over 5 net tons were certified as fishing craft during the year — 77 more than 1964, continuing the trend toward construction of larger vessels with greater horsepower. One hundred and seventeen new vessels were in the 60-70 ft. category. Strong ocean currents on the shrimp grounds of the Caribbean area, where many of these will be operating, dictated the need for greater horsepower.

Hurricane Betsy, one of the most destructive storms to strike the U. S., moved inland west of the mouth of the Mississippi River in September, affecting the area from Biloxi, Mississippi, to Morgan City, Louisiana. The coastal parishes of Louisiana, directly in the hurricane path, suffered the greatest damage. Seafood processing plants and unloading facilities were destroyed and many small craft were destroyed or extensively damaged. When fishing was resumed, a substantial number of shrimp trawls were lost in the debris that the hurricane deposited on the main fishing grounds.

Despite storm damage, shrimp landings were up by 9% in volume. In all states, the value of landings was greater than in 1964.

Good financial returns to the shrimp fishery resulted in the third successive year of expansion in construction in new shrimp vessels. In addition, Gulf shipyards worked at capacity to meet an increased demand for vessels for use in expanded oil exploration and drilling. Many prospective shrimp vessel owners found that shipyards could not guarantee delivery of a new vessel until far in the future.

The menhaden catch was only 3% less than the record 1962 landings, and for a second consecutive year a September hurricane shortened the fishing season. No fishable concentrations were found after these storms. In addition, the hurricane put two menhaden plants at Empire, Louisiana, out of operation for the remainder of the year. These two plants produced 14% of the U. S. supply of menhaden meal and oil in 1964.

Louisiana oyster landings declined by 27%, due in part to the almost complete destruction of reefs in Barataria Bay by hurricane Betsy. In September, oystering was curtailed in Mississippi waters pending determination that oyster reefs had not been polluted by debris deposited on them by Betsy.

1966

Landings of fish and shellfish were worth a record 122.6 million dollars, although the volume of landings was down by 267 million pounds from the previous year. This was due largely to the decline in menhaden landings. Alabama led in volume of landings with Texas ranked fourth.

Shrimp landings declined by 16 million pounds but the value increased by 12 million dollars. Alabama was the only Gulf state where shrimp landings exceeded those of the previous year. There was a sharp decrease in the yield from the Campeche grounds, the smallest on record from that area, and no reason for the decline could be determined. However, most species of shrimp were abundant along the Gulf states coast.

Menhaden were less plentiful on most fishing grounds than in the previous year, with schools widely dispersed by frequent thunderstorms and choppy seas. Landings were the smallest since 1959.

Oyster production was also down, largely as a result of the prolonged effects of hurricane Betsy in 1965.

Landings of flounder, red drum, king mackerel, spanish mackerel and spotted sea trout increased, but total landings of fin fish for human consumption were down by more than 3 million pounds.

1967

Louisiana led the nation in volume of landings with 646.6 million pounds — 16% of the U. S. commercial fisheries harvest. All Gulf states accounted for 73% of the U.S. production. More than 21,000 full-time fishermen operated in the Gulf fisheries — 454 more than 1966.

Hurricane Beulah seriously damaged vessels and seafood processing plants near Port Isabel, Texas, on September 21, 1967. Processing plants from Aransas Pass to Brownsville were severely damaged, and heavy rains and extensive flooding from these rains caused extensive oyster mortality from Lavaca Bay southward.

An unusually abundant crop of brown shrimp in both inshore and offshore waters of Louisiana and Texas resulted in near record landings. Small brown shrimp were so abundant in offshore waters of Louisiana and Texas during June and July that many vessels took more than 10,000 pounds in five-seven days of fishing. Heavy landings overwhelmed processing plants, delaying unloading of vessels and return of fishermen to shrimp grounds.

Menhaden landings were the lowest since 1958. Declining values resulted principally from record imports of fish meal from Peru.

Oyster production gains in Mississippi and Louisiana resulted largely from the opening of the Mississippi Dredge Reefs in February. The increased oyster harvest on Louisiana reefs in the fall indicated a nearly complete recovery from the effects of hurricane Betsy in August, 1965. In Texas, heat and drought prevailing throughout much of the year in the upper coastal bend was a major factor in oyster production decline in Galveston Bay. However, substantial catches and favorable marketing conditions throughout most of the year resulted in a strong Gulf oyster industry.

Fin fish landings for human consumption declined, with notably smaller landings of mullet, red snapper, grouper, Spanish mackerel, flounder, spotted sea trout and fresh water catfish.

Under the auspices of the Gulf States Marine Fisheries Commission, the United States Geological Survey, Branch of Oil and Gas Operations, an advisory committee was formed to solve some of the problems arising from the continued expansion of oil and gas activities on the Outer Continental Shelf, principally off Louisiana and Texas. Principal concerns were submerged well casings which damage otter trawls, and the use of explosives in seismographic operations.

1968

The commercial landings of fish and shellfish at Gulf states ports gained 108.1 million pounds and 11.6 million dollars compared with 1967. Greater landings of menhaden and oysters were the principal reason for the gain.

Landings increased in all states except Mississippi.

Three hurricanes reached the Gulf coast during the year but did only slight damage to the commercial fishing industry. Abby affected southern Florida in early June, followed somewhat later by Candy, north of Aransas Pass, Texas, and by Gladys in the Tampa Bay, Florida, area in mid-October.

Landings of shrimp were 10% less than in 1967, with small production resulting principally from a decline in the brown shrimp population in Louisiana and Texas waters. The inside and offshore waters from the mouth of the Mississippi River to the U.S.-Mexico border continued to be the most prolific shrimping area. These waters supplied about 63% of the total Gulf shrimp catch.

An increased fishing effort accounted largely for the greater harvest from Pensacola waters to the mouth of the Mississippi. Catches from international waters off Mexico were more than 4 million pounds greater than the previous year.

Landings of menhaden were 18% greater than 1967, and the best harvest since 1965.

Fishermen in all states except Alabama and Texas had one of the best oyster harvests in recent years. The 13.1 million pounds taken in Louisiana were nearly double 1967 production and were second only to the record harvest of 1939. Alabama landings were 42% less than in 1967, due to a curtailment in the fishery when early spring floods in the Mobile River polluted oyster beds. Texas landings declined 7%, principally because San Antonio Bay was closed to oystering in late 1967 and early 1968 because floods damaged the oyster reefs.

Landings of blue crab were the smallest since 1964, with notable declines on the west coast of Florida and Alabama. Mississippi, Louisiana, and Texas recorded gains, with Texas landings second only to the record harvest of 4.5 million pounds taken in 1962.

Landings of edible fin fish gained 1% in volume and 7% in value compared to 1967. This was due to an increase in landings of croaker, spotted sea trout, and red drum. Record landings of king mackerel, Spanish mackerel, and flounder were recorded.

However, landings of several major species declined, including the red snapper harvest. This continued a downward trend that began in 1966. The decline of red snapper catches on the Campeche grounds caused fishermen to extend their range to the Carribean.

1969

A record catch of menhaden was recorded from waters off the Gulf of Mexico. Gulf fishermen accounted for 75% of the total domestic menhaden catch and despite hurricane Camille in August 1969, they landed 1.2 billion pounds — an increase of 40% from 1968 landings. Further, Louisiana led all states in the volume of fish and shellfish harvest — 1,016 million pounds.

Shrimp landings were down slightly, except for Louisiana, where there was an excellent brown shrimp season and a near record harvest of white shrimp. Despite record high exvessel prices for shrimp throughout the year, many shipowners, dependent solely on offshore shrimp populations, were hard pressed to operate at a profit. There was a decrease in the number of new shrimp trawlers added to the fleet in 1969.

Hurricane Camille subjected the coastal areas of Alabama, Mississippi, and Louisiana to extreme wave and wind action causing extensive damage and destruction to the oyster resource and a serious disruption of the oyster industry.

1970

Menhaden landings in the Gulf of Mexico established a new record of over 1.2 billion pounds, up slightly from 1969. Further, Louisiana led all states in the volume of fish and shellfish harvest - 1,109 million pounds.

Shrimp landings of 230.7 million pounds approached the 1954 record landings of 237.2 million pounds. Excellent fishing in both inshore and offshore waters of Louisiana and Texas contributed to this volume. However, large landings coupled with record imports resulted in substantial exvessel price declines.

The decline in the oyster harvest indicated that oyster reefs in Louisiana and Mississippi waters had not fully recovered from the effects of hurricane Camille which struck the Mississippi coast and lower reaches of Louisiana in August of 1969.

1971

Menhaden landings in the Gulf of Mexico climbed to a new record landing of 1.6 billion pounds, comprising 73% of the total U.S. harvest of this species. Louisiana again led all states in the volume of the fish and shellfish harvest with record landings of 1,396 million pounds.

Shrimp landings accounted for most of the U.S. shrimp harvest—227.1 million pounds out of a total U.S. harvest of 387.9 million. Louisiana was the leading producer in the Gulf with landings of 92.4 million pounds, heads on. Additionally, the average wholesale price for Gulf brown shrimp rose from an average of $1.18 per pound in December 1970 to $1.80 per pound in December 1971.

Louisiana oyster landings rose conspicuously from 1970, with a harvest of 9.9 million pounds, an increase of 1.3 million pounds over 1970, possibly a reflection of the restoration of oyster reefs damaged by the 1969 hurricane.[20 21 22]

1972

Shrimp landings of 228.5 million pounds along the Gulf Coast were slightly more than in 1971, and the value ($163.4 million) increased 20 percent. Fishermen received record ex-vessel prices for jumbo and large shrimp until midyear, but after that time prices declined markedly. The Gulf states accounted for 59 percent of the total U.S. shrimp landings and 85 percent of the total value. Texas led all states in both production and value with 97.4 million pounds worth $79.8 million. Louisiana was next with 83.0 million pounds worth $46.9 million. The very profitable shrimp fishery in this area continued to attract investments in new trawlers. Many Gulf shipyards at the end of the year had backlogs of orders for these vessels.

Landings of menhaden at Gulf ports were almost 500 million pounds less than the record 1.6 billion pounds landed in 1971. Although landings at Gulf ports declined, landings at Atlantic Coast ports increased by 248 million pounds in 1972.

Oyster landings declined in the New England, Chesapeake, and Gulf states. Landings in the Chesapeake states (22.1 million pounds) were 12 percent less than in 1971 and in the Gulf states (17.9 million pounds) they were 8 percent less. The Chesapeake and Gulf states landing comprised 76 percent of the total U.S. oyster harvest.

1973

Louisiana led all states in volume of landings with 1,036 million pounds, followed by California with 669 million; Virginia, 631 million; and Alaska, 456 million pounds.

Shrimp landings along the Gulf Coast of 182.1 million pounds were 20% less in quantity than 1972. Fishermen received record ex-vessel prices during the year. Gulf state landings accounted for 49% of the total U.S. shrimp landings and 79% of the total value.

Hard blue crab landings of 134.9 million pounds declined 10 million pounds compared with 1972. Marked production increases in the Gulf states (and lesser increases in the middle Atlantic states) moderated sharp declines in landings of the Chesapeake and South Atlantic areas.

The menhaden harvest was smaller in both the Atlantic coast and Gulf areas. Ports along the Gulf of Mexico however accounted for 1.1 billion pounds (57%) of the total menhaden landings.

The major decline in oyster landings in the Gulf states (14.7 million pounds - 18% less than 1972) was due largely to spring floods that severely damaged the oyster resources of Alabama,

Mississippi and Louisiana. These resources represent a $5 million contribution to the economy of the three states and are an important part of the national supply of marine food. NOAA provided $213,620 to the three states for restoration of their oyster resources.

1974

Menhaden landings of 1,979.1 million pounds worth $66.4 million increased 88.7 million pounds, but declined $6.9 million compared with 1973. The value reflected a decline from the record high prices of 1973. Landings in the Gulf States were 1,295.9 million pounds — 223.0 million more than in 1973. Louisiana led all states with 1,079.3 million pounds — up 184.4 million compared with 1973.

Landings of hard blue crabs were 142.5 million pounds — 6 percent more than in 1973. However, the Gulf States harvest of 39.6 million pounds was 6 percent less than in 1973.

Oyster landings yielded 44.9 million pounds of meats worth $$33.6 million — a decline of 8 percent in volume and 5 percent in value compared with 1973. In the Gulf States, Louisiana led in production with 9.0 million pounds, followed by the West Coast of Florida with 2.4 million, and Texas with 1.3 million pounds. The oyster harvest declined generally in the Gulf area, principally because of floods in 1972 and 1973. Louisiana landings, however, increased slightly, and officials of the Louisiana Wild Life and Fisheries Commission predicted excellent oyster production in 1975. They pointed out that during the previous 2 years floods have washed conches and other marine animals that prey on oysters out to sea, and that old reefs in many areas are producing oysters for the first time in many years.

Shrimp landings were 369.6 million pounds (heads-on) worth $177.9 million — a decline of 2.6 million pounds and $41.6 million compared with 1973. The Gulf States accounted for 50 percent of the total volume and 77 percent of the total value. Texas was the leading state in value with $67.7 million, and the second state in production with 78.7 million pounds. Louisiana was second in value with $32.1 million, and third in production with 59.5 million pounds.

Compared with 1973, landings along the Gulf Coast of 185.7 million pounds increased 2 percent, but the value declined 21 percent. Most fishermen faced a difficult economic situation in 1974. Although shrimp landings generally increased, the record high prices of the previous year declined sharply. At the same time, vessel operating costs soared because of increased cost of fuel, gear, and other essentials. By year's end, many fishermen were in a precarious financial condition.

SOURCES

1) Fishery statistics of the United States, Statistical Digests, 1951-1971, Bureau of Commercial Fisheries, U.S. Department of the Interior, and National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

2) Fisheries of the United States, C.F.S. nos. 5300, 5600, 5900, 6100, 6300; 1969, 1970, 1971, 1972, 1973, Bureau of Commercial Fisheries, U.S. Department of the Interior, and National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Table 14

FISH AND SHELLFISH HARVEST - PACIFIC COAST[1]
1939 - 1974
(Thousand Pounds)

Year	Shellfish[2]	Fish	Total
1939	28,461		1,713,826
1940	28,461		1,456,000
1945	28,410		1,428,278
1950	35,313		1,515,249
1951	35,949		1,066,452
1952	37,511		832,000
1953	37,072		734,018
1954	40,288		825,900
1955	35,832		800,104
1956	48,072		862,355
1957	60,983		821,183
1958	64,191		899,338
1959	45,437		731,727
1960	49,504		703,112
1961	45,438		769,361
1962	33,325		696,529
1963	31,035		724,795
1964	29,151		658,998
1965	34,765		654,530
1966	51,097		671,967
1967	53,365		773,390
1968	60,877		667,708
1969	81,363		809,844
1970	77,554		934,447
1971	95,187		797,891
1972	55,523	797,622	853,145
1973	59,935	814,331	874,266 (Prelim.)
1974			956,562
1975			
1976			
1977			
1978			
1979			
1980			

(1) Includes Washington, Oregon, and California.
(2) Shellfish data are for crabs, lobsters, shrimps, abalone, clam meats and oysters.

SOURCES:

Historical Catch Statistics (Shellfish), U. S. Dept. of the Interior, Bureau of Commercial Fisheries, C.F.S. No. 5007, July, 1969.

Fisheries of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, C.F.S. No. 5600, March 1971, C.F.S. No. 5900, March 1972, C.F.S. No. 6100, March, 1973, C.F.S. No. 6400, March, 1974, and C.F.S. No. 6700, March, 1975.

Fishery Statistics of the United States, U. S. Dept. of the Interior, Bureau of Commercial Fisheries, Statistical Digests from 1939-1967.

Fishery Statistics of the United States, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Statistical Digests No. 62, 1968; No. 63, 1969; No. 64, 1970; No. 65, 1971.

Data for 1973 from National Marine Fisheries Service, NOAA.

Figure 12

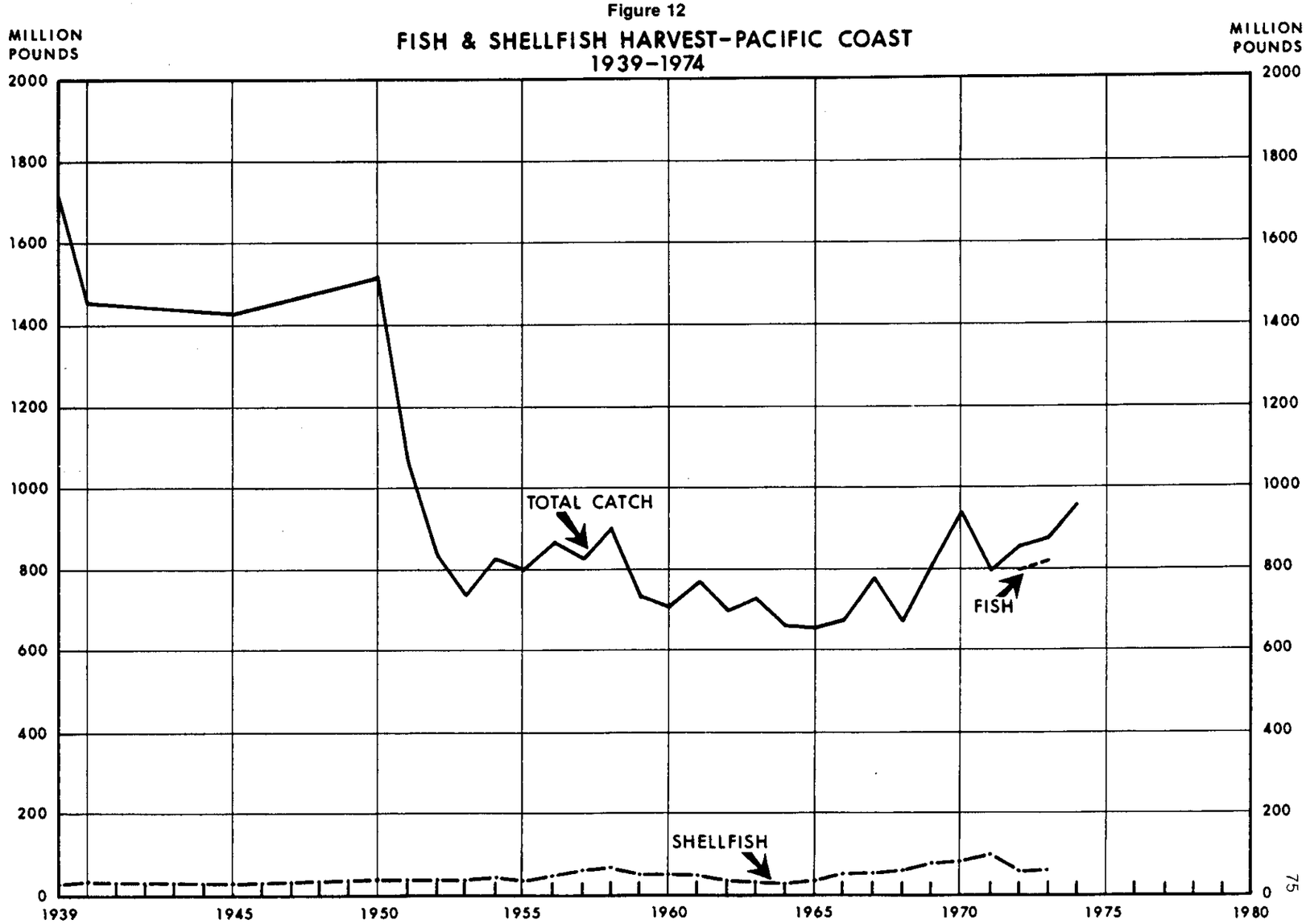

FISH & SHELLFISH HARVEST-PACIFIC COAST
1939-1974
MILLION POUNDS
MILLION POUNDS
2000
1800
1600
1400
1200
1000
800
600
400
200
0
TOTAL CATCH
FISH
SHELLFISH
1939
1945
1950
1955
1960
1965
1970
1975
1980

Table 15
PACIFIC COAST FISHERY OPERATING UNITS
(California, Oregon, Washington)

		Vessels		Boats	
Year	Fishermen	No.	Total Net Tonnage	Motor	Other
1951	28,692	3,308	85,467	5,827	556
1952	26,848	3,173	81,551	5,992	554
1953	27,283	2,960	65,788	5,941	568
1954	26,363	3,290	74,582	5,508	484
1955	25,002	3,548	77,179	5,267	488
1956	20,993	2,911	80,430	4,819	444
1957	22,347	3,313	73,470	4,806	438
1958	21,987	3,101	69,300	4,622	454
1959	19,025	2,622	57,701	4,606	430
1960	17,109	2,505	93,264	4,304	406
1961	17,662	2,640	96,679	5,199	443
1962	16,831	2,490	91,014	4,637	358
1963	16,598	2,505	91,581	5,299	303
1964	15,963	2,537	91,893	5,038	267
1965	17,324	2,623	97,208	5,404	291
1966	18,324	2,736	99,314	5,534	232
1967	20,243	2,907	103,337	6,797	241
1968	19,803	3,011	114,017	7,580	237
1969	21,402	3,170	120,459	9,471	291
1970	22,613	2,863	119,505	7,169	275
1971	24,191	3,340	134,413	9,062	244

SOURCE:

Fishery Statistics of the United States, U. S. Department of the Interior, Bureau of Commercial Fisheries, and National Marine Fisheries Service, Statistical Digests from 1951-1971.

FISH AND SHELLFISH HARVEST — PACIFIC COAST STATES OREGON, WASHINGTON, AND CALIFORNIA

The years 1935-39 marked the peak harvest years for the salmon and sardine fisheries in the Pacific coastal region. In 1936, the catch of sardines reached its peak at 1.5 billion pounds, After 1950, however, the sharp decline in the harvest of pilchard or sardines was the principal contributing factor in the decreasing Pacific coast landings. The sardine fishery declined precipitously to a mere 57 million pounds in 1960 and 140,000 pounds in 1967. As a result, the California State legislature in 1967 enacted a law establishing a two-year moratorium on fishing for sardines in California waters, but providing a 15% tolerance for sardines taken incidential to the catch of other species, such as mackerel.

During the period 1940-1950, the reduced harvest of sardines was offset by good catches of salmon and tuna, and the total fish production was comparable to the peak years of the late 1930's.

1953

Pacific coast landings declined drastically, reflecting particularly the low sardine catch of only 9 million pounds. Sardines were not present in the formerly important sardine producing waters off Monterey and San Francisco Bay. The cause of this decline has not been identified. Sardines were harvested principally from waters off southern California below Morro Bay. To compensate for the failing sardine industry, some fishermen started to fish for anchovies.

1954

Fishery landings increased when the Fraser River (British Columbia) sockeye salmon run was rehabilitated. This fishery dominated the canned salmon pack on Puget Sound until 1914 when a slide at Hell's Gate on the Fraser River destroyed the run. By 1954, the obstruction was by-passed which permitted a normal escapement of the sockeyes to the spawning lakes above Hell's Gate.

1955

The Pacific coast domestic tuna catch fell to 209.5 million pounds, approximately 54 million pounds less than 1954 and 121 million pounds less than the record 390.5 million pounds in 1950. The decrease was economic rather than biological in nature — reduced landings caused by a phenomenal rise in frozen tuna imports, record high inventories, cannery workers-management dispute, lengthy ex-vessel price disputes and unprecedented lay-overs between trips. Though the sardine harvest was encouraging in southern California waters by October 1, labor disputes and price controversies kept the fleet in port until November 7, and seiners were placed on small nightly catch limits preventing a greater catch. Also, the fall run of king salmon in the Columbia River area was discouragingly low. The cause of failure was unknown.

1956

Production was strengthened by substantially increased harvests of Pacific and jack mackerel — a reflection of the shortage of sardines with which these species closely compete.

1957

Landings of tuna, Pacific sardines and anchovies declined. The tuna industry was beset by several adverse factors: (1) a declining market, (2) competition with increased imports of canned tuna, and (3) labor and price difficulties. Due to price disputes, sardine fishing by the southern California fleet commenced two months after the September 1st opening date and, in the interim, sardines had migrated from the normal fishing areas. The decline of anchovies was partially due to the sardine fleets' tie-up.

1958

Sardines returned to California waters after a conspicuous absence since 1951. The sardine harvest was 207 million pounds.

1959

The tuna catch was down by 48 million pounds from the previous year, due primarily to a tie-up of tuna clippers and the purse-seine fleet in ex-vessel price disagreements.

1960

The decrease in total fishery production was due primarily to the decline in catches of salmon, sardine, and albacore tuna. The decline of salmon in Washington by almost 26 million pounds was due largely to the frequent closings and openings in the Puget Sound fall salmon fishing season which discouraged local fishermen from taking this species. The sardine catch in California dropped from 74 million pounds in 1959 to 58 million pounds in 1960. High surface water temperatures were believed partially to be the cause for poor showings of sardines during most of the season. Anchovy landings were two million pounds less due to costly packing and strong competition with less expensive imports.

1961

A decline in oyster production was apparently related to a curtailed demand by the canning industry which was attributable to imports of low priced canned Japanese oysters.

1962

Landings were down by 72 million pounds from the previous year, primarily due to lower landings of sardines, sea herring, and tuna. Only 15.4 million pounds of sardines were landed. A price dispute in the fall delayed the start of the season for about 5 weeks. At the end of the season, the one remaining cannery at San Francisco closed bringing an end to an industry which comprised over 25 processing plants in the late 1930's.

1963

The oyster harvest declined conspicuously, with the Willapa (Washington) Bay supply seriously affected by severe windstorms that damaged the oyster grounds late in 1962. Also, very few seed oysters had been planted during the previous four years.

1964

Landings declined from the previous year's harvests of mackerel, tuna, halibut, salmon, dungeness crabs, and shrimp. A two-month tie-up of the mackerel fleet in January and December decreased the catch by 19.2 million pounds from 1963. Good catches of tuna were made from Morro Bay north to Eureka and Fort Bragg (California) areas until high winds and rough seas curtailed fishing. The decline of halibut in Washington was due to smaller fishing fleets and higher prices paid at Alaskan ports. Further, many halibut fishermen dropped out in favor of

salmon, crab, and other more profitable fisheries. The decline in shrimp was more related to the loss of markets and processing facilities rather than a scarcity of the species. The year 1964 was an off-year cycle for Puget Sound sockeye salmon.

1965

Catches of mackerel and herring declined. The harvest of mackerel off California, the only Pacific coast state supporting this fishery, declined due to ex-vessel price dispute and rough weather. The oyster harvest also declined by 800,000 pounds, mostly in Willapa Harbor where beds were damaged by tidal waves and by the shortage and high mortality of oyster seed.

1967

The Pacific coast states had 28% of the volume and 32% of the value of the U.S. catch, and exceeded all other areas in value. California landings constituted 45% of the Pacific coast production.

More new tuna vessels were under construction in 1967 than in any other recent year, with 20 large vessels in various stages of completion.

For the fifth consecutive year, no commercial landings of albacore were made in California during June. July landings were the smallest since 1941. Albacore first appeared off the Oregon and Washington coast about mid-July and excellent catches were made within a few days. During August, the high water temperatures and rough seas scattered the schools, but by mid-September fish were abundant again.

Salmon production in both Washington and Oregon was greater than in 1966. The increased Washington production was the result of a 21.7 million pound landing of pink salmon in the cycle year. A run about 10.7 million fish allowed a catch of about 8 million pinks, somewhat better than the 7 million predicted by the International Pacific Salmon Fisheries Commission. The return of pink salmon to the Fraser River System, including an excellent high sea catch by the troll fishery was estimated at 12 million fish — the best in 20 years and nearly 7 times the 1965 cycle year.

Chinook salmon production in Oregon gained by nearly 1 million pounds compared with 1966, at 4.7 million pounds. California salmon landings declined about 2 million pounds from 1966.

Pacific sardine landings of 149,000 pounds were the smallest ever recorded. Since the 1.5 billion pound harvest in 1966, the sardine fishery has been declining sharply. The California State legislature enacted a law establishing a two-year moratorium on sardine fishing in California waters.

Washington led the Pacific coast oyster production with a 6.5 million pound harvest, but total Pacific harvests declined by 88,000 pounds from the previous year.

1968

Pacific states had 27% of the volume and 34% of the value of the U.S. harvest. California landings constituted 40% of the total.

The Washington pink salmon harvest declined dramatically, a result of a usual off year production in Puget Sound. Only 21,000 pounds were taken compared with 21.7 million in 1967. Red salmon landings were less than one-half of the 1967 harvest.

During the summer, thousands of salmon died because of malfunctioning of the fishways of the newly completed John Day Dam. An emergency mid-season closure of the salmon

sport fishery contributed to an escapement of chinook salmon that exceeded the 80,000 to 90,000 fish needed to perpetuate the run.

The tuna harvest declined by 33.6 million pounds, due largely to a sharp decline in skipjack tuna lands. The albacore catch a gain by 7.5 million pounds with a record 37.8 million pounds taken in Oregon waters. Weather and the availability of fish held up generally through September. The California albacore harvest was the smallest since 1947, with fishermen hampered most of the time with strong northern winds and rough seas in Northern and Central California waters.

The Pacific sardine fishery yielded only 124,000 pounds — the smallest catch on record.

1969

The Pacific salmon catch was 25% less than 1968. In Puget Sound, the pink salmon run for the 1969 cycle year was smaller than anticipated and one of the lowest cycle-year catches on record. Returns of the pink salmon were so small that the Washington Department of Fisheries closed commercial and sports pink salmon fishing in late August. California tuna landings were much better than 1968. Yellow fin tuna catches were excellent, and although albacore fishing off California was poor for the third successive year, excellent catches were taken from Oregon and Washington waters.

The sardine fishery yielded only 90,000 pounds during the year. The two-year moratorium, passed in 1967 by the California legislature, was continued indefinitely.

There was a record catch of Pacific anchovies, with California landings totaling a record 135.3 million pounds — 106 million pounds above 1968.

1970

The Pacific salmon catch was 61% larger than 1969 and the largest since 1949. Alaska accounted for 84% of the total catch. However, there were record catches of silver salmon taken off Washington and Oregon.

The California tuna catch was well above 1969 landings. The bluefin harvest was down, but good catches of skipjack and yellow fin were recorded. Total albacore landings from Pacific northwest waters were slightly above the 1969 landing.

Pacific and jack mackerel landings were 12% less than 1969, due in part to the concentration of fishing vessels on the anchovy fishery at the expense of the mackerel harvest.

Anchovy landings at California ports totaled a record 190.9 million pounds. The increased catch resulted from greater fishing effort, early season price agreement, and favorable market conditions.

1971

All Pacific salmon species declined in volume and value except chinook salmon which increased slightly in volume compared with 1970.

1972

Pacific Coast shrimp landings of 106.0 million pounds worth $6.6 million were 28 percent of the volume and 3 percent of the value of the total U.S. shrimp harvest. Alaska led in volume with a near-record 81.3 million pounds, followed by Oregon with a record 20.6 million pounds—an increase of 129 percent compared with 1971. The increase in Oregon shrimp production was the result of an unusually successful 1970 hatch.

Pacific salmon landings of 216.7 million pounds worth $62.8 million declined 95.4 million pounds and $15.0 million compared with 1971. Landings of all species except chum salmon declined sharply. Chum salmon landings were 5 percent greater than in 1971—result of a record harvest in Puget Sound. The 1972 canned pack of Pacific salmon was 49 percent less than in 1971, and one of the smallest packs on record.

Landings of tuna in the continental United States and Hawaii were 377.6 million pounds worth a record $89.9 million—an increase of 29.5 million pounds and $14.4 million compared with 1971. Record landings of *yellowfin* tuna and near-record landings of albacore tuna contributed substantially to the greater harvest. Despite the increased production of *albacore*, fishermen in the Pacific Northwest received a record price of $680 per ton for the fish. A worldwide shortage of albacore tuna was a contributing factor to the favorable price.

The Inter-American Tropical Tuna Commission set a 1972 quota of 140,000 short tons (the same as in 1971) for the yellowfin tuna fishery in the regulatory area of the eastern tropical Pacific. The season opened January 1 and closed March 5, 1972. It was the seventh consecutive year that this fishery operated under a quota system designed to maintain the yellowfin population at the maximum sustainable harvest. As in 1971, fishermen reached the assigned quota.

Total U.S. landings of flounders were 168.8 million pounds valued at $28.8 million, an increase of 8 percent in quantity and 30 percent in value. Increased landings of Pacific flounders in California and *yellowtail* flounders in Massachusetts and Rhode Island were responsible for the increase in the total quantity landed.

The Atlantic and Pacific fishery for groundfish (Atlantic and Pacific cod, cusk, haddock, white hake, pollock, and Atlantic ocean perch) yielded 148.8 million pounds valued at $18.1 million—down 6 percent in quantity but up 8 percent in value compared to 1971.

Landings of the leading groundfish species declined in 1972. Landings of the less important groundfish species increased: *Pacific cod* landings were 10.4 million pounds, up 61 percent compared to 1971; *pollock* landings were 12.8 million pounds, up 18 percent; and *white hake* landings were 6.6 million pounds, up 16 percent.

1973

San Pedro, California, with landings of 474 million pounds worth $66 million, was the leading commercial fishing port in 1973 in terms of value.

