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F I N F I S H A N D S H E L L F I S H

Commercial Species
of the Outer Continental Shelf Planning Areas

A Draft Document

Prepared by Investigators and Students of

P R O J E C T O C S M A P S

Coastal Ecology Research Laboratory
Box 1106
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Princess Anne MD 21853

Cooperative Agreement No. 14-12-0001-30114

Federal OCS Oil and Gas Activities:
A Relative Comparison of Marine Productivity
Among the Outer Continental Shelf Planning Areas

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INTRODUCTION

The most productive fisheries in the Atlantic region are in the north, and are centered in the highly productive waters of Georges Bank and the Gulf of Maine. This northern dominance of Atlantic fisheries is partly an effect of the unique fish and shellfish production capacity of the Georges Bank/Brown Bank/Gulf of Maine area, and (perhaps) partly an artifact of the history of offshore fishing on the Atlantic coast. New England fishing effort is rooted in its maritime past; catch statistics reflect fishing effort as well as stock size. However, several stocks, particularly of offshore shellfish (quahogs and surf clams), are approaching or exceeding sustainable yields in the Mid-Atlantic Planning Area, suggesting that the ranking of fisheries in decreasing productivity from North to Mid to South Atlantic is a real phenomenon. Fisheries data are difficult to interpret for comparative purposes because unutilized stocks are seldom assessed and potential is generally not known. It may be that certain populations of the less productive southern waters are simply underexploited, and could be harvested did the markets and techniques exist for their use.

All three planning areas of the Gulf of Mexico region support important commercial fisheries. Estuarine dependent fish and shellfish abound due to extensive nursery grounds in vegetated (marsh, swamp and seagrass) coastal waters. Additional diversity is provided to the ichthyofauna by reef areas in the southern Gulf off Florida and Texas. Due to the estuarine dependence of most important species, we have reemphasized discussion of ichthyoplankton in the Gulf region. Abundance and diversity of finfish and shellfish (including shrimp, scallops and oysters) and commercial value of such resources reflect coastal rather than pelagic conditions. In the text which follows, we have treated fish and shellfish of the eastern Gulf with a detailed discussion of ichthyoplankton. CGUL and WGUL have not been studied as intensively from the viewpoint of ichthyoplankton, and we have combined ichthyoplankton and fish and shellfish discussions.

Very productive fisheries in the Pacific region, as measured by total landings, occur in SCAL. However, many of these fisheries depend on species caught far from the coast and brought to port in populous southern California. The coastal waters do support commercial fin- and shellfisheries, particularly in the kelp beds around the Channel Islands. Commercial and recreational fisheries based on anadromous species (salmon and trout) in NCAL and ORWA are very important, in terms of both catch and economic value.

An index of fish and shellfish abundance for the Gulf of Alaska Planning Areas (Figure 1) was calculated by summing optimum yields for a number of commercially important fish, and recent harvest totals for crabs and shrimp, then scaling by relative sizes of Planning Areas. The Kodiak (KODK) and Shumagin (SHUM) Planning Areas clearly stand out as having the highest fisheries yields of the four Gulf of Alaska OCS Planning Areas. The Kodiak region has been an historically productive

fishing and whaling ground, and contains important spawning grounds for halibut, pollock and other valuable species.

The southeastern Bering Sea supports one of the world's largest and most productive fisheries. A large proportion of the Bering Sea catch of fish and shellfish comes from the St. George Basin (SGBA) and North Aleutian Basin (NABA). This general area also contains the largest biomass of demersal fish and invertebrates within the southern Bering Sea. Throughout the Bering Sea, fin fish, shellfish and other invertebrates are prey for many millions of seabirds and marine mammals.

Generally, the more northern Planning Areas in the Bering Sea (St. Matthew Hall, Navarin Basin and Norton Basin) produce smaller commercial catches of fish and shellfish than SGBA and NABA.

Fish and benthic resources in the central and northern Bering Sea, however, are exceptionally important to seabirds and marine mammals. Benthic infauna which seldom are included in fisheries statistics, reach high densities on the northern Bering Sea shelf (SMHL and NORB), and are quite important to mammalian benthic feeders: gray whales, walrus and bearded seals.

The Arctic OCS Planning Areas (Hope Basin, Chukchi Sea, and Beaufort Sea) generally are less productive of fish, shellfish and benthos than other Alaska Planning Areas, reflecting the limitations imposed by long periods of darkness, low temperature and prolonged ice cover. Fisheries are limited to subsistence catches. Nevertheless, fish and benthic resources in these Planning Areas support large populations of sea birds and marine mammals, so that these regions are far from unproductive of fish and benthos.

In summary, four Planning Areas stand out as the most productive of fish and shellfish within the Alaska Region. In decreasing order of apparent productivity, these are: SGBA, NABA, KODK and SHUM.

N O R T H A T L A N T I C

FINFISH AND SHELLFISH

The Strategic Assessment Branch, Ocean Assessment Division, NOAA, has analyzed finfish and shellfish resources from both the North Atlantic and Middle Atlantic OCS Planning Areas in conjunction with proposed OCS Lease Sale 82. Table 1 summarizes data for the most important commercial species.

Sea scallops were the most valuable species economically. However, they ranked only tenth in total harvest (fish and shellfish combined). North of Cape Cod, the sea scallop is frequently found just below the low tide line, in contrast with the Middle Atlantic Bight where temperature preferences restrict it to deeper waters. In the NATL, the greatest sea scallop densities occur on eastern Georges Bank (now Canadian) (Grosslein and Azarovitz 1982).

Atlantic cod rank first in both total catch and economic value of finfish. Four stocks are hypothesized to exist off the New England coast: 1) Georges Bank east of 68° west; 2) Gulf of Maine north of Provincetown, Massachusetts; 3) southern New England, south and west of Nantucket Shoals; and 4) mid-Atlantic coast, which stock spends part of the year mingled with the southern New England population. The mid-Atlantic stock favors water temperatures between 0 and 10 degrees and the population overwinters off the coasts of New York, New Jersey and the Chesapeake peninsula.

Current estimates of maximum sustainable yield for cod from New England waters are 40,000 to 45,000 metric tons. Cod are becoming increasingly important in the recreational catch from this area. The 1970 U. S. Marine Recreational Survey (Deuel 1973) estimated that more than 16,000 metric tons of cod were caught by recreational fisheries from New York to Maine (most were taken from waters of the New York Bight). By comparison, the commercial catch for the same area in 1970 was 24,000 metric tons (Grosslein and Azarovitz 1982).

The most productive areas in NATL include Nantucket Shoals, Georges Bank and the Gulf of Maine, particularly the southern portion of the latter. Despite heavy fishing pressure, Georges Bank is still one of the most productive areas of the western Atlantic (Cohen and Grosslein in press).

The latest available commercial fisheries statistics (1982-1984) are considered preliminary until published, but show some interesting trends in catches (NMFS 1985 b). Table 2 summarizes commercial catches and economic value of the most important finfish in the NATL OCS Planning Area. Atlantic cod, menhaden and herring comprised the greatest commercial catches and the most valuable fisheries were for cod and various flounders. Swordfish and bluefin tuna brought the highest prices per pound but the relatively small catches caused them to be ranked sixth and seventh in overall economic value. Over half of the commercial finfish catch was landed in Massachusetts, 149 thousand metric tons out of a total of 260 thousand metric tons. Landings at

NATL Finfish and Shellfish

Table 1. Summary of 1977 catch statistics for most important New England fisheries.

Species	Total catch (10 ³ metric tons)	Economic value (10 ³ \$)
Atlantic herring	50.17	\$ 4,957
Cod	34.32	17,096
Yellowtail flounder	16.21	16,942
Ocean perch (adult)	15.02	5,357
Whiting	14.88	2,820
Pollock	12.85	4,072
Haddock	12.85	9,318
Winter flounder	9.06	7,182
Dab (flounder)	7.09	4,913
White hake	4.96	1,409
Scup	3.82	1,383
Summer flounder	2.52	3,071
Gray sole (flounder)	2.49	2,702
Sand flounder	1.75	908
Alewife	1.71	139
Swordfish	1.30	3,760
Cusk eel	1.24	462
Angler fish (goosefish)	1.24	989
Red hake	1.13	210
Lemon sole	0.86	943
Unclassified	23.79	1,514
TOTAL FISH	226.6	95,214

NATL Finfish and Shellfish

Table 2. Commercial catches and economic value of the most important finfish in the **NATL** OCS Planning Area (New England Region) (NMFS 1985b, 1984b, 1983b).

Species	Landings 1982-1984 103mt		Economic Value 1982-1984 Thousand Dollars	
	Total	Average	Total	Average
Atlantic cod	141.32	47.11	110,186	36,729
Atlantic menhaden	112.56	37.52	5,127	1,709
Atlantic herring	88.96	29.65	10,059	3,353
Flounders (Atl.)	60.46	20.15	72,862	24,287
Pollock	46.12	15.37	18,839	6,280
Yellowtail flounder	67.97	22.66	84,705	28,235
Whiting	37.57	12.51	12,634	4,211
Winter flounder	41.37	13.79	49,813	16,604
Haddock	46.89	15.63	59,627	19,876
Butterfish	21.92	7.31	13,703	4,568
White hake	19.39	6.46	7,225	2,408
Ocean perch (Atl.)	20.16	6.72	12,199	4,066
Scup or Porgy	11.10	3.70	10,232	3,411
Summer flounder	10.08	3.36	18,631	6,210
Cusk	5.66	1.89	3,042	1,014
Red hake	.4.65	1.55	1,203	401
Atlantic mackerel	4.18	1.39	1,967	656
Swordfish	3.43	1.14	21,948	7,316
Bluefin tuna	2.58	0.86	16,604	5,535
Bluefish	2.55	0.85	1,014	338
Other finfish	28.46	9.49	13,418	4,473
TOTAL	794.42		556,384	185,461

NATL Finfish and Shellfish

Massachusetts ports accounted for 64.6% of the 192.4 million dollar commercial fishery in the NATL Planning Area.

Estimated numbers and weights of fish caught by marine recreational fisheries in NATL from 1980 through 1982 are summarized in Table 3. Winter flounder and bluefish dominated recreational catches by number caught, and bluefish accounted for highest total weight landed. Magnitude of total recreational catch is underestimated in this analysis, because catch estimates are based only on fish brought ashore in identifiable form for interviewer identification and enumeration. Fish used for bait, filleted on board, discarded dead or released alive are not included in these estimates. The 1980-1982 recreational catch accounted for seven to ten percent of commercial landings. Recreational landings in 1982 were highest in Massachusetts (27,183 thousand fish), followed by Connecticut (10,385 thousand), Rhode Island (8,149 thousand), Maine (2,171 thousand) and New Hampshire (812 thousand) (NMFS 1985 b).

Table 4 shows 1982 through 1984 commercial shellfish landings for the NATL Planning Area. American lobster dominated the catch both in total landings and in economic value. Long-finned squid (*Loligo* spp.) and "other" crabs ranked second and third in weight landed, and sea scallops and hard clams ranked second and third respectively in economic value. Massachusetts and Maine accounted for most landings. 47% of lobster catch was landed in Maine, and 81% of total sea scallop catch was landed in Massachusetts.

1977 New England shellfish catch statistics are summarized in Table 1. More recent data {1982-1984, Table 5} show great increases in catch of surf clams, ocean quahogs and sea scallops. For example, in 1981, 67,000 metric tons of sea scallops valued at 71 million dollars were landed in New England (Anderson 1984).

ICHTHYOPLANKTON

Several general trends are apparent from analysis of 1977 through 1979 MARMAP ichthyoplankton survey data (Smith *et al.* 1980). Taxonomic diversity decreased with increasing latitude. Pelagic eggs were most abundant in spring and summer, and larval abundance peaked in winter and again in late spring and summer. The winter larval peak was due to sand lance, *Ammodytes*, a dominant demersal spawner. Summer larval peak was due to the presence of several species in the ichthyoplankton, and seasonal changes in species composition were consistent among years.

Initial spawning success during spring and summer is influenced by onset of warming of the water column. Early spring warming is followed by greater spawning success than late warming, possibly in association with greater concentrations and biomass of phytoplankton and zooplankton.

Fish eggs were scattered or absent in winter (late February to mid-March), with greatest seasonal abundance over Georges Bank. However, we note that

NATL Finfish and Shellfish

Table 3. Estimated total number and estimated weight¹ of fish caught by marine recreational fishermen in the North Atlantic OCS Planning Area (NMFS 1984a; NMFS 1985a).

Species	Catch #Fish x 10 ³		Weight 10 ³ mt	
	1980-1982		1980-1982	
	Total	Average	Total	Average
Winter flounder	33,855	11,285	10.64	3.5.5
Bluefish	26,801	8,934	18.94	6.31
Scup	16,825	5,608	3.96	1.32
Pollock	8,740	2,913	1.85	0.62
Cunner	5,446	1,815	0.34	0.11
Atlantic cod	9,507	3,169	7.93	2.64
Smelts	2,230	743	0.16	0.16
Flounders	3,728	1,243	0.52	0.17
Atlantic mackerel	4,251	1,417	0.64	0.21
Taytog	3,906	1,302	3.75	1.25
Sculpins	2,964	988	0.43	0.43
Other fishes	2,878	959	1.33	0.44
Summer flounder	3,323	1,108	1.09	0.36
Tunas/mackerels	404	202	0.36	0.36
Sea robins	3,284	1,095	0.01	0.01
Striped bass	845	282	1.40	0.70
TOTALS	135,592	45,197	55.16	18.39

¹ An estimate of Part of the total catch, based on fish brought ashore in whole form, available for interviewer identification and enumeration, from which samples of lengths and weights were obtained. Estimate does not include fish used for bait, filleted, discarded dead or released alive.