Pacific coast shrimp landings were a record 144.3 million pounds worth 14.2 million dollars - 39% of the volume and 6% of the value of the total U.S. shrimp harvest.

Oregon shrimpers caught a record 24.3 million pounds of shrimp, followed by Washington with a near record 4.0 million pounds.

Salmon landings in Washington, Oregon, and California increased moderately. Compared with 1972, landings of silver salmon in Washington nearly doubled and red salmon landings more than doubled.

1974

Landings of Pacific groundfish and similar species (cod, hakes, ocean perch, and rockfishes) were 42.7 million pounds valued at $6.1 million, down 19 percent in quantity but up 31 percent in value. Decreased landings of rockfishes were mainly responsible for the decline in the quantity of Pacific groundfish landings. Sharply increased exvessel values for rockfishes caused the total value to increase.

The U.S. Pacific fishery for halibut extends from the Pacific Northwest to the Bering Sea. Management of the halibut fishery of the United States and Canada in this area is coordinated through the International Pacific Halibut Commission. Fishing by United States and Canadian fishermen is restricted to hooks. In recent years the halibut stocks in some areas have been substantially reduced through the incidental catch by the trawl (net) fisheries of other nations.

The Pacific catch of 48.4 million pounds of sea herring valued at $8.3 million accounted for 40 percent of the total U.S. quantity and about three-quarters of the value. Sea herring landings in California and Washington were up sharply, and total Pacific landings were the largest since 1964.

Landings of Pacific salmon were 196.8 million pounds worth $121.3 million — a decline of 16.2 million pounds and $3.8 million compared with 1973. The harvest was the smallest since 1915 when 120.4 million pounds were taken. In general, fishermen received good prices for salmon — somewhat better than the high prices of 1973. Landings declined in all states except Oregon where the production of 15.6 million pounds increased 10 percent compared with 1973 — principally because of excellent catches of silver salmon.

The harvest of dungeness crabs increased from 12.1 million pounds in 1973 to 16.1 million in 1974. The 1973 production, however, was the smallest since 1937. The slight volume increase in 1974 occurred in the Washington and Oregon fisheries. However, landings of dungeness crabs in Washington (5.6 million pounds) and in Oregon (4.5 million) were still much lower than the average production for these states in previous years.

Shrimp landings in the Pacific Coast States were 139.5 million pounds worth $16.8 million — a decline of 3 percent in volume, but a gain of 19 percent in value compared with 1973. Alaska led in volume with 107.5 million pounds, followed by Oregon with 20.1 million, and Washington with a record 9.1 million pounds.

EXPLORATORY FISHING DRAGS FOR DEMERSAL FISH AND SHELLFISH GULF OF ALASKA

ZENAIDA D. MATURGO

APPENDIX 8

Based Upon Data From
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Environmental Affairs
Shell Oil Company
Houston, Texas
February, 1972
(Revised, May, 1975)

PREFACE

This is based upon data from the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The large maps are composites of a series of about 260 map transparencies prepared by the National Marine Fisheries Service, oriented to standard Coast and Geodetic Survey maps. These transparencies identify the vessels, the precise locations dragged, the four principal demersal species taken, and the weight of each.

The small scale maps and tables are also originals, based upon the pounds of each species taken per hour of trawl.

The work was performed by Mrs. Zenaida D. Maturgo, under contract to the Shell Oil Company, as a contribution to the Environment and Biology Standing Committee of the Gulf of Alaska Operators Committee.

Mrs. Maturgo is a former Senior Technologist, Environmental Conservation Department, Shell Oil Company.

William F. Gusey
Senior Staff Wildlife Specialist
Shell Oil Company
Coordinator, Environment and
Biology Standing Committee

EXPLORATORY FISHING DRAGS FOR DEMERSAL FISH AND SHELLFISH IN THE GULF OF ALASKA

INTRODUCTION

During the past several decades, the National Marine Fisheries Service, formerly the Bureau of Commercial Fisheries, and the International Pacific Halibut Commission have conducted extensive fish and shellfish surveys in waters overlying the continental shelf and slope in the Northeastern Pacific Ocean. During these surveys, fish and shellfish populations were sampled with otter trawls, shrimp trawls and beam trawls. These exploratory trawls provide an excellent source to determine the type, distribution, and densities of demersal fish and shellfish species that inhabit these waters, especially in areas where no commercial fishing was conducted.

Data used in this report were taken from 2,463 exploratory drags conducted by the National Marine Fisheries Service starting in 1950 and ending in 1968 in the offshore and inside waters around the Gulf of Alaska; and from 432 drags conducted from May 3, 1969 to July 25, 1971. To facilitate analysis of the data, the Gulf of Alaska area was divided into five regions, namely: 1) Southeastern Alaska - from Dixon Entrance to Cape Spencer including the inside waters; 2) Yakutat region - from Cape Spencer to Cape St. Elias; 3) Prince William Sound region - from west of Cape St. Elias to Pye Island; 4) Cook Inlet; and 5) Kodiak-Shelikof region, which covers all parts around Shelikof Strait up to west end of Kodiak Island.

For the 1969-1971 exploratory drags, the relative abundance of catch for all species in the three Gulf regions and depth zones followed the same trend as the 1950-1968 drags except for scallops. Exploratory drags made off Kodiak Island during the 1969-1971 period revealed a great abundance of scallops in the Marmot and Ugak Bay areas where a record catch of 775 lbs. was dredged off Ugak Island in 0.6 hr. at 40-45 fathoms. Due to several high catches, the average catch per hour for this species in Kodiak-Shelikof region jumped from 99 lbs. (1950-1968) to 375 lbs. (1969-1971), exceeding the Yakutat region average catch by 134%.

The data were analyzed to determine the average catch per unit of successful trawling of a particular species or groups of species by regions and by depth intervals. A 50-fathom depth interval was used for the continental shelf (1-99 fathoms) and upper continental slope (100-199 fathoms). Beyond the 200-fathom contour, 100-fathom intervals were chosen to evaluate distribution and abundance patterns in deeper waters.

Catches from successful sampling stations were evaluated by major fish groups for the demersal fish species, except halibut and sablefish which were analyzed separately. Trace (10 lbs.) catches were excluded from the analysis; however, the location of drags taking a particular species or groups of species is indicated in the distribution maps. The depth of each haul was determined as the median between the deepest and shallowest depths recorded for each exploratory drag. The total minutes trawled for the specific depth interval was determined and converted to hours to establish standard units of fishing time. Average catches are computed per hour of successful trawling.

On areas of multiple depth zone sampling, the highest average catch per hour of trawling for demersal fish species occurred in the outer shelf (50-99 fathoms) and inner slope (100-149 fathoms). Alverson (1968) signified that the greatest density of demersal fishes in the Gulf of Alaska region occurred on the continental slope rather than on the continental shelf. This is especially true among the rockfishes, sablefish, and some flounder species. Most demersal fishes concentrate in the deeper portion of their vertical depth range during the winter months and move to shallower depths during spring and summer.

The shellfish populations concentrated in shallower depths than the demersal fishes. Shrimp and sea scallops were found most abundant at 30-70 fathoms, dungeness crab at 10-49 fathoms, king crab at 30-89 fathoms, and tanner crab at 50-149 fathoms.

Data for Prince William Sound, Cook Inlet, and Kodiak-Shelikof areas updated to include drag date for 1968-1971 in all tables except Table 2, and in all figures.

FLATFISH OR FLOUNDER GROUP

Flounders were present in all regions and depth zones of the continental shelf and slope in the Gulf of Alaska. As a group, they dominated the catches in the Gulf of Alaska regions. They were most frequently encountered in the offshore regions as compared to the inside waters of the Gulf. In the offshore regions, flounders were most abundant on the continental shelf (less than 100 fathoms) decreasing as it goes beyond the 150-fathom contour. The catch per hour of successful trawling for flatfish except halibut are given in Table 1 and Figure 1. The average catch rate on the inner shelf was lowest in Cook Inlet and greatest in the Yakutat area. Catch rates were considerably higher at depths greater than 100 fathoms in the Prince William Sound and Kodiak regions. The Yakutat region showed the greatest abundance of flatfish in all depth zones sampled (Figure 2). The arrowtooth flounder or turbot was the most frequently encountered, as well as the most dominant species, in the Gulf of Alaska (Table 2). It dominated catches of all five regions, comprising about half of all the 15 flatfish species caught. In southeastern Alaska, turbot made up about 73 percent of total flatfish caught.

Although Pacific halibut ranked second in frequency of occurrence among demersal fish species in the Gulf of Alaska, it dropped to the ninth place for most abundant species category (Table 2). Halibut was taken in depth zones up to 299 fathoms in the Gulf of Alaska regions. Halibut catches were highest on the continental shelf at depths less than 100 fathoms (Table 3), and catches generally decreased with increasing depth. Average catch per hour of trawling on the continental shelf was greatest in southeastern Alaska and Yakutat regions (Figure 3). Although halibut occurred in the inside waters surveyed, the catch rate was considerably less than in adjacent offshore regions with similar depth zones. The average catch of halibut per hour of trawling by regions is illustrated in Figure 4.

Table 1

POUNDS OF FLATFISH CAUGHT PER HOUR OF SUCCESSFUL TRAWLING
BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA[1]

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
1-49	2,029	10.6	191	20,261	30.7	660	9,116	43.0	212	554*	4.2	132	8,802*	32.5	271
50-99	39,126	107.4	364	44,459	81.0	549	35,827*	196.8	182	3,831*	17.1	224	41,292*	114.3	361
100-149	22,170	92.9	239	10,890	28.7	379	42,627*	133.5	319	1,002	4.6	218	17,897*	44.3	404
150-199	2,697	14.5	186	1,353	7.7	176	6,460*	13.5	479	165	1.0	I.S.[2]	3,805	4.0	951
200-299	345	2.5	138	550	3.1	177	805	7.4	109	-	-	-	4,120	4.0	1,030
300-399	31	1.0	I.S.[2]	-		-	-	-	-	-	-	-	-		-
TOTAL	66,398	228.9		77,513	151.2		94,835*	394.2		5,552*	26.9		75,916*	199.1	
Avg. catch/hr. for all depths			290			513			241			206			381

1/Flatfish data exclude halibut
2/Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF FLATFISH PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

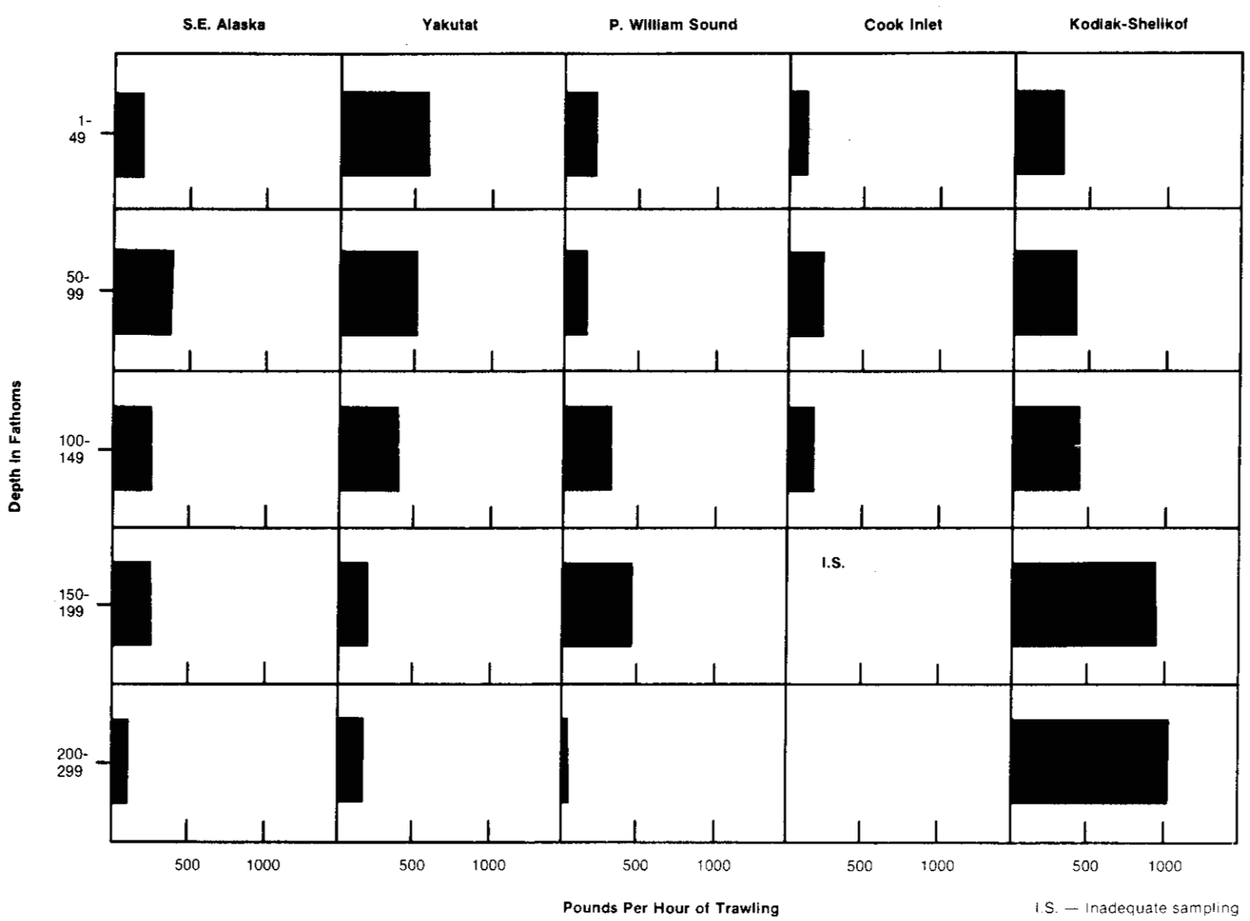
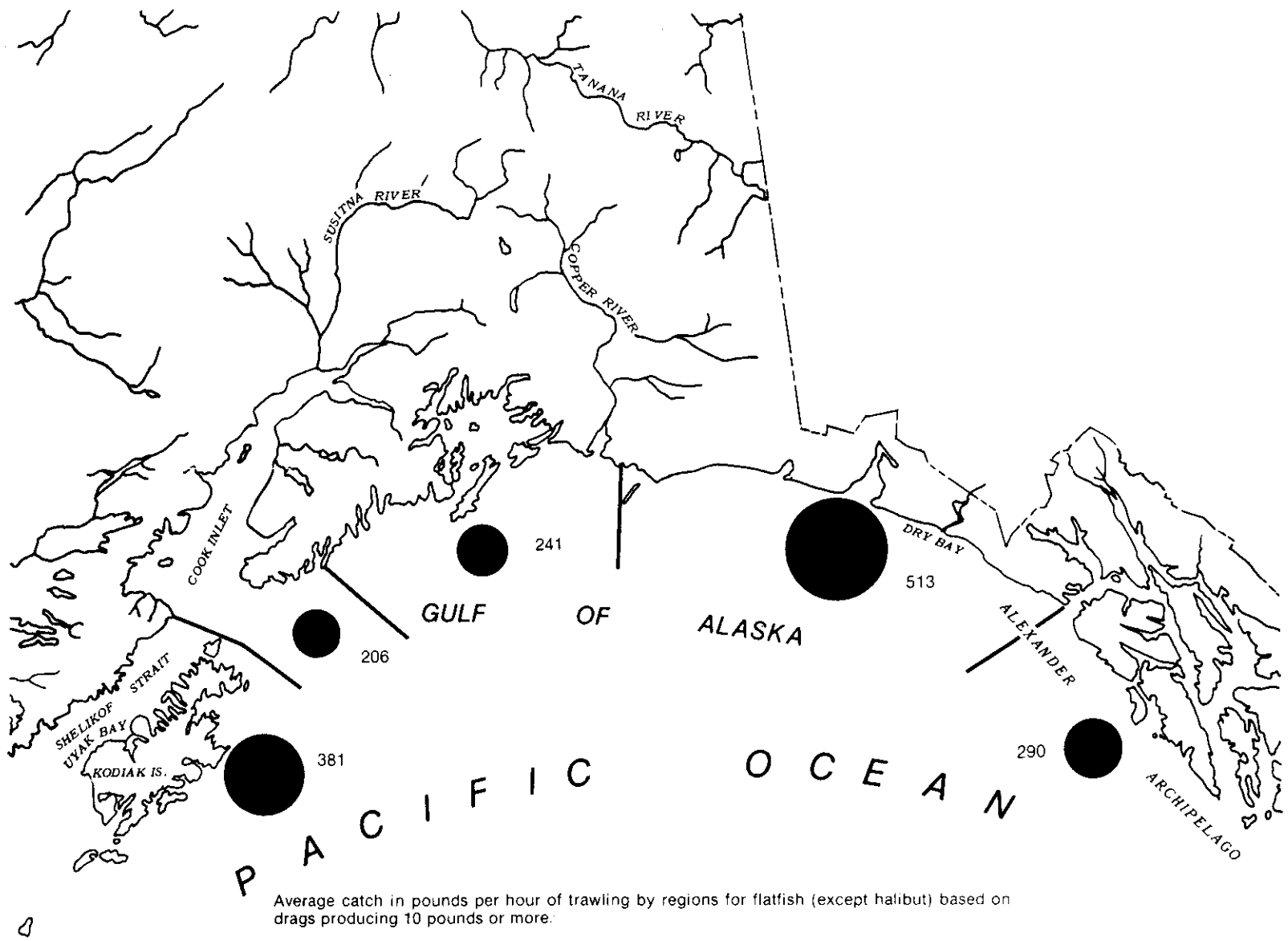


Figure 1



Average catch in pounds per hour of trawling by regions for flatfish (except halibut) based on drags producing 10 pounds or more.

Figure 2

Table 2

Ten most frequently encountered and most abundant demersal fish species in the Gulf of Alaska.

Frequently Encountered	Most Abundant
1. Arrowtooth flounder or turbot	1. Arrowtooth flounder
2. Pacific halibut	2. Pacific ocean perch
3. Flathead sole	3. Flathead sole
4. Pacific cod	4. Walleye pollack
5. Walleye pollack	5. Rock sole
6. Pacific ocean perch	6. Pacific cod
7. Rex sole	7. Dover sole
8. Sablefish	8. Sablefish
9. Skate	9. Pacific halibut
10. Rock sole	10. Starry flounder

Source: Alverson, D. L. 1968. Fishery resources in the Northeastern Pacific Ocean. *In* The Future of the Fishing Industry of the United States, New Series, Vol. 4, Univ. of Washington, pp. 86-101.

Table 3

POUNDS OF HALIBUT CAUGHT PER HOUR OF SUCCESSFUL TRAWLING
BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
1-49	310	2.5	124	914	7.8	117	2,745	34.6	79	198	2.5	79	585*	11.4	51
50-99	2,584	20.2	128	1,118	22.4	50	5,335*	68.6	78	349*	5.7	61	3,244*	36.7	88
100-149	434	9.5	46	287	2.4	119	895	18.1	49	42*	1.0	I.S.	367	5.4	68
150-199	215	1.1	I.S.1/	-	-	-	485	5.0	97	-	-	-	465	4.0	116
200-299	-	-	-	-	-	-	390	7.0	56	-	-	-	50	1.0	I.S.
TOTAL	3,543	33.3		2,319	32.6		9,850*	133.3		589*	9.2		4,711*	58.5	
Avg. catch/hr. for all depths			106			71			74			64			81

1/Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF HALIBUT PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

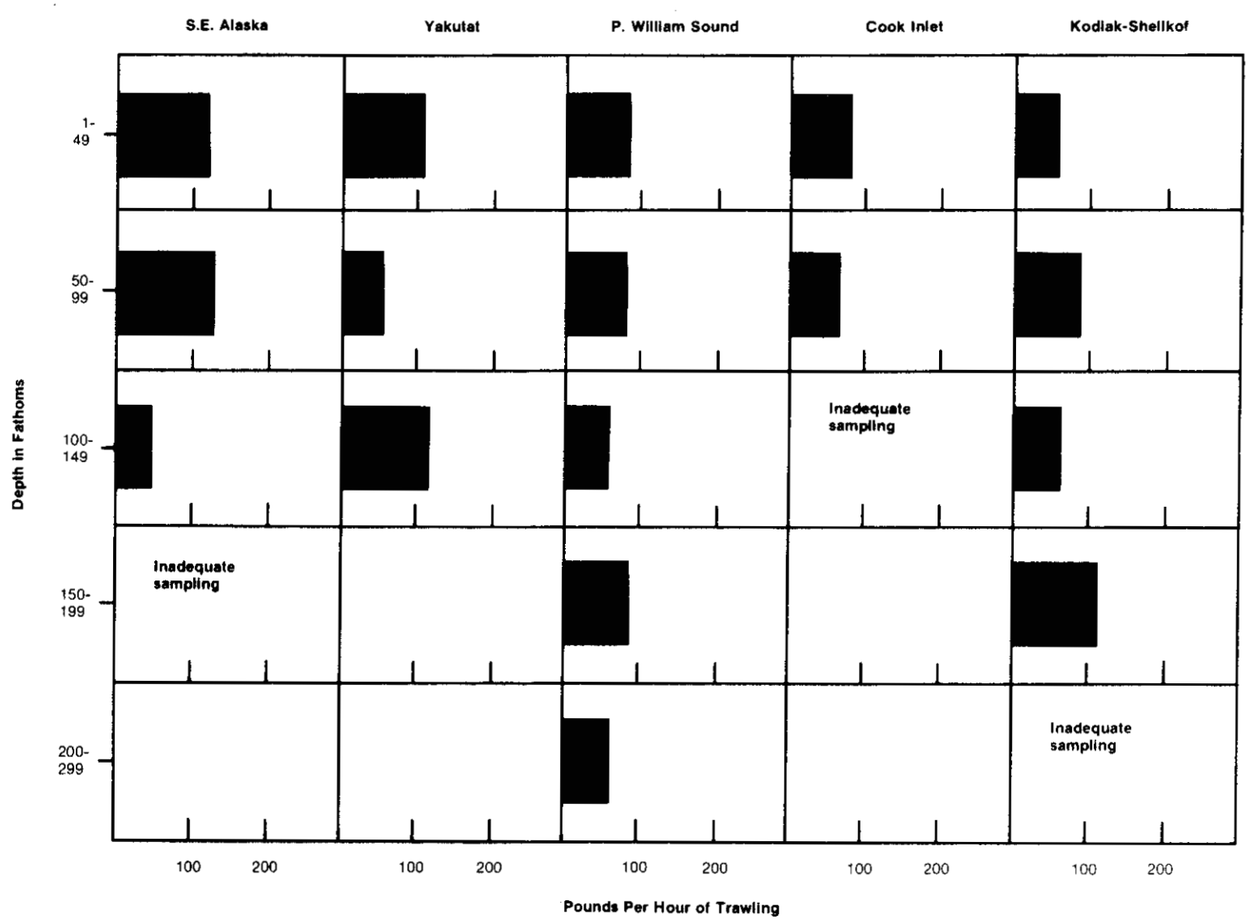
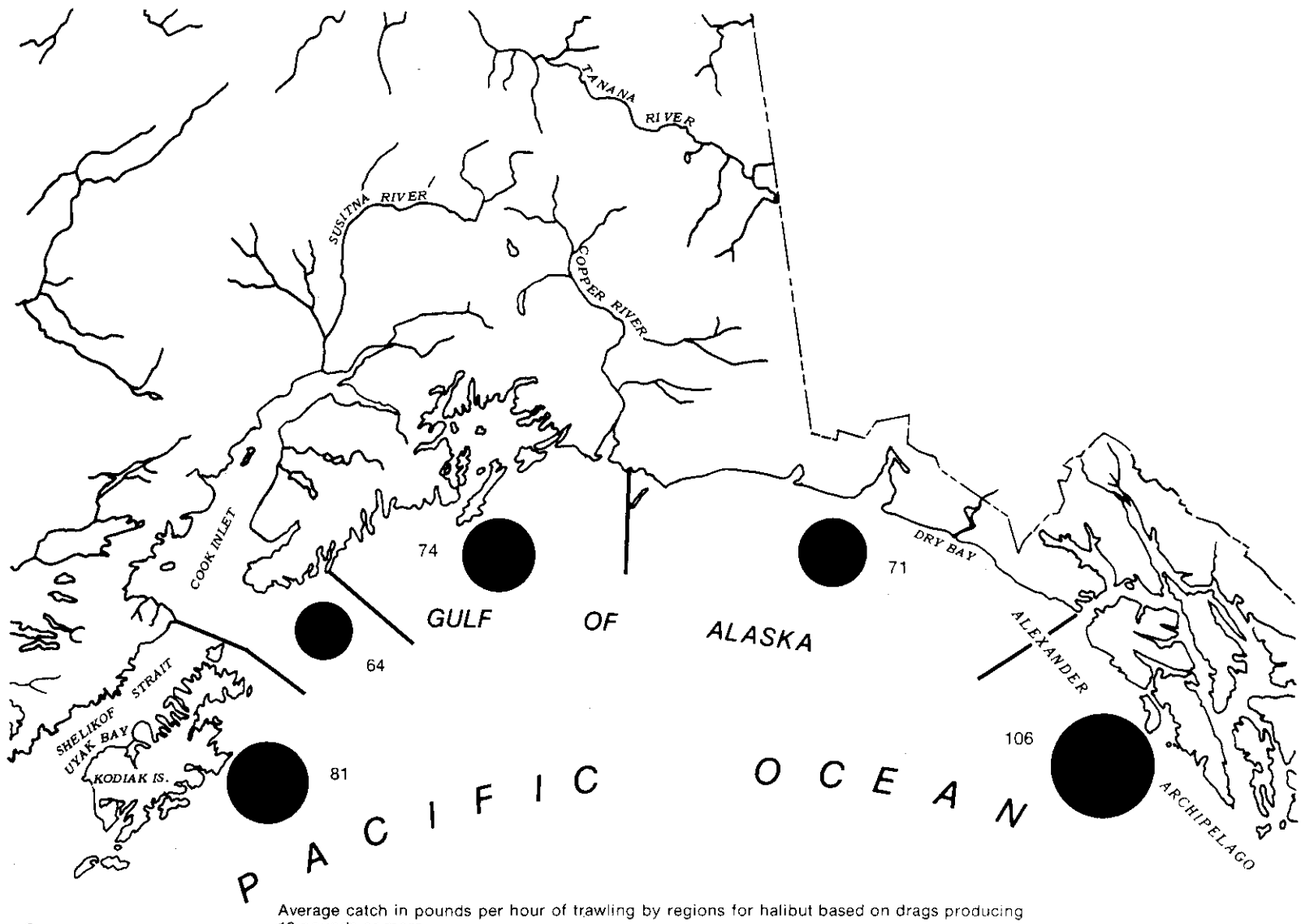


Figure 3



Average catch in pounds per hour of trawling by regions for halibut based on drags producing 10 pounds or more.

Figure 4

ROCKFISH GROUP

Rockfish populations in all regions are underestimated since these groups are known to be distributed both on the ocean bottom and at considerable distances above it. The rockfish group was represented by a greater number of species than any other fish group sampled. About 20 rockfish species, mostly from the genus *Sebastodes* occurred in the Gulf regions. The two species of the genus *Sebastolobus*, both of which are deep-water inhabitants contributed much to the rockfish catches beyond 99 fathoms. Many of the *Sebastodes* species appear to be primary pelagic forms and large catches of rockfishes were reported taken in midwater trawls. For this reason, these species had the greatest bathymetric range, occurring in all depth zones sampled.

Generally, the average catch per hour of trawling for rockfish increased with depth until it reached its maximum in the 100 to 149-fathom depth zone (Table 4 and Figure 5). Rockfishes were mostly encountered in the offshore waters of all regions, rarely were they found in the inside waters in southeastern Alaska. Furthermore, the number of species caught decreased in the inside waters. Pacific ocean perch, the most important single species of rockfish dominated the catches on the outer continental shelf and upper slope (50-149 fathoms) in the Gulf of Alaska. It was the main species caught in all regions and in almost all depth zones sampled, and was second to turbot as the most abundant species caught in the Gulf of Alaska area (Table 2). It accounted for over 62 percent of the entire rockfish catches at depths up to 199 fathoms. The highest catch rates of rockfish occurred in southeastern Alaska in the 100-149 fathom depth interval (Figure 6). Pacific ocean perch made up approximately 74 percent of the southeastern Alaska rockfish catch.

Table 4

POUNDS OF ROCKFISH CAUGHT PER HOUR OF SUCCESSFUL TRAWLING
BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
1-49	-	-	-	-	-	-	65	1.0	I.S.1/	-	-	-	240	2.0	120
50-99	30,923	23.5	1,316	3,090	16.5	187	21,236	58.1	366	-	-	-	23,184*	29.9	775
100-149	142,363	94.2	1,511	14,231	25.8	552	27,668	59.3	466	-	-	-	6,243	15.5	403
150-199	14,100	14.4	979	1,072	5.0	215	1,560	6.0	260	-	-	-	300	1.0	I.S.
200-299	500	2.0	250	2,315	3.1	747	-	-	-	-	-	-	-	-	-
300-399	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	187,886	134.1		20,708	5.04		50,529	124.4					29,967*	48.4	
Avg. catch/hr. for all depths			1,401			411			406			-			619

1/Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF ROCKFISH PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

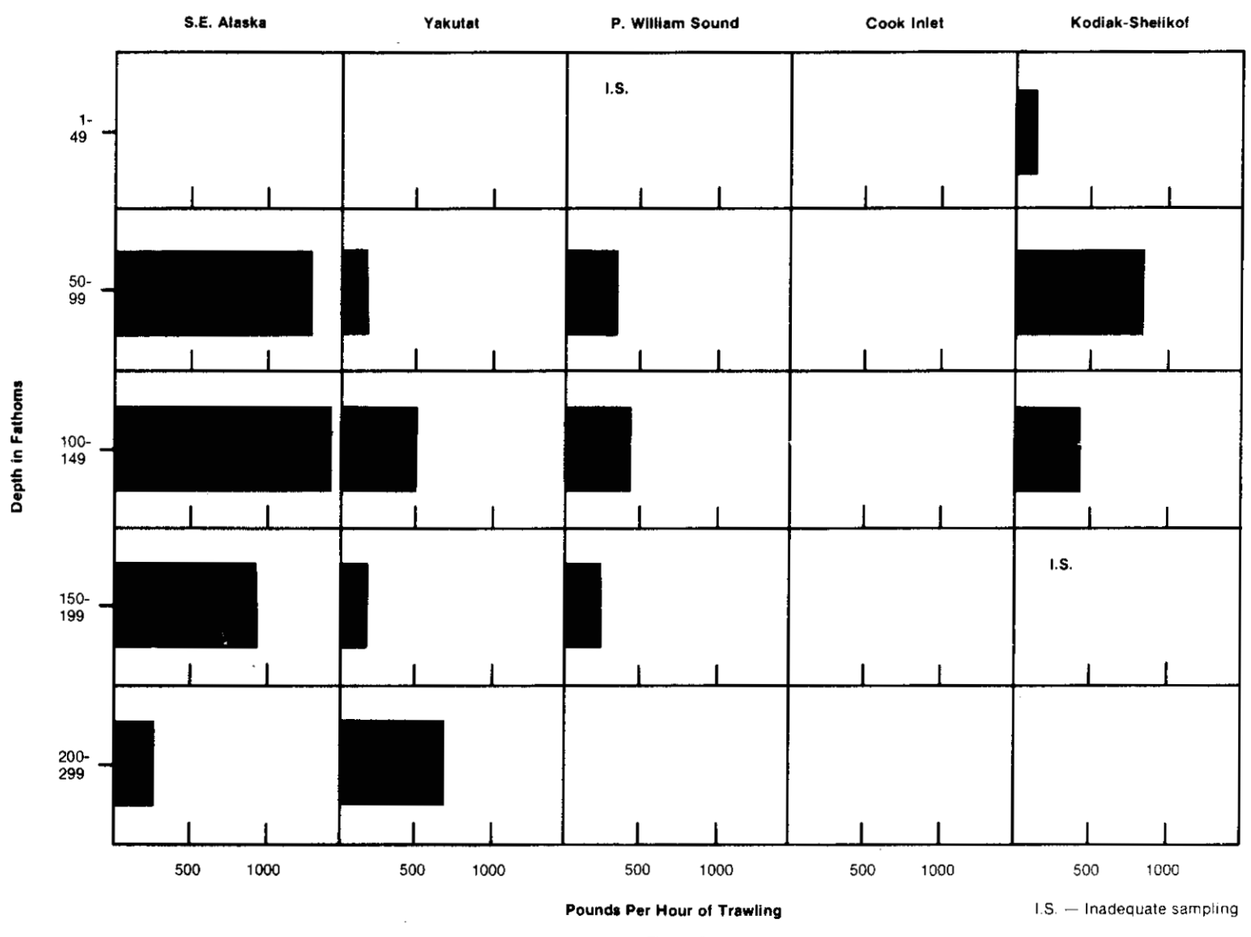
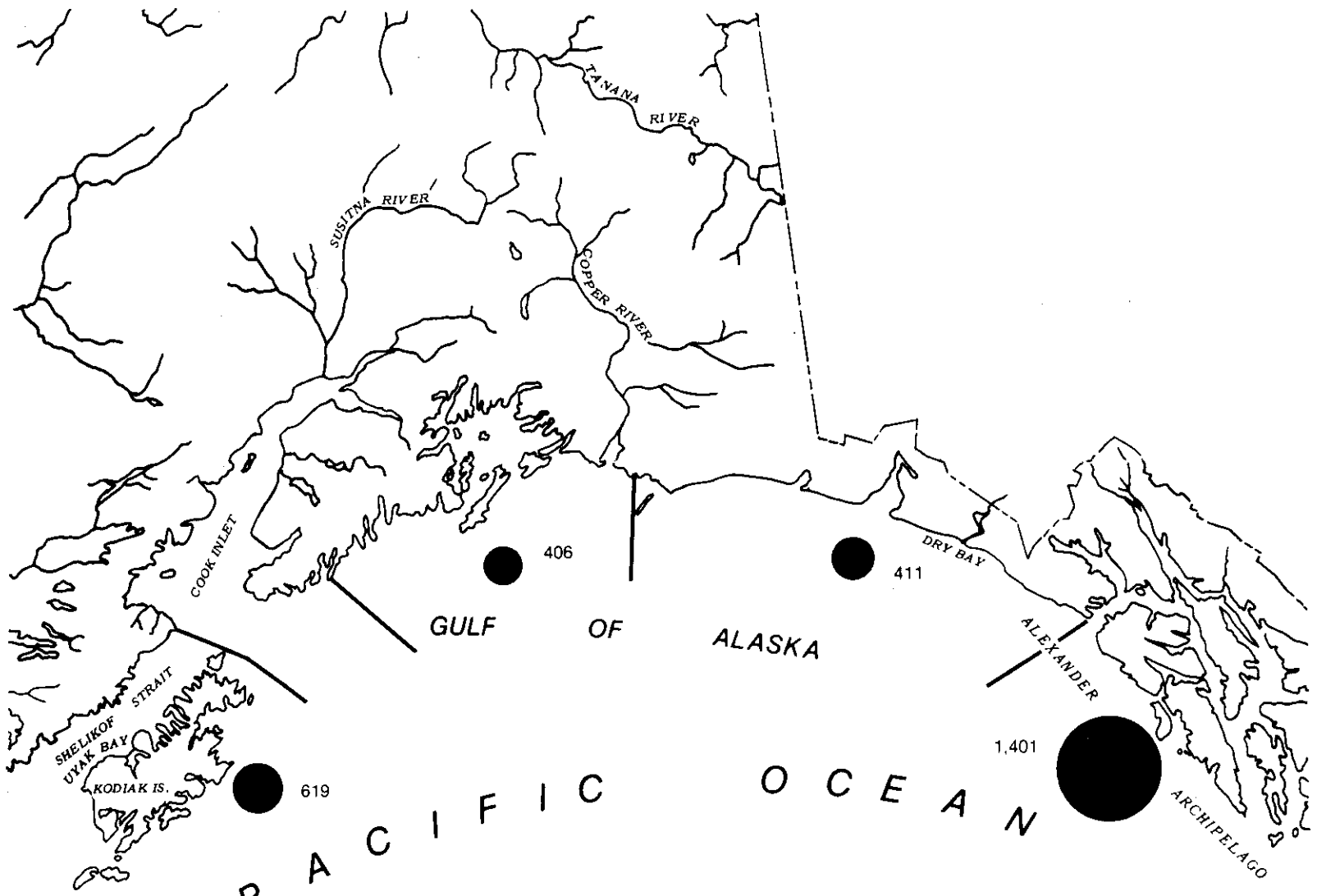


Figure 5



Average catch in pounds per hour of trawling by regions for rockfish based on drags producing 10 pounds or more.

Figure 6

SABLEFISH

Sablefish were distributed over the entire offshore areas of the Gulf. They were caught in trace amounts in the inside waters of southeastern Alaska, Prince William Sound, Cook Inlet, and Shelikof Strait. They are known to be particularly concentrated within or near submarine canyons or gullies, preferring blue-clay or mud bottom to sand or rock bottom. Highest catches occurred beyond the 100-fathom zone in all regions with adequate sampling (Table 5 and Figure 7). Sablefish are known to be abundant in the deeper waters along the continental slope. They were scarcely found on the continental shelf at depths less than 50 fathoms.

The major offshore fishing banks for sablefish are found off Baranof Island, from Cape Cross to Cape Fairweather, and from Middleton Island to Portlock Bank. This accounted for the highest catch rates in the Yakutat area (Figure 8). The major sablefish fishing areas in the inside waters of southeastern Alaska are located in Clarence Strait, Frederick Sound and Chatham Strait (see map).

Small immature sablefish are common in inshore waters in southeastern Alaska, particularly during the spring and summer months. Adult sablefish appear to inhabit the deeper waters along the continental slope, and seasonal bathymetric movements were observed for this species, migrating from deep to shallow waters with the onset of spring.

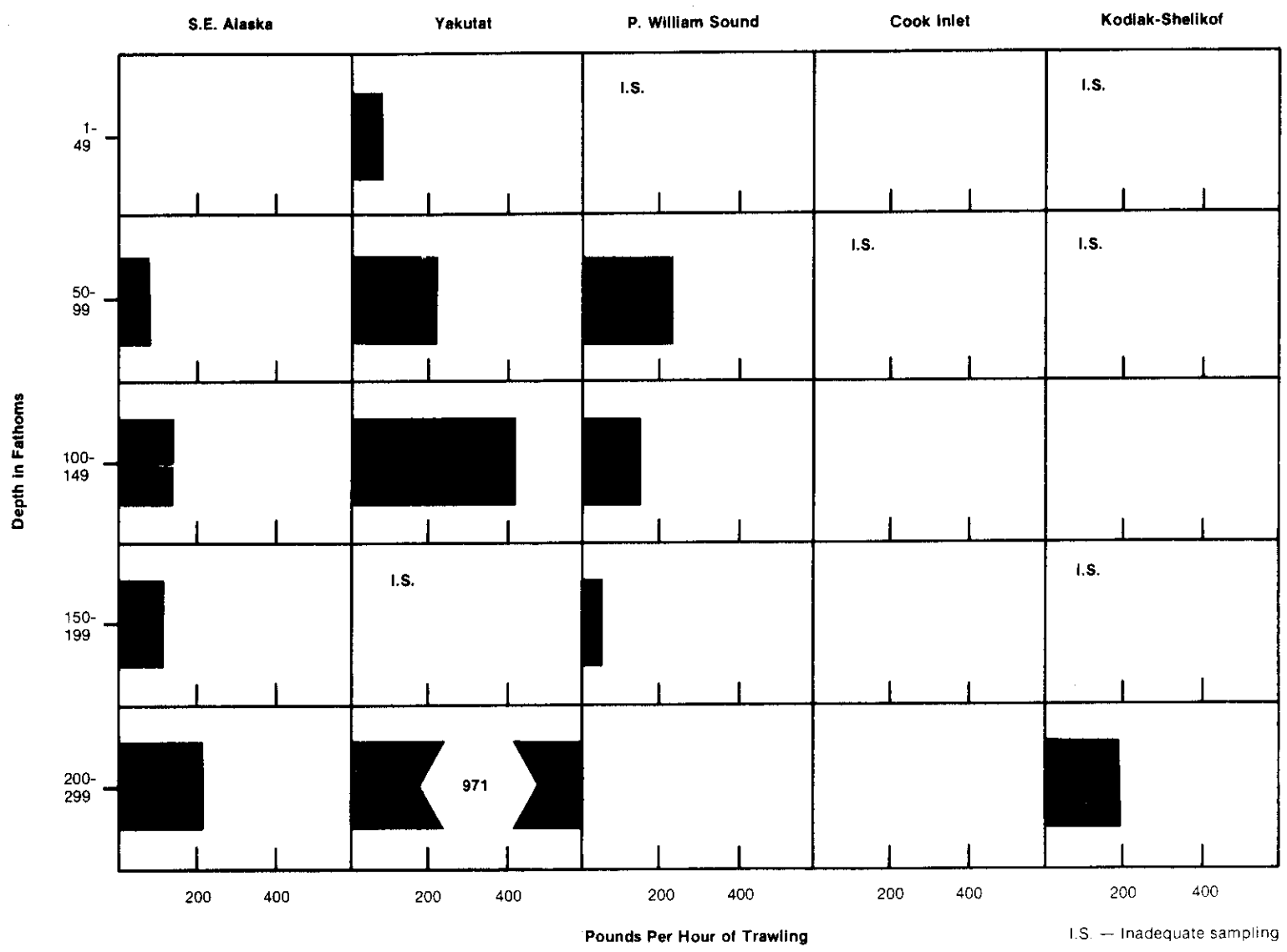
Table 5

POUNDS OF SABLEFISH CAUGHT PER HOUR OF SUCCESSFUL TRAWLING BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
1-49	-	-	-	150	2.0	75	48	1.5	I.S.1/	-		-	40	1.0	I.S.
50-99	642	9.0	71	1,915	9.3	206	2,938	13.3	221	20		I.S.	702	2.0	I.S.
100-149	2,336	20.0	117	2,630	6.3	417	4,127	29.0	142	-		-	-	-	-
150-199	1,010	10.2	99	20	0.6	I.S.	100	2.0	50	-		-	35	1.0	I.S.
200-299	485	2.5	194	2,040	2.1	971	-	-	-	-		-	510	3.0	170
300-399	29	0.9	I.S.	-		-	-	-	-	-		-	-	-	-
TOTAL	4,502	42.6		6,755	20.3		7,205	45.8		20			1,287	7.0	
Avg. catch/hr. for all depths			106			333			157			I.S.			184

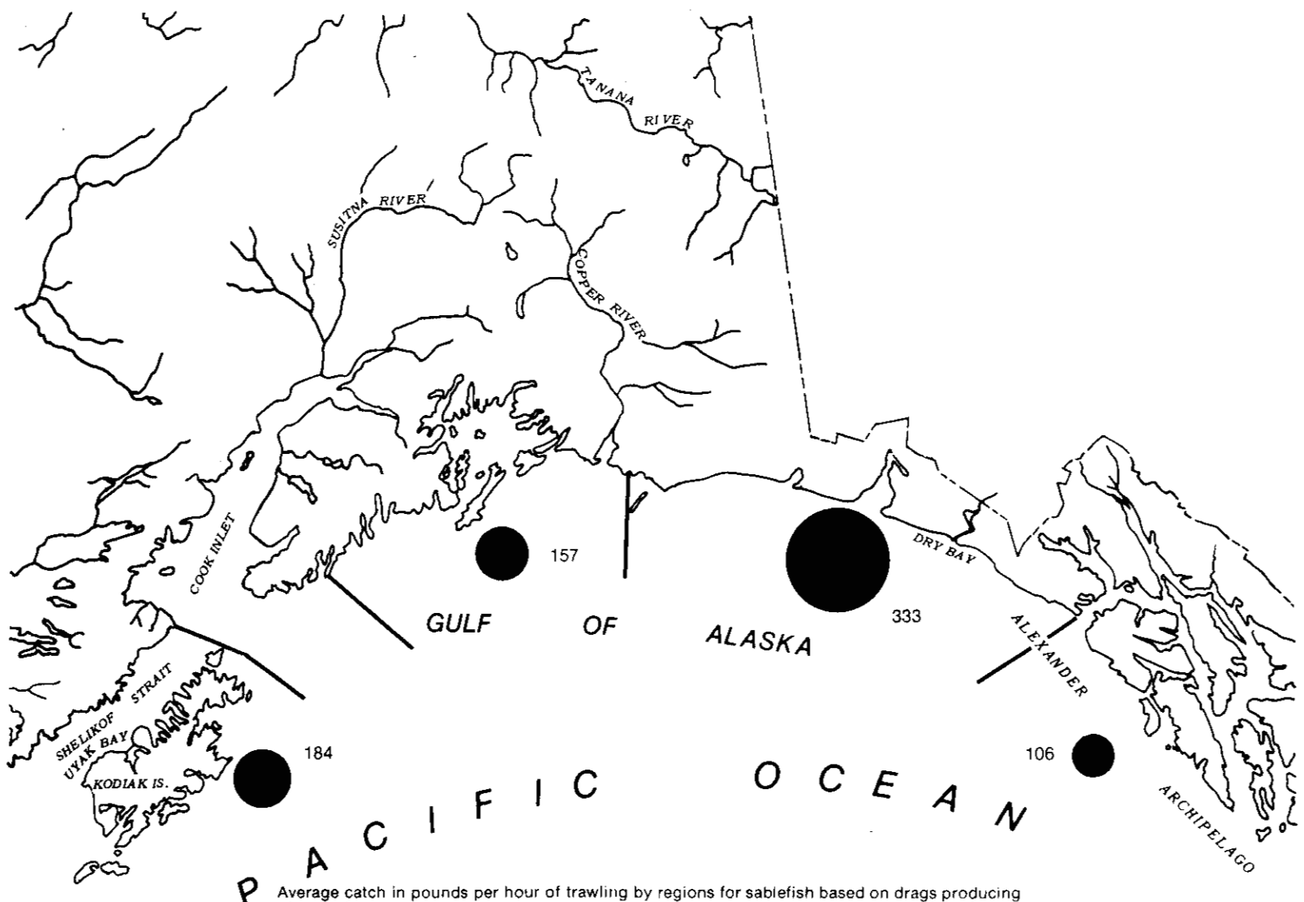
1/Inadequate sampling

AVERAGE CATCH OF SABLEFISH PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA



I.S. — Inadequate sampling

Figure 7



Average catch in pounds per hour of trawling by regions for sablefish based on drags producing 10 pounds or more.

Figure 8

SHRIMP

The pink *(Pandalus borealis)*, side-stripe *(Pandalopsis dispar)*, spot *(Pandalus platyceros)*, and coon-stripe *(Pandalus hypsinotus)* shrimp are the most frequently encountered species in surveys conducted in the Gulf of Alaska. The ocean pink shrimp dominated the shrimp trawl catches followed by side-stripe and coon-stripe shrimp. Pink shrimp made up about 73 percent of shrimp catches for the entire Gulf of Alaska regions. About 86 percent of shrimp catches in Prince William Sound area alone were pink shrimp.

The relative abundance of shrimp increased progressing north and west towards Kodiak Island (Figure 10). Explorations of the passages and bays in southeastern Alaska revealed commercial concentrations of pink shrimp in Glacier Bay, Stephens Passage, Lynn Canal, Idaho Inlet, and Keku Strait (see map). Best catches were made between 30-89 fathoms in all regions explored. The highest catch rate, based on average catch per hour of trawling for shrimp consistently occurred in the 30-49 fathom depth interval in all regions (Table 6). The highest single catch of shrimp (13,450 lbs.) occurred at depth range of 78-83 fathoms in Uganik Bay in Kodiak Island. The Kodiak-Shelikof region provides the major source for commercial shrimp fishing. Good catches were made at 30-109 fathom intervals in bays and inlets, as well as the offshore waters of the continental slope from Prince William Sound to the west end of Kodiak Island. In the Yakutat area, shrimp were only found in Yakutat Bay where they were relatively abundant at depth range of 30-49 fathoms (Figure 9).

Table 6

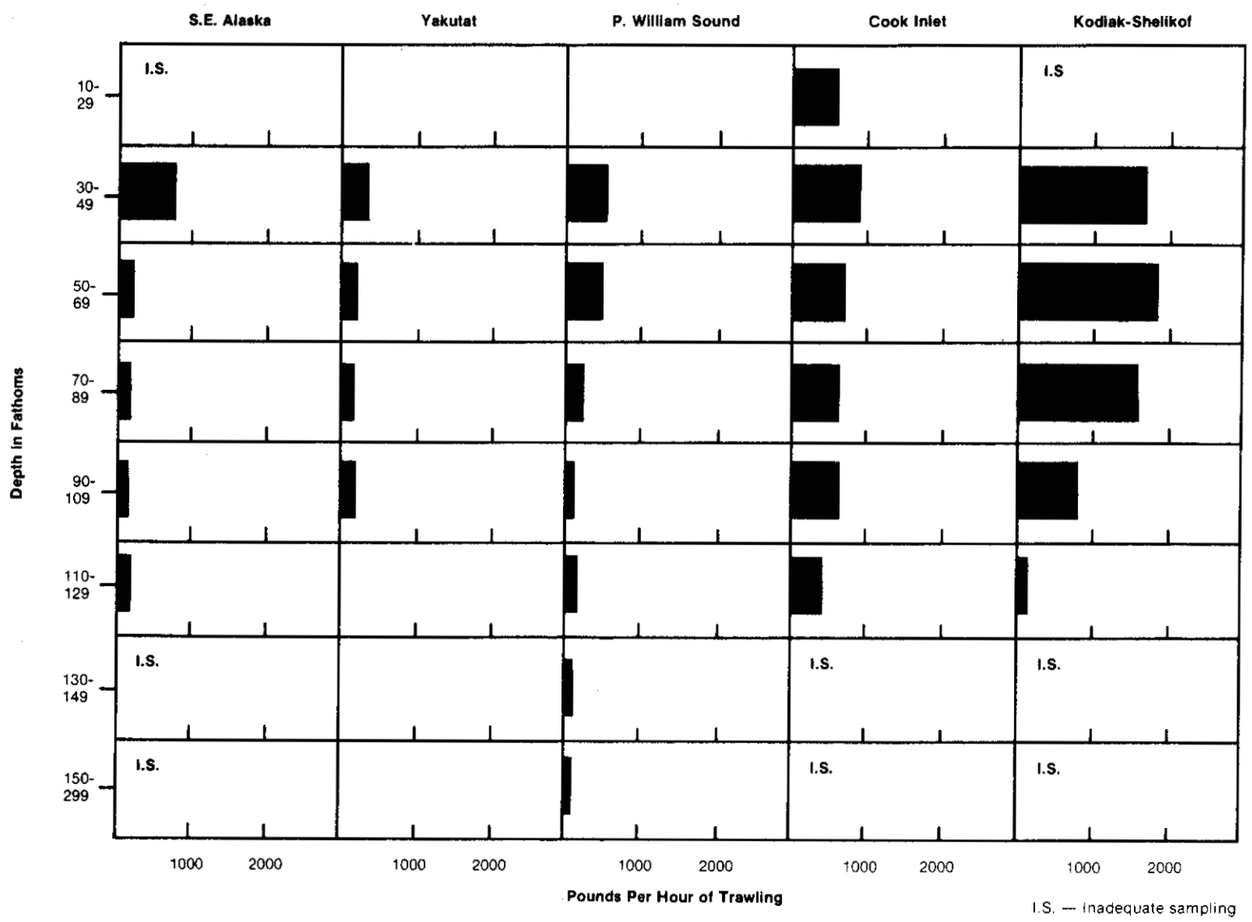
POUNDS OF SHRIMP CAUGHT PER HOUR OF SUCCESSFUL TRAWLING BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
10-29	547	1.6	I.S.[1/]	-	-	-	-	-	-	1,572	3.0	524	560	1.0	I.S.[1/]
30-49	8,049	22.2	362	2,173	7.0	310	2,292	4.7	488	5,998*	6.4	937	33,323	19.0	1,754
50-69	6,067	33.9	179	1,356	7.7	176	12,030*	28.1	428	8,451*	10.1	837	62,047*	31.4	1,976
70-89	5,111	33.3	153	1,353	11.0	123	11,424*	47.2	242	11,344*	19.4	585	102,834*	71.1	1,446
90-109	2,162	17.5	124	395	3.0	132	5,171*	40.4	128	1,589*	2.7	589	27,128*	30.7	884
110-129	537	4.0	134	-	-	-	1,520*	10.5	144	1,137*	3.5	325	1,123	9.0	125
130-149	71	1.5	I.S.	-	-	-	585	5.8	101	690	1.4	I.S.	214	1.5	I.S.
150-299	56	1.2	I.S.	-	-	-	330*	5.5	60	532	1.0	I.S.	273	2.0	I.S.
TOTAL	22,600	115.2		5,277	28.7		33,352*	142.2		31,313*	47.5		227,502*	165.7	
Avg. catch/hr for all depths			196			184			235			659			1,373

1/ Inadequate sampling

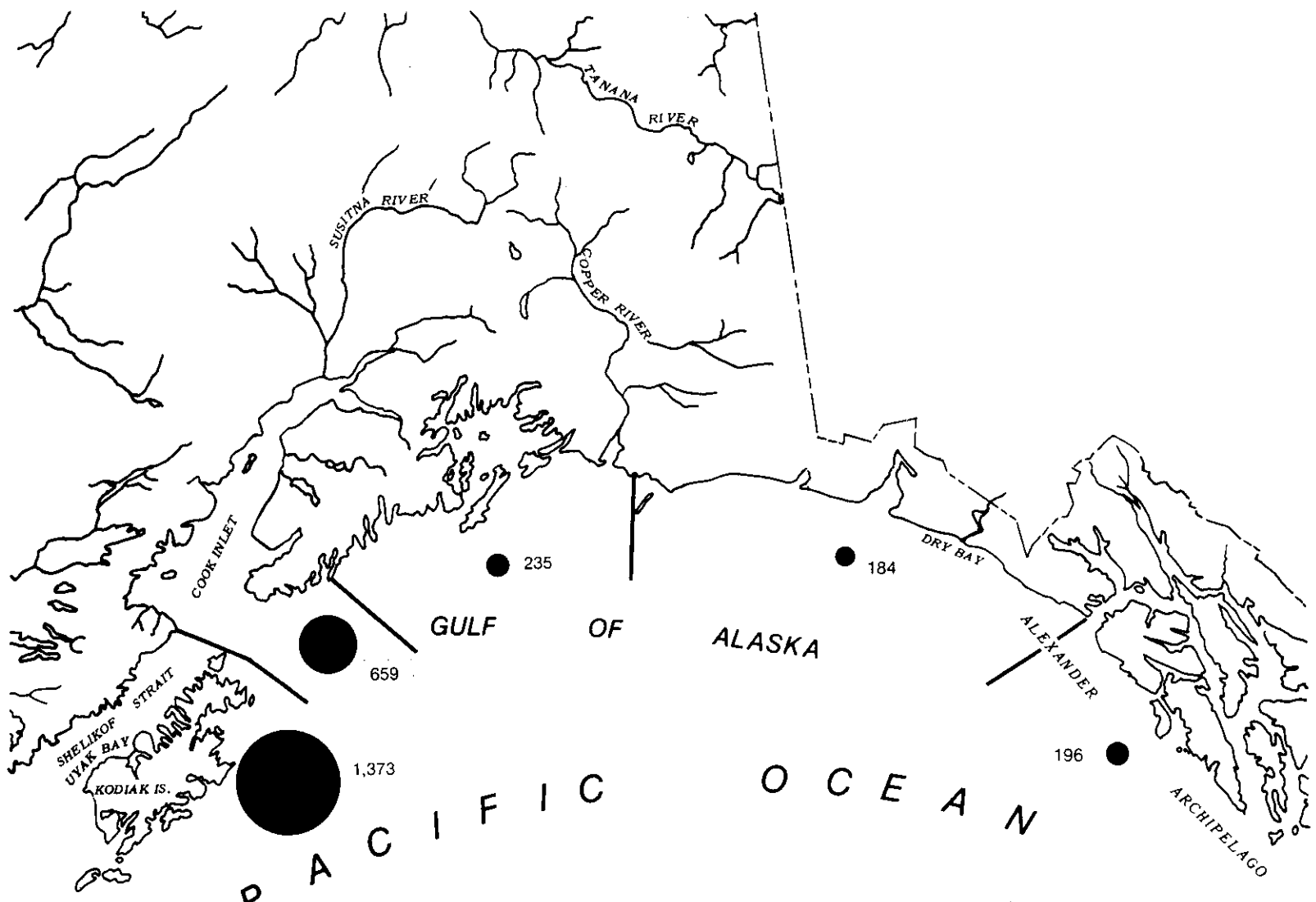
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF SHRIMP PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA



I.S. — Inadequate sampling

Figure 9



Average catch in pounds per hour of trawling by regions for shrimp based on drags producing 10 pounds or more.

Figure 10

DUNGENESS CRAB

Dungeness crabs concentrate in relatively shallow waters on the continental shelf at depths less than 50 fathoms (Table 7). They occurred frequently in the inshore waters of Prince William Sound at depth zones between 10-29 fathoms. Exploratory drags conducted in the vicinity of Cape Fairweather in the Yakutat region revealed concentrations of dungeness crabs at depth intervals of 10-49 fathoms. Smaller catches were found in southeastern Alaska and the Kodiak-Shelikof regions (Figures 11 and 12).

Data are inadequate to ascertain the standing stock of dungeness crab resources in the Gulf. However, there are speculations that both king crab and dungeness crab may now be approaching full utilization and yields may decline unless new stocks are fished.

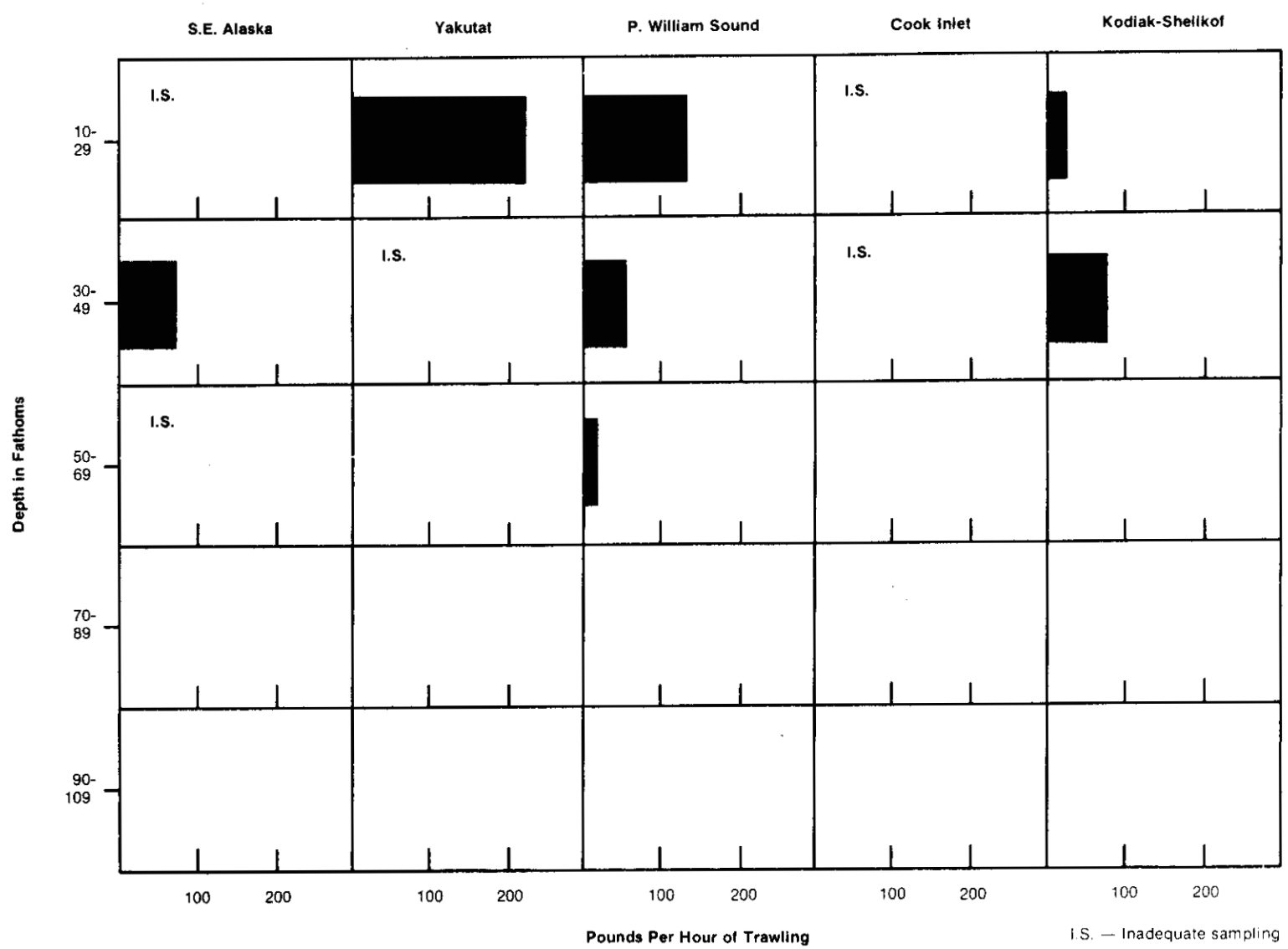
Table 7

POUNDS OF DUNGENESS CRABS CAUGHT PER HOUR OF SUCCESSFUL TRAWLING BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
10-29	10	.1	I.S.1/	475	2.1	226	1,678	13.0	129	140	0.5	I.S.1/	86*	3.8	23
30-49	136	2.0	68	65	1.0	I.S.	214	4.0	54	25	0.8	I.S.	246*	3.3	75
50-69	10	.5	I.S.	-	-	-	38	2.0	19	-	-	-	-	-	-
TOTAL	156	2.6		540	3.1		1,930	19.0		165	1.3	-	332*	7.1	-
Avg. catch/hr. for all depths			60			174			102			127			47

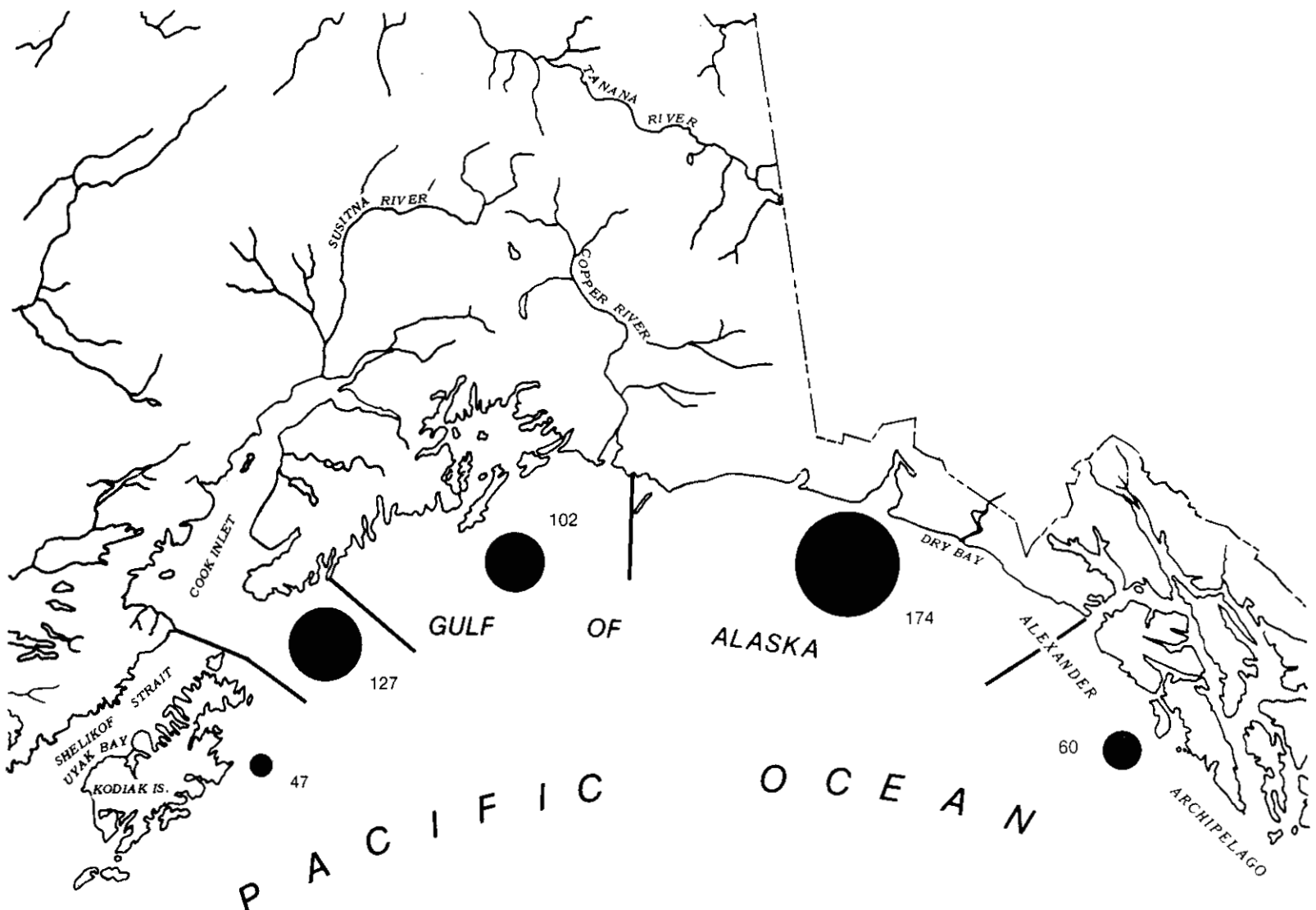
1/Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF DUNGENESS CRABS PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA



I.S. — Inadequate sampling

Figure 11



Average catch in pounds per hour of trawling by regions for dungeness crab based on drags producing 10 pounds or more.