NATL Finfish and Shellfish

Table 4. Commercial catches and economic value of the most important shellfish in the NATLOCS Planning Area - New England Region (NMFS 1985b, 1984b, 1983 b).

Species Dollars	Landings 10 ³ mt		Economic Value 10 ³	
	Total	Average	Total	Average
American lobster	54.82	18.27	292,651	97,550
Squid - <u>Lol igo</u>	14.54	4.85	9,573	3,191
Crabs - other	7.16	2.39	5,463	1,821
Sea scallops (meats)	18.57	6.19	197,653	65,884
Surf clams (meat)	6.68	2.23	7,519	2,506
Northern shrimp	6.33	2.11	7,797	2,599
Soft clams (meats)	8.65	2.88	40,977	13,659
Hard clams (meats)	7.39	2.46	52,166	17,389
Clams-ocean quahogs	4.60	1.53	3,688	1,229
Bay scallops (meats)	1.87	0.62	22,264	7,421
Oysters (meats)	1.54	0.51	14,624	4,875
Squid, <u>Illex</u>	0.77	0.26	239	80
Other shellfish	18.90	6.3	29,162	9,721
TOTAL	153.90	51.30	685,260	228,420

NATL Finfish and Shellfish

Table 5. Summary of 1977 catch statistics for most important New England shellfish fisheries.

Species	Total catch (103 metric tons)	Economic value (10 ³ \$)
<u>Crabs</u>		
Jonah crab	0.36	138
Rock crab	0.70	163
Unclassified	1.24	922
Total Crabs	2.30	1,226
Lobsters, American	13.65	54,850
<u>Clams</u>		
Hard	1.07	5,302
Ocean quahog	1.33	\$42
soft	3.79	10,274
Total Clams	6.50	15,875
Mussels	1.14	895
Oysters	0.41	2,130
<u>Scallops</u>		
Bay	0.47	3,085
Sea	8.08	29,721
Squid	2.03	1,018
TOTAL SHELLFISH	37.09	112,007

NATL Finfish and Shellfish

abundance estimates for Georges Bank and the Gulf of Maine were based on insufficient survey coverage in the 1977 through 1979 survey years. Atlantic cod (Gadus morhua and/or haddock (Melanogrammus aeglefinus) eggs (early stage eggs of these species are nearly impossible to differentiate by standard taxonomic techniques) were moderately abundant around the perimeter of Nantucket Shoals, with a moderate concentration of offshore hake (Merluccius albidus) eggs near the shelf break south of Long Island. Sand lance larvae accounted for 98% of winter larvae, with the center of distribution off southern New England.

Greatest egg abundance in spring (mid-April to mid-May) was over Georges Bank. Haddock, Atlantic cod and yellowtail flounder (Limanda ferruginea) dominated egg populations on eastern portions of Georges Bank and in the Gulf of Maine, where concentrations of these species were moderate over Browns Bank. Egg populations at shoreward stations on Stellwagen Bank and in Cape Cod Bay were dominated by American plaice (Hippoglossoides platessoides). Spring egg populations in general in southern New England were dominated by yellowtail flounder, with local dominance at some stations by pollock (Pollachius virens).

Spring larval populations were dominated by sand lance, Atlantic cod, and haddock. A few stations on Georges Bank were dominated by American plaice.

In May, Atlantic mackerel (Scombrus scombrus) spawn off southern New England, and dense concentrations of mackerel and yellowtail flounder eggs were found from southern New Jersey to Georges Bank. Near the shelf break along Georges Bank, silver hake (Merluccius bilinearis) and tusk (Brosme brosme) eggs were abundant. In the Gulf of Maine, mackerel, silver hake, American plaice and yellowtail flounder eggs dominated the late spring egg drift.

Summer egg populations (mid-June to early September) were dominated by Cunner (Tautoglabrus adspersus) nearshore off southern New England, with silver hake and American hake offshore. Larvae on Georges Bank were predominantly hake and silver hake. In the remainder of southern New England, tautog (Tautoga onitis), windowpane flounder, silver hake and American hake comprised a dense mixed ichthyofauna. In the Gulf of Maine, redfish (Sebastes marinus) were found in the deeper central basin and small Atlantic herring occurred in northern areas.

Egg abundances declined in October in New England waters. Most of the Gulf of Maine and portions of Georges Bank were void of eggs. Moderate abundances of summer flounder (Paralichthys dentatus) eggs were scattered along the inner half of the shelf off southern New England. Hake eggs occurred along the shelf on the southern part of Georges Bank. Egg distributions in the Gulf of Maine were restricted to the western part around Stellwagen Bank, where nearly all eggs were pollock. Atlantic herring larvae were found in the Gulf of Maine, and some hake and silver hake south of Nantucket Shoals and on Georges Bank.

NATL Finfish and Shellfish

In November and December, Atlantic cod eggs occurred in the portion of the shelf that was surveyed, but **pollock** eggs were most abundant on Georges Bank and in the Gulf of Maine. Low to moderate concentrations of summer flounder larvae were found off southern New England. Larvae were absent or scattered over most of Georges Bank and in the Gulf of Maine, except in the western portion where Atlantic herring larvae remained.

Recurring patterns of egg and larval distributions and abundance emphasize the importance of shoal areas as spawning grounds. Fish eggs and larvae were consistently more abundant along the inner half of the shelf in the southern New England and Middle Atlantic subareas. Nantucket Shoals, an area too shallow to survey, is an important spawning area for several species. Likewise, on Georges Bank dense concentrations of eggs and larvae occurred over the shallow waters on the center of the Bank, and in the Gulf of Maine, abundance estimates were highest in the shallow areas around the periphery of the Gulf (Smith *et al.* 1980a),

Table 6 summarizes the spawning times of 42 fish species arranged in six groups based on life history patterns. Most of these species are spring and summer spawners, and begin their life cycles at the time of spring warming. Thus, spawning for these species generally occurs later on the Nova Scotian shelf and in the Gulf of Maine than in southern New England and on Georges Bank (Smith 1983). The following discussion reviews stock assessments, with comments on spawning patterns on larval distributions, of some commercially valuable species of fish and squids.

Atlantic herring (*Clupea harengus*) begin spawning in the eastern Gulf of Maine region and on the Scotian Shelf in August; spawning is concluded in this area by November. Spawning typically progresses to the western Gulf of Maine in September and ends there in December. Prior to the collapse of the spawning stock by 1977, herring used to spawn on Georges Bank from September to December, with peak activity during late September and early October. The southernmost extension of significant spawning occurs during October (W. G. Smith *et al.* 1980b, Smith 1983). Status of northwest Atlantic herring stocks are reviewed by Sindermann (1979) and by Fogarty and Clark (1983). Herring stocks along the entire northeast Atlantic coast are very low. During the 1980-81 spawning season, as in the previous three years, herring larvae were centered along the western and northern reaches of the Gulf of Maine where they occurred in moderate to low densities. Autumn 1980 marked the first spawning season within the last 25 years that Atlantic herring larvae were not caught during the autumn-winter period on Georges Bank, the center of spawning activity during the 1960's and early 1970's (W. G. Smith *et al.* 1981 b). In coastal Maine, nominal 1982 catches showed a drastic decline from 1981 levels, and recruitment assessment indicates that short-term outlook for population densities is not promising (Fogarty and Clark 1983).

NATL Finfish and Shellfish

Table 6. Spawning seasons for principal coastal species off the northeastern U.S. {from Smith 1983}.

	Southern New England	Georges Bank	Gulf of Maine
<u>Boreal (shallow) species</u>			
Sea herring	Ott-oac (Ott)	Sep-Dec (Sep-Oct)	Aug-Dec (Sep-Ott)
American plaice	Feb-Jun Apr-May*	Feb-Jun (Apr-May)	Feb-Jun (Apr-May)
Atlantic cod	Nov-May (Nov-Mar)	Nov-May (Feb-Mar)	Nov-May (Mar-May)
Pollock	Oct-Mar (Dec-Jan)	Oct-Mar (Dec-Jan)	Ott-H-r (Dec-Jan)
Haddock	Jan-May (Mar-Apr)	Jan-May (Mar-Apr)	Feb-May (Mar-Apr)
<u>Boreal (deep) species</u>			
ITCh flounder	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)
Redfish	Apr-Jul (May-Jun)**	Apr-Aug (Jun-Jul)*	Apr-Aug (Jun-Jul)
Cusk	Apr-Jul (Apr-May)	Apr-Jul (Apr-May)	Apr-Jul (Apr-May)
Wolffish	None reported	Nov-Jan (peak unknown)	Nov-Jan (peak unknown)
Atlantic argentine	None reported	None reported	Mar-May (Mar)
Thorny skate	Probably none	All year (Apr-Sep)	All year (Apr-Sep)
<u>Warm water species</u>			
Bluefish	May-Aug (Jul)	None reported	None reported
Northern searobin	Jun-Ott (Aug-Sep)	None reported	None reported
Scup	May-Aug (May-Jun)	None reported	None reported
Longfin squid	Apr-Sep (Jun)	Apr-Jul (Jun)	Jul (Jul)
Fourspot flounder	Jun-Aug (Jul)	Jun-Aug (Jul-Aug)	None reported
Summer flounder	Aug-Nov (Oct)	Sep-Nov (Oct)	None reported
Butterfish	May-Sep (Jul)	Jun-Sep (Jul)	Jun-Sep (Jul)
<u>Eurythermal species</u>			
Ocean pout	Sep-Oct (Oct)	Sep-Ott (Sep)	Sep-Ott (Sep)
Longhorn sculpin	Nov-Feb (Dec-Jan)	Nov-Feb (Dec-Jan)	Nov-Feb (Dec-Jan)
Yellowtail flounder	Apr-Aug (May-Jun)	Apr-Aug (May-Jun)	Apr-Aug (Jun)*
Winter flounder	Feb-May (Feb-Mar)	Mar-May (Apr)	Apr-May (Apr)
Windowpane	May-Nov (Sep)	Jun-Ott (Jul-Aug)	Jun-Ott (Jul-Aug)
Little skate	All year (Nov-Jan & Jun-Jul)	All year (Nov-Jan & Jun-Jul)	All year (Ott-Jun)
Winter skate	All year (Apr-May & Nov-Feb)	All year (Apr-May & Nov-Feb)	Aug-Nov (Sep)
<u>Stenothermal species</u>			
Red hake	Mar-Oct (Aug-Sep)	May-Sep (Jun-Jul)	May-Sep (Jun-Jul)
Spiny dogfish	Nov-Feb (Jan)	Sep-May (Jan-Mar)**	None reported
Silver hake	Apr-Oct (Jun)	Apr-Oct (May-Aug)	Jun-Oct (Jul-Aug)
Sea raven	Oct-Dec (Nov-Dec)	Ott-Dec (Nov)	Oct-Dec (Nov)
Cunner	Apr-Oct (Jun)	May-Aug (May-Jun)	Jun-Sep (May-Jun)
American lobster	May-Aug (May-Jul)	Jun-Aug (Jul-Aug)	Jul-Aug (Jul-Aug)
White hake	Oct-Mar (Dec-Feb)	Oct-May (peak unknown)	Nov-Apr (peak unknown)
Goosefish	Apr-Aug (Jun)	Jun-Aug (Jun-Jul)	Jun-Sep (Jun-Jul)
<u>Other</u>			
Alewife	Mar-Apr (Apr)	None reported	Apr-May (May)
Blueback	Apr-Jun (May)	None reported	May-Jun (Jun)
Sand lance	Nov-Mar (Jan-Feb)	Nov-Mar (Jan-Feb)	Dec-Apr (Feb-Mar)
Atlantic mackerel	Apr-Jun (May)	Apr-Jul (May-Jun)*	May-Jul (Jun)**
Gulf Stream flounder	Jun-oct (Jul-Aug)	Jun-Oct (Jul-Aug)	None reported
Rock crab	All year (Apr-Jun)	All year (Apr-Jun)	All year (Apr-Jun)
Jonah crab	Jul (Jul)		
Sea Scallop	Jul-Sep (Aug)	sep-Ott (Sep-Oct)	Aug-Ott (Aug-Sep)
Swordfish	None reported	None reported	None reported

NATL Finfish and Shellfish

Atlantic cod spawn from late November to April or May, depending on latitude (Smith et al. 1979 b). The period of peak spawning is related to environmental conditions. During 1978-79, the third in a succession of three severe winters, cod spawning peaked in spring, the same pattern observed during the record cold winters of 1976-1977 and 1977-1978 (Smith et al. 1981a). Cod larvae are centered over the eastern half of Georges Bank with lesser concentrations in the Gulf of Maine and off southern New England. Haddock spawn from February to June and bottom temperature is an important factor determining onset and duration of haddock spawning (Smith et al. 1979b). Major concentrations of haddock larvae are centered over the eastern half of Georges Bank, with lesser concentrations in the Gulf of Maine and southern New England waters.