Figure 12

KING CRAB

Unlike dungeness crab, king crabs inhabit a greater vertical depth range and occurred at depths well beyond the 100-fathom contour. Almost all of the king crab resources in the Alaskan Gulf are concentrated in waters from Cook Inlet and Kodiak region west to Unimak Pass.

The greatest abundance of king crab based on total catches and average catch per hour of exploratory drag for this species lie in depth zones ranging from 30-89 fathoms (Figure 13). Total catches of king crabs were highest in Kodiak-Shelikof region (Table 8), where they were frequently encountered in most exploratory drags for all depth zones. However, catch rates were lower in this region due to higher single catches in the Cook Inlet area. The highest single catch of king crab (3,000 lbs.) was taken northwest of Ushagat Island in the lower Cook Inlet region. The average catch per hour of successful trawling for king crabs for all regions is illustrated in Figure 14. It is estimated that a standing stock of approximately 500 million pounds of king crabs exist in the Gulf of Alaska.

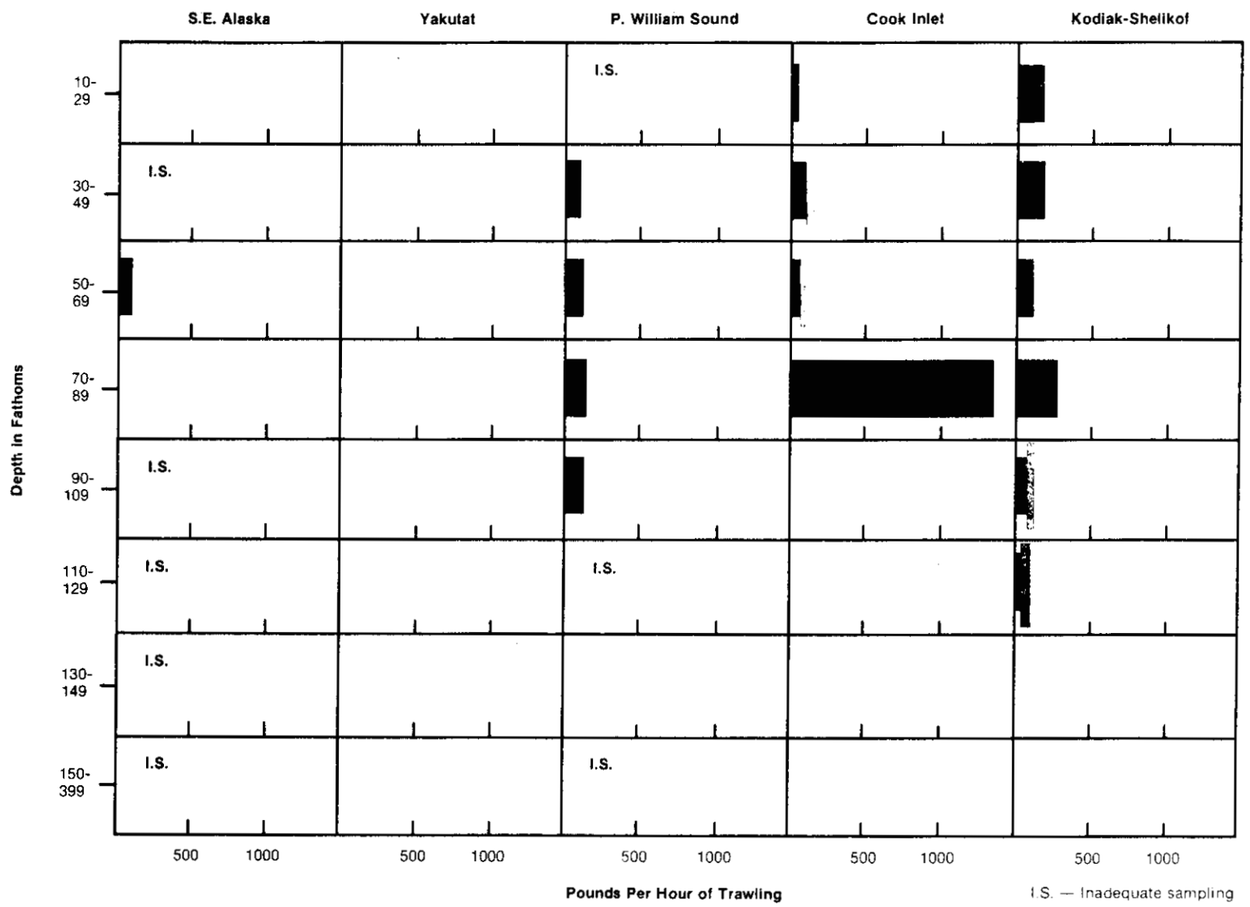
Table 8

POUNDS OF KING CRABS CAUGHT PER HOUR OF SUCCESSFUL TRAWLING BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
10-29	-		-	-		-	21	0.9	I.S.[1/]	47	1.5	31	1,193*	5.4	221
30-49	162	1.0	I.S.	-		-	156	4.4	35	330	2.8	118	5,545*	24.5	226
50-69	67	2.1	32	-		-	456	8.2	56	85	1.5	57	2,252*	18.0	125
70-89	-		-	-		-	901	9.1	99	7,176	5.3	1,354	7,817	32.8	238
90-109	10	.4	I.S.	-		-	515	6.8	76	-	-	-	556	6.0	93
110-129	25	.5	I.S.	-		-	12	0.5	I.S.	-		-	160	2.7	59
130-149	12	.5	I.S.	-		-	-	-	-	-		-	-	-	-
150-399	51	1.0	I.S.	-		-	108	1.0	I.S.	-		-	-	-	-
TOTAL	327	5.5		-			2,169	30.9		7,638	11.1		17,523*	89.4	
Avg. catch/hr. for all depths			59			-			70			688			196

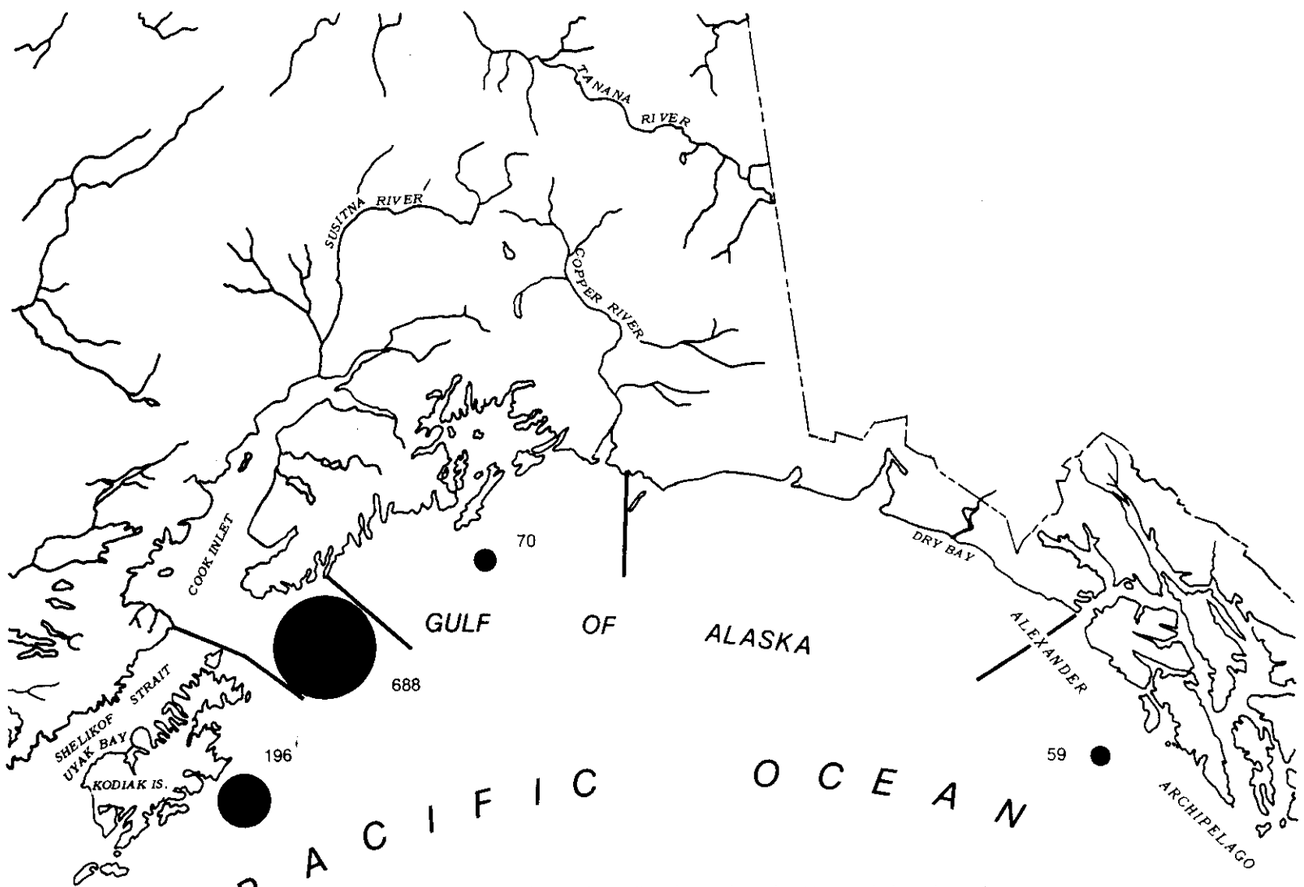
1/ Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF KING CRABS PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA



I.S. — Inadequate sampling

Figure 13



Average catch in pounds per hour of trawling by regions for king crab based on drags producing 10 pounds or more.

Figure 14

TANNER CRAB

Like king crab, tanner crabs have great vertical depth range. They were most abundant on the outer continental shelf and upper slope at depths between 50 to 149 fathoms from Cook Inlet to west of Kodiak Island (Table 9 and Figure 15). Highest catch rates were observed in the lower Cook Inlet area at 50-109 fathom interval. They were frequently caught in all regions explored. The average catch per hour of trawling for tanner crabs in all regions are shown in Figure 16.

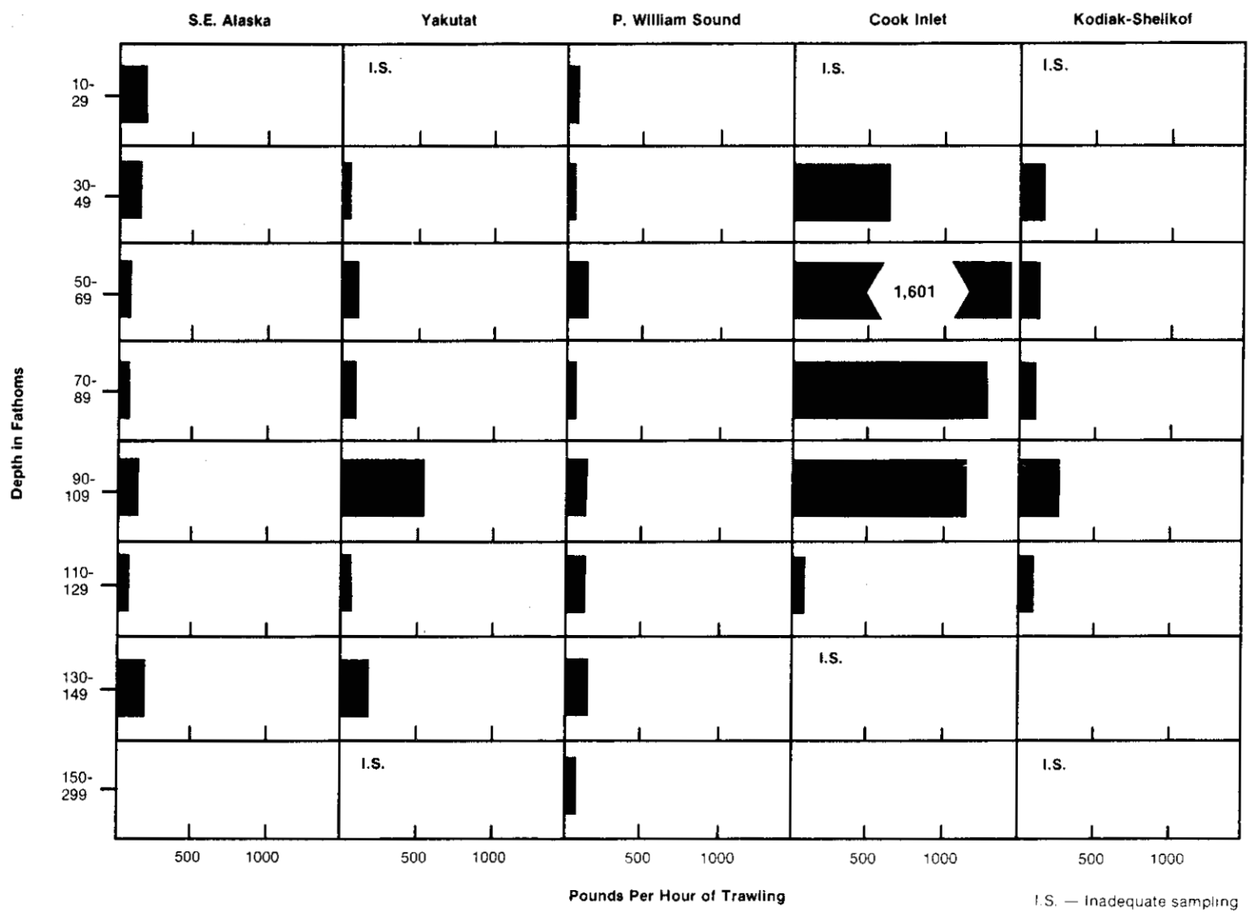
Table 9

POUNDS OF TANNER CRABS CAUGHT PER HOUR OF SUCCESSFUL TRAWLING
BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	S. E. ALASKA			YAKUTAT			P. W. SOUND			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
10-29	350	2.0	175	155	1.1	I.S.[1/]	229	2.9	79	20	0.5	I.S.	419*	1.7	I.S.
30-49	782	5.2	150	176	4.0	44	363	6.5	56	1,605	2.5	642	3,663*	18.2	201
50-69	491	7.0	70	1,784	14.7	121	5,090	38.4	132	4,804*	3.0	1,601	2,716*	18.7	145
70-89	297	4.5	66	1,371	12.9	106	2,284	34.3	66	17,845	13.8	1,293	2,147	17.3	124
90-109	556	4.0	139	5,940	10.4	571	7,030	54.3	129	3,570	3.1	1,152	3,543	13.4	264
110-129	92	1.5	61	197	4.0	49	2,559	21.2	121	120	2.0	60	977	8.0	122
130-149	360	2.0	180	385	2.0	192	1,257	8.9	141	50	0.9	I.S.	-	-	-
150-299	-	-	-	38	1.0	I.S.	378	7.3	52	-	-	-	25	0.5	I.S.
TOTAL	2,928	26.2		10,046	50.1		19,190	173.8		28,014*	25.8		13,490*	77.8	
Avg. catch/hr. for all depths			112			200			110			1,086			173

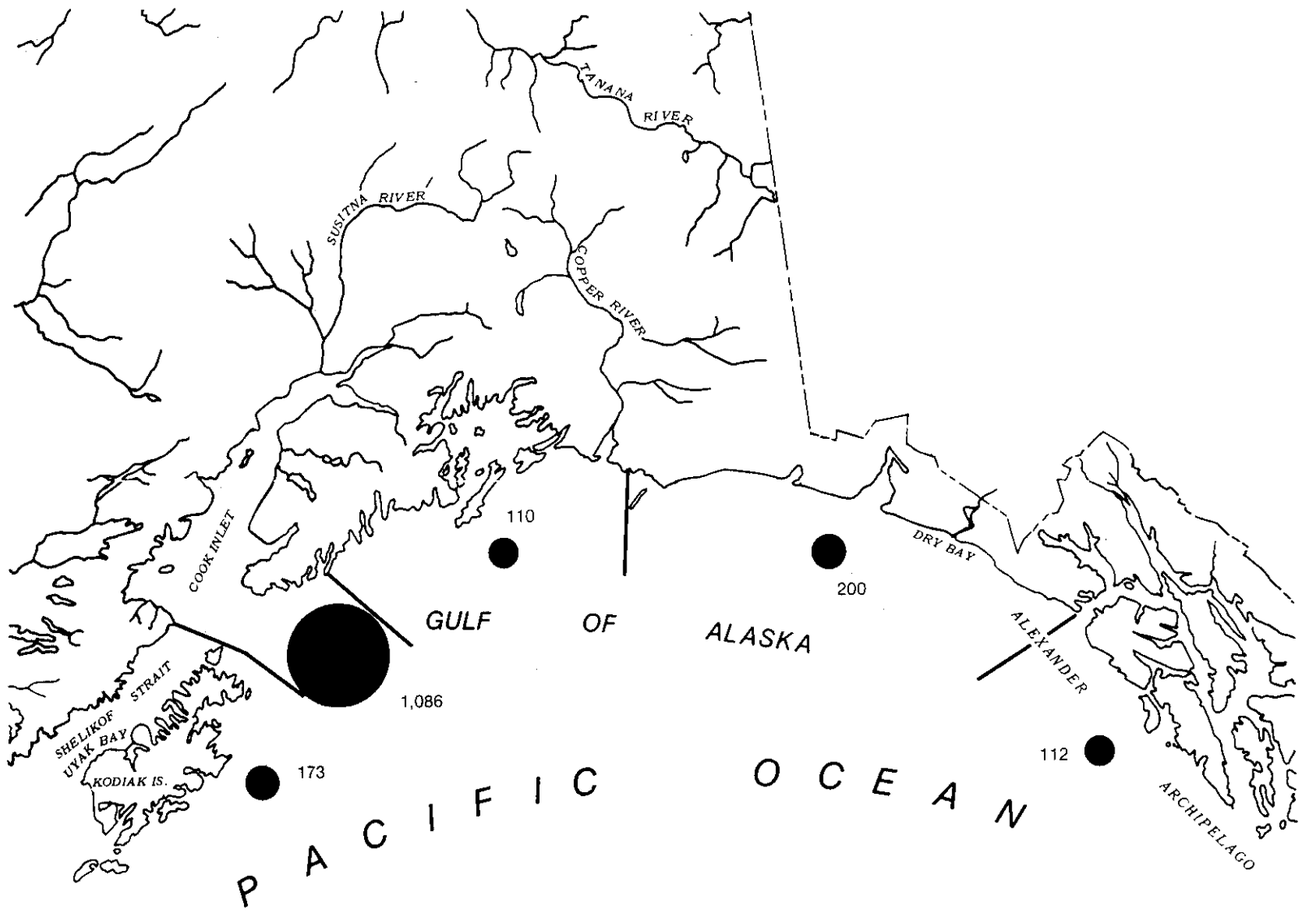
[1/] Inadequate Sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

AVERAGE CATCH OF TANNER CRABS PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA



I.S. — Inadequate sampling

Figure 15



Average catch in pounds per hour of trawling by regions for tanner crab based on drags producing 10 pounds or more.

Figure 16

SEA SCALLOP

Best catches were made in depths between 30 and 70 fathoms (Table 10). The areas of best catches included Cape Fairweather, off Icy Bay, and east of Cape St. Elias, all located in the Yakutat region (Figures 17 and 18). Sea scallops were also successfully dredged in Marmot Bay and Stevenson Entrance off Kodiak Island and trace amounts were observed off lower Kenai Peninsula and Shelikof Strait.

Exploratory drags made off Kodiak Island during the 1969-1971 period revealed a great abundance of scallops in the Marmot and Ugak Bay areas where a record catch of 775 lbs. was dredged off Ugak Island in 0.6 hr. at 40-45 fathoms. Due to several high catches, the average catch per hour for this species in Kodiak-Shelikof region jumped from 99 lbs. (1950-1968) to 375 lbs. (1969-1971).

Table 10

POUNDS OF SCALLOPS CAUGHT PER HOUR OF SUCCESSFUL TRAWLING
BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

	C. FAIRWEATHER			YAKUTAT BAY			ICY BAY TO C. YAKATAGA			C. ST. ELIAS			COOK INLET			KODIAK-SHELIKOF		
DEPTH FM.	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR	TOTAL CATCH	FISHING EFFORT (HOURS)	CATCH/ HOUR
<30	-		-	-		-	-	-	-	-		-	-	-	-	55*	0.5	I.S. 1/
30-39	1,410	5.6	252	25	.3	I.S. 1/	75	.5	I.S.	-		-	-	-	-	2,276*	4.7	484
40-49	422	2.1	201	28	1.0	I.S.	830	4.0	208	108	1.3	I.S.	-	-	-	1,760*	3.6	489
50-59	-	-	-	115	.5	I.S.	415	2.0	208	1,422	6.7	212	-	-	-	1,085*	2.5	434
60-69	-		-	165	2.5	66	395	2.1	188	196	3.5	56	-	-	-	510	3.4	150
70-79	-		-	92	2.5	37	-	-	-	-	-	-	17*	1.0	I.S.	15	0.5	I.S.
80-89	-		-	10	1.1	I.S.	-	-	-	-	-	-	-	-	-			
TOTAL	1,832	7.7		435	7.9		1,715	8.6		1,726	11.5		17	1.0		5,701*	15.2	
Avg. catch/hr. for all depths			238			55			199			150						375

1/ Inadequate sampling
*Includes exploratory drag data for the period 5-31-69 to 7-25-71

AVERAGE CATCH OF SCALLOPS PER HOUR TRAWLED BY REGIONS AND DEPTH ZONES IN THE GULF OF ALASKA

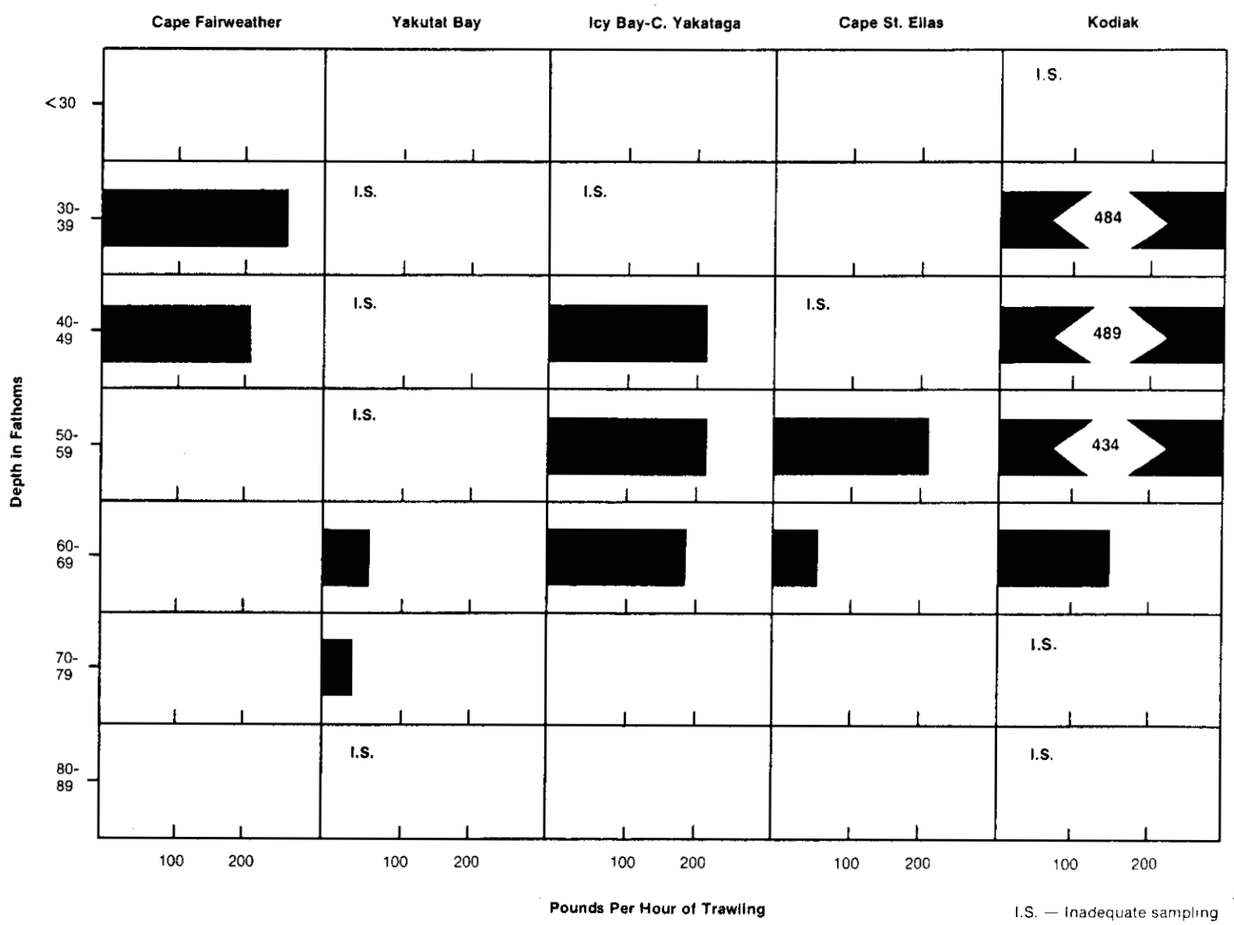
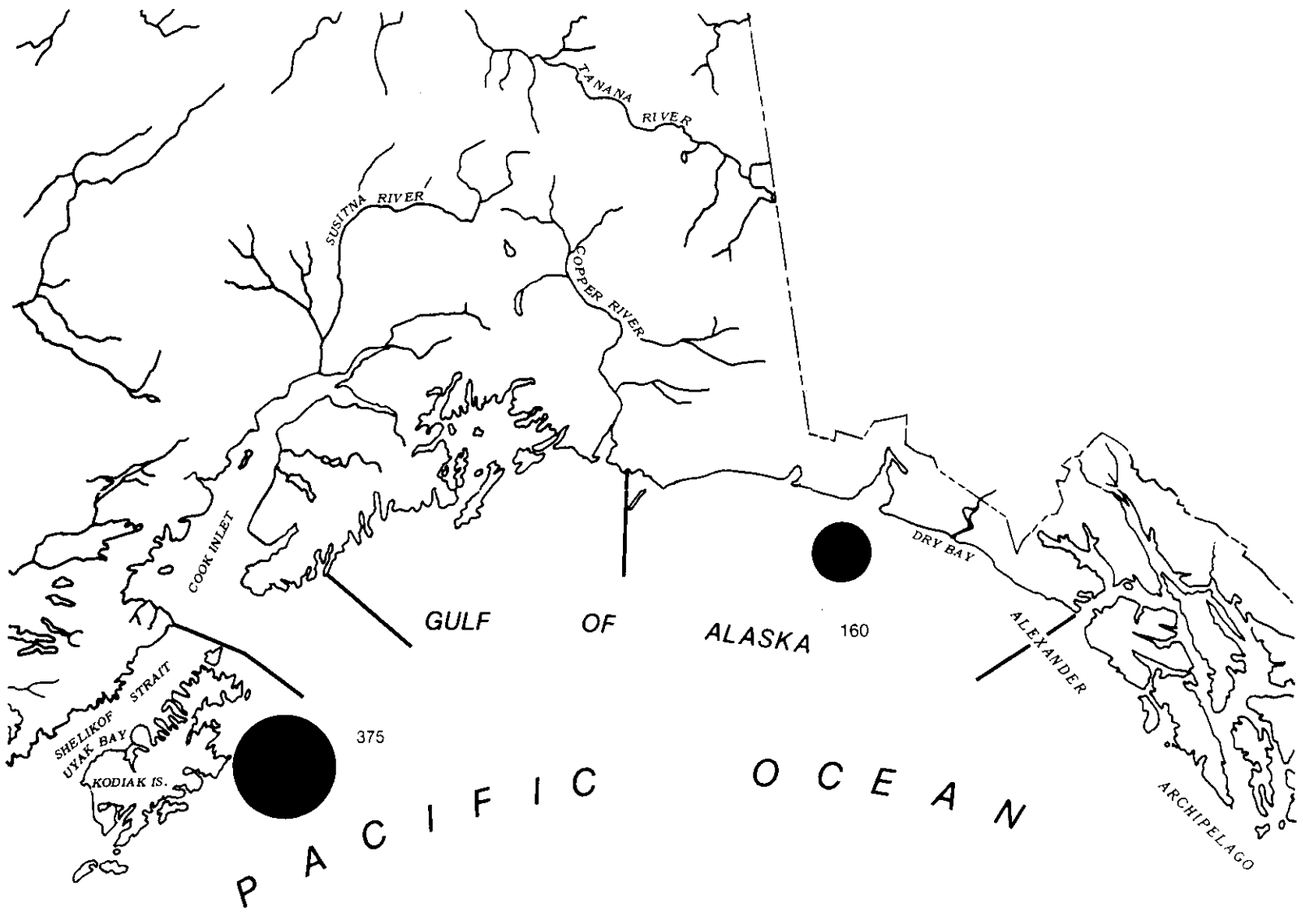


Figure 17



Average catch in pounds per hour of trawling by regions for sea scallop based on drags producing 10 pounds or more.

Figure 18

TABLE 11

Average Catch of Demersal Fish and Shellfish Per Hour of Successful Trawling By Regions in the Gulf of Alaska

(In pounds per hour trawling)

	S.E. ALASKA	YAKUTAT	P.W. SOUND*	COOK INLET*	KODIAK-SHELIKOF*
Flatfish (Except halibut)	290	513	241	206	381
Rockfish	1,401	411	406	-	619
Sablefish	106	333	157	-	184
Halibut	106	71	74	64	81
Dungeness Crab	60	174	102	127	47
King Crab	59	-	70	688	196
Tanner Crab	112	200	110	1,086	173
Shrimp	196	184	235	659	1,373
Sea Scallop	-	160	-	-	375

*Includes exploratory drag data for the period 5-31-69 to 7-25-71.

REFERENCES

Alaska National Marine Fisheries Service Exploratory Fishing Drags. Data compiled by R. J. Wolotira, S. A. Astrahantseff, N. B. Parks, and C. R. Hitz, NMFS Exploratory Fishing and Gear Research Bases in Kodiak, Alaska and Seattle, Washington.

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 lectures in fisheries, Inst. of Fisheries, the Univ. of Brit. Columbia, Vancouver. 190 pp.

Alverson, D. L. 1968. Fishery resources in the Northeastern Pacific Ocean. *In* The Future of the Fishing Industry of the United States, New Series, Vol. 4. Univ. of Washington, pp. 86-101.

CHEVRON MAIN PASS BLOCK 41 OIL SPILL: CHEMICAL AND BIOLOGICAL INVESTIGATIONS

Clayton D. McAuliffe
Chevron Oil Field Research Company
La Habra, California

Alfred E. Smalley
Tulane University
New Orleans, Louisiana

Robert D. Groover
NUS Corporation
*Houston, Texas**

W. Marvin Welsh and W. Stewart Pickle
Shilstone Testing Laboratory, Inc.
New Orleans, Louisiana

and

George E. Jones
Chevron Oil Company
New Orleans, Louisiana

ABSTRACT

During a three-week period in 1970 an estimated 65,000 barrels of 34° API gravity crude oil were discharged from the Chevron Main Pass Block 41C Platform, 11 miles east of the Mississippi River Delta. Two thousand barrels of chemical dispersants were sprayed on the platform and surrounding water surface.

It is estimated that between 25-30% of the oil evaporated during the first 24 hours, 10-20% was recovered from the water surface, less than 1% dissolved, and less than 1% of the oil was identified in sediments within a 5-mile radius of the platform. The remaining oil emulsified and dispersed to undetectable levels, biodegraded, or photooxidized.

The highest measured concentrations in water at the platform and at 1 mile were: oil-in-water emulsion, 70 to 1 ppm; dissolved hydrocarbons, 0.2 to 0.001 ppm; dispersant 1-3 to unmeasurable (<0.2 ppm).

Total extractable organic matter was highest in sediments near the Mississippi River Delta and in the inland bays.

Spilled oil, identified in bottom sediments by gas chromatography, showed rapid weathering after 1 week to 1 month and at the end of 1 year was reduced to a few percent of the amount after the spill. Spilled oil was not found in the sediment below 1.5 inches.

Over 550 species of benthic organisms were identified in 233 benthic samples. The number of species and number of individuals of benthic organisms showed low values in some samples near the platform. However, seasonal variations, bottom sediment type, and possibly other environmental parameters made it impossible to determine whether these locations had been affected by the spilled oil.

There was no correlation of number of species, number of individuals, or other biological parameters with the hydrocarbon content of the sediments for samples from within a 10-mile radius of the platform. This lack of correlation suggests lack of significant effect of oil on benthic organisms.

Extensive trawl samples showed no alteration in the annual life cycle of commercially important shrimp. Blue crabs were observed throughout the area, and the number of species of fish collected were comparable to a prior survey.

*Robert D. Groover formerly worked for Bio-Oceanic Research, Inc., New Orleans, Louisiana.

INTRODUCTION

Extensive chemical and biological studies were undertaken during and following the discharge of oil from the Main Pass Block 41C (MP41C) platform to determine the fate of discharged oil and to determine any adverse effects of the oil on the marine environment.

To answer these questions, hydrocarbon determinations were made of the water column, sediments, and selected tissue samples. Benthic organisms in numerous bottom samples were enumerated and identified. Numerous trawl samples were taken to collect various species of fish, shrimp, and crab. Bioassays were made using two surfactants, the spilled crude oil and the oil and surfactants in combination.

Chevron Production platform C, Main Pass Block 41, located about 11 miles east of the Mississippi Delta and 80 miles southeast of New Orleans caught fire February 10, 1970. Until March 10, most of the discharged oil and gas burned. On March 10, the fire was successfully extinguished and oil was discharged until March 31 when the last wells were brought under control. During this 3-week period, an estimated 35,000 to 65,000 barrels of crude oil were discharged [1]. Assuming the higher value, the rate of discharge the first 3 days was approximately 6,000 B/D, decreasing after the third day to 3,000 B/D, and then to 1,500 B/D during the final week as oil discharge from the various wells was terminated.

As a safety precaution during the fire and oil spill, 2,006 barrels of chemical dispersants were mixed in water and sprayed on the platform and surrounding water surface.

Fate of discharged oil

When oil is introduced to the marine environment, a variety of transformations involving physical, chemical, and biological processes occur. These include evaporation, spreading, dispersion, solution, emulsification, sedimentation, biodegradation, and chemical oxidation. As discharged oil weathers, the various dispersive and degradative processes shift from the more rapid physical effects to the slower chemical and biological modifications.

Evaporation. Most oil discharged from the MP41C platform was 33-35° API gravity. Much of the oil sprayed high into the air favoring evaporation of the lower molecular weight hydrocarbons. Kreider [7], in simulated laboratory experiments, showed that oil 0.5 mm thick on a water surface lost all hydrocarbons through 12 carbon atoms in the molecule in 24 hours. If the film thickness was only 0.1 mm, hydrocarbons through 14 carbon atoms were lost during the first day. Using Kreider's data and the Bureau of Mines analyses of MP41 crude oil, petroleum fractions through the kerosene distillate (C_{12}) would have evaporated and 28% of the oil would have been lost to the atmosphere in the first 24 hours.

Spreading and dispersion of the oil. Because MP41 crude is a low viscosity oil, it spread rapidly on the water surface. The surface oil moved under the combined influence of wind, waves, and surface currents. The surface oil, often in reddish-brown rope-like windrows, was generally water-in-oil emulsion or "chocolate mousse." On most days, the slick was about 6 miles in length and 1 mile wide. On 2 days, during relatively calm weather, the surface slick was observed 40 miles to the south, and on another day it extended a similar distance to the east.

Some oil was emulsified. This oil-in-water emulsion was observed as a widening creamy-yellow near-surface plume as it moved with the water from the platform. The emulsified plume became sufficiently dispersed so that at a distance of about 1 mile from the platform it became difficult to observe.

Amount of oil collected. Chevron's measurements indicated that during the first 10 days, 15,000 barrels of oil which contained water was recovered by skimming devices. As flow rate decreased, the amount recovered per day probably likewise decreased. Assuming recovered oil (water-in-oil emulsion) averaged 1,000 B/D for 21 days and contained 50% oil, approximately 10,000 barrels of oil were recovered (15% of that spilled).

Hydrocarbons and surfactants in the water column

Water samples were collected during the last 5 days when the oil discharge was estimated at 1,500 B/D. Samples were collected in the immediate vicinity of the platform and outward at distances up to 30 miles. Water samples were collected from near-surface, mid-depth, and near-bottom.

Low molecular weight hydrocarbons (C_1-C_9). Water samples were analyzed for individual dissolved hydrocarbons having 1-9 carbon atoms in the molecule by a gas equilibration method [9] capable of measuring low molecular weight hydrocarbons in the sub μg/l (ppb) range.

On March 26, 28, and 29, water samples were collected in areas which visually had the highest concentrations of oil-in-water emulsion in near-surface waters. Samples were collected as near to the platform as safety would permit (900 to 1400 feet) and the emulsified oil followed outwardly until it could no longer be distinguished visually in near-surface waters.

Total dissolved hydrocarbons associated with the spill which exceeded .002 ppm in the collected waters are shown in table 1. These dissolved hydrocarbons are all located near the platform. About one-half the dissolved hydrocarbons were low molecular weight aromatics—benzene, toluene, xylenes, and trimethylbenzenes. In most instances, dissolved hydrocarbons were observed only in near-surface waters, although on March 28, hydrocarbons were observed in mid-depth and near-bottom samples from locations 37 and 38. When concentrations in table 1 are plotted versus distance from the platform and extrapolated to the platform, the highest predicted concentration in the water was 0.20 ppm.

Table 1. Total low molecular weight hydrocarbons dissolved in water samples by gas equilibration method

Water Sample Location[a]	Date Sampled	Distance From Platform, Feet	C_1-C_9 Hydrocarbons, ppm
5 S	3-26-70	1400	0.010, 0.170
1 S	"	4100	0.125
2 S	"	4700	0.015, 0.18
3 S	"	6000	0.002
37 S	3-28-70	1200	0.022
37 M	"	"	0.021
37 B	"	"	0.010
38 S	"	2600	0.002
38 M	"	"	0.002
38 B	"	"	0.005
49 S	3-29-70	900	0.200
50 S	"	2900	0.002
50 M	"	"	0.002

[a]S = Near-surface; M = mid-depth; B = near-bottom

The percentage of hydrocarbons from the crude oil which dissolved in the water column can be estimated by taking an imaginary incremental 1-foot thick vertical section through the oil-in-water emulsified plume and calculating the volume of water passing through this incremental section with time. Table 2 summarizes estimates made at various distances from the platform on the 3 days. These estimates indicate that an average of 0.14% of the oil dissolved during the first 2-hour period. Because oil-in-water emulsion droplets are small, the rate of hydrocarbon dissolution was rapid, and it is estimated that during the first 24 hours, less than 1% of the oil dissolved in water.

Table 2. Estimation of the percentage of C_1 - C_9 hydrocarbons that dissolved in the water column during the Chevron oil spill

Water Sample Location	Date	Dimensions Of Assumed Increment Of Water, Feet	Measured Hydrocarbons Concentrations, ppm	Percentage of Spilled Oil Dissolved[a]
5 S	3-26-70	1x 300x10	0.090	0.17
2 S	"	1x1000x10	0.017	0.16
37 S, M, B	3-28-70	1x 200x40	0.018	0.13
38 S, M, B	"	1x 600x40	0.003	0.07
49 S	3-29-70	1x 150x10	0.200	0.29
50 S, M	"	1x 600x30	0.002	0.03
			mean =	0.14%

[a]Assumed current of 0.5 knot and an oil discharge rate of 1500 bbl/day

With time, these dissolved hydrocarbons either became extremely dilute by dispersion, biodegraded, photooxidized, or evaporated as predicted by the partitioning of hydrocarbons between water and the atmosphere [10].

High molecular weight hydrocarbons (C_{12}-C_{30}). Water remaining in sample bottles following the gas equilibration analysis was extracted with 1,1,1-trichloroethane. A portion of the solvent was analyzed for hydrocarbon content by gas chromatography. The lower limit of detection by this method was about 1 mg/l or 1 ppm.

Only water samples in the vicinity of the MP41C platform contained oil emulsified in the water in excess of 1 mg/l. The oil contents are given in table 3.

As for dissolved hydrocarbons, the amount of oil emulsified can be estimated by calculating the amount of oil passing through a 1-foot thick vertical section (table 4). It is apparent from the table that considerable variation existed. Amounts of emulsified oil varied either from 4 to 65% calculated on the amount of oil spilled or from 6 to 93% based upon partially weathered oil. With so few measurements, little reliability can be placed upon the estimates. The one value of 60 ppm (table 3) is not representative for the assumed incremental section because it is unlikely that most of the oil was emulsified.

Table 3. High molecular weight hydrocarbons in water samples (solvent extraction–gas chromatographic method)

Water Sample Location	Date Sampled	Distance From Platform Feet	Hydrocarbons as Oil From Platform MP41C ppm
1 S	3-26-70	4100	6
2 S	"	4700	2
5 S	"	1400	8, 60
37 S	3-28-70	1200	2
49 S	3-29-70	900	2

Table 4. Estimation of the percentage of crude oil spilled that was emulsified

Water Sample Location	Dimensions of Assumed Increment Of Water, Feet	Measured Oil Concentration, ppm	Percentage Oil Emulsified	
			Of Oil Spilled	Of Weathered Oil
5 S	1x 200x10	34	66	94
1 S, 2 S	1x1000x10	4	39	55
37 S, 49 S	1x 200x10	2	4	6

Surfactants. Waters that contained the highest oil content were also analyzed for surfactants [6].

Determination of nonionic surfactants in waters at low concentrations is difficult. The method has a minimum detectable sensitivity of about 0.2 ppm with an uncertainty of about 0.2 ppm when analyzing standard solutions. Table 5 shows estimated concentrations of nonionic surfactants in several water samples. Values in the table are based on the surfactant "Cold Clean." The analytical method has a sensitivity for Corexit 7664 which is only 1/3 as high as for Cold Clean. If the surfactant in the water samples was only Corexit 7664, the values would be about 3 times higher. Only samples 1S, 2S, 37S, and 49S had detectable surfactant content.

Table 5. Concentrations of nonionic surfactants in water samples collected in oil plume

Sample No.	Concentration, ppm	Sample No.	Concentration, ppm
1 S	1.0, <0.2	37 S	0.9
2 S	0.2	37 M	<0.2
4 B	<0.2	38 M	<0.2
5 M	<0.2	38 B	<0.2
5 B	<0.2	39 M	<0.2
7 S (3 mi. SW)	<0.2	49 S	0.6

Hydrocarbons in sediment samples

Samples of the bottom sediments were collected concurrently and adjacent to each site from which samples of benthic organisms were collected. Most sediment samples were collected by a diver except when water depths approached or exceeded 100 feet. Plastic tubes two inches in diameter and 12 inches long were pressed into the bottom sediment until the tubes penetrated about 10 inches. The tubes were stoppered, returned to the surface, placed on dry ice, and maintained in freezers at -10°F.

In deeper waters, samples were taken by inserting 2-inch by 6-inch plastic tubes into the sediment sample obtained by a Shipek dredge.

Total extractable organic matter. The sediment sample in the plastic tube was extruded from the tube; the upper 1.5 inches to be analyzed was excised with a knife. The sediment was air-dried 1 to 2 days and thoroughly mixed. Twenty grams were placed in teflon capped glass bottles and extracted with carbon tetrachloride. The separated CCl_4 containing extracted organic compounds was analyzed by infrared spectroscopy. The detection limit was 1-2 mg/kg (ppm) of organic material in air-dried sediment.

Figure 1 shows sample locations and organic matter content of these samples. Locations having greater than 100 ppm organic matter are shown by a larger symbol. Locations whose values exceeded 100 ppm were primarily in near-shore bays and particularly in sediments surrounding the Mississippi River Delta. Some values around MP41C exceeded 100 ppm and probably were associated with the oil spill. High values around the Mississippi River Delta strongly suggest that the organic matter in these sediments originated from the Mississippi River.

C_{12+} hydrocarbons. The top 1.5-inch interval and occasionally the second 1.5-inch interval of selected sediment core samples were analyzed by hexane extraction, liquid chromatography to separate hydrocarbons from nonhydrocarbons, and followed by gas chromatographic analysis and gravimetric analysis of the separated hydrocarbons.

C_{12}-C_{33} hydrocarbons determined by gas chromatography. Figure 2 shows the amount of hydrocarbons having from 12-33 carbon atoms in the molecule in sediment samples as determined by gas chromatography. The highest values were observed in some samples taken near the MP41C platform. Sediments deposited principally from the Mississippi River and those from some near-shore bays had hydrocarbon concentrations approaching average values for sediments collected near the platform. Hydrocarbon concentrations in sediment samples from Breton Sound and Chandeleur Sound were considerably lower. The character of the hydrocarbons as determined by gas chromatography were also different in the various areas sampled.

Although there were variations, chromatograms of samples 25 through 34, 55, 56, and 57 were similar and have characteristics which resemble the MP41 crude oil. Figure 3 shows chromatograms of the crude oil and hydrocarbons from samples 30 and 136. Sediment hydrocarbons from sample 30 have characteristics similar to that of the crude oil, but weathering had already occurred as evidenced by loss of low molecular weight hydrocarbons and evidence of biodegradation of normal paraffins relative to the isoprenoids pristane and phytane. Pristane and phytane, which biodegrade more slowly than normal alkanes, were higher than the corresponding n-C_{17} and n-C_{18} for sample 30, and only pristane and phytane remained in sample 136. These two samples were collected 7 and 33 days respectively after the oil spill.

Additional evidence of weathering of the spilled oil was shown by the decrease in the C_{12}-C_{33} hydrocarbon content for samples 32, 57, and 129 collected in the spill areas after the spill and about 1 year later (figure 2). The concentrations changed from 125 to 2.5, 63 to 6, and 51 to 4 ppm respectively. The hydrocarbon concentrations after about 1 year approached or were at background values showing the almost complete weathering of the crude oil.

Crude oil from the spill was not incorporated into the sediments below the top 1.5 inches, the interval analyzed. The second 1.5-inch interval for samples 31 and 32 had a low concentration of hydrocarbons and the gas chromatograms did not show MP41 crude oil characteristics. Other samples which had the top two intervals analyzed were in the nearshore samples. The lower interval had hydrocarbons generally as high and sometimes higher than the first interval (figure 2). This suggests that hydrocarbons have been continually added during the time required to add three inches of sediment.

Hydrocarbons in sediments discharged from the Mississippi River are exemplified by the chromatogram for core D38, figure 4, collected off Southwest Pass. The chromatogram shows a lack of predominance of normal alkanes and a high unresolved envelope indicative of highly weathered hydrocarbons. The hydrocarbon content increases with molecular weight until the peaks start to decrease, probably due to incomplete vaporization in the C_{30+} region after sample injection. The chromatogram shows evidence of hydrocarbons from biogenic sources indicated by the odd-to-even predominance of normal alkanes in the C_{25}-C_{33} range. Sample D38 is representative of samples 160, 162, 166, 167, D1, D2, D7, D10, D21, D26, D29, D38, X13, X19, X21, X30, X31, WD4, WD5, WD6, WD6A, WD8, and WD10. The hydrocarbons appear to be from Mississippi River discharge and possibly from inland bays. Because biogenic sources of hydrocarbons are apparent from the chromatograms, it is not known what portion of the unresolved hydrocarbon envelope originates from petroleum and/or biogenic sources.

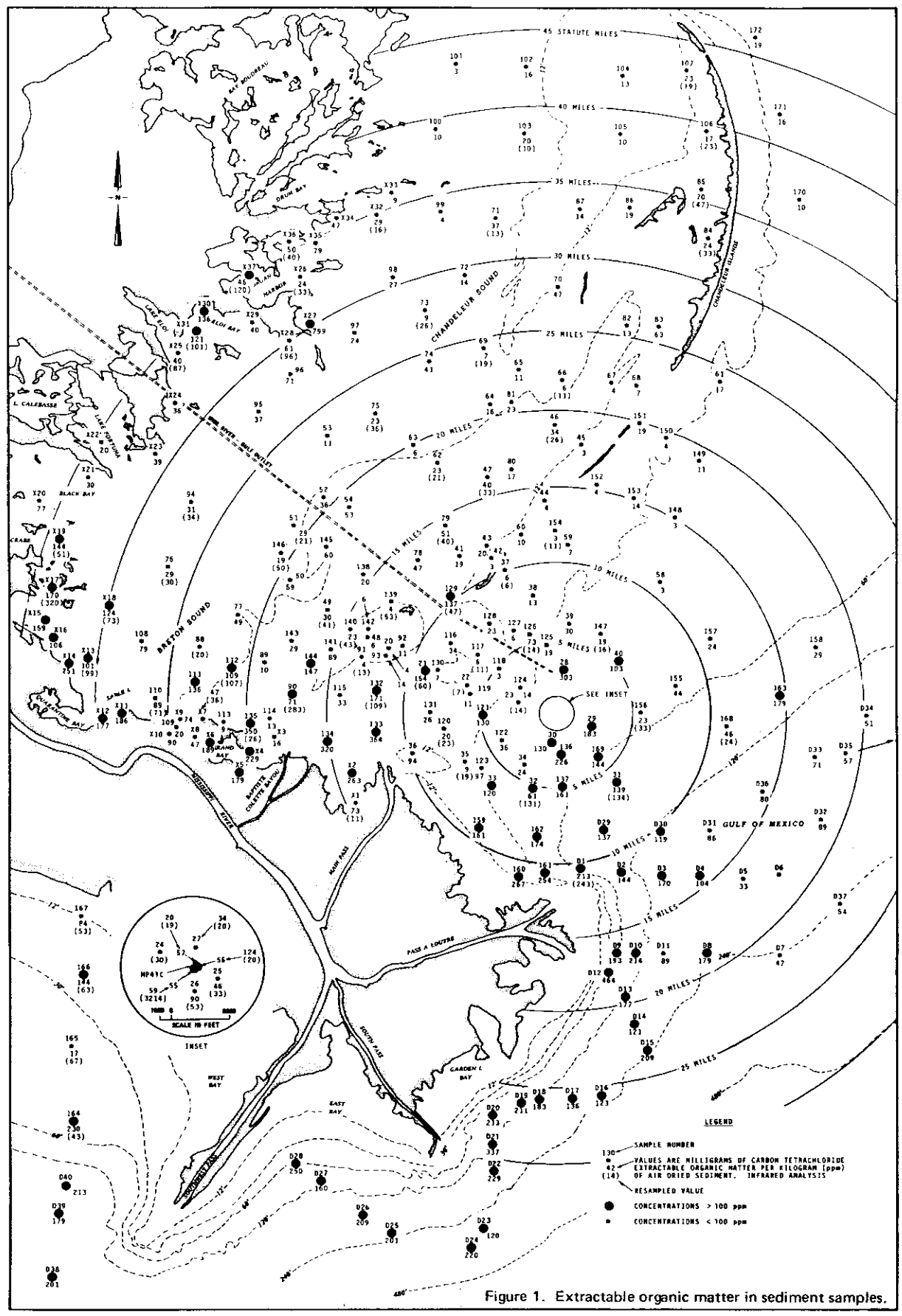


Figure 1. Extractable organic matter in sediment samples.

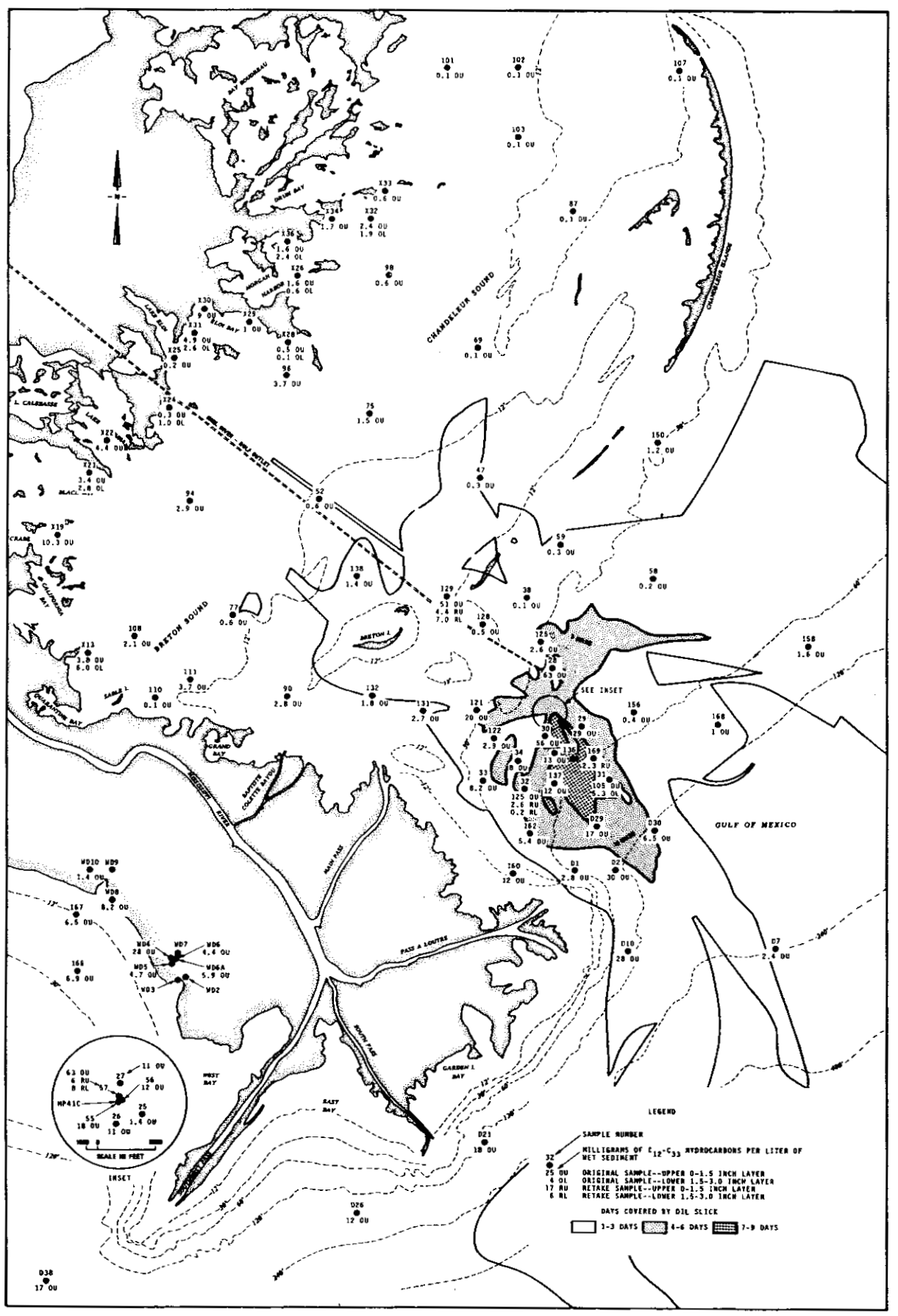


Figure 2. C_{12} - C_{33} hydrocarbon content of sediment samples measured by gas chromatography

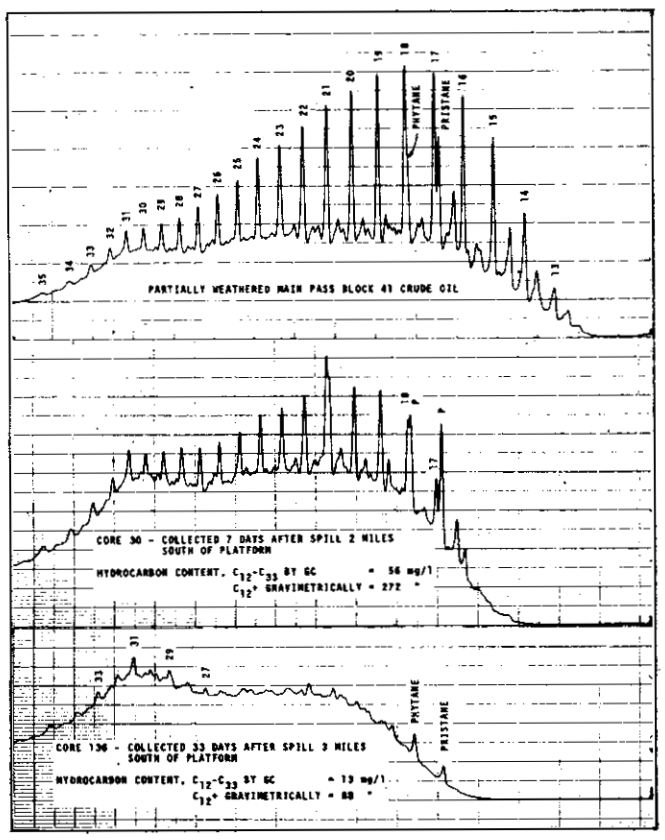


Figure 3. Gas chromatograms of partially weathered MP41 crude oil and MP41 oil in two sediment samples exhibiting biodegradation of hydrocarbons

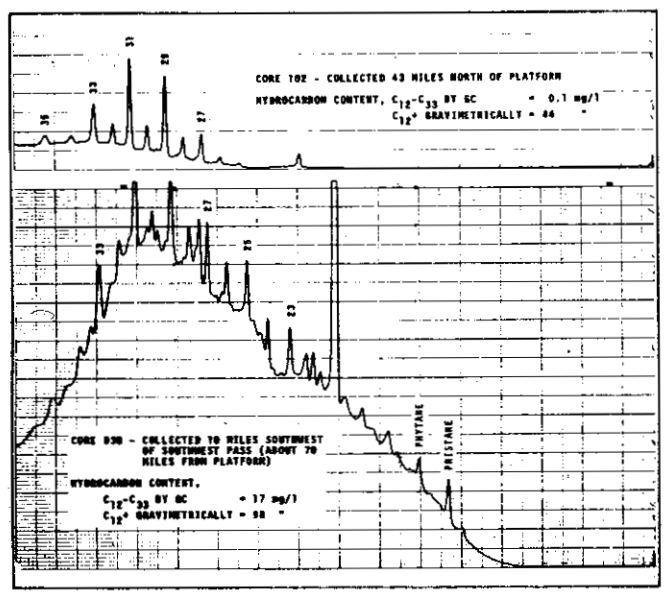


Figure 4. Gas chromatograms of hydrocarbons typical of those found in sediments near Mississippi River discharges and in Chandeleur Sound

Samples collected in Chandeleur Sound away from petroleum operations, shipping, and Mississippi River discharge show markedly different chromatograms; sample 102, figure 4, is typical. The hydrocarbon content is low and the principal hydrocarbons present are n-C_{25} through n-C_{33} with odd-over-even carbon number predominance, indicative of biogenic sources.

Hydrocarbons in sediments determined gravimetrically. In general, the same relationship was found for total hydrocarbons as for the C_{12}-C_{33} hydrocarbon fraction; i.e., high values were found around the platform, in sediments discharged by the Mississippi River, and in nearshore bays. Lower values were found in Breton and Chandeleur sounds. The contrast between areas, however, was not as great as for the C_{12}-C_{33} fraction due to the generally higher total hydrocarbon values in the sediments from the sounds.

Additional evidence of spilled oil in the sediments near the platform was indicated by comparing the C_{12}-C_{33} hydrocarbon fraction to the total hydrocarbons in the sediments. The C_{12}-C_{33} fraction was 21% of the total sediment hydrocarbons in the platform vicinity, and averaged only 6.8% for the other locations.

Estimate of the amount of oil that sedimented. Even though the residuum of the MP41 crude oil will not sink in seawater, its presence in the bottom sediments indicated that droplets probably attached to suspended particles, such as silt, in the water column and subsequently sedimented.

The amount of oil sedimented was estimated by taking average sediment oil concentrations, subtracting the estimated hydrocarbon background, and correcting for weathering. This is only an estimate because: sample coverage was not uniform, the area affected was not precisely known, the amount of oil spilled was not precisely known, and the actual degree of weathering was uncertain.

If a 5-mile radius is assumed which includes samples 25 through 34, 55, 57, 121, 122, 136, and 137, the average hydrocarbon concentration in the C_{12}-C_{33} fraction was 31 mg/l. Subtracting a 1 mg/l background value, the amount of hydrocarbons in this fraction in the sediments would be 60 bbl. If the more highly weathered samples 121, 122, 136, and 137 are deleted, the amount of oil would be 71 bbl. If the C_{12}-C_{33} hydrocarbon fraction represents one-half of the crude oil and if this fraction is one-half weathered, it represents 0.4% and 0.5% of the total oil discharged from the MP41C platform.

A similar estimate can be made using total hydrocarbons measured gravimetrically in the same samples. The average of all samples was 151 mg/l (excluding the more weathered samples, 178 mg/l) with a background of 20 ppm. If the oil had weathered one-third, the amount in the sediments would be equivalent to 0.6% and 0.7% of the oil spilled. Both calculations reveal that less than 1% of the oil discharged was found in sediments within a 5-mile radius of the platform.

Hydrocarbons in tissue samples

Many trawl samples were made over an 11-month period from which samples of marine organisms were analyzed for hydrocarbon content. Using the gas chromatographic technique which identified the spilled crude oil in the sediments, no hydrocarbons in tissue could be identified with oil from the spill.

The hydrocarbon contents of shrimp, crab, and fish were generally low. Oysters from reefs, all of which were more than 30 miles from the platform, both on the east and west side of the Mississippi Delta shallow-water inland bays, contained appreciable hydrocarbon concentrations.

Benthic studies

Benthic organisms spend the major portion of their life cycles living on or in bottom sediments. This mode of sedentary life confines movement of these organisms to relatively short distances and subjects them to both short and long term effects of environmental stresses. Because most benthic organisms do not have an avoidance ability, careful studies of benthic communities can frequently reveal whether extensive damage occurs from the presence of toxicants. As documented earlier, the highest concentrations of crude oil in bottom sediments were near the platform and appeared to be predominantly restricted to within 5 miles and certainly within 10 miles of the platform.

Evaluation of possible effects of oil on benthic organisms is not as straight-forward as might first appear because numerous environmental factors influence benthic communities. These factors include bottom type, season, temperature, salinity, and food availability.

Benthic studies were conducted over a large area to obtain samples from within and outside areas observed to have oil on the surface. Therefore, organisms were collected from a number of different environmental areas: near discharge points of the Mississippi River, near-shore bays, and the relatively nonsilted area of northern Chandeleur Sound. Because of the wide range in environmental conditions, the number and types of benthic organisms could be expected to vary widely. Changing conditions, which might occur over relatively short distances, make it difficult to distinguish natural variations from variations which might have been produced from the spilled crude oil. Thus, as shown later, only relatively large effects are measurable.

Benthic organisms were collected from a 0.3 m^2 area (3 combined 0.1 m^2 samples) to a depth of 15 inches using a diver-held suction sampler [3]. Debris and organisms were separated from most of the sediment in a 1.0 mm mesh bag, brought to the surface, and washed through a 1.2 mm screen to remove additional sediment particles.

In waters approaching or exceeding 100 feet where diver sampling would have been difficult, samples (D locations, figure 5) were obtained by a Shipek dredge. This sampler collected a bottom surface area of 0.04 m^2 and penetrated to a maximum depth of 4 inches. A total of 7 grabs were taken at each location; 5 were divided to give duplicate 0.1 m^2 benthic samples, and 2 were for hydrocarbon samples.

The smaller area and the much lower volume of sediment resulted in a much lower number of species and individuals. Because of these differences, no attempt has been made to integrate the dredge sample results with the diver collected samples. These differences point up yet another factor to be considered in evaluating benthic organisms.

The samples were preserved in formaldehyde and brought to the laboratory where the benthic organisms were sorted, identified, enumerated and tabulated.

In addition to number of species and individuals, two mathematical expressions were calculated: (1) the Shannon-Weaver diversity index $\bar{H}$ [14], and (2) Crustacean-Polychaete ratio (C/P). If the crustacean group is more sensitive to oil than the polychaete group, the ratio should magnify any possible detrimental effects.

Discussion of Results. Because of the large number of benthic samples analyzed, only summary information is presented here. A wide variation in number of individuals found in benthic samples ranging to a high of about 56,000 individuals per 0.3 m^2. The high number of individuals was caused by sampling colonies of small mollusca (clams) of the species *Abra aequalis* and/or *Mulinia lateralis*. The large variation in the number of individuals introduced an extremely high variance in subsequent statistical analysis of the benthic data involving number of individuals. In an attempt to minimize the variation, two corrections were made. The first was elimination of these 2 species of clams from the 9 samples which had these organisms present in numbers greater than 4,000. The second correction was made by removing from the sample one species if the number of individuals of that species exceeded 40% of the total number of individuals, two species if the individuals were present in an amount greater than 60%, and three species if present in an amount greater than 70%.

The Shannon-Weaver diversity index was calculated from the actual number of individuals and from the corrected number of individuals to give $\bar{H}$ and $\bar{H}$ (corrected). These corrections were made in an attempt to minimize variation to determine whether spilled oil had an effect on the number of individuals as well as whether there was a correlation of number of individuals with other environmental parameters such as date of collection, sediment type, and organic matter content of sediments. As shown later, this attempt was successful in some evaluations but not in others.

Two statistical approaches were used to evaluate the benthic data. The first approach grouped samples according to distance from the platform, graphically presented the various biological parameters, and tested for significance using one-way analysis of variance. The second approach was a stepwise multiple regression analysis to determine which parameters had effects upon the observed biological data.

Figure 5 shows the collection location for each benthic sample and the number of species in each (excluding the D samples). Locations having two values were resampled; the bottom value is for 1971. Benthic samples containing >35 species are indicated by an enlarged symbol. Such samples were concentrated near the Mississippi River Delta with many of the stations located in the near-shore areas and some of the samples located along the Breton Island-Chandeleur Island trend. In addition, a few samples with a low number of species were scattered in the vicinity of MP41C.

The lower number of species shown in figure 5 in the nearshore areas was considered indicative of different environmental conditions compared with other areas. These differing conditions could include sediment type, salinity, and temperature.

1970 samples versus distance from platform. Based on the concept that higher concentrations of oil, documented by chemical analysis, occurred in sediments near the platform and decreased outwardly to extremely low values, benthic samples have been grouped as follows: near platform, 1-5 miles from platform, and at 5-mile intervals thereafter.