Year class strength in both cod and haddock is apparently controlled by the same factors. Both species produced two relatively strong year classes, in 1974-75 and in 1977-78. Moderate winter weather occurred during 1974-75 while 1977-78 was abnormally cold. Thus, winter weather conditions do not seem to directly influence year class success, although such conditions do affect temporal spawning patterns (Smith et al. 1981a). Evidence suggests that anomalous advective processes may play a large role in establishing year class success for fishes spawned on Georges Bank. Mean circulation on the Bank is described as a clockwise gyre, a feature that tends to retain planktonic organisms within its bounds. Although the gyre is believed to be fairly constant, mounting evidence suggests that episodic anomalies frequently disrupt the pattern. Two anomalies that could adversely affect cod and haddock larvae are the on/off movement of the shelf water/slope water front, and warm core rings which spin off the Gulf Stream and move westward along the southern flank of Georges Bank (Smith et al. 1981a).

Cod and haddock were among the most heavily exploited demersal stocks during the late 1960's and early 1970's, a time of intense fishing pressure which saw a 50% reduction in biomass of principal fish species (Clark and Brown 1977). Cod spawning stocks on Georges Bank were reduced to 50,000 metric tons by the mid-1970's, the lowest since 1965 when they exceeded 110,000 metric tons. Haddock stocks on the Bank, estimated at 250,000 metric tons in 1966, were reduced to 23,000 metric tons by 1972, an apparent all-time low (Smith et al. 1979 b). Recruitment simulations of haddock stocks on Georges Bank and in the Gulf of Maine suggest that if current fishing levels are maintained, potential for stock recovery and catch improvement is low (Overholtz et al. 1983).

Nearly all yellowtail flounder (Limanda ferruginea) spawning occurs from mid-April to late June at bottom temperatures of 4 to 9 ° centigrade. Larvae first appear in April on Georges Bank and in May in the southwestern Gulf of Maine. From 81 to 95% of larvae caught in 16 MARMAP cruises (1977-1981) were spawned on Georges Bank and southern New England (Silverman 1983). Annual landings peaked at 57,500 metric tons in 1969, but dropped sharply in the 1970's due to decreased population levels (Clark et al. 1981). Abundance and

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recruitment increased in 1982 relative to 1981 levels in southern New England and on Georges Bank (McBride and Clark 1983).

Silver hake (Merluccius bilinearis) begin spawning during early May in southern New England, in late May on Georges Bank and in July in the Gulf of Maine (Silverman 1982). Peak spawning occurs in July and August. Larvae were found in the Middle Atlantic Bight between May and December, with peak abundances in September. Most larvae occur on the shelf between Hudson Canyon and Martha's Vineyard (Fahay 1974). Larval transport is negligible, apparently because of diel-depth distributions. Most silver hake larvae are found at depths of approximately 30 meters during the day, rising to about 15 meters at night. By remaining at these depths, they are not subjected to the major advective processes that influence planktonic distributions in near-surface strata (Silverman 1982).

Offshore hake (M. albidua) larvae primarily occur along the shelf edge and slope, usually at depths greater than 100 meters. Smallest offshore hake larvae occur between May and October, and they are most numerous in June and July on Georges Bank and in southern New England (McKenney 1983). Silver hake larvae were approximately ten times more abundant than offshore hake larvae during the five years of MARMAP survey data reported by McKenney (1983).

Catch of Atlantic mackerel (Scomber scombrus) declined between 1981 and 1982, with the United States and Canada accounting for the bulk of the total international harvest (Anderson 1984). High recruitment success in 1980-1982 year classes has increased harvestable stocks considerably, and at current or reasonable projected catch rates, Atlantic mackerel populations should continue to build (Anderson 1984).

Butterfish (Peprilus triacanthus) are short-lived, and population levels are high dependent on recruiting year class (Waring and Anderson 1984). Stocks were high in 1984 due to strong recruitment in the 1983 year class, but recent changes in processing for sale (packing a "supersmall" category) may result in heavy fishing and/or discard pressure on first year populations with subsequent depletion of future stocks (Waring and Anderson 1984).

Long-finned squid (Loligo pealei) catches were high in 1982 and in 1983 projections (Lange 1983a), while short-finned squid (Illex illecebrosus) catch was low in 1983, and low recruitment projection forecast reduced availability (Lange 1983 b). Stocks of both species, however, are sufficient to support current fisheries and/or optimum yields.

Witch flounder (Glyptocephalus cynoglossus) spawn over a long season, with peak activity in May and June (Colton et al. 1979). Spawning grounds cover broad areas of the western Gulf of Maine, and shelf water circulation transports some larvae south across the continental shelf south of Georges Bank (Markle 1975). This species was once managed under regulations governing the "other flounders" group of International Commission for Northwest Atlantic

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Fisheries. However, catch has increased in recent years, and current levels of harvest are probably greater than those which the population can support. The species may be included in the Atlantic Demersal Finfish Plan of the New England Fishery Management Council (Burnett and Clark 1983).

Redfish (Sebastes fasciatus) landings have declined considerably since the 1970's and demographic parameters indicate an unbalanced population that is extremely sensitive to recruitment. Projections indicate poor recruitment to the population, and continued fishing at current levels will result in continued stock declines (Mayo et al. 1983).

MID-ATLANTIC

FINFISH AND SHELLFISH

Cape Hatteras and Cape Cod have long been recognized as important zoogeographic barriers in the Northeastern Atlantic, and the region between them is designated the Middle Atlantic Bight. Nevertheless, for the purpose of faunal classification, Grosslein and Azarovitz (1982) have included the area from Cape Hatteras to and including the whole of George's Bank as part of the "mid-Atlantic region." This reflects the fact that the Bank is an extension of the Continental Shelf proper and in the summer provides suitable habitat for many warm-water finfish species. These authors, using data obtained from spring and autumn MARMAP trawl surveys, have reported 180 fish species from this broad region. Of these, only ten (dusky shark, snake eel, blueback herring, lined seahorse, striped bass, tilefish, scup, blackbelly rosefish, summer flounder, and windowpane flounder) are considered principal residents of MATL waters.

No where else in U.S. coastal waters is there as large a seasonal temperature change as in the Middle Atlantic Bight. For example, in the New York Bight surface temperatures range from a maximum of 26°C in summer to <1°C in winter. The extremes of this range decrease with depth; near the shelf edge at the 150-200m isopleths temperatures range only 7-13°C (Grosslein and Azarovitz 1982).

The Strategic Assessment Branch, Ocean Assessments Division, NOAA, has analyzed living marine resources for MATL OCS Lease Sale No. 76 (NOAA 1982a). Data for range, spawning, and abundance of twelve species of commercial fish and shellfish are tabulated and mapped. (Species included are deep-sea scallop, American lobster, surf clam, ocean quahog, long-fin squid, short-fin squid, yellowtail flounder, summer flounder, winter flounder, scup, tilefish, and bluefish.) The data include consideration of relative economic value of each species.

Results indicated that the density of marine species in the canyonheads is approximately five-fold greater than in other areas (for the seven MARMAP commercially important species examined). MARMAP data do not exist for the other five species included in the analysis, such as the tilefish (Lopholatilus chamaeleonticeps). Approximately 24% of the spawning and 16% of the range of the tilefish in Lease Area 76 are located in the canyonhead tracts, and these habitats also important to populations of American lobster (Homarus americanus, 22%), long-fin squid (Loligo pealei, 16%), and SCUP (Stenotomus chrysops, 32%) (NOAA 1982a). The highest densities of sea scallop in the MATL also occur in the vicinity of the Hudson, Baltimore, and Norfolk Canyons. As a result of the analysis, NOAA recommended that canyonheads tracts be deleted from the OCS Lease Sale.

The "shelf break zone" is also a relatively productive subregion of the OCS Lease Sale 76 area of the MATL. MARMAP trawl surveys indicate this to be a region of high fish abundance, comparable to the mouths of the Chesapeake and Delaware Bays and the productive New York Bight.

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Commercially important concentrations of lobster, long-fin squid, and scup occur here, as well as nearly half of the spawning grounds and more than 50% of the range of tilefish. However, more information is needed to fully assess the size and composition of fish stocks in these waters (NOAA 1982a).

Catch statistics for the most important finfish species in the **MATL** are summarized in Table 1 - Middle Atlantic Region (New York, New Jersey and Delaware) and Table 2 - Chesapeake Region (Maryland and Virginia). Whiting, scup, and summer flounder dominated the Middle Atlantic catches (Table 1), whereas menhaden, summer flounder and weakfish (gray sea trout) dominated Chesapeake catches (Table 2).

Total commercial catches in the **MATL** Planning Area for 1984, 51 thousand mt, were less than 20% of the 260 thousand mt landed in the **NATL** region. Summer flounder were the most valuable fishery followed by swordfish and tilefish in the Middle Atlantic Region and striped bass and weakfish in the Chesapeake Region. Analysis of landings by state indicated that Virginia (18 thousand mt) and New Jersey (16.6 thousand ret.) led the region in total fish landings. Note, however, that preliminary landings of menhaden in Virginia are severely underestimated. There are only two companies that fish for menhaden from Reidville, Virginia, neither of which wants their competitor to know the size of their catches. (Cluney Stagg, Chesapeake Biological Laboratory, personal communication, June 1985).

Table 3 summarizes estimated total numbers and estimated weights of the marine recreational fisheries catch in the **MATL** OCS Area for 1980-82, the most recent data available. Bluefish and summer flounder dominated recreational catches, both in total numbers caught and in estimated weights in 1980. During 1981 spot and bluefish ranked first and second in total numbers caught; bluefish contributed most to the total weight of the catch - 41. % of the 42.3 thousand mt landed. Greatest numbers of summer flounder, bluefish and black sea bass were caught in 1982; again bluefish dominated the recreational catch in terms of total mt landed. The total estimated recreational catch decreased in 1982 to 36.6 thousand mt less than half of the 78 thousand mt landed in 1980. Catches of bluefish, summer flounder and weakfish declined the most during these three years (Table 3). Estimated commercial finfish catches for the **MATL** Region during 1980-82 were 70.76, 59.61 and 57.31 thousand mt respectively. Recreational fisheries caught significant amounts of fish in the **MATL** Region; from 1980-1982 the estimated total weight of the recreational catch was 110%, 71% and 64% respectively of the total commercial fisheries harvests for those three years. (NMFS 1981a, 1982, 1983a).

Catch statistics for the most important commercial shellfish species in the Middle Atlantic and Chesapeake Regions are summarized in Tables 4 and 5. Surf clams and ocean quahogs dominated Middle Atlantic catches whereas blue crabs and surf clams comprised the greatest catches in the Chesapeake Region. Blue crabs were the most valuable commercial shellfish. The total economic value of

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Table 1. Commercial catches and economic value of the most important finfish in the MATL OCS Planning Area (Middle Atlantic Region) (NMFS, 1985b, 1984b, 1983a).

Species	Landings 1982-1984 10 ³ mt		Economic Value 1982-1984 Thousand Dollars	
	Total	Average	Total	Average
Whiting	15.65	5.23	8,562	2,854
Summer flounder	9.61	3.20	15,877	5,292
Scup or porgy	10.04	3.35	10,797	3,599
Tilefish	5.53	1.84	12,802	4,267
Weakfish	5.72	1.91	5,941	1,980
(gray sea trout)				
Bluefish	5.30	1.77	2,759	920
Atlantic menhaden	4.44	1.48	955	318
Yellowtail flounder	4.57	1.52	5,096	1,699
Atlantic mackerel	4.57	1.52	1,333	444
Winter flounder	4.33	1.44	6,266	2,089
Butterfish	2.06	0.69	1,843	614
Swordfish	1.34	0.45	9,861	3,287
Red hake	1.84	0.62	693	231
Black sea bass	1.29	0.43	2,079	693
Atlantic cod	0.96	0.32	1,269	423
Bigeye tuna	0.47	0.16	2,829	943
Striped bass	0.65	0.22	2,945	982
Bluefin tuna	0.27	0.09	1,616	539
Atl. flounder	0.22	0.07	185	62
Other finfish	3.70	1.25	4,016	1,339
Total			94,763	31,588

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Table 2. Commercial catches and economic value of the most important finfish in the MATL OCS Planning Area (Chesapeake Region) (NMFS 1985b, 1984b, 1983a).

Species	Landings 1982-1984 10 ³ mt		Economic Value 1982-1984 Thousand Dollars	
	Total	Average	Total	Average
Atlantic menhaden	38.71	12.90	3,149	1,050
Summer flounder	10.95	3.65	14,236	4,745
Weakfish (gray sea trout)	3.45	1.15	3,924	1,308
Black sea bass	1.71	0.57	1,485	495
Scup or porgy	2.27	0.76	1,787	596
Striped bass	1.15	0.38	3,558	1,186
Alewives	2.17	0.72	497	166
Bluefish	2.89	0.96	1,011	337
Atlantic mackerel	0.48	0.16	96	32
Atlantic croaker	0.48	0.16	364	121
Swordfish	0.55	0.18	3,138	1,046
Butterfish	0.43	0.14	267	89
Dogfish shark	3.05	1.02	526	175
Whiting	0.23	0.08	108	36
Bigeye tuna	0.15	0.08	525	263
Other finfish	12.61	4.20	6,402	2,134
Total	81.92	27.31	42,867	14,289

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Table 3. Estimated total number and estimated weight¹ of fish caught by marine recreational fishermen in the Middle Atlantic OCS Area, 1980-1982 (NMFS 1984a, 1985a).