Figure 6 is a plot of means of various biological parameters versus distance intervals from the platform. Analysis of variance revealed a highly significant effect between distance intervals for number of species, $\bar{H}$ and $\bar{H}$ (corrected), and a significant difference for Crustacean-Polychaete ratio. No significant difference was observed for the number of individuals. In this paper * and ** represent statistical significance at the 5% and 1% probability level and are referred to as significant and highly significant; NS means not significant at the 5% probability level.

Correcting 6 samples for the high number of clams did not show statistical significance (F = 1.55). The difference in the means of the number of individuals was greatly reduced, but variance within groups was still large. Analysis of variance for the number of individuals (corrected) gave an F = 1.05, also insignificant.

Although significant differences were shown for all biological parameters except number of individuals, it was not clear what environmental parameter or parameters may have caused the observed effects. The second statistical approach, multiple regression, permitted a more complete evaluation of the various environmental interactions.

Multiple regression analysis of the 1970 benthic data (165 sample locations with data for time of collection, distance from platform, sediment type, and organic matter) is shown in table 6 with only significant correlations (t-values) given. The same effects for distance were observed as for the analysis of variance, except for the number of individuals; the latter showed a highly significant decrease in number of individuals with distance from the platform. This was caused by the high number of individuals of some species (clams) in a few of the samples. Their removal resulted in no significant correlation except for a highly significant decrease with increase in organic matter content of the sediments.

Number of species showed a highly significant decrease with time of collection (seasonal variation) from April 6 through June 10 and a similar decrease with increase in organic matter content of the sediments. The observed variation for species and individuals may not be due to organic matter, but it related to changes correlating with organic matter in near-shore environment such as sediment type and salinity.

The C/P ratio decreased with distance from the platform and showed a highly significant increase for sandy bottom sediments as compared with mud. This confirms the general observation that Crustacea prefer a sand bottom, whereas polychaeta are more prevalent in mud or silt.

The Shannon-Weaver diversity index is a function of the number of species and individuals. It is presented for those readers who use this index or attach significance to diversity indices. In this paper, no detailed interpretation will be made using the index.

Multiple regression analysis of 1970 benthic samples indicated variation due to time of collection, sediment type, distance from the platform, and organic matter content of the sediment. These variations would be expected in near-shore marine environments.

Variations were also indicated by the fact that over 550 species of benthic organisms were identified throughout the study area, yet the number of species in any one sample ranged from 11 to 95 with

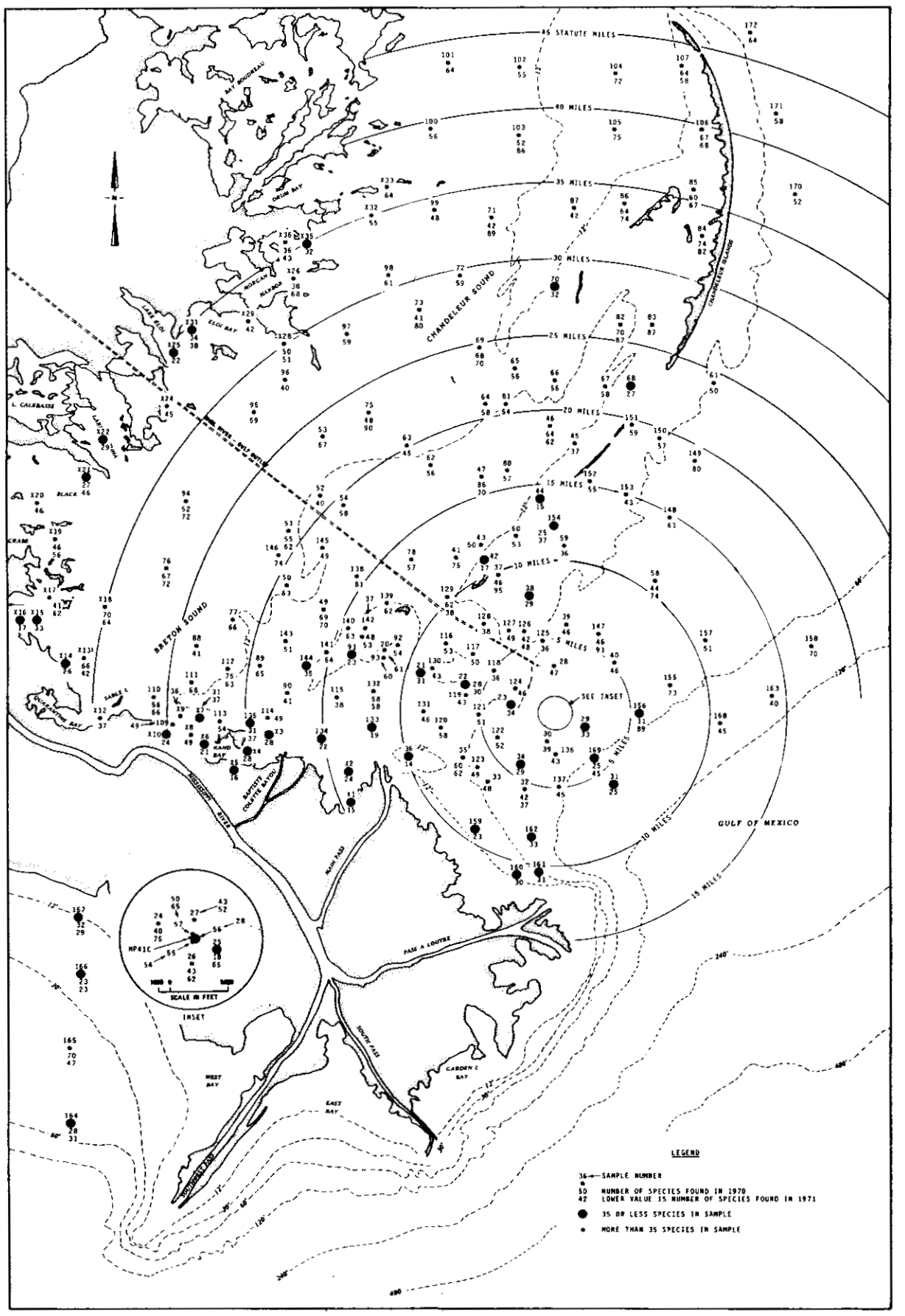


Figure 5. Number of species of benthic organisms per 0.3 m^2

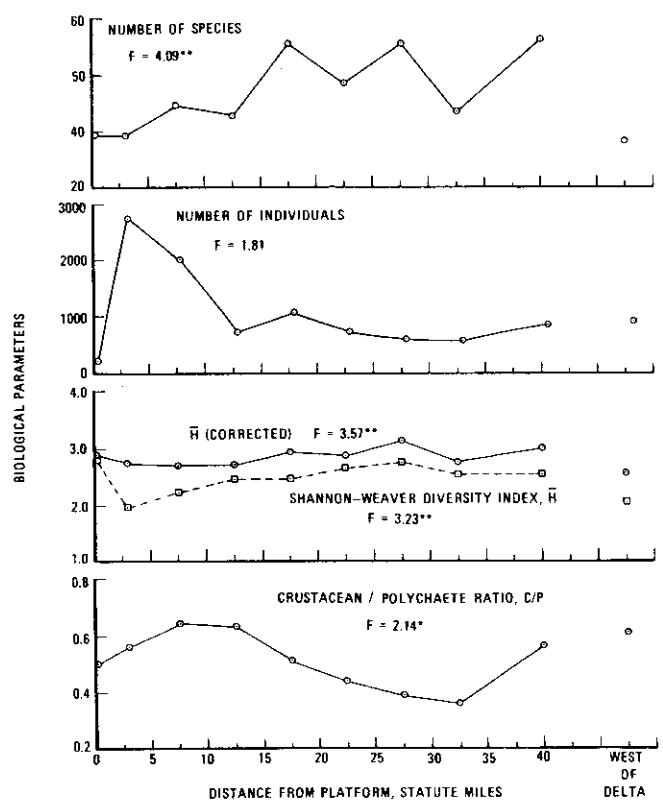


Figure 6. Mean value for 1970 biological parameters as a function of distance from the platform

Table 6. Multiple regression analysis of 1970 benthic samples using date of collection, distance from platform, bottom sediment type, and organic matter content of sediment samples (165 samples)

Ratio of Coefficient in Equation to its Standard Error (t-value)

	Species	Ind.	Ind.[a]	Corr. Ind.	H̄	Corr. H̄	C/P
Days	-3.34**					-2.68**	
Distance	2.81**	-2.90**			3.20**	2.75**	-1.97*
Silt					2.16*		
Sand		-2.11*			2.71**		3.40**
O. M.	-3.79**			-3.34**			

[a] Six samples corrected for high number of clams

a mean of 50. The number of individuals ranged from 25 to 56,000, with a mean of 1,390.

Comparison of 1970 and 1971 samples. Fifty-one of the 1970 sample locations were resampled about 1 year later. Because resampled locations were taken as close to the original location as Raydist navigation permitted (10-15 feet), environmental factors other than time of collection may have been reasonably similar, and a comparison of 1970 and 1971 samples should give a measure of yearly variation.

Table 7 summarizes mean ± standard deviation for the number of species and individuals for benthic stations sampled in 1970 and resampled in 1971, and it gives a t-test comparison between years. There was a highly significant yearly variation for numbers of species and numbers of corrected individuals for all sample locations (47) east of the Mississippi River Delta. Correcting only three samples for high numbers of individuals resulted in a significant variation comparing 1970 and 1971 for numbers of individuals, whereas no significance was shown for uncorrected numbers of individuals.

Table 7. Comparison of 1970 and 1971 benthic samples and statistical test for year-to-year variation

	Mean + Standard Deviation 1970	1971	t
47 Locations East of Delta			
Number of species	49.5 ± 16.6	62.9 ± 17.1	3.84**
Number of individuals	1207 ± 3305	2478 ± 8177	0.99
Number of individuals[a]	735 ± 706	1036 ± 705	2.07*
Number of individuals, corrected	401 ± 263	742 ± 446	4.51**
t_{05} = 1.66, t_{01} = 2.37			
35 Locations beyond 10 miles			
Number of species	53.7 ± 15.4	63.8 ± 16.7	2.64**
Number of individuals	822 ± 741	2657 ± 9275	1.17
Number of individuals[b]	822 ± 741	1082 ± 746	1.46
Number of individuals, corrected	447 ± 266	748 ± 481	3.24**
t_{05} = 1.67, t_{01} = 2.39			

[a] Samples 126 (22,872), 126R (13,398), 132R (55,787) corrected for high number of clams.
[b] Sample 132R corrected.

Multiple regression analysis for these same samples by year, date of collection, distance, and bottom sediment type showed the same yearly effect: t for species is 2.55**, for individuals (3 corrected) is 2.17*, for corrected individuals is 2.51**, and for individuals is not significant.

As shown in figure 7, the number of species and corrected number of individuals (not shown) were lower for the first two distance intervals during 1970. Because of the possible effects spilled oil might have contributed to the observed yearly variation measured for all sample locations discussed above, the lower portion of table 7 statistically tests 1970-1971 variation for samples beyond 10 miles and the limit where oil from the spill was found in sediments. There was a highly significant yearly variation for number of species and number of corrected individuals. Correcting number of individuals for one sample in these 35 samples resulted in no significance. A year-to-year variation was clearly evident by these analyses.

The 1970 and 1971 resampled values for means of various parameters by distance are plotted in figure 7. Because of fewer samples, a different grouping, as compared with all 1970 samples, was made with distance to obtain a sufficient number of samples within a group for statistical analysis. Groups by mile intervals were: 0-0.5, 5-10 (sample 169 was included in this group), 10-20, 20-30, and greater than 30. Analysis of variance showed no significance (although several approached the 5% level) for any of the biological parameters except a highly significant effect with distance for number of species in 1970. Multiple regression analysis (table 8) for 1970 and 1971 for days, distance, and sediment type showed very similar results for biological parameters versus distance. Following the previous discussion for table 6, the correlations in table 8 are self explanatory. Seasonal variations for the two years were different: the number of species decreased with date of collection in 1970 but increased in 1971.

The t-values for multiple regression analysis for all benthic samples (213) for 1970 and 1971 which had data for years, day of collection, distance from platform, and bottom sediment type are shown in table 9. For species, there were highly significant correlations: higher number of species in 1971, decreasing species number with time of collection, increasing species number with increasing distance from platform, and higher number of species in silt and sand sediments as compared with mud sediments. The other biological parameters can be similarly evaluated as were the species.

The above evaluations illustrate that several environmental factors cause variations in numbers and diversity of benthic organisms. Other factors not measured, such as salinity and temperature, can also have influence. Inspection of the figures shows a lower number of species and individuals in the platform vicinity, but considerable uncertainty remains as to whether these lower numbers were due to natural variations or to possible effects from the discharged oil.

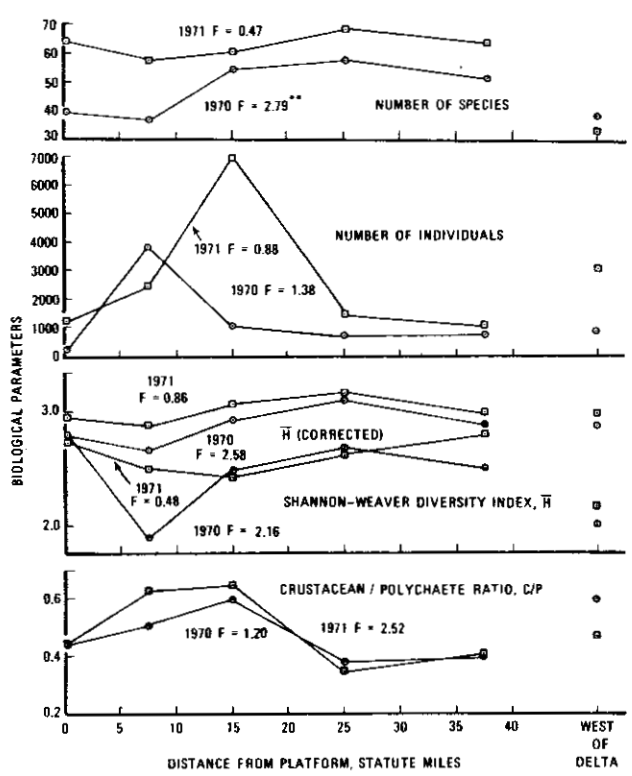


Figure 7. Mean value for biological parameters for 1970 and 1971 repeated samples as a function of distance from the platform

Table 8. Multiple regression analyses for 47 samples collected in 1970 and resampled in 1971

Ratio of Coefficient in Equation to its Standard Error (t-value)

	Species	Ind.	Ind.[a]	Corr. Ind.	H̄	Corr. H̄	C/P
			1970				
Days	-3.83**	NS	NS	NS	-2.29*	-2.73**	
Distance	3.86**					2.66**	
Silt						2.20*	
Sand							2.14*
			1971				
Days	2.47**		b		2.60**		
Distance							
Silt	1.82*	3.49**				1.90*	
Sand	2.00*			2.10*			2.35*

[a] 1 sample corrected for high number of clams

[b] 2 samples corrected for high number of clams

Table 9. Multiple regression analysis for 213 benthic samples

Ratio of Coefficient in Equation to its Standard Error (t-value)

	Species	Ind.	Ind.[a]	Corr. Ind.	H̄	Corr. H̄	C/P
Year	2.55**	2.31*		4.59**			
Days	-2.42**		-3.47**			-3.99**	2.31*
Distance	3.69**	2.17*			3.40**	3.66**	-2.59**
Silt	2.92**	2.07*		1.86*	1.97*		
Sand	4.16**			3.32**	3.31**		3.89**

[a] Eight samples corrected for high number of clams

Correlation of hydrocarbon content of bottom sediments with benthos provided additional information.

Correlation of hydrocarbon content of sediment with benthic organisms. Spilled oil measured in sediments was principally found within a 5-mile radius of the platform and was probably restricted to within 10 miles. The most diagnostic evaluation of the possible effect of oil on benthic organisms should be related with the oil content of the sediments measured at the same locations. Table 10 shows the simple linear regression coefficient, r, and the multiple regression results for the 28 samples located within 10 miles of MP41C platform. None of the linear regression coefficients were significant for correlation of either C_{12}-C_{33} or C_{12+} hydrocarbons with any biological parameter. Multiple regression analysis for both hydrocarbon fractions showed no significance with any biological parameter except H̄, which increased with increasing sediment hydrocarbon content (opposite that expected if biological damage had occurred). All t-values for correlations with hydrocarbon content are shown to give the order of magnitude for whatever correlation existed. Only significant t-values are shown in table 10 for parameters other than hydrocarbon content of sediment samples.

Table 10. Linear regression and multiple regression analysis of 28 sample locations within 10 miles of MP41C platform. Correlation of biological parameters with hydrocarbon content of sediments

	Species	Ind.	Ind.[a]	Corr. Ind.	H̄	Corr. H̄	C/P
C_{12}-C_{33} Hydrocarbons by Gas Chromatography							
Linear regression, r for:	0.090	-0.055	-0.042	-0.074	0.300	0.301	0.042
Ratio of Coefficient in Equations to its Standard Error (t-value)							
Year					-2.90**		
Days							
Distance						-2.26*	
Silt		1.80*					-1.74*
Sand					2.15*	-2.76**	
GC HC's	0.35	-1.08	0.17	-0.11	2.28*	0.88	1.17
C_{12}^{+} Hydrocarbons by Gravimetric Analysis							
Linear regression, r for:	0.097	-0.108	-0.004	-0.094	0.284	0.341	0.112
Ratio of Coefficient in Equation to its Standard Error (t-value)							
Year							
Days					-2.89**		
Distance						-2.47*	
Silt							-1.98*
Sand		-1.94*			2.28*	-2.97**	
C_{12}^{+} HC's	-0.79	-1.55	0.15	-0.33	2.36*	0.89	1.35

[a] Two samples corrected for high number of clams

This direct comparison of benthic organisms with sediment hydrocarbon content strongly indicates no effect of spilled MP41 crude oil on the benthic community.

Bioassay studies

Static bioassay tests were conducted with MP41 crude oil, the two dispersants used during the spill, and the combination of 1 part of dispersant plus 10 parts of oil using 6 test organisms. The bioassay procedure followed the method outlined by La Roche et al. [8]. The test animals were *Menidia beryllina* (Tidewater silverside), *Fundulus similis* (longnose killifish), *Palaemonetes pugio* (grass shrimp), *Gasterosteus aculeatus* (threespined stickleback), *Fundulus heteroclitus* (mummichog), and *Artemia salina* (brine shrimp).

Table 11 summarizes the results of the bioassay studies giving the median lethal concentration (LC_{50}) at the end of 96 hours. In all instances the MP41 crude oil was relatively nontoxic to all test organisms with the exception of brine shrimp; it required 660 ppm oil to cause one-half kill.

Table 11. Median lethal concentration (LC_{50}) at 96 hr for six organisms, subjected to MP41 crude oil, two dispersants, and one part dispersant plus 10 parts oil

Test Animal	LC_{50} in ppm			
	MP41 Crude Oil	Dispersant	1 Part Dispersant + 10 Parts Oil[a]	Dodecyl Sodium Sulfate Reference
		"Cold Clean"		
Longnose killifish	39,000	110	80	1.8
Grass shrimp	3,000	3,700	130	13.8
Tidewater silverside	5,200	75	90	1.5
Stickleback	> 20,000[b]	70	66	0.51
Mummichog	> 18,000	130	135	1.25
Brine shrimp	660	28	30	1.48
		Corexit 7664		
Longnose killifish	18,000	13,400	320	0.51
Stickleback	6,500	2,600	89	4.2
Brine shrimp	> 10,000	130,000	320	5.6

[a]Concentration for dispersant-oil mixture is for dispersant, not the combination
[b]Preliminary test

Of the two dispersants, Cold Clean was more toxic, although grass shrimp appeared relatively resistant to this dispersant. Corexit 7664 was relatively nontoxic to three test organisms. The combination of 1 part dispersant plus 10 parts oil showed little change in toxicity caused by Cold Clean, but the combination increased the toxicity of Corexit 7664. This toxicity increase has been observed in several studies including those recently conducted by Swedmark [15,16]. Increased toxicity of the emulsified oil was probably related to the effective dispersion of the oil in water, but in open waters such as those at the Chevron spill, rapid dilution would compensate for the increased toxicity shown in the bioassays.

The bioassays of the 6 test organisms indicate that concentrations causing one-half kill are very much higher than those observed at the time of the MP41C oil spill. The highest concentrations in the water column in the platform vicinity were 70 ppm oil, 1-3 ppm surfactant, and 0.2 ppm dissolved hydrocarbons. The observed concentrations decreased rapidly to very low values at the end of 2 hours. In all bioassay tests the organisms were subjected continuously to the toxicants without dilution for periods up to 4 days. Based on these observations, it appears unlikely that the spilled oil from MP41C had a measurable effect on marine organisms such as fish, shrimp, and crabs.

Postulations have been made that egg, larval, and juvenile stages of organisms are much more sensitive than adult organisms to crude oil and surfactants. Recent investigations [4,13,16] have shown that these life stages of some marine organisms are quite resistant to oil and oil dispersions.

Trawl fauna

From April 1970 to March 1971, 440 trawls were made using 3 boats and 15-foot otter trawls to determine if there was measurable damage to commercially valuable species such as shrimp, blue crab, and fish. The trawling time was from 2 minutes to 2½ hours; most trawls took 10 minutes. Trawls were made throughout the study area but were principally concentrated between Pass A Loutre and Black Bay to intercept shrimp which would have migrated through the oil spill area. The organisms were sorted, identified, and enumerated in the laboratory.

Shrimp. The most common species of shrimp taken in trawls were brown (*Penaeus aztecus*) and white (*P. setiferus*). Small numbers of pink shrimp (*P. duorarum*) and seabob (*Xiphopeneus kroyeri*) were also collected, as well as 76 species of noncommercial invertebrates.

Both brown and white shrimp spawn and hatch in relatively deep water. The young migrate to estuaries, grow rapidly, and subsequently return to deeper waters to repeat the annual cycle [2,5,11]. Some of the shrimp would have passed through the oil spill area.

The number of shrimp collected per trawl and their sizes indicated that a normal annual life cycle occurred with no evidence that larval or post-larval shrimp were affected by passing through the oil spill area.

Fish. Trawl samples cannot quantitatively describe or measure the number of fish in an area. However, the number of fish collected and the 84 species collected from the study area compare favorably with the 100 species identified by the Louisiana Estuarine Inventory [12] conducted from April 1968 through March 1969 along the entire coast of Louisiana. The bay anchovy (*Anchoa mitchilli*) and croaker (*Micropogon undulatus*) were the most abundant species obtained by trawl.

Blue crab. Blue crabs (*Callinectes sapidus*) were abundant in trawls from throughout the sampling area with no evidence of a decrease in numbers.

Report availability

A report with the same title as this paper but presenting much greater detail is available upon request from Chevron Oil Company, 1111 Tulane Avenue, New Orleans, Louisiana 70112. Also available are two volumes of appendices—a biological volume listing species and number of individuals for all benthic samples and all trawl samples, and a chemistry volume presenting all chemical analyses and gas chromatograms.

Acknowledgments

All field collections, separation of benthic samples, identification of some groups of benthic organisms and all trawl organisms, and hydrocarbon analysis of sediment samples were performed by Bio-Oceanic Research, Inc. The authors gratefully acknowledge the contributions of the many individuals who contributed to the studies.

REFERENCES

1. Alpine Geophysical Associates, Inc. 1971. Oil pollution incident, platform Charlie, Main Pass Block 41 Field, Louisiana. Project 15080 FTU, Water Quality Office, Environmental Protection Agency, Washington, D.C.
2. Baxter, K.N., and Renfro, W.C. 1970. Seasonal occurrence and size distribution of postlarval brown and white shrimp near Galveston, Texas, with notes on species identification. *Fish. Bull.* 66:149-158.
3. Brett, C.E. 1964. A portable hydraulic diver-operated dredge-sieve for sampling subtidal macrofauna. *J. Mar. Res.* 22:205-9.
4. Brockson, R.W., and Bailey, H.T. 1973. Respiratory response of juvenile chinook salmon and striped bass exposed to benzene, a water-soluble component of crude oil. *Proceedings of Joint Conference on Prevention and Control of Oil Spills*, March 12-15, 1973, pp. 691-95. Washington, D.C.: American Petroleum Institute.
5. Caillouet, C.W.; Fontenot, B.J., Jr.; and Dugas, R.J. 1968. Diel fluctuations in catch of postlarval white shrimp, *Penaeus setiferus* (Linnaeus), with the Renfro beam trawl. *Bull. Mar. Sci.*, 18:829-835.
6. Greff, R.A.; Setzkorn, E.A.; and Lesnie, W.D. 1965. A colorimetric method for the determination of parts per million of nonionic surfactants. *J. Amer. Oil Chemists Soc.* 42:180-85.
7. Kreider, R.E. 1971. Identification of oil leaks and spills. *Proceedings of Joint Conference on the Prevention and control of Oil Spills*, June 15-17, 1971, pp. 119-124. Washington, D.C.: American Petroleum Institute.
8. La Roche, G.; Eisler, R.; and Tarzwell, C.M. 1970. Bioassay procedures for oil and oil dispersant toxicity evaluation. *J. Water Pollut. Control Fed.* 42:1982-89.
9. McAuliffe, C.D. 1971. GC determination of solutes by multiple phase equilibration. *Chem. Tech.* 1:46-51.

10. McAuliffe, C.D. 1973. Partitioning of hydrocarbons between the atmosphere and natural waters. Background Papers for a Workshop on *Inputs, Fates, and Effects of Petroleum in the Marine Environment*, Vol. 1, p. 280-290. Washington, D.C.: National Academy of Sciences.
11. Perez-Farfante, I. 1969. Western Atlantic shrimp of the genus *Penaeus*. *Fish. Bull.* 67:461-591.
12. Perret, W.S. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Phase IV, Biology. La. Wildl. Fish. Comm., pp. 29-105.
13. Renzoni, A. 1973. Influence of crude oil, derivatives and dispersants on larvae. *Marine Pollut. Bull.* 4:9-13.
14. Shannon, C.E., and Weaver, W. 1963. *The mathematical theory of communication*. Urbana: Univ. of Illinois Press.
15. Swedmark, M.; Braaten, B.; Emanuelsson, E.; and Granmo, A. 1971. Biological effects of surface active agents on marine animals. *Mar. Biol.* 9:183-201.
16. Swedmark, M.; Granmo, A.; and Kollberg, S. 1973. Effects of oil dispersants and oil emulsions on marine animals. *Water Research* 7:1647-1672.

ATTACHMENT "B"

Inventory of Equipment

Clean Gulf Associates

A. Fast Response Open Sea and Bay Skimmer System

This is a portable system designed for boat mounting. It consists in part of a floating oil boom, skimmer, outrigger, pump and storage tanks. The system is designed to provide equipment capable of fast response to emergency spill situations.

I. A. For use as immediate response system for offshore spills in accordance with 12-hour response provisions contained in lease agreements for certain offshore tracts recently acquired by member companies.

B. Locations

1. One complete system located at Venice.

2. One complete system located at Intracoastal City.

C. For use on boats of 65 feet or larger in the utility or work boat class. (See page 2 for details.)

D. Maximum recovery capability with both tanks is 360 barrels fluid.

E. For general use in seas up to 3-4 feet and water depths greater than 6-8 feet; specific use will depend on individual spill situations.

II. Equipment consists of six packages

A. Primary skid (23' x 7 1/2') containing:

One 180 barrel tank (Coast Guard approved)
One Lister SR 2 Diesel Engine
One Gorman-Rupp 4 x 4, 500 GPM pump
One outrigger for oil boom
One stern davit for launch and recovery of skimmer

B. Auxiliary skid (23' x 5 1/2') containing:

One 180 barrel tank (Coast Guard approved)

C. One Don Wilson skimmer (triangular 9' x 9' x 10')

D. One lot of Bennett oil boom sections - consisting of three 5 foot sections, nine 10 foot sections and one 15 foot section.

E. One lot of 4" hose lines - One 40' length; one 20' length; two 10' lengths.

F. One tool box complete with miscellaneous tools, shackles and other items essential for launch, recovery and maintenance.

B. HIGH VOLUME OPEN SEA SKIMMER SYSTEM

Central to this system is a barge specially modified to carry, deploy, and retrieve all components of a boom and skimmer system (except tugs) as shown in DWG No. CGA Hoss-1. The barge is constructed with a skimmer ramp and boom stingers on the aft-end. Launching and retrieval of these components are facilitated by a ballast system on the aft-end of the barge. Launching and retrieving of the skimmer and boom occur with the barge in the ballasted mode. The barge is de-ballasted for skimming.

The barge is towed to the worksite. The lead end of the barge is reversed, and two other tugs attach to the lead ends of boom to assist in deployment. With the booms and skimmer deployed, and booms spread, as in DWG No. CGA Hoss-1, the system is towed through the oil to be picked up into the mouth of the skimmer. Oil entering the skimmer is picked up and pumped to the separation and storage tanks located on the barge.

1. Use and Design Criteria

a. Equipment - Intergrated system consisting of Bennett Offshore Booms, Union Oil Type Skimmer and 52' x 160' x 12' barge. See DWG Nos. CGA Hoss-1 & 2.

b. Personnel - 14 to 16 including a superintendent, leadman and mechanic when deploying or retrieving boom and skimmer.

c. Auxillary Equipment (supplied by Operator) - 1 - 1200 hp tug to transport barge and control on location.
2 - 600 hp tugs to drag boom while skimming.

d. Design Criteria

(1) 36" draft approximately 12' water depth required while ballasted

(2) Approximately 4 knots maximum towing speed with all components on barge

(3) 5 foot maximum sea for skimming operations

(4) Approximately 1 knot current relative to barge movement for skimming operations

(5) U. S. Coast Guard Certified Vessel Class - unmanned barge

(6) Fuel supply - 3 days on barge. 4 - 250 gallon diesel fuels are located on the barge above the boomracks (Refer to DWG No. CGA Hoss-2)

(7) Personnel quarters - none

e. Location - Halliburton dock at Grand Isle, Louisiana

2. Equipment List (see DWG No. CGA Hoss 2 & 3)

a. Air compressor - 1 Ingersoll Rand-600 ft. ^{3}/min @115 psi. Prime mover-GM, V-6, 210 HP @1700 rpm, diesel engine; battery started.

b. Separation and storage tanks - 4 - 500 bbls., primary tanks with 380 bbls. behind Weir on each tank (shown in black on DWG No. CGA Hoss- 2).

c. Generator - 2 - 25 KW w/Lister air cooled, HR-3 diesels rated at 37.5 HP at 1800 rpm.

d. Lighting system (see DWG No. CGA Hoss-3)

Barge service lights - 1000 watt, mercury vapor lights are pole-mounted on each side of the barge. 400 watt, mercury vapor lights are located on each side of the barge under the superstructure near the skimmer. Smaller cage protected lights are abundantly distributed along all walkways, boom racks, work areas and sheds.

Navigational Lights

Running lights are located on each side of the barge bow.

Working lights are pole mounted above the storage tanks on the barge bow. The three lights (uppermost-red, middle-clear, bottom-red) are the international markings for a dredge. Use the bottom red light only if offloading oil at night. A red flag hoisted to the bottom light indicates offloading oil during daylight hours.

Anchor and stern lights (both clear lens) are located on the stern above the superstructure, over the skimmer.

e. Winch system (see DWG Nos. CGA Hoss-2 & 3)

Air powered - position 1 winches are used to assist in raising and lowering the stinger and stabilizing the skimmer during launch and retrieval. Position 3 winches are used in retrieving the boom. Position 4 winches are used to help deploy, connect and disconnect the boom and skimmer during launch and retrieval.
Position 5 winches (DWG No. 3) are used to raise and lower the stinger.
Position 6 winch is used to control the skimmer suction and return hoses during launch and retrieval.
Position 7 winch is used to launch and retrieve the skimmer.
Position 8 winches are used to control boom launch and retrieval.

Hand winches -

Position 2 winches (DWG No. 2) located on the front end of the skimmer are used for connecting and disconnecting the boom to the skimmer during launch and retrieval. Although not shown in the drawings, hand winches are located near the piping headers, at each side of the aft end of the skimmer ramp, at the forward end of the skimmer and in the middle of each stinger to assist in boom launch and retrieval.

f. Pumps (see DWG No. CGA Hoss-2)

2 - 2000 gpm centrifugal (pumps P-A and P-B; 40-60' head) 8" x 8" powered by GM 271 diesel engines rated 65 HP at 2000 rpm; hydraulic started. Hand pump hydraulic system to 2500-3000 psi before starting the engines.

g. Piping system (see DWG Nos. CGA Hoss-4, 5, & 6)

Ballast (DWG No. 4) - Take suction through sea chest valve to 38.4' x 52' x 12' hull tank compartment inlets designated as A, B, C, and D.

Manifold (DWG No. 5) - Pump lines from the skimmer to the storage and separation tanks are 8". The overflow line carrying separated water from the tanks back to the skimmer is 10".