Species	Catch #Fish x 10 ³ 1980-1982		Weight 10 ³ mt 1980-1982	
	Total	Average	Total	Average
spot	51,731	17,243.7	3.63	1.21
Bluefish	59,583	19,861	59.57	19.86
Summer flounder	57,817	19,272.3	22.74	7.58
Winter flounder	24,565	8,188.3	5.69	1.90
Weakfish (sea trout)	25,826	8,608.7	24.09	8.03
Atlantic mackerel	13,775	4,591.7	8.07	2.69
Toadfishes	5,728	1,909.3	0.02	0.02
Black sea bass	22,432	7,477.3	7.74	2.58
Sheepshead	2,268	2,268	0.61	0.31
Scup	12,776	4,258.7	2.36	0.79
Sea robins	11,521	3,840.3	0.09	0.03
Atlantic croaker	3,688	1,229.3	0.42	0.14
Freshwater catfishes	1,623	541	0.23	0.12
Toutog	4,958	1,652.7	3.01	1.00
Porgies	4,979	1,659.7	3.22	1.07
Cunner	4,514	1,504.7	0.08	0.03
Sharks , dogfish ³	4,168	1,389-3	1.91	0.64
Other fishes	6,211	2,070.3	1.30	0.43
White perch	5,442	1,814	0.81	0.27
Silver hake	17,444	5,814.7	3.63	1.21
Atlantic cod	1,104	368	1.41	0.47
Total	352,462			

¹ An estimate of part of total catch, based on fish brought ashore in whole form, available for interviewer identification and enumeration from which samples of length and weight were obtained. Estimate does not include fish used for bait, filleted, discarded dead or released alive.

² March 1981-December 1981

³ Includes categories sharks and sharks, dogfish for 1981 and 1982.

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Table 4. Commercial catches and economic value of the most important shellfish in the MATL OCS Planning Area - (Middle Atlantic Region) (NMFS1985b, 1984b, 1983a).

Species	Landings 1982-1984 10 ³ mt		Economic Value 1982-1984 Thousand Dollars	
	Total	Average	Total	Average
Surf clams (meat)	43.43	14.48	44,282	14,761
Ocean quahog clams (meat)	29.54	9.85	19,668	6,556
Squid <u>Loligo</u>	8.42	2.81	6,066	2,022
Squid, <u>Illex</u>	4.58	1.53	1,182	394
Hard clams (meat)	6.06	2.02	45,853	15,284
Blue crabs	3.19	1.06	2,866	955
Sea scallops (meat)	3.21	1.07	36,463	12,154
American lobster	2.93	0.98	18,431	6,144
oyster meats	2.80	0.93	19,614	6,538
Soft clams	0.48	0.16	1,630	543
Bay scallops	0.44	0.15	4,065	1,355
Other shellfish	0.38	0.13	775	258
Total	105.58	35.19	201,048	67,016

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Table 5. Commercial catches and economic value of the most important shellfish in the MATL OCS Planning Area (Chesapeake Region) (NMFS 1985b, 1984b, 1983a).

Species	Landings 1982-1984 10 ³ mt		Economic Value 1982-1984 Thousand Dollars	
	Total	Average	Total	Average
Blue crabs (hard)	130.1	43.37	81,378	27,126
Surf clams (meats)	29.67	9.89	33,410	11,136.7
Ocean quahog clams (meats)	15.21	5.07	10,076	3,358.7
Oysters (meats)	18.96	6.32	66,819	22,273
Sea scallops (meats)	3.84	1.28	42,555	14,185
Squid - <u>Illex</u>	3.35	1.12	971	323.67
Crabs - other	2.99	1.00	9,220	3,073.33
Squid - <u>Loligo</u>	2.86	0.95	1,781	593.67
Soft clams (meats)	1.91	0.64	9,442	3,147.33
Hard clams (meats)	1.14	0.38	5,756	1,918.67
American lobsters	0.12	0.04	966	322
Other shellfish	2.81	0.94	5,572	1,857.33
Total	213.24	71.08	268,083	89,361

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the shellfish catch from MATL waters was 3.3 times greater than that of the finfish catch: 171 million vs. 52 million.

Maryland, Virginia and New Jersey led the region in shellfish harvest. Surf clams dominated New Jersey catches whereas blue crabs ranked first in the Chesapeake States. Surf clams were the most valuable shellfish harvested in New Jersey, oysters were the most valuable in Maryland and sea scallops in Virginia (NMFS 1983a: 1984b; 1985 b).

ICHTHYOPLANKTON

Although the Middle Atlantic Bight does not possess a large endemic fish fauna, it is an important spawning and/or nursery area for many major recreational and commercial fish populations. Spawning seasons for principal coastal species of the region are summarized in Table 6).

Significant quantities of fish larvae may be found in all areas of the Bight throughout the year. However, each species has its own distributional pattern, and a quantitative resolution of that pattern requires a very large logistical effort. This is because egg incubation times are short (from two days to a few weeks), and many species spawn over a period of several months and throughout the entire Bight. Fish eggs and larvae are planktonic and are rapidly dispersed with currents. Direct estimates of egg development, egg and larval mortality, larval growth and feeding conditions, etc., require intensive sampling within representative "patches" of eggs and larvae throughout their development. This is a difficult and expensive undertaking.

Although investigations of sufficient scope and magnitude have not been undertaken, a fairly comprehensive picture of the geographical and seasonal distribution of ichthyoplankton is available from nine R.V. Dolphin cruises conducted in continental shelf waters between Martha's Vineyard and Cape Lookout, NC, in 1965 and 1966. Grosslein and Azarovitz (1982) have summarized data on the larval distributions of 27 fish species which comprised the bulk of the larval catches (a total of 87 species were obtained). Data summaries of the Dolphin cruises are provided in Smith et al. (1979 b). Also included in this report are the results of monthly cruises during a two-year study of the New York Bight. Table 7 provides catch summary data for the 27 principal species; Table 8 summarizes seasonal and % total catch data.

Winter is the time of minimum spawning activity in the Middle Atlantic Bight. The January-February cruise caught an average of 1.9 species per station-1 for a total of 13 species, the smallest number for any season. Average larval abundance, 30 per station-1, was also the lowest of the four seasons (Table 8). Sand lance (71%) and cod (38%) larvae were found at the greatest number of stations. Together, these two species accounted for almost 90% of the total larval catch, with sand lance alone accounting for 83%. The relatively high larval densities found off Martha's Vineyard and from Cape Henlopen (CH)

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Table 6. Spawning seasons for principal coastal species in MATL OCS Planning Area. Period of peak spawning is given in parentheses (from Smith, 1983).

<u>Boreal (shallow) species</u>	
Sea herring	None reported
American plaice	None reported
Atlantic cod	Nov-Apr (Mar-Apr)
Pollock	Oct-Mar (Dec-Jan)
Redstart	None reported
<u>Boreal (deep) species</u>	
Witch flounder	Apr-Aug (May-Jun)
Redfish	None reported
Cusk	None reported
Wolffish	None reported
Atlantic argentine	None reported
Thorny skate	None reported
<u>Warm water species</u>	
Bluefish	May-Aug (Jul)
Northern sea robin	Jun-Oct (Aug-Sep)
Scup	May-Aug (May-Jun)
Longfin squid	Apr-Sep (Jun-Sep)
Fourspot flounder	May-Sep (Jul)
Sixspot flounder	Sep-Dec (Oct-Nov)
Blackfish	May-Sep (Jan-Jul)
<u>Eurythermal species</u>	
Ocean pout	None reported
Longhorn sculpin	None reported
Yellowtail flounder	Mar-Aug (May)
Winter flounder	Mar-May (May)
Windowpane	May-Nov (May-Sep)
Little skate	All year (Nov-Jan-Jun-Jul)
Winter skate	None reported
<u>Stenothermal species</u>	
Red hake	Mar-Oct (Jun-Jul)
Spiny dogfish	Nov-Feb (Jan)
Silver hake	Apr-Oct (Sep)
Sea raven	None reported
Cunner	Apr-Oct (Jun)
American lobster	May-Aug (May-Jun)
White hake	Oct-Apr (Dec-Feb)
Goosefish	Mar-Aug (May-Jun)
<u>Other</u>	
Alewife	Mar-Apr (Apr)
Blueback	Apr-Jun (May)
Sand lance	Nov-Mar (Jan-Feb)
Atlantic mackerel	Apr-Jun (Apr-May)
Gulf Stream flounder	May-Oct (Jul-Aug)
Rock crab	All year (Apr-Jun)
Jonah crab	
Sea scallop	Jul-Sep (Aug)
Swordfish	None reported

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Table 7. Catch summary for larvae of 27 principal fish species taken during the 1965-1966 ichthyoplankton survey in the MATL OCS Planning Area (from Grosslein and Azarovitz 1982).

Season	Number of species		Numbers of larvae	
	Total	Average-station-1	Total	Average-station ⁻¹
Winter	13	1.9	2,264	29.8
Spring	24	3.8	13,267	161.8
Summer	23	7.8	23,955	292.1
Autumn	20	7.0	27,312	333.1

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Table 8. Percent total catch and occurrence of major fish larvae in the Middle Atlantic Bight (MATL). Data represent the top five species in abundance, and/or all species which represented at least 5% of total survey catch (from Grosslein and Azarovitz 1982).

	% total catch	% occurrence on stations
WINTER		
Sand lances	82.8	71.1
Atlantic cod	6.4	38.2
Atlantic menhaden	2.8	18.4
Atlantic herring	2.5	27.5
spot	1.7	7.9
SPRING		
Yellowtail flounder	56.4	86.6
Winter flounder	17.8	41.5
Atlantic mackerel	9.3	17.1
Windowpane flounder	8.6	42.7
Sand lances	3.1	61.0
Atlantic cod	0.9	43.9
SUMMER		
Yellowtail flounder	19.8	62.2
Hakes	12.0	64.6
Silver anchovy	11.9	50.0
Atlantic mackerel	11.7	45.1
Butterfish	9.4	86.6
Frigate mackerel	7.5	45.1
Bluefish	6.4	31.7
Silver hake	5.8	43.9
Fourspot flounder	4.9	73.2
AUTUMN		
Hakes	32.1	91.5
Northern searobin	27.1	68.3
Atlantic menhaden	17.8	65.9
Windowpane flounder	7.5	67.1
Summer flounder	3.8	79.3

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to Parramore Island (PI) resulted from catches of sand lance larvae (Grosslein and Azarowitz 1982).

Abundance of sand lance larvae from eighteen MARMAP surveys (1974-1980) (Morse 1982) were used to estimate spawning stock biomass from Cape Hatteras, NC, to Nova Scotia. Abundance estimates of sand lance larvae increased twenty-fold, from 490×10^9 in 1974, when they accounted for less than 50% of the winter larval fish assemblage, to 946 OX109 in 1979 when they comprised nearly 90% of the winter ichthyoplankton (Sherman *et al.* 1981). This change in ichthyoplankton composition was probably a result of the tremendous fishing pressure placed on commercial stocks off the northeastern U.S. in the later 1960's and early 1970's. By 1975 the biomass of principal finfish and squid populations in shelf waters between Nova Scotia and Cape Hatteras was reduced nearly 50% (Clark and Brown 1977).

The dramatic increase in sand lance stocks followed the precipitous decline in Atlantic herring and Atlantic mackerel stocks and is evidence of a shift in energy flow within the pelagic component of the ecosystem. Although sand lance biomass increased fifty-fold from 1974-1978, biomass decreased to about one-third of the 1978 level in 1980. Whether this shift in species composition is a long-term trend or whether under present management strategies for herring and mackerel a return to pre-1960 species composition and biomass levels will occur, remains to be seen (Morse 1982).

Increases in both larval fish abundance and in the number of species present were observed during the April-May cruises (Table 7). Larvae most frequently found were yellowtail flounder, sand lance, Atlantic cod, windowpane flounder, and winter flounder (Table 8). Yellowtail flounder comprised the majority of all fish larvae (56%). Within the areas of greatest larval abundance, off New Jersey and Delaware Bay, winter flounder were the most abundant larvae inshore, and yellowtail flounder larvae the most abundant in mid-shelf waters. These two species comprised 92% of the larvae collected on the three transects from Barnegat Inlet (BI) to Cape Henlopen (CHe) (Grosslein and Azarowitz 1982). Four species of larvae, yellowtail flounder, winter flounder, Atlantic mackerel, and windowpane flounder, comprised 92% of the **total larval** catch from Martha's Vineyard to Cape Hatteras.

Yellowtail flounder spawn from April through August in the Middle Atlantic Bight; peak spawning occurs in May and June (Colton *et al.* 1979). However, most yellowtail spawning occurs further north on Georges Bank and off southern New England. During the five year period from 1977-1981, these two subareas produced 81-95% of all yellowtail larvae spawned (Silverman 1983).

Winter flounder spawn from Cape Hatteras to the Gulf of St. Lawrence. Most spawning occurs in the shoreward half of the continental shelf at water temperatures of 7-16°C. During May, spawning was observed to occur from Martha's Vineyard to below the mouth of Chesapeake Bay; eggs were concentrated from Fire Island, New York, to Cape Henry, Virginia. By June,

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spawning had shifted to the northeast, and eggs were collected only on the Martha's Vineyard, Montauk Point, and Fire Island transects (Berrien 1978).

An average of 7.8 species per station were caught during July-August cruises, the highest number of species·station⁻¹ for any season (Table 7). Species distributed over the widest areas were butterfish, fourspot flounder, bakes, and yellowtail flounder. Yellowtail flounder again dominated the catch (20% of total seasonal catch) (Table 8). Areas of high larval abundance (more than 500 larvae per station-1) were more widespread than in spring, occurring across the entire continental shelf off Martha's Vineyard and Montauk Point and in three aggregations in mid-shelf waters from Barnegat Inlet to Cape Hatteras (Grosslein and Azarovitz 1982). Most areas of low larval density were inshore waters.

Average number of species per station-1 and average larval abundance for the September-October and November-December cruises were comparable to summer larval abundances (Table 7). Species with the widest larval distribution were bakes, summer flounder, northern searobin, windowpane flounder, and Atlantic menhaden (Table 8). There were two areas of high larval abundance: 1) a large area between Fire Island and Assateague Island, dominated by menhaden, bakes, northern searobin, and windowpane flounder; and 2) a small area of Oregon Inlet and Cape Hatteras, dominated by striped anchovy and Atlantic croaker (Grosslein and Azarovitz 1982).

Numerous papers on the early life history of fishes, especially those important in commercial and recreational fisheries, have been published as a result of the MARMAP ichthyoplankton surveys. Spawning areas from Cape Sable, Nova Scotia, to Cape Hatteras, North Carolina, have been summarized in Colton *et al.* (1979). Early life history accounts of fishes spawning in the Middle Atlantic Bight include: bluefish (Kendall and Walford 1979); Atlantic menhaden (Kendall and Reintzes 1975; Judy and Lewis 1983); summer flounder (Smith 1973); silver hake (Fahay 1974); black sea bass (Kendall 1972); Atlantic mackerel (Berrien 1978); and sand lance (Richards and Kendall 1973).

SOUTH ATLANTIC

FINFISH AND SHELLFISH

Between 1951 and 1964 the former Bureau of Commercial Fisheries (now National Marine Fisheries Service, NMFS/NOAA/USDC) conducted a study of demersal fish resources of the SATL Continental Shelf from Cape Hatteras, North Carolina, to Jupiter Inlet, Florida. A total of 956 exploratory trawl stations were studied in depths of 12-200m. This study suggests that the SATL Shelf can be divided into five general habitats (Struhsaker 1969): coastal, open-shelf, live bottom, shelf-edge, and lower-shelf. Each of these possesses a distinctive assembly of demersal finfish.

The coastal shelf habitat extends from coastal sounds and estuaries out to water depths of 16-20m. The bottom is generally smooth, consisting of sand mud. Due to its proximity to coastal influences, bottom temperatures fluctuate considerably on a seasonal basis within a range of 10-29°C. Important shrimp and crab fisheries occur in this nearshore habitat. The finfish fauna is dominated by sciaenids (drum), Atlantic croaker, spot, southern and Gulf kingfish, silver perch (yellowtail), weakfish and spotted seatrout, and star, red, and banded drum (Struhsaker 1969). Music and Pafford (1984) provide detailed accounts of the life histories and population dynamics of the major marine sportfishes found in SATL coastal shelf habitats.

Though the transitional boundary is gradual and indistinct, the open-shelf habitat is arbitrarily considered to extend from approximately the 20m isobath out to the beginning of the shelf break, 50-60m deep. This habitat comprises most of the offshore shelf area. Bottoms consist of smooth, slightly undulating sand and generally slope imperceptibly offshore. Bottom water temperatures fluctuate less widely, ranging from 11-27°C, and the proximity of the Gulf Stream normally creates average temperatures which are generally warmer than those closer to shore. The open-shelf is relatively unproductive; the finfish fauna is dominated by small numbers of scup, orange filefish, sea robins, inshore lizardfish, sand perch, and occasionally large numbers of planehead filefish (Struhsaker 1969).

At various locations the SATL Shelf is interspersed with patches of broken relief called live bottoms -- rock outcropping heavily encrusted with sessile invertebrates such as sponges and octocorals. Water temperatures are similar to those of the open-shelf habitats. The live-bottom areas harbor a rich association of subtropical and tropical species of fish and form the bases for productive commercial handline and trap fisheries and increasingly important recreational fisheries. Many of these areas are found at depths greater than 30m, but there are numerous scattered live-bottom habitats at depths of 18-28m, especially off the Carolinas. Struhsaker (1969) reported that the most productive areas were found off northeastern Florida and South Carolina at depths of 26-46m. Bureau of Commercial Fisheries' trawl catches in these areas averaged $556\text{kg}\cdot\text{hr}^{-1}$ as contrasted with $159\text{kg}\cdot\text{hr}^{-1}$ over the open-shelf habitat of the same regions.

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The fourth habitat, shelf-edge, extends more or less continuously **along** the entire edge of the Continental Shelf at depths of 50/70 -120m. The bottom types range from smooth mud to areas of great relief characterized by heavy encrustations of coral, sponge, and other predominantly tropical invertebrates. The Florida Current (Gulf Stream) dominates this area and maintains warm average water temperatures (13-26°C). The predominant finfish are tropical species: seabasses, snappers, groupers, and porgies, with smaller numbers of wrasses, parrotfishes, and damselfishes. The fishes are usually scattered except over areas of broken bottom relief where they form local aggregations (Struhsaker 1969).

Finally there is the lower-shelf habitat, which is geologically a part of the upper Continental Slope. The habitat occurs at depths of 120->200m, with predominantly smooth bottoms and cooler water temperatures (10-14°C). In general, it marks the transition between the continental shelf and continental slope fauna. The most numerous fishes are the cold-water and high-latitude forms such as bakes, flatfishes, butterfish, and John Dory (Struhsaker 1969).

Five extensive cruises under the MARMAP Program have surveyed the sand bottom groundfish community in the South Atlantic Bight extending from Cape Fear, North Carolina, to Cape Canaveral, Florida (Wenner *et al.* 1979a, 1979b, 1979c, 1979d; 1980). A stratified random sampling design was used to allocate data to the 6 depth zones shown.

Table 1 summarizes biomass of trawl-caught demersal fishes in the South Atlantic Bight according to this MARMAP data base. Large elasmobranchs, pelagic species, and squid have been omitted. These and the following standing stock data should be viewed as minimal estimates since the effectiveness of sampling (3/4 Yankee trawl) was not known. The largest catches normally occurred over the open-shelf habitat (19-55m depth ranges).

Minimal standing stock estimates of groundfish and demersal bony fishes in the sand bottom communities of the South Atlantic Bight are summarized in Table 2. Total groundfish standing stocks were highest in spring; demersal bony fish stocks peaked in both spring and fall.

Table 3 summarizes commercial catches and economic value of the various fisheries in the SATL for the years 1980-1982 (NMFS 1983a, 1984b, 1985 b). These are preliminary catch statistics subject to revision by NMFS. Atlantic menhaden, an industrial fish, totally dominated the commercial fishery in terms of weight, whereas swordfish brought the greatest economic return to the fishermen. Other valuable food fishes included summer flounder, weakfish, king mackerel and Atlantic croaker. Commercial catches ranged from 129-145 thousand mt valued between 64 and 66 million dollars for 1980-1982. North Carolina landings dominated commercial fisheries in the SATL accounting for 106.6 thousand of the total 128.6 thousand mt landed in the region in 1984. Menhaden accounted for 67% of the commercial landings in North Carolina. North Carolina fisheries also ranked first in economic value - 30.6 million dollars

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Table 1. Mean catch for trawl-caught groundfish, excluding pelagic species, squid, and elasmobranchs, in the South Atlantic Bight (from Wenner *et al.* 1979a-d; 1980).¹

Depth zone (m)	Corresponding Habitat	Mean Biomass (kg·ha ⁻¹)				
		Fall '73	Spring '74	Summer '74	Winter- e.Spring '75	Summer '75
9-18	<u>coastal habitat</u>	11.6	4.6	4.0	1.5	3.9
19-27		13.4	0.7	5.1	5.0	4.3
28-55	<u>open-shelf habitat</u>	2.0	6.4	2.0	4.5	3.5
56-110	<u>shelf-edge habitat</u>	1.8	5.7	1.3	2.3	1.2
111-183	<u>lower-shelf habitat</u>	2.2	1.6	1.0	2.7	1.3
188-366		1.4	0.4	0.2	1.0	0.2

¹Converted from mean catch per tow assuming 2.835ha as area swept during standard 30 min. tow (Wenner *et al.* 1979a).

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Table 2. Minimum standing stock estimates of sand-bottom groundfish in South Atlantic Bight (from Wenner et al. 1979a-d; 1980).

Year	Category	Mean (10 ³ metric tons)	90% confidence interval
Fall, <u>1973</u>	total groundfish	9.79	7.08-12.50
	demersal bony fish	5.00	3.06- 6.93
Spring, <u>1974</u>	total groundfish	14.06	9.64-18.48
	demersal bony fish	4.07	2.43-5.51
Summer, <u>1974</u>	total groundfish	8.32	5.65-10.96
	demersal bony fish	2.11	1.63-2.57
Winter e.spr ng, 1975	total groundfish	7.23	6.47-11.77
	demersal bony fish	2.36	1.07-2.97
Summer <u>1975</u>	total groundfish	9.24	5.35-13.12

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Table 3. Commercial catches and economic value of the most important finfish in the SATL OCS Planning Area (South Atlantic Region) (NMFS 1985b, 1984b, 1983a).

Species	Landings 1982-1984 10 ³ mt		Economic Value 1982-1984 10 ³ Dollars	
	Total	Average	Total	Average
Atlantic menhaden	248.37	82.79	17,548	5,849.33
Summer flounder	15.22	5.07	20,403	6,801
Weakfish (gray sea trout)	16.17	5.39	13,900	4,633.33
Atlantic codfish	12.49	4.16	10,006	3,335.33
Alewives	10.62	3.54	2,125	708.33
Bluefish	8.90	2.97	3,425	1,141.67
Mullet	4.65	1.55	2,238	746
King mackerel	6.06	2.01	12,536	4,178.67
Swordfish	5.25	1.75	30,659	10,219.67
Groupers	3.41	1.14	8,229	2,743
Scup or porgy	3.31	1.10	4,507	1,052.33
Spanish mackerel	5.90	2.0	3,898	1,299.33
Tilefish	3.03	1.01	6,085	2,028.33
Black sea bass	1.57	0.52	2,628	876
Snapper - other	1.49	0.50	5,204	1,734.67
Sharks - unclass.	0.9	0.3	738	246
Tunas - unclass.	0.49	0.16	1,918	639.33
Striped bass	0.54	0.18	1,472	490.67
Spotted sea trout	0.88	0.29	1,638	546
Atlantic mackerel	0.15	0.08	44	22
Red snapper	0.38	0.13	1,974	658
Whiting	0.60	0.30	398	199
Yellow fin tuna	0.10	0.03	209	69.67
Other fish	57.36	19.12	42,285	14,095
Total	408.67	136.22	194,749	649, 163

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followed by the east coast of Florida - 19 million. Summer flounder brought the greatest economic return to North Carolina commercial fishermen, whereas swordfish were the most valuable catch in the Florida east coast fishery.

Table 4 summarizes marine recreational catches for 1980-82 by number and by estimated weight (NMSF 1984a; 1985 b). Spot and bluefish dominated the marine recreational catch in the SATL Region during 1980 (approximately 11 and 7.3 million fish, respectively; whereas, bluefish and king mackerel dominated landings by weight; 4,550 and 3,850 mt or 16% and 13.5% of the total recreational catch. Spot, black sea bass and bluefish comprised the largest portion of the recreational catch during 1981 and 1982; king mackerel and bluefish ranked first and second in terms of total weight caught for both years. Catches of king mackerel comprised 27.5% and 14% of the estimated weight of the total recreational catch during 1981 and 1982. Total commercial finfish catches for 1980-82 were 170.56 x 10³ metric tons (NMFS 1981a, 1982, 1983a); recreational catches accounted for 14.6%, 11.7% and 14.4% respectively of the commercial catches for these years. However, menhaden comprised between 58 and 73% of the commercial catches for 1980 to 1982. (NMFS 1981a, 1982, 1983a). Thus, recreational fisheries accounted for a significant portion of the total edible fish catch in the SATL.

Table 5 compares groundfish densities between the South Atlantic Bight and other areas of the Atlantic and Gulf coasts. Note the importance of live bottom to finfish communities in the SATL. These MARMAP estimates for sand bottom habitat are generally lower than published accounts for areas off the east coast of the U.S. and off Louisiana, but similar to estimates for the OCS off Texas as given by Moore et al. 1970).

In the MARMAP survey the biomass of the demersal bony fish catch in the South Atlantic Bight was dominated by longspine porgy (southern porgy, Stenotomus caprinus) in the 9-18m (coastal habitat) depth zone and by longspine porgy and orange filefish (Aluterus schoepfi) in the 19-55m (open-shelf habitat) depth zones. The spotted hake (Urophycis regius) dominated the catch in the two deepest zones, 111-366m. Table 6 summarizes these species data.

The general dominance of the longspine porgy in the waters of the South Atlantic Bight can be seen from the numbers and weight data summarized in Table 7. In the intermediate depth zones (28-110m) the ubiquitous sand bottom species, planehead filefish (Stephanolepis hispidus), inshore lizardfish (Synodus foetens), sand perch (Diplectrum formosum), offshore lizardfish (Synodus poeyi), and northern sea robin (Prionotus carolinus) predominated the MARMAP trawl samples.

There is an estimated 7403km² of reef habitat from Cape Fear, North Carolina, to Cape Canaveral, Florida, of which 7% (1743km²) has relief greater than 1m. Additionally, the area northward from Cape Fear to Cape Hatteras, North Carolina, contains an additional 2040km² of reef habitat, 1.4% of which (204km²) exhibits relief greater than 1m (Parker et al. 1983).