Transfer (DWG No. 6) - Transfer lines from primary to secondary separation tanks are 6".

h. Booms - 2 - 500' sections Bennett Offshore Boom (see DWG No. CGA Hoss-6-A)

i. Skimmer - Union Oil Type (see DWG No. CGA Hoss-7)

j. Communications system - 5 fm radio handsets and 2 megaphones

3. Operational Procedure

a. Deployment (total time approximately 6 hours)

(1) Position barge; use lead tugs to assist.

(2) Ballasting Barge - Approximately 1½ hours @ max. pump speed. Check ballast manifold; make sure proper valves are opened or closed. Don't leave seacock open. Ballast until the sea just meets the forward end of the barge.

NOTE: All engine oil is series 3-30 wt.
Air compressor oil is DEXRON hydraulic transmission oil.
All air motors on winches use SAE 20 oil with a viscosity of 250/350 SUS at 1000°F., a carbon residual of 0.3% and a neutralization No. 0.1.

C. Shallow Water Skimmer System, Grand Isle Unit

GENERAL DESCRIPTION

This unit is a self-contained shallow-water skimmer. The vessel is 24' long by 11'-4" wide by 9'-10" high and is propelled by two 125 hp Johnson outboard engines. It weighs 9000 lbs. and can be transported on a Lowboy truck. The unit is basically a floating API separator and the basic skimming mechanism is that employed in the High Volume Open Sea Skimmer System. Four 10 bbl. storage tanks are built into the hull. The vessel draws 8" of water with the hull tanks empty and 20" with all four filled. Two pumps are manifolded so that one can be used for skimming, the other for offloading, jetting oil from beneath docks, etc. Metal outrigger booms allow the vessel to sweep an area up to 20' wide. Connection points are provided for attaching commercial booms if a wider sweep is desired. The metal booms fold in to form a bow for travel. Maximum travel speed is five miles per hour. The maximum skimming speed is from one to two miles per hour.

In order to increase the oil handling capacity of the system and provide a means of transferring the oil from the skimmer to shore without shutting down the skimming operation, two 50 bbl. floating separation and storage units are available for use with the skimmer. The floating units can be moved to and from the location by conventional shallow water boats or a lugger. These units are 18' long by 11' wide by 3' high. The units weigh 8000 lbs. each and both can be transported on a flat bed truck.

DESIGN CAPABILITIES

1. Self-propelled by two 125 hp outboard engines.

2. For mobile skimming in calm shallow water bays and inland protected waters. Can maneuver to chase spills in shallow waters.

3. When deployed with conventional shallow water booms this unit can remain stationary to pick up spills moving under the influence of tides or winds.

4. Can be used in water depths as shallow as 12" for short periods. Vessel draws 8" of water empty and 20" when all four 10 bbl. storage tanks are full.

5. Effective skimming is limited to use in wave heights of one foot or less. It is not suited for use in open Gulf waters or very choppy inland waters.

TRUCK TRANSPORTABLE

1. Dimensions, 24' long by 11'-4" wide, 9'-10" high, weight is 9000 lbs.

D. Auxiliary Shallow Water Skimmers and Boom

Several individual pieces of equipment are provided for skimming oil which is contained by inshore boom, isolated in dead end canals, at dockside or other areas accessible from boat, barge or on foot. Two Parker Oil Hawgs will be kept at Grand Isle. Two Swiss Olea III type skimmers will be maintained at Venice. Intracoastal City will have one skimmer of each type. Drawings CGA Aux. 1 and 2 show the application of these units.

Parker Oil Hawg Skimmer
200 GPM Diesel Driven, Skid Mounted, Centrifugal Pump

Design Capabilities

1. Works well with any grade of oil ranging from Distillates through Cold Bunker C.

2. Is fully controllable from ashore, or from a boat or barge.

3. Eliminates the hazards of a power source on the skimmer.

4. Is easily cleared of trash.

5. Has inherent stability.

6. Will skim oil at the full capacity of the pump where the oil depth will allow.

7. Can be operated by unskilled personnel.

8. Limited to calm, shallow water, inland canals, docks, rivers, etc.

   Not to be used until the oil layer is reduced to one-half inch or less.

Location

1. Grand Isle, La. - Two oil Hawg skimmers

2. Intracoastal City - One oil Hawg skimmer

3. Can be hauled by truck or boat.

Personnel Required

1. Two-man crew is required.

2. No training necessary.

Note: Only one pump is available at each Base. The units are designed to be run by an air compressor or hydraulic pump. No air compressor is supplied. Each unit can be driven by rental air compressors supplying from 20 to 80 SCFM at 100 psi.

D. Auxiliary Shallow Water Skimmers and Boom (continued)

Swiss Olea III Skimmers
200 GPM Diesel Driven, Skid Mounted, Centrifugal Pump

Design Capabilities

1. Works with any grade of oil.

2. Is fully controllable from ashore, or from a boat or barge.

3. Stable floating.

4. Can be operated by unskilled personnel.

5. Limited to calm, shallow water, inland canals, docks, rivers, etc.

Location

1. Venice, La. - Two Swiss skimmers.

2. Intracoastal City - One Swiss skimmer.

3. Can be hauled by truck or boat.

Personnel Required

1. Two-man crew is required.

2. No training necessary.

Note: Only one pump available at each location.

D. Auxiliary Shallow Water Skimmers and Boom (continued)

Inshore Boom

Available both at Grand Isle and at Venice are 1,000 feet of 36 inch Bennett Inshore boom. This is on pallets mounted for helicopter transport. An anchor system is included.

1. This boom can be deployed in relatively calm waters to control oil movement into undesirable areas.

2. It can be used in conjunction with the auxiliary skimmers listed prior.

3. Can be transported on pallets of approximately 500 feet each by helicopters of Bell 204 size or larger. Weight of each skid is approximately 2,500 pounds. It may also be transported by truck or barge.

   PHI helicopter personnel are familiar with the loads and can advise on its movement by helicopter.

4. It will usually be deployed by a crew boat, by pulling off a pallet positioned on the beach, or from a barge by anchoring boom and pulling barge out from under it.

5. This boom is similar though not as large as that employed in the HVOSS system. (Figure CGA Aux. 3)

6. Personnel requirement to deploy is four roustabouts and a pusher.

E. Helicopter Spray System - HUSS Unit

GENERAL DESCRIPTION

The HUSS (Helicopter Underslung Spray System) unit is a helicopter supported spray unit such as those used for crop spraying. The unit is used to spray surface collecting agents or dispersants. The unit is a self-contained tank and pump unit with the spray nozzles mounted below the tank. The tank has an 84 gallon capacity. The spray is controlled from a control box that is mounted on the cyclic stick of the helicopter. The detailed brochure titled SHELL OIL HERDER which is included herein shows the HUSS equipment mounted under a helicopter in the application section. This brochure also contains information for using this surface active agent in containing oil spills, while recovery procedures are in effect. Handling and application recommendations are also included. It is emphasized here that the using member company is required to obtain authority from the Federal On-Scene Coordinator and the appropriate regulatory agencies, federal, state and local, before any chemicals can be used.

DESIGN CAPABILITIES

1. Used to spray collecting agent, Oil Herder*, or dispersant.
2. Tank has 84 gallon capacity.
3. Application of chemicals
   a. Apply Oil Herder in a fine stream at a rate of 2 gallons per mile of slick perimeter.
   b. Apply dispersant in a spray, 84 gallons of dispersant will cover 1,000,000 sq. ft.
4. Recommended flying speeds
   a. Flying to and from slick - 50 MPH
   b. Spraying speed - 30-40 MPH
5. One hour is required to get unit ready.
   a. Mount control box in 47G or 206 helicopter.
   b. Fill unit with collecting agent or dispersant, get pump ready, mount the unit, etc.

LOCATION

1. Grand Isle, La. - one complete unit
2. Venice, La. - one complete unit

*Shell Trademark

HELICOPTER UNDERSLUNG SPRAY SYSTEM (HUSS)
LIST OF SPARE PARTS INCLUDED WITH UNIT

No.	Description	Manufacturer's Name & Part No.
1	Motorized Gate Valve With Teflon Seals	Whittaker 18-30V 103437
2	Spark Plugs	Champion GJ-6
1 Set	Points	Wico X 14270C
1	Condenser	Wico X 16329
1	Pump Seal	Homelite 62694
1	2 Pc. Trailer Connection	Echlin TC6206-7 or Substitute
80	Tee Jet Tips No. 8002	Spraying Systems Tee-Jet
80	Tee Jet Tips No. 8006	Spraying Systems Tee-Jet
10	Diaphragms For Nozzles	Spraying Systems Fairprene
6	Nozzles, c/w Caps & 50 Mesh Screens	Spraying Systems #8360
16	Aluminum Blanks For Nozzles	Spraying Systems
2	1/4" Drain Cocks	Paulin Co. or Substitute
1	Pressure Switch	Stewart-Warner (Hobbs) M-4009-15
1	1/4" Pipe Plug	-
10 Ft.	2 - 5 Ft. Lengths - Nylon Starter Cord	-

EQUIPMENT

Water Fowl Rehabilitation

1. Scare Away Propane Guns

A. The following equipment is available to deter waterfowl:

48 automatic propane bird scare-away guns complete with regulators and tank (in carrying case) (12 guns per case)

B. The automatic propane guns are designed to scare waterfowl away from an oil spill. Their range is about 1/3 mile. This spacing or closer should be used for initial operations. Experience may dictate a closer spacing if birds are observed in the area.

C. The automatic propane guns are located as follows:

24 propane guns are located at Grand Isle

24 propane guns are located at Venice

The scare-away guns can be mobilized by filling the propane tanks, installing a flint and transporting to the spill location. Each propane tank holds 5 gallons of propane. Carrying cases have been built for 12 propane tanks and 12 guns. The barrels have been removed for ease of transportation.

D. In operation the guns are spaced about 1/3 mile apart in the contaminated area. They operate completely automatic. The tank of propane will last for 2 to 4 weeks depending on the frequency of the shots. Initially a 3 to 5 minute shot frequency should be used.

E. The scare-away guns are lightweight, portable and may be deployed by trucks, boats or helicopter. Twelve complete guns have been packaged to be deployed at one time by helicopter. This is the quickest and easiest way to deploy the propane guns. The only routine servicing required is replacing the flint, corrosion protection and filling the propane tank.

The flint in the ignitor requires replacement about once each week. At this frequency the unit should be protected from corrosion by spraying with a silicone lubricant like WD-40. This weekly maintenance can be performed by two men plus transportation.

F. Operation of the propane guns will not require training of personnel. Each member company should appoint one supervisor to observe operation of the scare-away gun. This would include filling the propane tank, replacing the flint, adjusting the firing frequency and placing the gun in operation.

2. Fast Response Waterfowl Rehabilitation Station

A. The following equipment and materials are available to rehabilitate waterfowl should they become oil soaked.

1. Portable Fast Response Waterfowl Rehabilitation Station. (An inventory of rescue and rehabilitation materials is tabulated by Table WF-1)

B. The portable waterfowl rehabilitation station is designed for fast response to rehabilitate contaminated waterfowl. The portable station provides the facilities to transport birds to the most convenient bird-care center shown on the map Figure WF-2. The station can be moved by trailer or boat and includes the necessary materials to clean and rehabilitate birds. State and Federal approval must be obtained to collect and rehabilitate waterfowl. The following should be contacted.

Federal Bureau of Sport Fisheries and Wildlife
Fred Williams or Jack Frost - (404) 526-5100 - Atlanta, Ga.
and David Hall (504) 527-2611, Ext. 6139 or 527-6139 - New Orleans, La.

Louisiana Wildlife and Fisheries Commission
Dr. J. Burton Angelle (504) 527-5126 - New Orleans, La.

C. The fast response rehabilitation station is located at Grand Isle.

D. Detailed instructions on collecting, transporting, cleaning, and rehabilitation of water fowl are included in API booklet "Operations Rescue" (WF-3). A comprehensive list of equipment, supplies, and personnel requirements for a large scale rehabilitation center is included in the paper "Implementation of Operations Rescue" by Bill Ayers and Phil Stanton (WF-4).

E. The fast response rehabilitation station will require the following operating personnel depending on the number of birds involved:

1 to 2 Trained Supervisors
2 to 8 Bird Cleaners and Attendants

If a large number of waterfowl are contaminated it will be necessary to immediately implement "Operations Rescue" (WF-5)

INVENTORY

RESCUE AND REHABILITATION MATERIALS

1 First Aid Kit
12 Clear Goggles
Box Rubber Bands
Box Cotton Swabs
2 Tubes A & D Dintment
2 Folding Tables
50# Rags
1 Card File Holder w/cards
1 Wheelbarrow
1# Boric Acid Powder
1 Roll Visqueen Plastic Sheeting
12 Aprons
1 Tool Chest
1 Socket Set (WSB-14)
1 Wrench Set (7)
2 Steel Tapes
12 Chick Feeders
6 Hose Nozzles (Garden)
4 Scrub Brushes
6 25' ø 5/8" Garden Hose
1 Post Hole Digger
1 Bird Banding Set of Assorted Pliers and Bands (Numbered)
2 Drums Polycomplex A-11
1 S & R Shovel
2 8# Sledge Hammers
1 Roll Bailing Wire
24 Pair Rubber Gloves
2 5 Gallon Water Coolers
2 BR22 Flash Lights w/Batteries
12 Cans Misquito Spray
24 Bars Soap
12 Bottles Hand Lotion
5 Packages Freezer Bags
2 20 Gallon Garbage Cans
2 Garden Rakes
6 #3 Galvanized Tubs
1 Jumbo Galvanized Water Trough
12 Handled Fish Nets
6 8 Quart Buckets
1 lb #8 Galvanized Nails
1 lb #12 Galvanized Nails
1 lb #16 Galvanized Nails
1 Roll, 600', 1/4" Polypropylene Rope
1 Hand Saw

Table WF-1

3-25-74

Inventory
Rescue and Rehabilitation Materials
Page 2

1 16 oz. Hammer
1 24" Wrecking Bar
2 Pair 410 Snips
2 Pair 210 Pliers
2 Aluminum Scoops
1 Pitch Fork
1 IBI Shovel
2 Roll 2" x 5' Fence Wire (Poultry), 300'
50 Fence Posts
2 Wall Thermometers
6 30" Mirror Nets
12 Timbers, 4" x 6" x 8'
1 Case Single Fold Paper Towels
4 Rolls, 2" Duct Tape
2 Ø 48 Quart Ice Chests
12 Bottles Murine eye wash
12 Ø 1 Quart Mason Jars
3 Deck Brushes w/Handles
3 25' Water Resistant Extension Cards

Table WF-1

3-25-74

G. Miscellaneous Material Inventory

The following list of material will be maintained at location indicated.

Quantity	Nomenclature	Location
200 pads	Polyurethane Foam	Venice Grand Isle
2 drums	Oil Herder	Venice (z) Grand Isle

(z) For use with Helicopter Underslung Spray System

H. Portable Foam Generation Equipment

These five skid, helicopter transportable packages for generating polyurethane foam will be maintained at Grand Isle, Venice and Intracoastal City. The equipment is available as of August 13, 1973.

Basic equipment is on skids as follows:

1. Mixing equipment.
2. Chemical barrels - foam constituants.
3. Compressor - to provide air for process.
4. Wringer - to squeeze used foam for reuse.
5. Incinerator - to burn foam after use (Grand Isle only).

An expanded section on operating instructions will be supplied at a later date.

ATTACHMENT "C"

Inventory of Equipment

Clean Seas, Inc.

2700 - RESOURCES

This section lists a great majority of the items of containment and cleanup equipment, materials, and services plus support equipment and services, that might be needed in coping with a major oil spill. Most of the member companies have also stockpiled various types of oil spill cleanup equipment that would be made available.

The following sub-sections contain:

2701 - Inventory of Clean Seas Owned Equipment

2702 - Absorbents - Collecting Agents

2703 - Aircraft - Helicopters - Fixed Wings

2704 - Booms

2705 - Chemicals - Dispersants

2706 - Contractors - Manpower - Beach Cleanup

2707 - Disposal Sites - Oil & Oil Soaked Trash

2708 - Divers - Underwater Welding

2709 - Heavy Equipment - Trucks, Cranes, Bulldozers, Graders

2710 - Marine Equipment - Boats, Barges, Tugs

2711 - Skimmers

2712 - Trailer Rentals

2713 - Special Services and Supplies

2701 CLEAN SEAS - INVENTORY OF OWNED EQUIPMENT

MATERIAL AND/OR EQUIPMENT	STORAGE AREA	QUANTITIES	REMARKS	CONTACTS
01.01 Mark II Skimmer System				
. Mark II Skimmer	CSI Yard - Carpinteria	2	All grades of oil can be recovered at rates up to 200 gallons per minute in light to moderate sea state	(805)963-3488 (805)684-4719
. 80 Barrel Vacuum Tank	" " "	1		
. Suction Hoses - 3"	" " "	150'		
01.02 CSI Skimmer System				
. Skimmer 45'x 17'x 6'	Anchored - S.B. Harbor	1	The system is capable of recovering all grades of oil from light to bunker fuel at rates up to 2000 gallons per minute. It will operate successfully in moderate sea states, 20-K winds and towing speeds up to 1 1/2 K.	See above
. 30" Kepner Sea Curtain Boom	On Skimmer	480'		
. 100 Bbl. Tanks	CSI Yard - Carpinteria	2		
. Oil and Water Pumps	" " "	3		
01.03 Sea Dragon System				
. Sea Dragon Skimmer 45'x 26'x 8'	Anchored - S.B. Harbor	1	Heavy duty, moderate volume skimmer(45' long and with a 26' beam). The system will recover all grades of oil and large amounts of solid materials. It is operable in a moderate sea state and winds up to 25 K.	See above
01.04 Bottom Tension Boom				
. 4'x 13' floats, 8'curtain	CSI Yard - Carpinteria	1000'	Use as containment boom in heavy seas. Curtain in 250' lengths on spools. B-T line in 500' lengths on spools. Booms can be used in 500' lengths or multiples of 500'.	See above
01.05 Floating Weir Skimmers	CSI Yard - Carpinteria	3	6' diameter floating weirs with air driven Acme-type pumps. Use in conjunction with B-T Boom or may be used independently. Will not handle debris. Handles most oils.	See above

Revised 9-74
Replaces 5-74

2701 CLEAN SEAS - INVENTORY OF OWNED EQUIPMENT

MATERIAL AND/OR EQUIPMENT	STORAGE AREA	QUANTITIES	REMARKS	CONTACTS
2701.06 Medusa Skimmer	CSI Yard - Carpinteria	1	10' diameter, gasoline engine drive. Handles light oil in calm waters only. No debris	(805)963-3488 (805)684-4719
2701.07 Vikoma Seapack Assembly	CSI Yard - Carpinteria	1	Immediate response containment boom. The 23' hull containing 1600' of inflatable seaboom can be towed to the oil slick at high speed. The boom can be fully operational within 12 minutes of arrival onsite.	See above
2701.08 Kepner Sea Curtain				
1. 480' (240'per unit)	CSI Yard - Carpinteria	480'		See above
2. 2000' 8"x12"(400'per unit)	" "	2000'		
3. 2000' 16"x12"(200'per unit)	" "	2000'		
2701.09 Barge - Tide Mar VII	Anchored offshore Santa Barbara	1	160'x39'x13' Tank Barge, 7800 bbl. capacity in 10 tanks. Has 6 diesel driven pumps and 2 diesel driven 50 KW generators.	See above
2701.10 Absorbent-Collecting Agent				
1. Strickite NOT Licensed	CSI Yard - Carpinteria	142-35lb.bags	Good sorbent for all grades of oil.	See above
2. Shell Oil Herder Licensed	CSI Yard - Carpinteria	8-5 gal.cans	Good sorbent for all grades of oil.	See above
2701.11 Boat (work)	Santa Barbara Harbor Marina #1, Slip #19	1	19' Larson Fiber Glass with 125HP Johnson motor. Not safe in adverse weather.	See above

Revised 9-74
Replaces 5-74

2701 CLEAN SEAS - INVENTORY OF OWNED EQUIPMENT

MATERIAL AND/OR EQUIPMENT	STORAGE AREA	QUANTITIES	REMARKS	CONTACTS
701.12 Chemicals				
1. Gold Crew (Dispersant)	CSI Yard - Carpinteria	4-55gal drum	Good cleaning agent and dispersant. Not licensed.	(805)963-3488 (805)684-4719
701.13 Compressor	CSI Yard - Carpinteria	1	Gardner-Denver 600 cfm rotary diesel engine driven.	See above
701.14 Radio System				
1. Repeater-Motorola	Santa Ynez Peak	1	49.04/48.62 - 45 watts	-----
2. Santa Barbara base	St. Barbara office	1	49.04/48.62 43 "	-----
3. Carpinteria base	CSI Yard - Carpinteria	1	49.04/48.62 - 50 "	-----
4. Portable base	" " "	1	49.04/48.62 - 48 "	-----
5. Portable - Handie Talkie	" " "	13	49.04/48.62 - 5 "	-----
6. Mobile	1971 Ford	1	49.04/48.62 & 48.66/49.42 - 50 "	-----
2701.15 Wilden M-15 Pump	CSI Yard - Carpinteria	2	For use on the MK-II Skimmers and miscellaneous pump requirements.	
2701.16 Flat storage tanks 100 bbl.	CSI Yard - Carpinteria	4	Used with MK-II Skimmers or other systems.	

Revised 9-74
Replaces 5-74

ATTACHMENT "D"

Inventory of Equipment

Clean Bay, Inc.

801 CBI CLEANUP EQUIPMENT AND MATERIALS

1. MOBILE HEADQUARTERS TRAILER

8' x 25' Office Trailer w/tandem axle

Callout Procedure

Gulf Oil Company-California will provide a driver and vehicle to deliver the trailer at any time to a location as directed by Clean Bay Inc. or a member company. Union Oil Company will provide a vehicle and driver for backup service.

Calls should be placed in the order shown below. Union Oil Co. should not be called unless Gulf is unable to furnish a driver. All Gulf members should be exhausted first.

Calling Procedure

1. Shift Foreman (415) 758-4840
   Gulf Oil Company-Calif. Ext. 268

   Shift Foreman will notify a driver to deliver the CBI trailer to the requested site.

2. Bulk Shift Foreman (415) 799-2478
   Union Oil Company 799-4411

   Shift Foreman will notify a driver to pick up the CBI trailer at Gulf and deliver it to the requested site.

A list of the equipment in the trailer follows:

801 CBI OIL SPILL CLEANUP EQUIPMENT AND MATERIALS

Mobile Headquarters Trailer

Equipment List

Quantity	Item
1	Intech Marine Base Station on Marine Channels 10,16, 18A & 22A
1	Motorola UHF Mobile Radio
1	Intech Scan Receiver on Marine Channels 10, 16, 18A, 22A & WXI
3 sets	Headphones, Superex and Motorola
10	1-Watt Motorola Handi-Talkies (Paksets)
2	4-Watt Motorola Handi-Talkies (Paksets)
1	Motorola Multi-Unit Portable Charger
1	Onan Trickle Charger
1	Onan Gasoline Generator
1	Sony Cassette Tape Recorder
1	Craftsman Multi-Band Receiver
2	Motorola Megaphones
2	McGill Trouble Lights
1	50' Extension Cord, McGill & Hubble
1	100' ITT Extension Cord
3	"Scare-Away" Noise Units/Propane Supply
Numerous	Hardhats
1	J-W Combustible Gas Indicator
18	Pint Sample Bottles
12	Hand Lanterns
Numerous	Hand Tools

Rev. 11/74
Replaces 4/73

Mobile Headquarters Trailer

Equipment List (continued)

Quantity	I t e m
2 sets	U.S.G.S. Maps of CBI Area of Coverage
2 sets	Nautical Charts of CBI Area
Numerous	Road Maps
Numerous	Tide and Current
1	Petroleum Pipeline Map
6	Map Overlays, 36" x 48" Clear Plastic
Numerous	Telephone Books
1 pr.	Binoculars
1	Dymo 2300 Tapewriter Kit
1	Polaroid 430 Camera
Numerous	Stationary Supplies
12	Raincoats
1	Blanket
2 sets	Emergency Road Reflectors
27	Emergency Road Flares (15-min.)
4	Fire Extinguishers
1	First Aid Kit

2. M/V RECOVERER

202', 9,000 bbl. petroleum cargo tanker capable of acting as:

- Command ship
- Primary control for cleanup, skimming, or lightering operations
- Central receiving vessel for off-loading skimmers
- Central receiving vessel during lightering
- Communications center
- Central location for crew changes
- Supply ship
- Central repair and maintenance facility
- First aid center
- Storage, transport and/or deployment of:
  - Skimmers
  - Booms
  - Dispersants
  - Sorbents
- Vacuum pumping capacity. Two pumps at least 1200 BPH each

(See Tank Plan (801-5) and Operation Plan (801-6 - 801-9)

Callout Procedure

In order to call out the M/V Recoverer, calls should be made to one of the following in the order shown:

R. W. Norton, CBI	(415) 685-2800 (24-hr.)
R. E. Nichols, HT&B	(415) 398-1150 (office) 376-1998 (home)
Harbor Tug & Barge Co. Pier 41 - Dispatcher	(415) 982-1600 (24-hr.)

3. OIL CONTAINMENT BOOM

A - Kepner Sea Curtain Boom

2000' - 16" Float x 12" Curtain, 3/8" Chain weight in curtain

This boom is stored in two (2) 1000' sections complete with towing bridles; each 1000-ft. section in a 35' semi-trailer van at Royal Trucking Co. (address & phone below).

Each trailer has five sections, 200' each, of Kepner boom bolted together making a 1000' boom. The boom is packed for easy deployment. One end of the boom with towing bridle attached is at the rear door and ready to be pulled out by boat. A second towing bridle is located near rear door. The trailing end of the boom is free so the two booms can be bolted together for a 2000' boom or install the towing bridle for a 1000' boom.

NOTE: The boom trailers are not licensed. When boom is ordered out, a Trip Permit is required. A Trip Permit is obtained from the Department of Motor Vehicles for $5.00 per vehicle per trip. Royal Trucking Co. has a permit for each vehicle and they should be reminded to fill it out and handle according to instructions before moving each trailer-van.

Royal Trucking 1420 Royal Industrial Way Concord, CA 94520	(415) 934-0190 or 689-6441
Roy Querio (Home)	(415) 939-6057

B - Submarine Engineering Associates

1600' - 36PFX Sea Boom, 12" Freeboard x 24" Draft with mooring plates, anchors and USN-SEALOC Adapters

This boom is stored in four (4), 25' x 8' x 4'5" containers in the CBI Warehouse, Royal Trucking yard, Concord, and can be obtained through CBI or Royal.

C - Pacific Pollution Control

500' - 24C Aquafence Boom, 12" Freeboard x 24" Draft

This boom is stored in five (5) fiberglass containers, 30" x 46" x 90" in the CBI Warehouse, Royal Trucking yard, Concord, and can be obtained through CBI or Royal.

D - Sayles Boom

2 - 100' sections, 36" Sayles Boom with towing attachments, stored on the M/V SPILL SPOILER to be used as diversion booms for the skimmer. Boom not to be removed from the vessel.

E - Vikoma Seapack & Seaboom

1600' - Ocean Boom, 27" Float x 17" Water Tube, stored in 23' boat on a trailer. Can be towed on road to launching site or boat can be towed on water at high speed.

VIKOMA stored at Merritt (415) 982-1600
Ship Repair Yard, Oakland (415) 893-7020

In order to call out the VIKOMA, calls should be made to one of the following in the order shown:

R. W. Norton, CBI	(415) 685-2800	(24 hr.)
R. E. Nichols, HT&B	(415) 398-1150	(office)
	376-1998	(home)
Harbor Tug & Barge Co. Pier 41-Dispatcher	(415) 982-1600	(24 hr.)

4. PUMPING EQUIPMENT

A - Tanker Lightering Equipment

1 - 40 HP air-cooled diesel engine prime mover mounted in a fiberglass container.

2 - 8" submersible turbine pumps, capacity of each pump is 1000 GPM through 1000' of 6" and 8" discharge hose.

1600' of 8" floating discharge hose

800' of 6" " " "

Accessory equipment for handling pump and driver.

Tanker lightering equipment is stored on board the M/V RECOVERER at Merritt Ship Repair Yard, Oakland, and is handled through the Harbor Tug and Barge Company.

Pier 41 - Dispatcher (415) 982-1600 (24 hr.)
Merritt Shipyard (415) 893-7020

B - Diaphram Pumps

2 - Wilden M15B Spark Free, Diaphram Pumps, 3" Kamlok inlet and outlet, compressed air driven, 150 GPM @ 100# air pressure.

These pumps with related air hose and fittings stored in CBI Warehouse at Royal Trucking Yard. Obtain through CBI.

(415) 685-2800 (24 hr.)

C - Oil Herder Helicopter Spray Pumping Unit

1 - Simplex Pumping Unit. Consists of a fiberglass bucket, 150 gal. capacity, 3 HP Briggs & Stratton gas engine and small gear pump, set at 1 GPM flow rate. Designed as helicopter undersling unit.

This pumping unit, plus 2 drums of Shell Oil Herder is temporarily stored at the CBI Warehouse in Concord (until contract is made with helicopter company). Obtain through CBI.

(415) 685-2800 (24 hr.)

5. SKIMMING EQUIPMENT

A - Marco Class III Oil Recovery System

1 - M/V SPILL SPOILER - A 57' x 24' jet propelled bay skimmer with 2-3' wide Martin-Marietta filterbelts and 90 bbls. onboard storage capacity. Capable of recovering all grades of oil and debris at oil recovery rates up to 1,000 GPM, in 3' to 4' waves.

Moored at Pier 41, San Francisco

Manned and operated by:

The Harbor Tug and Barge Company
24-hr. Dispatcher (415) 982-1600

B - Floating Weir Skimmers

2 - Exxon Floating Weir Skimmers for use in recovering fairly thick oil concentrated within a boom.

Each skimmer equipped with an air driven pump, 200' of Acme 4" discharge hose with hose floats and 150' of 1" Dayco air hose.

This equipment was designed to work in conjugation with a barge. An air compressor is required, min. size of 300 CFM, to handle both units. A davit or crane is necessary to deploy these units.

Skimmers are stored at CBI Warehouse at Royal Trucking and are available through CBI (24-hr.).

6. SORBENTS, TOOLS, ETC.

A - 35' Semi-Trailer Van - Sorbent Trailer

This van is stored at Royal Trucking Co. who furnish a tractor and driver to deliver the van as instructed by CBI on a 24-hr. basis.

NOTE: The Sorbent Trailer is not licensed. When sorbents are ordered, a Trip Permit is required following the same procedure as when calling out the boom trailers. (See 3-A, Page 801-10.)

Royal Trucking
1420 Royal Industrial Way
Concord, CA 94520

(415) 934-0190 or
689-6441

Roy Querio (Home) - (415) 939-6057

Inventory of Equipment & Supplies in Sorbent Trailer

(See following pages 801-15/16)

801 CBI CLEANUP EQUIPMENT AND MATERIALS

Sorbent Trailer Inventory

Quantity	Item
5	Ball Peen Hammers, 1¼# Channel lock or equal
6	10" Diamoloy crescent wrenches, or equal
2	30" MCC Bolt Cutters
36	½" Shackles w/screw pin, galv.
36	3/4" Shackles w/screw pin, galv.
24	5/8" x 1½" long machine bolts w/hex nuts
2	30" or larger tool box to store Items 1-7; Kennedy or equal
600 ft.	½" Manila rope (1 coil)
600 ft.	3/4" Manila rope (1 coil)
600 ft.	1" Manila rope (1 coil)
200 ft.	½" wire rope, 6 x 19, black
2	Morse model 85A drum carrier
2 sets	#52 Merrill drum lifter clamps
10	6' steel stakes
2	2 lb. rolls baling wire
2 pr.	Kline side-cut pliers
10 pr.	Heavy gloves; rubber lined gauntlet-type, work gloves, large size
12	Long-handle square point shovels
3	" " round point shovels
1	Sledge hammers - #8, long handle
1	Single bit axe
2	Ansul A-5, 5 lb. fire extinguisher, w/Foray dry chemical, or equal

Rev. 11/74

Sorbent Trailer Inventory (cont.)

Quantity	Item
1	Standard Medical First-Aid kit
2	4-5 tine, long-handle pitchforks
17	Hoes
8	Long-handle sickles
14	Short-handle sickles
6	Garden type rakes
1	Chain Saw
1	8-point regular carpenter's saw
1	24" Pruning saw
2	30 gal. trash cans, galv. metal
2	Stanley razor blade knives
6	2-cell regular flashlights
10 rolls	3M Type, 100 rolls, 36" wide, 12 oz/yd^2, 3/8" thick
10 bales	3M Type 151 pads, 18" x 18" x 3/16"
8 rolls	Conwed Sorbent Blankets, 35" x 200' roll
12 ctns.	" " Pads, 17" x 17" x 1/4"
4 rolls	" " Rug, 40" x 300' roll
8 ctns.	" " Heavy duty boom, 10" x 8'

7. PORTABLE RADIO REPEATER TRAILER

This radio repeater trailer can be used in conjunction with the radio packsets in remote areas to improve communications. It contains a primary and secondary radio repeater and has two batteries which make the repeater independent for 48 hours. If available, 110 VAC should be connected to the self-contained battery charger.