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Table 4. Estimated total number and estimated weight of fish caught by marine recreational fishermen in the South Atlantic OCS Area, 1980-82 (NMFS 1984a, 1985a).

Species	Catch x 10 ³ 1980-1982		Weight 10 ³ mt 1980-1982	
	Total	Average	Total	Average
spot	24,681	8,227	2.51	0.84
Black sea bass	15,968	5,322.7	3.22	1.07
Bluefish	19,795	6,598.33	9.80	3.27
Kingfisher	8,321	2,773.7	1.08	0.36
Atlantic croaker	10,015	3,338.3	1.14	0.38
Saltwater catfishes	10,467	3,489	0.65	0.22
Mulletts	10,080	3,360	2.22	0.74
King mackerel	4,424	1,474.7	13.29	4.43
Other fishes	13,998	4,666	3.74	1.25
Pinfish	5,642	1,880.7	0.32	0.11
Grunts	6,850	2,283.3	0.47	0.16
Spanish mackerel	3,715	1,238.3	1.63	0.54
White grunt	4,445	1,481.7	1.2	0.40
Herrings	9,354	3,118	0.04	0.01
Sharks	2,100	700	3.79	1.26
Summer flounder	4,396	1,465.3	1.12	0.37
Spotted seatrout	4,634	1,544.7	1.57	0.52
Gray snapper	2,462	820.67	0.32	0.11
Dolphins	2,860	953.3	5.69	1.90
Florida pompano	1,889	629.7	0.33	0.11
Blue runner	2,690	896.7	0.35	0.12
Pigfish	1,343	671.5	0.15	0.08
Vermilion snapper	5,331	1,777	0.97	0.32
Red porgy	3,702	1,234	1.43	0.48
Total	209,285	69,761.7	73.09	24.36

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Table 5. Density estimates for trawl-caught groundfish from the east coast of United States and Gulf of Mexico (assembled by Wenner et al. 1979a).

Geographic Area	Density (kg·ha ⁻¹)	Trawl Gear
<u>NATL</u>		
Gulf of Maine ¹	18.5 -55.9	#36 Yankee
George's Bank ²	11.4-36.1	#36 Yankee
Southern New England ¹	13.9-71.4	#36 Yankee
<u>MATL</u>		
Middle Atlantic Bight	7.0-55.3	#36 Yankee
<u>SATL</u>		
South Atlantic Bight		
--sand bottom	13.1	3/4 Yankee
--live bottom	27.3	URI 60/80 high rise
<u>CGUL</u>		
Louisiana ²	9.9-46.3	13.7m flat
<u>WGUL</u>		
Texas ²	6.3-13.3	13.7m flat

¹Calculated from unweighted stratified mean catch per tow for each year; the standard trawl had a sweep of approx. 12.2m and travelled 3.241km; swept area calculated to be 3.954ha; data are maximum and minimum values.

²Calculated from data presented in Table 3 of Moore et al. (1970); data represent their minimum and maximum values; swept area 36.7m (trawl sweep) times data.
= 3,723 ha.

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Table 6. Dominant demersal bony fish species by weight in the South Atlantic Bight; numbers in parentheses indicate % total weight in each depth zone.

9-18m depth	19-27m depth	28-55m depth	56-110m depth	111-183m depth
<u>Fal 1, 1983¹</u>				
Longsp. porgy (43)	Longsp. porgy (54)	Or. filefish (33)	Dusky flound. (22)	Spot. hake (62)
Cobia (20)	Tomtate (111)	Cobia (12)	N. searobin (11)	Longsp. porgy (9)
Or. filefish (11)	Or. filefish (5)	Sand perch (11)	Ins. lizardf. (8)	Boarf. (7)
<u>Spring, 1974²</u>				
Longsp. porgy (47)	Or. filefish (38)	Longsp. porgy (50)	Ins. Lizardf. (22)	Spot. hake (30)
Or. filefish (19)	Longsp. porgy (36)	Or. filefish (10)	Verm. snapper (15)	Longsp. porgy (25)
Spot (11)	Sand perch (7)	Sand perch (7)	Longsp. porgy (12)	Sl. searobin (6.6)
<u>Summer, 1974³</u>				
Longsp. porgy (30)	Or. filefish (44)	Or. filefish (40)	Snakefish (19)	Spot. hake (63)
Sea catfish (14)	Sand perch (11)	Sand perch (22)	Offs. lizardf. (18)	Sl. searobin (4)
Or. filefish (10)	Pl. head filef. (10)	Ins. lizardf. (15)	Wh. bone porgy (15)	3-eye flounder (4)
<u>Winter-early spring, 1975⁴</u>				
Black drum (31)	Longsp. porgy (26)	Or. filefish (39)	S. porgy (26)	Spot. hake (32)
Or. filefish (11)	Or. filefish (20)	Cobia (15)	Dusky flound. (16)	Sl. searobin (16)
Longsp. porgy (10)	Spot (20)	Knobbed porgy (7)	Ins. lizardf. (7)	Beardfish (12)
<u>Summer, 1975⁵</u>				
Longsp. porgy (55)	Longsp. porgy (37)	Or. filefish (20)	Dusky flound. (29)	Snowy grouper (30)
Sea catfish (11)	Or. filefish (15)	Ins. lizardf. (14)	Snake sh (13)	Spot. hake (22)
Sand perch (8)	Sand perch (10)	Sand perch (12)	offs. lizardf. (9)	Deepbod. boarf. (17)

¹Wenner *et al.* 1979a; "Longspine porgy" = "Southern porgy" of these authors.

²Wenner *et al.* 1979b.

³Wenner *et al.* 1979c.

⁴Wenner *et al.* 1979d.

⁵Wenner *et al.* 1980.

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Table 7. Dominant demersal fish by number and by weight in the South Atlantic Bight (from Wenner et al. 1979a-d; 1980). Numbers in parenthesis indicate % of total.

Fall 1973	Spring 1974	Summer 1974	Winter-e. Spr. 1975	Summer 1975
<u>On basis of total numbers</u>				
Longsp. porgy (45)	Longsp. porgy (76)	Longsp. porgy (23)	Longsp. porgy (71)	Longsp. porgy (53)
Spot. hake (9)	Spot. hake (3)	Pl. head filef. (21)	Spot. hake (7)	Offs. lizardf. (6)
Tomtate (7)	Ins. lizardf. (2)	Offs. lizardf. (8)	B. mouth bass (2)	Sand perch (6)
Pl. head filef. (4)	Pl. head filef. (2)	Sand perch (8)	spot (2)	Pyg. argentine (3)
Ins. lizardf. (4)	G. Stream floun. (2)	Spot. hake (5)	Sl. searobin (1)	Ins. lizardf. (3)
<u>On basis of total weight</u>				
Longsp. porgy (45)	Longsp. porgy (38)	Or. filefish (29)	Or. filefish (21)	Longsp. porgy (28)
Cobia (9)	Or. filefish (21)	Longsp. porgy (14)	Longsp. porgy (12)	Or. filefish (11)
Or. filefish (9)	Ins. lizardf. (6)	Sand perch (10)	spot (7)	Sand perch (9)
Spot. hake (5)	Sand perch (5)	Pl. head filef. (6)	Cobia (5)	Ins. lizardf. (8)
Tomtate (4)	Dusky flound. (3)	Ins. lizardf. (6)	Spot. hake (5)	Dusky flound. (5)

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On the basis of principal component analysis, Chester *et al.* (1984) have distinguished five reef communities off the coasts of North and South Carolina. These communities and their principal component finfish are listed in Table 8. According to Huntsman and Munooch (1978), temperature more than latitude appears to be the major factor affecting reef fish distributions.

Although the reef fish communities of the South Atlantic Bight have supported important recreational (headboat) fisheries for more than 20 years and commercial handline and trawl fisheries for more than 25 years, descriptions of these communities have been qualitative and superficial. The major exception is a recently published report by Chester *et al.* 1984. Effective sampling remains the single most significant problem in estimating reef fish populations (Barans 1982; Gutherz 1982); no matter what technique is used (trawling is generally not possible over high-relief bottom) the resulting biomass/population estimates must be considered as minimum values.

Based on the largest mean trawl catches, Powles and Barans (1980) estimated SATL reef fish biomass as $27.3\text{kg}\cdot\text{ha}^{-1}$. Species making the greatest contribution to this trawl-estimated biomass were as follows:

red porgy	<u>Pagrus pagrus</u>	10.6 $\text{kg}\cdot\text{ha}^{-1}$
longspine porgy	<u>Stenotomus caprinus</u>	6.5 "
tomtate	<u>Haemulon aurolineatum</u>	5.1 "
black sea bass	<u>Centropristis striata</u>	1.1 "

However, these authors caution that estimates for longspine porgy and black sea bass made via television monitoring of reefs were significantly greater than the trawl estimates.

Effective management of reef fishery stocks presents specific problems in their assessment because of sampling difficulties and the complex three-dimensional nature of the reef substrate (Barans 1982; Gutherz 1982; Ogden 1982). Fish communities found on the reefs are particularly vulnerable to overfishing because of the territorial behavior of most species. Effective management strategies necessitate knowledge of reproductive strategies of reef fishes and an understanding of physical and biological factors and mechanisms controlling recruitment. Comprehensive reviews of spawning behavior and reproductive strategies of reef fishes are presented in Colin (1982) and C.L. Smith (1982).

Richards (1982) discusses the role of physical factors in establishing and maintaining reef fish stocks and presents a coordinated oceanographic and ichthyoplankton research program designed to obtain the necessary in-depth knowledge of oceanographic factors needed to rehabilitate and properly manage small island fisheries. McFarland (1982) reviews knowledge of recruitment patterns of tropical reef fishes.

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Table 8. Major reef finfish communities of the SATL, coasts of North and South Carolina (after Chester et al. 1984).

Community	Depth (m)	Principal species	Comments
I	40-70	red porgy vermillion snapper (<u>Rhomboplites aurorubens</u>) red snapper (<u>Lutjanus campechanus</u>) gray trigger fish (<u>Balistes carolinensis</u>)	occurs along entire Carolina Continental Shelf
II	>100	snowy grouper (<u>Epinephelus niveatus</u>) warsaw grouper (<u>E. nigritus</u>) yellowedge grouper (<u>E. flavolimbatus</u>) bluefin tilefish (<u>Caulolatilus microps</u>)	deep shelf-break community
III	40-70	red grouper (<u>E. morio</u>) rock hind (<u>E. adscensionis</u>) red hind (<u>E. guttatus</u>) scamp (<u>Mycteroperca phenax</u>)	found from Cape Fear s. along SC coast
IV	50-100	knobbed porgy (<u>Calamus nodosus</u>) speckled hind (<u>E. drummondhaji</u>)	more common s. of Cape Fear SC
V	<30	black sea bass (<u>Centropristis striata</u>) sheep head (<u>Calamus penna</u>) whitebone porgy (<u>C. leucosteus</u>) longspine porgy (<u>Stenotomus caprinus</u>) spottail pinfish (<u>Diplodus holbrooki</u>)	inshore community

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Huntsman et al (1983) examined yield per recruit models for red porgy, vermilion snapper, white grunt, red snapper, black bass, gag, scamp, snowy grouper and speckled hind: the most important species to both recreational and commercial fishing of North Carolina and South Carolina. For all species yield per recruit at median recruitment ages increased rapidly in response to increasing the instantaneous fishing mortality rate. By the late 1970's most of the practical available yield was already being taken from the grounds fished at that time. Thus large and intensive fisheries are probably not needed to fully harvest reef fish in the SATL. These models also demonstrated that major gains in yield resulted when recruitment to the fishery was delayed to age 3 or older. (Huntsman et al. 1982).

The South Atlantic Fishery Management Council in their management plan for the snapper-grouper fishery recognized that thirteen species in this complex are in a documented state of overfishing.

A compendium of life history, ecology, commercial and recreational catches, estimates of stock size, and population dynamics for SATL snapper-grouper fisheries are given in the Fishery Management Plan, Regulatory Impact Review and Final EIS for the Snapper-Grouper Fishery of the South Atlantic Region (South Atlantic Fishery Management Council 1983a, 1983 b). Fish families included in the Snapper-Grouper Fishery Management Unit include snappers, sea basses, groupers, porgies, grunts, tilefishes, triggerfishes, wrasses, and jacks. [A similar compendium of information for coastal migratory pelagic fishes (mackerels) is available from the South Atlantic or Gulf of Mexico Fishery Management Councils (1983).]

Live bottom communities in the SATL apparently support greater total finfish biomass than the reef habitats described in the South Atlantic OCS Area Living Marine Resources Study (SC Marine Resources Research Inst. 1981a, b; 1982). Seven live bottom stations -- three each on the inner shelf (19-27 m), mid-shelf (28-55 m), and outer shelf (56-100m) -- were sampled between Charleston, South Carolina, and Jacksonville, Florida. Results of this study are summarized in Table 9 Mean biomass estimates of both demersal fish and total nekton were larger in summer than in winter on the inner shelf; the reverse was true for mid-shelf stations. Total biomass estimates were greatest at the middle shelf stations.

A significant portion of the variance in the total nekton biomass was due to large elasmobranchs [stingrays (Dasyatis spp.) and nurse shark (Ginglymostroma cirratum)] and large catches of schooling pelagic fishes [e.g., rough scad (Decapterua unctatus, a jack)] (SC Marine Resources Inst. 1981a). Along the North Carolina coast inner shelf stations, differences between total nekton and demersal teleost biomass were primarily explained by the presence of the pelagic butterflyfish (Peprilus tricanthus). Caution is therefore urged in making much of these apparent biomass differences.

National Marine Sanctuary Program

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Table 9. Biomass estimates for trawl-caught demersal teleosts and for trawl-caught nekton (pelagic and demersal fishes and squids) over live-bottom areas of the South Atlantic Bight (SC Marine Resources Res. Inst. 1981). Biomass units in kg-ha-1 of swept area.

	Inner Shelf		Middle Shelf		Outer Shelf	
	winter	summer	winter	summer	winter	summer
Demersal:						
average	25.8	47.4	97.6	48.6	15.8	24.4
standard dev.	34.3	8.0	67.3	18.3	only 1 sample	
Nekton:						
average	40.2	87.6	109.1	66.2	92.2	26.6
standard dev.	51.8	34.2	73.5	20.8	only 1 sample	

S **ATL** Finfish and Shellfish

Title 111 of the Marine Protection, Research and Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate ocean waters as national marine sanctuaries for the purpose of preserving or restoring their conservation, recreational, ecological or esthetic values. Gray's Reef National Marine Sanctuary was designated in January, 1981, to provide protection and comprehensive management for one of the largest and most popular nearshore live bottom reefs on the SATL Continental Shelf. Located 17.5 nautical miles (32.4 km) east of Sapelo Island, Georgia, the site encompasses 16.68 square nautical miles (57 sq. km) of intermittent live bottom and is a haven for a variety of marine plants; invertebrates, fishes and sea turtles. Relative to surrounding areas, Gray's Reef contains extensive but patchy and discontinuous hard bottom of moderate relief (up to 2m) **and moderate to abundant epibenthic and fish communities.**

Gray's Reef supports a mixture of temperate and tropical species. A variety of algae and invertebrates grow on exposed rock surfaces. Bryozoans, ascidians, sponges, barnacles and sessile, tubed polychaetes form dense encrustations. Sessile scyphozoans such as sea whips, sea fans, and hard corals and large sponges provide refuges for many smaller invertebrates. Other dominant invertebrates include starfish, brittle stars, crabs, lobsters, shrimps, bivalve and gastropod molluscs.

Recreational target fish species include bottom-dwelling species of snapper, grouper, sea bass, porgy and sheephead and seasonal migratory pelagic species of bluefish, jack, cobia, mackerel and little tunny. Small tropical reef fishes, including cardinalfish, damsel fish, wrasses, blennies, gobies and angelfish, form an important, though probably only seasonal, component of the reef ecosystem. Moray eels and other cryptic fish are found as well as trigger, soap and goatfish, burrfish, tomtate, cubbyu and jackknife fish, lizard and toadfish and sea horses. Small schooling fishes, primarily scad and sardines hover above the reef surface and mid-water fishes such as Atlantic spadefish, amberjack and barracuda are found higher in the water column (NOAA 1983c).

Table 10 summarizes commercial shellfish landings in the SATL region for 1982-1984. Blue crabs ranked first in total catch for all three years; calico scallops ranked second in 1984 and shrimp ranked second in 1983 and 1982. Shrimp were the most valuable shellfish caught in all three years; calico scallops ranked second in 1984 and blue crabs were second in 1983 and 1982. The largest landings occurred on the Florida east coast, followed by North Carolina. Calico scallops comprised the greatest portion of the Florida catch, whereas blue crabs ranked first in North Carolina. Calico scallops were the most valuable fishery in Florida; whereas, shrimp brought the greatest economic return to the other South Atlantic states.

A comprehensive review of penaeid shrimp biology, life history, stock assessment and the commercial and recreational shrimp fishery in the SATL is provided by the South Atlantic Fishery Management Council (1981). Shrimp

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Table 10. Commercial catches and economic value of the most important shellfish in the SATL OCS Planning Area (South Atlantic Region) (NMFS 1985b, 1984b, 1983a).

Species	Landings 1982-1984 103mt		Economic Value 1982-1984 10 ³ Dollars	
	Total	Average	Total	Average
Blue crabs (hard)	77.97	25.99	39,315	13,105
Calico scallops (meats)	27.07	9.02	44,756	14,918.7
Shrimps	32.37	10.79	163,693	54,564.3
Hard clams (meats)	3.23	1.08	27,798	9,266
Oysters (meats)	3.34	1.11	27,103	9,034.3
Bay scallops (meats)	0.32	0.11	1,728	576
Spiny lobsters	0.78	0.26	4,411	1,470.3
Squid, <u>Loligo</u>	0.2	0.07	139	46.3
Sea scallops (meats)	0.09	0.05	968	322.67
Other shellfish	1.71	0.57	1,905	635
Total	147.19	49.06	291,678	97,226

S ATL Finfish and Shellfish

stocks in the SATL are currently near normal levels, though annual variations in white and pink shrimp stocks caused by severe winter weather continue to occur. Landings of pink shrimp in North Carolina are strongly correlated with the average water temperature of the two coldest consecutive weeks each year. Following the cold winters of 1977, 1978, 1980 and 1981, when temperatures averaged below 5°, landings were less than 160 mt, whereas landings exceeded 450 mt following the warm winters of 1965, 1974 and 1975, when temperatures averaged above 8°C. (Hettler and Chester 1982).

Shrimp (mostly white shrimp) and blue crabs together produce an annual average of 93% (shrimp - 82%, blue crabs - 11%) of the ex-vessel value of marine products landed in Georgia. The January, 1977 freeze killed most of the overwintering juvenile white shrimp population in Georgia waters. The Georgia Department of Natural Resources responded to protect the remaining female white roe shrimp by closing all state waters within the 3-mile limit (4.8km) to all power drawn nets effective noon, May 13, 1977. Approximately 75% of white shrimp spawning activity occurs during May and June. On July 6 offshore waters were open to commercial shrimpers to catch brown shrimps which are abundant only during the summer months, and inside creeks and rivers were open to commercial bait shrimpers. Sounds, however, remained closed to all power drawn nets for the duration of the 1977 season. As a result of these management decisions the estimated surviving 7% of average numbers of spawning white shrimp propagated enough shrimp to equal 60% of the ten-year average commercial catch (Music 1979).

Seven species comprised approximately 99% of the 1981 North Carolina commercial shellfish harvest of 19.710 mt valued at over 21 million dollars. Ranked in order of value these species were shrimps, blue crabs, hard clams, sea scallops, oysters, and calico and bay scallops. Additionally, North Carolina waters support large recreational shellfish fisheries (Continental Shelf Associates, Inc. 1983).

The calico scallop, Argopecten gibbus occurs at moderate depths of 18-73m and is restricted generally to the continental shelf of the western North Atlantic and Gulf of Mexico between approximately 35°N and 20°N latitude. The commercial calico scallop harvest began in the late 1950's; commercial beds are located northeast and southwest of Cape Lookout, North Carolina -in 19-31m; off Cape Canaveral, Florida at depths of 19-74m, extending from the St. John's River south to Fort Pierce.

E A S T E R N G U L F O F M E X I C O

FINFISH AND SHELLFISH

In comparison to the northwestern Gulf of Mexico (CGUL and WGUL), the northeastern Gulf (EGUL) possesses greater finfish species diversity. This is due in part to large areas of "live bottom" (in contrast to the terrigenous sediments typical of much of the northern Gulf) and in part to the presence of more tropical species. Catches of demersal fishes on the West Florida Shelf qualitatively resemble those from other areas of the northern Gulf but the dominant families and species are considerably different and in fact resemble those of the South Atlantic Bight (Darcy and Gutherz 1984).

Darcy and Gutherz (1984) have analyzed finfish data for the northern Gulf of Mexico and provided standing stock estimates for demersal species. Because the data are largely derived from trawl samples, these estimates are relevant only to low-relief bottoms. Table 2 compares various density estimates for various regions of the entire northern Gulf; Table 3 summarizes species composition of winter trawl samples (Oregon II cruise 85, Jan. 1978) for the northern (Cape San Bias to Tampa Bay) and southern (Tampa Bay to Dry Tortugas) EGUL. According to this analysis, the West Florida Shelf, particularly the northern area, possesses a relatively high demersal fish density comparable only to waters off Louisiana. Overall (9-93m) winter densities in this area are greater than summer densities anywhere in the northern Gulf.

Because trawl samplings are necessarily restricted to low-relief bottoms, these estimates are undoubtedly lower than the actual standing stocks. Darcy and Gutherz (1984) suggest assuming a sampling efficiency of 25%, and therefore estimate the actual demersal fish standing stock of the 9-93m zone from Cape San Bias to the Dry Tortugas as 1.7×10^6 metric tons. Houde *et al.* (1976) have examined ichthyoplankton surveys and concluded that the aggregate total clupeid standing stock must exceed 10^6 metric tons in the EGUL.

Darcy and Gutherz (1984) also compared demersal fish densities (based on trawling surveys) from the northern Gulf of Mexico and the South Atlantic Bight (SATL) (Table 4). Although conclusions based on trawl data are not without criticism, it is evident, that the EGUL (West Florida Shelf) supports a relatively high density of demersal fish, at least during the winter months.

There are at least four distinct bottom communities in the Gulf of Mexico fishery: white shrimp grounds, brown shrimp grounds, pink shrimp grounds, and broken-relief areas. The three shrimp grounds differ primarily in bottom type and in degree of estuarine dependence.

The white shrimp grounds community occupies terrigenous mud or clay bottoms at 3.5-22m depths and is best developed in the north-central and northwestern Gulf, particularly the Mississippi Delta (CGUL). This community is largely estuarine dependent and is dominated by sciaenids (drums), trichiurids (cutlassfishes), polynemids (threadfins), and ariids (sea catfishes). The Atlantic

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Table 2. Estimated density and apparent standing stock of demersal fishes in the north Gulf of Mexico, summarized over depth of 9-93m (from Darcy and Gutherz 1984).

Location	Season	Density kg·ha ⁻¹	Area 10 ³ ha	Apparent Standing Stock 10 ³ metric tons
Brownsville, TX	winter	5.6	1631	9.2
--> Corpus Christi, TX	summer	25.6	1631	41.7
Corpus Christi, TX	winter	7.7	2291	17.7
--> Galveston, TX	summer	30.3	2291	69.3
Galveston, TX	winter	13.8	4915	68.0
-->Ship Shoal, LA	summer	55.0	4915	270.1
Ship shoal, LA	winter	76.2	3077	234.5
-->Mobile Bay, AL	summer	46.6	3077	143.3
Mobile Bay, AL	winter	11.8	1997	23.5
--Appalachicola, FL				
Cape San Bias, FL	winter	51.3	5182	265.8
--Tampa Bay, FL				
Tampa Bay, FL	winter	22.9	7302	167.2
--Dry Tortuga, FL				

EGUL Finfish and Shellfish

Table 3. Fishes contributing more than 1% of total catch biomass (9-93m) at stations with catches more than 22.7kg for winter trawl samples in EGUL (from Darcy and Gutherz 1984).

Species	Per cent of total fish biomass and [rank]	
Tomtate	15.1	[1]
spot	8.5	[2]
Pigfish	8.0	[3]
Scrawled cowfish	6.8	[4]
Sand perch	5.1	[5]
Spotted pinfish	4.4	[6]
Pinfish	4.0	[7]
Littlehead porgy	3.7	[8]
Dusky flounder	3.6	[9]
Grass porgy	3.1	[10]
Cownose ray	2.7	[11]
Sea catfish	1.8	[12]
Barbfish	1.6	[13]
Jolthead porgy	1.6	[14]
Bank seabass	1.6	[15]
Sheepshead porgy	1.5	[16]
Gray triggerfish	1.1	[17]

EGUL Finfish and Shellfish

Table 4. Comparison of demersal fish catch density based on trawling surveys in the Gulf of Mexico and the South Atlantic Bight (after Darcy and Gutherz 1984).

Geographic Area	Density kg·ha ⁻¹	Trawl Gear
South Atlantic Bight	7.0 - 17.1	3/4 Yankee
South Atlantic Bight, live bottom	27.3	URI 60/80 highrise
Gulf of Mexico West Florida Shelf	6.9	9.2m & 11.9m roller rigged
Gulf of Mexico West Florida Shelf	34.7	12.1m semi-balloon
Gulf of Mexico, Louisiana	9.9 - 46.3	13.7m flat
Gulf of Mexico, Texas	6.3 - 13.3	13.7m flat

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croaker (Micropogonias undulatus) is the dominant species (Chittenden and McEachran 1976).

The brown shrimp grounds community also occupies soft bottoms of mud or sandy mud, sometimes mixed with shell (Perez-Farfante 1978, cited in Darcy and Gutherz 1984) at depths of 22-93m. This community is largely found in the northwestern and north-central Gulf, especially off Texas (WGUL). It is not strongly estuarine dependent; the fish fauna consists largely of sporids (porgies), triglids (searobins), sciaenids (drums), bothids (lefteye flounders), and serranids (seabasses) with the longspine porgy (Stenotomus caprinus) the dominant species (Chittenden and McEachran 1976).

The pink shrimp grounds community prefers calcareous sediments of firm mud, sand, or shell (Hildebrand 1955; Perez-Farfante 1978). The major pink shrimp grounds are found from Tampa Bay to the Dry Tortugas (EGUL). The fish fauna is not highly estuarine-dependent and is dominated by haemulids (grunts), bothids, gerreids (mojarras), carangids (jacks), and serranids.