Radio repeater trailer is stored at Royal Trucking. Obtain through CBI. The CBI car is equipped with towing attachment for towing trailer to desired location.

8. WORK BOAT

1 - 16' Boston Whaler w/40 HP Johnson outboard

This boat is primarily a ship-to-shore boat for the M/V RECOVERER but is available for oil spill work if the Recoverer is not in use.

To increase the flexibility of the boat, it is stored on a trailer in CBI warehouse at Royal Trucking and will be towed to the M/V Recoverer when needed or to other oil spill work.

A 1-7/8" ball is required for towing. An electrical plug with identified leads is with the trailer.

Towing and operating instructions on boat. (See also following Pages 801-18/19)

Both the CBI company car and R. E. Nichols' company car are fitted with towing gear to tow this boat and trailer to desired location.

9. WAREHOUSE INVENTORY

In addition to equipment and supplies listed, there are other items stored in the CBI Warehouse located at: Royal Trucking
1420 Royal Industrial Way
Concord, CA

Following is an inventory list of items available through Clean Bay Inc.:

Quantity	Item
1 roll	Plastic 20' x 100' x .006"
6 rolls	Conwed Rug, 40" x 300'
7 "	" Blanket, 35" x 200'
10 ctns.	" Pads, 17½" x 17½" x 1/4"
9 "	" Boom 10" x 8'
10 ea.	Empty Boom crates
1	Radio repeater trailer (Item No. 7)
1	Boston Whaler & trailer(Item No. 8)
5	Floatation boxes for lightering equipment (Equipment on M/V Recoverer)
2 boxes	Repair equipment for Kepner boom (Item No. 3-A)
2	Exxon skimmers w/air & discharge hoses (Item 5-B)
1	Skimmer (Skim, Inc.)
6	Boom towing cables
1 set	Fork lift extensions
2	15-men life rafts (inspection needed before use)
2 ctns.	Foam absorbent pads

801 CBI CLEANUP EQUIPMENT AND MATERIALS

Warehouse Inventory (cont.)

Quantity	Item
2	Wheelbarrows
2	Bbls Oil Herder (Partially full)
1	" Diesel oil (Partially full)
1	Pallet containing boxes of manual inserts
11	Pallets of 3" vacuum hose
2	" " 1¼" " "
7	" containing bags of sawdust
12	Pitchforks
6	Square-corner shovels
4	Round-corner shovels

10. EQUIPMENT UNDER LEASE TO CBI

Contractor: Marine Service, Inc.
305 First Street
Benicia, CA 94510

(707) 745-2949 (24-hr.)
J. L. Garske

Equipment located at Marine Service, Benicia:

2 Mark II Oil Skimmers
1 56' LCM Boat,"Sponge"

Equipment located at Shell Oil, Martinez:

1 Mark II Oil Skimmer

Equipment located at C&H Sugar Co. Wharf, Crockett:

2 Mark II Oil Skimmers
1 56' LCM Boat, "Squeegee"

ATTACHMENT "E"

Draft

Agreement for Alaskan Gulf Clean-Up Cooperative

AGREEMENT

FOR

ALASKAN GULF CLEAN-UP COOPERATIVE

THIS AGREEMENT shall be effective when made and entered into, by and between ten (10) or more parties which execute the original of this Agreement or a counterpart hereof or other instrument agreeing to become a party hereto, being hereinafter sometimes referred to collectively as "Participants."

W I T N E S S E T H

WHEREAS each of the parties hereto has an interest, both financial and civic, in the prompt and efficient removal of oil spills occurring on or in the public and private properties, beaches, harbors, and offshore islands and waters within the Area of Interest; and

WHEREAS, the parties desire to provide resources for and to develop, maintain, and improve the procedure among the parties for mutual assistance and cooperation in the control of oil spill emergencies occurring within the Area of Interest; and

WHEREAS, the parties desire to commit themselves to an efficient and effective clean-up organization, and in so doing, agree to investigate and acquire appropriate equipment and materials, and to develop training programs for personnel who will be involved in the clean-up of oil spills; and

WHEREAS, due to the magnitude of the anticipated risks and costs related to the acquisition or lease of materials and equipment, the parties deem it necessary to join together under the terms of this Agreement for the purpose of sharing said costs and risks and minimizing the individual expenses and investments related thereto;

NOW, THEREFORE, in consideration of the premises and of the mutual covenants and agreements of the parties hereto, hereinafter set forth, the parties do hereby mutually covenant and agree as follows:

ARTICLE I

AREA OF INTEREST

The primary operations of the parties shall be confined to the geopgraphical area described as:

> the public and private properties, including but not limited to beaches, harbors, inland waterways, and offshore islands and water along the coast of the State of Alaska, between and including Cape Fairweather on the east and Cape Clear on the west,

which area shall hereinafter be referred to as the "Area of Interest;" provided, however, that nothing herein shall preclude the parties from contracting or cooperating with persons or organizations in other geographical areas for the purposes set forth in the recitals above.

ARTICLE II

PARTICIPANTS

A. Qualifications. Persons, partnerships, companies, corporations or other entities which contemplate operating refineries, terminals, pipelines or other facilities for handling, storing, transporting, or manufacturing petroleum or liquid hydrocarbons or which drill for or produce petroleum or liquid hydrocarbons or which contemplate conducting operations related thereto within the Area of Interest and which pay the initial advance as well as any costs related to subsequent joinder and which pay costs and expenses incurred in operations hereunder in accordance with the Participation Formula described in Article VI shall be qualified for Participation herein.

B. Voting Rights. The number of votes of the Participants may be unequal, and shall be determined by the Participation Formula described in Article VI.

C. Admission of New Participants. New Participants shall be admitted upon a showing to the Representatives that such potential Participants are qualified for membership hereunder. Such new participation shall be effective upon receipt by the Executive Committee of the inital advance required by the Participation Formula described in Article VI and in the case of a partnership or corporation the filing of the written designation of representation by such Participant as required by Article III.

D. Voluntary Withdrawal or Expulsion

1. Voluntary Withdrawal from Participation. Article VI to the contrary notwithstanding any Participant may withdraw from participation by filing written notice thereof with the Executive Committee; and such withdrawal shall become effective immediately upon filing of said notice. Such Participant shall fully pay all costs and expenses due and payable from it pursuant to the terms of this Agreement and fully provide for all contingent obligations to the remaining Participants on the effective date of withdrawal. This shall include, but not be limited to, prepayment by the Participant of its proportionate share of all outstanding long term lease obligations entered into by the Participants. The withdrawal by a Participant under the provisions hereof shall not relieve such Participant of his proportionate share of any liability incurred by, or rights or claims existing against the Participants at the effective date of withdrawal. Such withdrawing Participant shall be given credit for the current value of his ownership interest as defined in Article VI.F in co-owned capital equipment, materials, and cash or other liquid assets. Said current value shall be determined on the basis of the original cost depreciated at a rate of twenty percent (20%) per annum. If Participant's credit exceeds his obligations hereunder, he shall be refunded the difference in cash upon withdrawal.

2. Expulsion from Participation. Any Participant may be expelled for failure to pay part or all of any costs and expenses properly attributable to such Participant or for failure to reimburse part or all of any expenses duly incurred

hereunder within 45 days of incurring of such obligation. Such expulsion may be imposed only by a vote of at least 75% of the remaining Participants' Representatives. Any Participant so expelled shall be given credit for the current value of his ownership interest as defined in Article VI.F in co-owned capital equipment, materials, and cash or other liquid assets. Said current value shall be determined on the basis of the original cost depreciated at a rate of twenty percent (20%) per annum. If Participants' credit exceeds his obligations hereunder, he shall be refunded the difference in cash upon withdrawal. Said Participant shall become immediately obligated for prepayment to the remaining Participants its proportionate share of all outstanding long term obligations entered into by the Participants. No expulsion shall relieve such expelled Participant from any obligation to the remaining Participants before its expulsion and shall not preclude the remaining Participants from taking any other action to effect the collection of costs and expenses properly due and owing.

E. Adjustment of Voting and Participation Upon Voluntary Withdrawal or Expulsion. The votes of the Participants and future participation as determined by Article VI shall be adjusted as of the effective date of withdrawal or expulsion of a Participant or the admission of a new Participant.

ARTICLE III

DELEGATION OF AUTHORITY

Every Participant shall file with the Executive Committee a duly authorized and executed instrument designating a Representative, and one or more alternates, who shall for all purposes hereof have full power and authority to represent such Participant in all matters relating to this Agreement and upon whom any other communications with respect to this Agreement may be given, delivered or served. The power and authority of such Representative shall continue until the Participant represented by him shall designate another Representative and shall notify the Executive Committee in writing of the name and address of such new Representative, or until the participation of the Participant is withdrawn or expelled in accordance with Article II.

ARTICLE IV

MEETINGS OF REPRESENTATIVES

A. The business and affairs of the Cooperative shall be managed by the Representatives except where specifically provided herein for a power to be exercised by another person or other persons.

B. Without limiting the general grant of power set out in Article IV.A, the Representatives may, from time to time and at any time, delegate authority hereunder to the Executive Committee, a Manager or such other person or persons as the Representatives may deem appropriate. Said delegation may be withdrawn or rescinded at any time; provided, however, that no action previously taken by such delegate shall be affected by the withdrawal or rescision. Notwithstanding any provision herein to the contrary the Representatives shall approve by vote as provided herein (and shall not delegate authority to approve) an annual budget of expenditures and any necessary supplemental budgets or authorizations for expenditures of sums exceeding the amount budgeted for each category, if any, set out in the annual budget.

C. Annual Meeting. The annual meeting of Representatives shall be held on the third Tuesday of September each year at 9:00 a.m. at the offices of the Manager, if any, or at such other time or place as the Representatives may from time to time designate.

D. Special Meetings. Special meetings of the Representatives may be called by the Chairman, the Vice Chairman, the Manager, or by any three (3) Representatives. Not less than five (5) days' written notice to all Representatives for special meetings is required. The notice shall state the purpose of the meeting.

E. Emergency Meetings. Emergency meetings of the Representatives may be called by the Chairman, the Vice Chairman, the Manager, or by any three (3) Representatives for purposes of resolving policy or financial problems in connection with any oil spill or spills by giving not less than twenty-four (24) hours' telegraphic or personal written notice.

F. Action by Consent. Any action which may be taken at a meeting of the Representatives may be taken without a meeting if approved by a writing signed by 75% of the weighted vote. Said writing shall be mailed to the Executive Committee within thirty (30) days of the date of the first signature to be effective. The Secretary-Treasurer shall promptly notify the Representatives of the action taken and shall file the writing in the Minutes of the organization.

G. Quorum. At least five (5) Representatives representing ownership of sixty-five percent (65%) of the total number of the votes must be present before business may be transacted, but a lesser number may adjourn the meeting from time to time until a quorum is obtained. Representatives present at a duly called or held meeting at which a quorum is present may continue to do business until adjournment notwithstanding the withdrawal of members leaving less than a quorum.

H. Vote. Unless otherwise specified, wherever in this Agreement any action is to be taken upon vote of the Representatives, approval or passage is to be by a majority of the votes present or a majority of the votes necessary for a quorum, whichever is greater. The number of Representatives present at a meeting shall be considered only for the purpose of determining whether there is a quorum.

The number of votes for each Representative shall be based upon the percentage participation as described in Article VI. The number of votes may change from time to time if and as the percentage participation changes.

ARTICLE V

EXECUTIVE COMMITTEE

A. Composition. The Executive Committee shall be composed of five (5) persons including the Chairman, the Vice Chairman, the Secretary-Treasurer and two additional members. The Manager, if any, shall attend meetings of the Executive Committee but shall not have the right to vote.

B. Election. The members of the Executive Committee shall be elected by a majority vote of the Representatives at their annual meeting. Vacancies occurring before the next annual meeting may be filled by the Representatives at a special meeting called for that purpose in accordance with the provisions of Article IV.D.

C. General Powers and Authority. The members of the Executive Committee shall have such powers and duties, individually or collectively, as expressly stated herein or as may be provided from time to time by resolution or other directive of the Representatives.

D. Meetings. The Executive Committee may act in any meeting called at any time by the Chairman or any other member of the Executive Committee. Committee action may also be taken without a convened meeting by vote or agreement, by telephone, wire or letter.

E. Voting. Each voting member of the Executive Committee shall have one vote. Action by the Committee shall require three (3) affirmative votes. If three (3) such votes cannot be obtained, the matter may be considered and acted upon by the Representatives.

F. Administrative Duties

1. Chairman and Vice Chairman. The Chairman, or in his absence, the Vice Chairman:

(a) shall preside at all meetings of the Representatives and the Executive Committee;

(b) shall sign all contracts, and other instruments in writing when authorized by the Representatives by special or general grant of authority;

(c) shall discharge all other duties that may be required of him by the Agreement or delegated to him by the Representatives.

2. Secretary-Treasurer. The Secretary-Treasurer:

(a) shall keep a record of the proceedings of all meetings (1) of the Representatives and (2) of the Executive Committee;

(b) shall countersign all documents whenever required;

(c) shall keep a record of the votes each Participant is entitled to;

(d) shall keep a current record containing the name and address of each Participant and its Representatives;

(e) shall serve all notices required by law or by this Agreement;

(f) shall keep accounts of all receipts and disbursements and deposit all moneys or other valuable effects in the name and to the credit of the Cooperative in such depository bank or banks as may be designated by the Representatives;

(g) shall present at the regular meeting of the Representatives, or whenever requried by them, accounts of all his transactions as Secretary-Treasurer and the financial condition of this joint undertaking, and discharge such additional duties as the Representatives may from time to time prescribe.

3. Manager. The Executive Committee may, within the power and authority it has hereunder, assign such duties and delegate such authority to the Manager, if any, as the Executive Committee deems necessary and appropriate. The Manager, if any, shall administer the joint activities of the Participants hereto subject to the direction of the Executive Committee.

G. Compensation. Except for the Manager, if any, no member of the Executive Committee shall be entitled to compensation. The compensation of the Manager, if any, shall be set by the Representatives.

H. Removal. The Chairman, Vice Chairman, Manager, if any, or Secretary-Treasurer may be removed at the pleasure of the Representatives, in accordance with Article IV.F., G. and H.

ARTICLE VI

OWNERSHIP OF ASSETS

FINANCES AND PARTICIPATION FORMULA

A. Advances and Budget. The Executive Committee shall, each year, prior to the annual meeting of Representatives, prepare and submit to the Representatives a budget for advances for operations for the following calendar year. Approval of the budget for the advances shall be by vote of the Representatives.

The budget for advances shall state an amount of money to be used for each of the following categories:

1. Day-to-day operations including but not limited to salaries, office expenses, and equipment and material lease and maintenance costs;

2. Investment in capital equipment and materials to be used in connection with clean-up activities.

Each Participant executing this Agreement on or before August 1, 1975 shall be deemed an original Participant and shall pay an initial advance of $25,000. Subsequent advances shall be determined in accordance with the balance of this Article VI.

Any party executing this Agreement after August 1, 1975, but prior to the first lease sale in the Area of Interest shall pay as a portion of its initial advance $25,000 plus its proportionate share, determined in accordance with B(1) below, of the current value of the original cost of all capital equipment and materials co-owned by the Participants. In addition, such party shall pay an additional sum equal to its proportionate share, determined in accordance with Paragraph B(1) hereunder, of the current value of all liquid assets co-owned by the Participants.

Within thirty (30) days following the award of leases at the first lease sale in the Area of Interest each original Participant to this Agreement who was not awarded a lease in said sale may withdraw from this Agreement and shall have refunded all advances and additional moneys paid by them to the cooperative less an amount equal to its share of the expenses incurred by the Cooperative hereunder during the period in which it was a Participant. A Participant who is admitted to the Cooperative after the effective date of this Agreement but prior to said lease sale who is not awarded a lease may also withdraw from this Agreement and shall have refunded all moneys paid by him to the cooperative, less $25,000, and less an amount equal to its share of the expenses incurred by the Cooperative hereunder during the period in which it was a Participant. The remaining Participants shall have their proportionate interests redetermined and allocated in accordance with Paragraph B(2) below.

Any party executing this Agreement subsequent to the first lease sale in the Area of Interest and the award of leases therein shall pay as a portion of its initial advance $25,000 plus one hundred fifty percent (150%) of its proportionate share of the actual cost of the capital equipment, and materials, and the current value of all liquid assets co-owned by the Participants. Such party shall also pay one hundred fifty percent (150%) of its proportionate share of the cumulative expense incurred by the Participants to the date of execution of this Agreement. Upon termination of this Agreement or withdrawal from same by such party the amount refundable shall be only that party's proportionate share of its current ownership interest, in accordance with Paragraph B below.

The preceding requirements for payment of a proportionate share of the initial advance and of the current value of all liquid assets will not be required when such entering party has purchased or otherwise acquired some portion of the assets or operating function of a Participant to this Agreement and by doing so assumes that Participant's interest. Those moneys paid in for an ownership in co-owned equipment and materials shall be refunded to the Participants in good standing in accordance with their ownership interest therein as set out in Paragraph B below.

B. Payments by Participants. Each of the Participants under this Agreement shall make payments as required to fund the budget in accordance with the following Participation Formulas:

1. Prior to Redetermination After First Lease Sale all expenditures shall be shared by each Participant on an equal basis.

2. Within ninety days (90) following the awarding of leases from the First Lease Sale the proportionate share of each Participant hereto shall be redetermined and reallocated on the basis of fifteen percent (15%) per capita and eighty-five percent (85%) acreage awarded in the first sale in the Area of Interest. Following any subsequent sale in the Area of Interest the proportionate share of each Participant shall be redetermined and reallocated on the basis of the Participation Formula then in effect.

The per capita share shall be divided equally among Participants. The acreage share shall be a Participant's fraction of leased acreage to the total leased acreage of all Participants.

Parties of Joint Interest may become Participants jointly or singly but in no instance can acreage be proportioned more than once.

3. Following the first calendar year in which twelve (12) rig months of drilling have occurred the proportionate share of each Participant hereto shall be redetermined and reallocated on the basis of ten percent (10%) per capita, ten percent (10%) acreage and eighty percent (80%) exposure risk. For the purposes of this Agreement, rig month is defined as each and every month a drilling rig or vessel is on location and working, including breakdown and maintenance time. A drill rig or vessel is considered on location at such time as the last anchor or leg is set in place at any proposed drilling site.

The basis for the per capita and acreage allocations shall be as described in subparagraph 3 above. The basis for the exposure risk shall be:

Activity	Units	Weighting Factor
Offshore Production and Pipelines	Barrels of HC Produced	1.0
Marine Transport (Crude & Products)	Barrels of HC Transferred	1.0
Onshore Pipelines	Barrels of HC Transferred	0.5
Exploration and Drilling	Rig Months	100,000 Development

All rates in B(3) above shall be tabulated from the preceding calendar year's operation.

For purposes of voting, each Participant shall be entitled to the same number of votes as its percentage interest rounded to the nearest 0.1% as determined by the applicable Participation Formulas.

Annually, prior to approval of the budget as described in Article VI.A, the Representatives shall determine the participation of each Participant according to the applicable Participation Formula. The initial yearly payment of each Participant will then be determined by relating the participation of each Participant to the budget.

C. Additional Requirements. Additional moneys may from time to time be added to and specified for any or all of the categories of advances referred to in Article VI.A by charge against the Participants in accordance with the applicable Participation Formula, but only on an affirmative vote of the Representatives in accordance with Article IV.F., G and H; provided, however, that any Participant who has given notice of withdrawal in accordance with Article II.D.1 shall not be required to advance additional money after date of such notice.

D. Payment of Advances. Payment of advances required to meet the cash call for the annual budget and any additional advances provided in this Article VI shall be made within thirty (30) days after call by the Secretary-Treasurer. Such call shall be for aggregate amounts not to exceed the amount determined by the Secretary-Treasurer to be sufficient to meet cash requirements for the ensuing thirty (30) days.

E. Authority to Expend Advances. The Executive Committee is authorized to expend the moneys received, subject to the condition that no moneys designated for use in any of the specified categories described in Article VI.A. may be used for the purposes described in any of the other categories specified in Article VI.A without an affirmative vote of the Representatives in accordance with Article IV.F., G and H. All expenditures within each of the specified categories shall be in accordance with the budget approved by the Representatives or in accordance with any instruction received from the Representatives.

F. Co-Ownership of Jointly Acquired Property. All capital equipment and materials or other real and personal property, tangible or intangible, acquired jointly by the Participants hereunder shall be co-owned as tenants-in-common. Each Participant's ownership interest therein shall be based upon and shall be equal to its participation under the applicable Participation Formula. Each Participant's ownership interest will accordingly be adjusted annually with the annual adjustments of the applicable Participation Formula. Such ownership interests may also be adjusted during the year with the addition of a new Participant or withdrawal or expulsion of an existing Participant.

G. Withdrawal Over Budget or Certain Expenditures. Any Participant voting against approval of the budget or against approval to make additional unbudgeted payments for acquisition or lease of capital equipment or materials or for the cost of cleaning up unidentified oil spills may withdraw, provided that such Participant exercises such right of withdrawal using the procedure described in Article II.D.1, within five (5) days after result of the vote is available to the Participant. Such resigning Participants shall be freed from any liability to the remaining Participants resulting from the aforesaid budget or additional unbudgeted payments, but shall, however, be subject to all other obligations imposed by Article II.D.1.

ARTICLE VII

CLEAN-UP POLICY

A. Oil Spills in the Area of Interest. Within the monetary limitations established from time to time and in accordance with the provisions of Article VI, it is the policy of the Participants to release co-owned and/or co-leased oil spill clean-up equipment and materials for use within the Area of Interest as follows:

1. Notice of Spill. In the event of an actual or threatened spill of liquid hydrocarbons by any Participant originating within the Area of Interest, and if such Participant desires to utilize the co-owned or co-leased equipment and materials, then such Participant shall promptly notify the Executive Committee Chairman, or if not available, any member of the Executive Committee. Such notification shall include the location and known nature and size of the spill, the required equipment and materials. Such notification may be oral, but shall be confirmed in writing as soon as practical.

2. Use by Participant. Upon receipt of the above notice, the Chairman or any member of the Executive Committee shall, without further approval of the Participants or their Representatives, release the requested equipment and material to the affected Participant. The affected Participant shall have the use of such equipment and material as may be required in containing and cleaning up such spill. During the time such equipment and material are thus committed, complete control thereof shall be in the affected Participant.

During such time the other Participants and Executive Committee shall not have any responsibility therefor, regardless of negligence. If such spill originates within the Area of Interest or, if such spill originates within such area but the containment and clean-up requires use of the equipment and material outside of the Area of Interest, the affected Participant may continue to use the equipment and material as required. The affected Participant shall return the equipment and material to as good a condition as when called into service subject to reasonable wear and tear, or at the discretion of the Executive Committee, shall pay to the Executive Committee an amount of money equal to the cost which would have been incurred in complying with such requirement. The other Participants and Executive Committee shall in no way be liable or responsible for the payment of any costs and expenses incurred by said Participant and the Participant affected by such spill shall indemnify said other Participants and the Executive Committee against all liability for such costs and expenses.

3. Multiple Use by Participants. If two or more spills affecting different Participants occur at the same time or require use of the same equipment and material in the containment or clean-up thereof and if all such spills occur in the Area of Interest, the Executive Committee shall decide in absence of agreement among the affected Participants which equipment hereunder shall be used for each spill. If, however, one such spill occurs in the Area of Interest and the other spill occurs outside the Area of Interest, the Participant affected

by the spill in the Area of Interest shall have the prior right to use such equipment and material as required, but may agree to the release of such equipment and material for use in connection with the other spill.

4. Use by Non-Participants. In the event of a request by any party who is not a Participant for the use of any equipment and material subject hereunder to contain and clean up a spill or threatened spill of liquid hydrocarbons, the Executive Committee may allow such use and determine the condition thereof, including the extent and location of such use. During the time such equipment and material are thus committed, complete control thereof and full responsibility therefor shall be in the Non-Participant subject to Article VII.A.5. During such time the Participants and Executive Committee shall not have any responsibility therefor, regardless of negligence. To compensate Participants for the cost and expenses incurred in providing and maintaining a continuing stockpile of equipment and material with expected early obsolesence and replacement and for the continuing expenses of maintaining standby services, the rate charged by the Executive Committee to a Non-Participant for the use of such equipment and material shall be an equitable rate established by the Executive Committee (subject to periodic review and change where justified), taking into consideration the continuing costs, amortization, cost of money and other pertinent factors. The Non-Participant shall be obligated to return the equipment and material to as good a condition as when called into service, or, at the discretion of the Executive Committee, shall pay to the Executive Committee an amount equal to the cost which would have been incurred in complying with such requirement. The Participants and Executive Committee shall in no way be liable or responsible for payment of any costs and expenses incurred by said Non-Participant, the Non-Participant affected by such spill shall indemnify said Participants against all liability for such costs and expenses.

5. Multiple Use by Participant and Non-Participant. In the event of concurring spills of liquid hydrocarbons by Participants and Non-Participants or unknown parties, the Participant affected shall have the prior right to use such equipment and material as are required, but may agree to the release of such equipment and material for use in connection with other spills.

6. Unidentified Spills. The Chairman or any member of the Executive Committee may, without approval of the Participants, release equipment and material for use in the clean-up of oil spills from unidentified sources within the Area of Interest only at the request and under the direction of the governmental agency having jurisdiction over the spill. Such usage shall comply with Article VII.A.4, 5 and 8 and Article XI.

7. Oil Spills Originating Outside of the Area of Interest. The Executive Committee may release equipment and material for use in the clean-up of oil spills originating outside of the Area of Interest. Such usage shall comply with Article VII.A.4, 5 and 8 and Article XI.

8. Charges for Use of Equipment and Material. Any charges provided for under this agreement to Participants or Non-Participants, other provisions hereof notwithstanding, shall be based on costs incurred, it being the intent of the Participants hereunder to provide such equipment and material on a non-profit basis.

ARTICLE VIII

INDEMNITY

A. Indemnity for Use. In the event of damage to, loss of, or consumption of any equipment and material subject hereunder, while committed to use by any Participant or Non-Participant in connection with any spill of liquid hydrocarbons by such Participant or Non-Participant, the affected Participant or Non-Participant shall be solely responsible and liable to the Participants for repairing or replacing such equipment and material or reimbursing the Participants for the costs thereof, and the affected Participant or Non-Participant shall indemnify all other Participants, subsequent Participants and the Executive Committee against all liability on account of such damage, loss or consumption.

B. Indemnity Agreements. Each Participant shall hold harmless and indemnify each other Participant or subsequent Participant, the Executive Committee, and the agents, servants and employees of the foregoing, against and for all liability, and costs incurred, including, but not limited to, attorneys' fees, expenses, claims, fines and damages which the affected parties suffer or sustain or become liable for by reason of any accidents, damages or injuries, either to the persons or property of the foregoing parties or to the person and/or property of any third party, including, but not limited to, federal and state governments and agencies thereof, in any matter arising out of or connected with the furnishing of equipment and materials hereunder to the indemnifying party. A like indemnity shall be obtained from a Non-Participant before such party can use the above-noted equipment and material as provided for in Article VII. The foregoing indemnity and hold harmless provisions by a Participant or Non-Participant shall be applicable whether or not the accident, damages, or injuries indemnified against were caused or contributed to in whole or in part by the negligence of the Participants, subsequent Participants, the Executive Committee or the members or subsequent members thereof, and the agents, servants, and employees of the foregoing. The party furnishing this indemnity further agrees that the parties to whom this indemnification and hold harmless provision extends shall have the right, but not the obligation, to tender the defense to the indemnifying party of any and all law suits arising out of or in any way connected with matters which are the subject of this indemnity and hold harmless provision, but that failure to tender any such law suit for defense shall in no way or wise release or relieve party furnishing this indemnity of his obligations hereunder. The party furnishing this indemnity also covenants and agrees that the indemnity and hold harmless provision granted to all the parties hereunder or subsequent parties hereunder shall not be limited, restricted or in any way affected by the amount of insurance by the party furnishing this indemnity.

ARTICLE IX

IMPLEMENTATION

To implement the purposes of this Agreement, and promptly after the effective date hereof, the Executive Committee shall appoint Committee(s) to evaluate the oil spill response capabilities required to contain and clean up potential oil spills which might occur within the Area of Interest. In evaluating the above the Committee(s) shall consider but not be limited to the following:

(1) entering into contracts and/or leases for the purchase or lease of appropriate oil spill capital equipment and materials; and

(2) entering into service contracts under which the contractor may (a) maintain such equipment and materials at specified locations; (b) furnish experienced operating personnel and provide training concerning use of such equipment and materials; (c) conduct sea trials of such equipment and material; and (d) furnish such other services as may be mutually agreed upon between the contractor and the Executive Committee; and

(3) providing for functions listed in IX(2) above by other means, such as response teams.

Immediately upon this Agreement becoming effective a Committee shall be appointed to develop and publish an Oil Spill Contingency Plan.

ARTICLE X

INDEPENDENT CLEAN-UP OPERATIONS

Nothing in this Agreement shall require or be construed as requiring any Participant to use co-owned or jointly leased materials and equipment or the services of the other Participants in connection with oil spill clean-up activities. Each Participant may, if it so desires, purchase or contract for its own clean-up equipment and materials, or engage any other person to assist it with the clean-up of oil spills, or may, as provided for in this Agreement, use co-owned or jointly leased clean-up equipment and materials and the services of the other Participants jointly with some other person or persons.

ARTICLE XI

INSURANCE

The Executive Committee shall secure and maintain in full force and effect, Alaska Workmen's Compensation Insurance and Employer's Liability Insurance, including coverage under the Longshoremen and Harbor Workers' Act and Outer Continental Shelf Act, and other insurance as required by the Participants. The Executive Committee shall also require any and all independent contractors performing work or services in connection with operations hereunder to provide adequate insurance coverage as required by Participants. In addition, the Executive Committee shall secure and maintain in full force and effect such other insurance as the Representatives may from time to time direct. The cost of all such insurance secured by the Executive Committee shall be deemed a normal cost of performing operations and shall be chargeable to the Participants in accordance with the Participation Formula. All insurance shall include the Alaskan Gulf Clean-Up Cooperative and the names of each Participant as a named insured. Such insurance shall contain a waiver of subrogation clause in favor of each of the Participants and Alaskan Gulf Clean-Up Cooperative.

ARTICLE XII

RELATIONSHIP OF THE PARTICIPANTS

It is expressly agreed that Participants hereto are engaged in a joint venture and that the relationship of the Participants is that of independent contractors and not as members of a partnership or association and that the duties, obligations and liabilities of the Participants are several and not joint or collective, and that nothing contained herein shall be construed to create or impose a partnership duty, obligation, or liability on any of the Participants. Participants shall share in accordance with the applicable Participation Formula as set forth in Article VI herein, all losses, claims, damages, judgments (and costs and expenses in connection therewith) or liabilities arising out of this Agreement.

No language in this Agreement shall in any way constitute a waiver of subrogation rights by the Participants for willful misconduct or gross negligence of the other Participants, subsequent Participants, the Executive Committee or the members or subsequent members thereof and the agents, servants and members of the foregoing.

Each Participant hereby elects to be excluded from the application of SUBCHAPTER K OF CHAPTER 1 of SUBTITLE A of the Internal Revenue Code of 1954, or such portion or portions thereof as may be permitted or authorized by the Secretary of the Treasury of the United States or his delegate insofar as such subchapter, or any portion or portions thereof, may be applicable to the Participants. If any present tax laws of any state contain provisions similar to those contained in the SUBCHAPTER of the Internal Revenue Code of 1954 above referred to under which a similar election is permitted, each Participant hereby elects to be excluded from the application of such laws. If requested by Operator, each Participant agrees to execute and join in such instruments as are necessary to make such elections effective.

ARTICLE XIV

AMENDMENTS

This Agreement may be amended only by majority vote of the Representatives. Such amendment may be made at any annual meeting or special meeting of Representatives at which time a quorum is present, provided that notice shall have been given that the amendment will be considered. This Agreement may also be amended in accordance with the procedure set forth in Article IV.F. Notwithstanding any other provision of this Agreement, the affirmative vote or written consent of seventy-five percent (75%) of the Representatives entitled to vote shall be necessary to amend Article II.D or Article VI.G, or this sentence. Notwithstanding any other provision of this Agreement, the affirmative vote or written consent of seventy-five percent (75%) of the total number of votes shall be necessary to amend Article VI of this Agreement or this sentence.

ARTICLE XVI

SEPARABILITY

If any provision of this Agreement is found to be illegal under the laws of the United States or the State of Alaska or any subdivision thereof, the remainder of the Agreement shall not be affected.

ARTICLE XVII

EXECUTION

This Agreement may be executed in any number of counterparts, and each executed counterpart shall have the same force and effect as an original instrument and as if all of the parties to the aggregate counterparts had signed the same instrument. Any signature page of this Agreement may be detached by any party from any counterpart hereof without impairing the legal effect of any signatures thereon, and may be attached to another counterpart of this Agreement identical in form hereto but having attached to it one or more additional signature pages.

IN WITNESS WHEREOF, each party hereto has caused this Agreement to be executed by its duly authorized officer or attorney in fact as of the date first above written.