The broken-relief community is extensive, but disjunctively distributed throughout the northern Gulf of Mexico and is interspersed with soft bottom communities (Springer and Bullis 1954). Areas of low relief correspond to the live-bottom habitat described by Struhsaker (1969) for the South Atlantic Bight (SATL) whereas high-relief areas correspond to reefs such as the Flower Garden Banks off Texas (WGUL) and the Florida Middle Grounds of the West Florida Shelf (EGUL). Many tropical species are found in the broken-relief communities and produce a characteristic increase in species diversity near these areas (G. B. Smith et al. 1975; Chittenden and McEachran 1976).

Although not extensive in area or percent bottom coverage (see BENTHOS), the reefs of the EGUL are extremely important finfish habitats. At least 198 reef-fish species are presently known from the West Florida Shelf. Of these, 143 are considered primary reef fish, i.e., peculiar to the reef environment. The remainder are also normal reef inhabitants but are also found in other habitats. Common reef fishes of the EGUL are summarized in Table 5 and shallow water reef fishes of the EGUL (from G.B. Smith 1976).

The EGUL ichthyofauna is most closely allied to that of the Florida Keys and SATL north to Cape Canaveral; 98 of its 101 species occur in these areas (G.B. Smith 1976). However, the finfish fauna of the Keys area is much richer than that of the West Florida Shelf. Starck (1968) identified 389 species of reef-associated fishes at Alligator Reef in the Florida Keys.

G.B. Smith (1976) also notes that groups of fishes with demersal eggs and short planktonic larval stages (e.g., cardinalfishes and certain pomacentrids) are not well represented in the EGUL, a phenomenon which he attributes to their inability to utilize current transport mechanisms in this area. Other fishes seem to be prevented from establishing significant populations in the EGUL due to its only marginally tropical nature.

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Table 5. The most common deep water (including Florida Middle Ground) and shallow water reef fishes of the EGUL (from Smith 1979).

Deep water, > 30m	Shallow water, 12-18m
Serranidae	
Bank sea bass	
Red grouper	Red grouper
Sag	Sag
Scamp	Scamp
Belted sandfish	Belted sandfish
Grammistidae	
	White-spotted soapfish
Apogonidae	
Twospot cardinalfish	
Lutjanidae	
Gray snapper	Gray snapper
Pomodasyidae (Haemulidae)	
Tomtate	White grunt
Sparidae	
Littlehead porgy	Sheepshead
Sciaenidae	
Jackknife-fish	
Cubbyu	Cubbyu
Pomacanthidae	
Blue angelfish	Blue angelfish
Pomacentridae	
Yellowtail reeffish	
Purple reeffish (Middle Ground only)	
Cocoa damselfish	Cocoa damselfish
Bicolor damselfish (Middle Ground only)	

E **GUL** Finfish and Shellfish

Table 5. (continued)

Deep water, > 30m	Shallow water, 12-18m
Labridae	
Slippery click	Slippery click
Painted wrasse	Hogfish
Blenniidae	
Seaweed blenny	Seaweed blenny
Sobiidae	
Spotted goby	
Balistidae	
	Gray triggerfish

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ICHTHYOPLANKTON

A fisheries assessment survey of sardinelike fishes in the eastern Gulf of Mexico was conducted during 1971-1974. The purpose of this survey was to estimate spawning **biomasses**, using seasonal abundances and distributions of fish eggs and larvae (Houde and Chitty 1976; Houde et al. 1976). Figure 2 shows sampling stations and depth contours during these seventeen cruises (not all stations were sampled on every cruise).

Houde and Chitty (1976) arbitrarily divided the survey area into halves along 27°15'N (Figure 2). Table 6 summarizes mean abundances of fish eggs and larvae from the northern and southern portions of the study area. Mean abundances of fish eggs were usually greatest in the northern half, whereas fish larvae had a higher pooled mean abundance south of 27°15'N. During the fall-winter months, mean abundance of fish eggs (all stations combined) was $<300 \cdot 10m^{-2}$ of sea surface whereas mean numbers exceeded $550 \cdot 10m^{-2}$ during the spring-summer months. Mean abundance of fish larvae was $<350 \cdot 10m^{-2}$ during fall and winter months, but increased to $>500 \cdot 10m^{-2}$ in the spring and summer (Houde and Chitty 1976).

The 50-m isobath also divided the shelf study area into approximate halves. Table 7 summarizes mean abundances of fish eggs and larvae by depth zone. Mean fish egg abundance was usually higher at stations shallower than 50m, but mean larval abundance was always higher at stations deeper than 50m. As Houde and Chitty (1976) noted, one reason for this observation is the duration of the egg vs. larval stages. Fish eggs usually hatch within two days of spawning in the eastern Gulf precluding the possibility of numbers accumulating over a period in any area. Fish larvae, however, may range in age from one day to more than three weeks and may be widely dispersed from their spawning site. Also, a higher portion of shallow water species are demersal, and their larvae become demersal at a younger age than larvae of demersal offshore species. Table 8 summarizes spawning biomass and potential yield of several clupeid and carangid fishes in the EGUL OCS Planning Area. Houde et al. (1976) estimated that the aggregate total clupeid biomass, including menhaden (Brevoortia patronus) must exceed one million metric tons in the eastern Gulf of Mexico.

Estimates of stock size of round herring ranged from 715×10^3 metric tons in 1971-72 to 13×10^3 metric tons the following year. Potential annual yield to fisheries were estimated at $50-250 \times 10^3$ metric tons (Table 8). This species spawns from mid-October through May, with peaks in January and February. Houde (1977a) found a major spawning area for round herring 150km from Tampa Bay between 27°-28°N and 83°30'-84°30'W. Larval mortality rates were estimated at $12.3\% \cdot da^{-1}$ for 1971-72 and $12.1\% \cdot da^{-1}$ for 1972-73. Approximately 4 larvae per 1000 eggs spawned survived to 31 days and 15.5mm in 1971-72 while about 12 larvae per 1000 eggs survived to that stage in 1972-73 (Houde 1977a).

EGUL Finfish and Shellfish

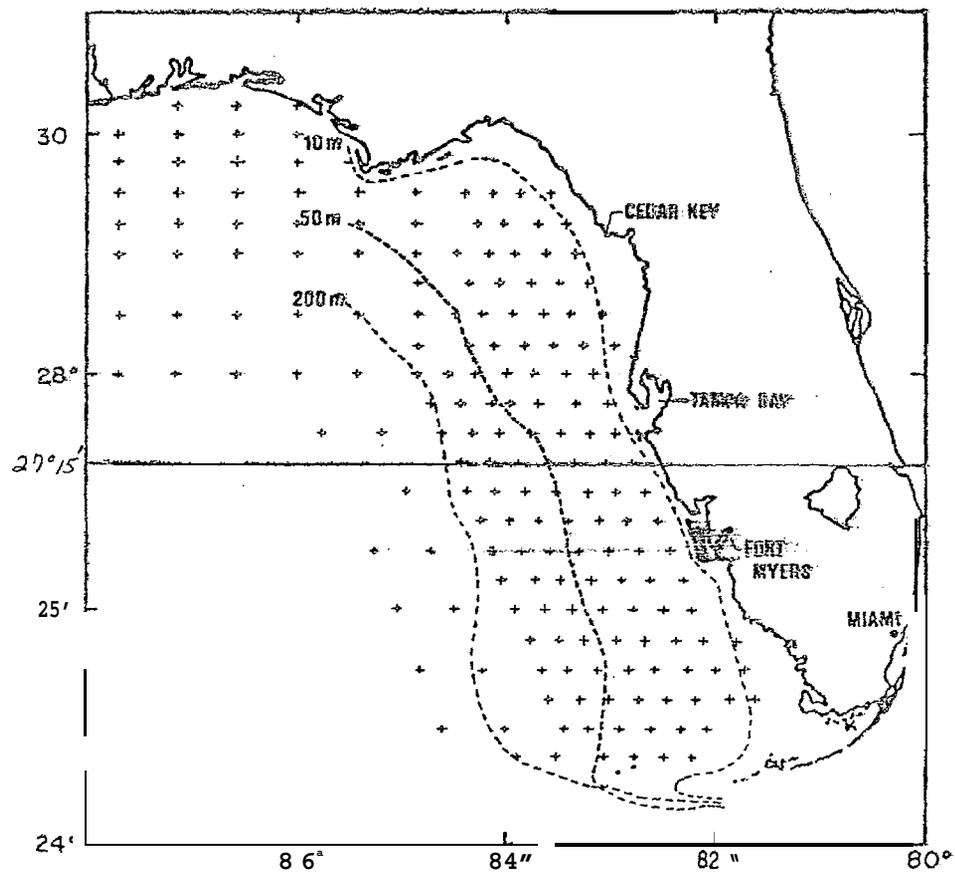


Figure 2. Chart of ichthyoplankton survey area, with sampling stations and depth contours, in eastern Gulf of Mexico, 1971-1974 (from Houde et al., 1976).

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Table 7. Summary of mean abundances (numbers" $10m^{-2}$) of fish eggs and larvae in the eastern Gulf of Mexico by depth zone (from Houde and Chitty 1976). Numbers in parentheses indicate numbers of stations occupied.

Date	EGGS		LARVAE	
	< 50m) 50m	(50m) 50m
2/72	420.1 (18)	880.3 (12)	153.2 (18)	336.7 (12)
5/72	820.0 (16)	300.6 (14)	348.8 (16)	489.1 (14)
6/72	no stations were) 50m deep			
9/72	559.9 (26)	640.1 (8)	742.7 (26)	1093.7 (8)
11/72	196.4 (34)	161.0 (16)	134.8 (34)	638.0 (16)
1/73	419.0 (34)	362.2 (17)	146.1 (34)	645.3 (17)
5/73	955.2 (34)	684.0 (15)	545.8 (34)	767.0 (15)
6-7/73	483.8 (34)	379.7 (17)	328.7 (34)	997.0 (17)
8/73	857.2 (34)	368.4 (16)	363.1 (34)	1045.8 (16)
11/73	364.3 (32)	138.1 (18)	121.5 (32)	698.2 (18)
3/74	no stations were) 50m deep			
5/74	737.4 (39)	354.9 (3)	508.7 (39)	655.5 (3)
Pooled Means:	606.4 (301)	402.8 (136)	342.2 (301)	739.2 (136)

%

EGUL Finfish and Shellfish

Table 6. Summary of mean abundances (number" $10m^{-2}$) of fish eggs and larvae in the eastern Gulf of Mexico (from Houde and Chitty 1976). Cruise area divided into northern and southern halves along $27^{\circ}15'N$ latitude. Numbers in parentheses indicate numbers of stations occupied.

Date	EGGS		LARVAE	
	North	South	North	South
2/72	722.3 (13)	221.8 (15)	162.9 (13)	297.1 (15)
5/72	497.2 (10)	617.8 (20)	406.7 (10)	418.1 (20)
6/72	656.4 (4)	469.8 (9)	340.3 (4)	342.1 (9)
9/72	764.2 (13)	464.0 (21)	764.4 (13)	863.2 (21)
11/72	166.2 (24)	205.2 (26)	286.6 (24)	377.7 (26)
1/73	451.3 (24)	307.0 (27)	219.3 (24)	274.3 (27)
5/73	945.2 (24)	898.1 (25)	477.2 (24)	744.4 (25)
6-7/73	415.5 (25)	481.4 (25)	466.6 (25)	633.0 (26)
8/73	909.2 (25)	492.4 (25)	621.9 (25)	541.2 (25)
11/73	150.7 (25)	175.1 (26)	288.9 (25)	401.0 (26)
3/74	191.1 (16)	391.1 (16)	60.4 (16)	50.2 (16)
5/74	926.1 (23)	884.5 (19)	497.2 (23)	545.8 (19)
Pooled Means:	545.4 (226)	443.4 (225)	380.5 (226)	486.9 (255)

EGUL Finfish and Shellfish

Table 8. Spawning biomass and potential yield (both in 103 metric tons) of several clupeid and carangid fishes in the EGUL OCS Planning Area.

Species	Stock biomass (year)	Potential Yield	Reference
<u>Clupeidae</u> - herrings			
Round herring <u>Etrumeus teres</u>	287 (1973-74)	50 - 250	Houde et al. 1976 Houde 1977a
Scaled sardine <u>Harengula jaguana</u>	185 (avg. , 1971-73)	46.1 - 92.3	Houde 1977c
Atlantic thread herring <u>Opisthonema oglinure</u>	372 (1973)	60.3 - 120.6	Houde 1977b
Spanish sardine <u>Sardinella aurita</u>	250	125	Houde and Berkeley 1982
<u>Carangidae</u> -- jacks			
Round scad <u>Decapterus punctatus</u>	350	100	Leak 1981
Rough scad <u>Trachurus lathami</u>	27	7	Leak 1981
Atlantic bumper <u>Chloroscombrus chrysurus</u>	27	7	Leak 1981

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Scaled sardine also spawn over an extended period, from January to September, with a peak from May to August. This species spawns between the coast and the 30-m isobath, mostly within 50km of the coast. Spawning biomass apparently increased from 1971 to 1973, averaging 185×10^3 metric tons over this three-year period (Houde 1977c). Larval mortality rates apparently are higher than for round herring; estimated daily losses ranged 16.7-29.3%. The most probable mortality rate based on age from the 1973 data when larvae were more abundant was $24.7\% \cdot \text{da}^{-1}$ (Houde 1977c).

Atlantic thread herring, another coastal species, seldom was sampled at depths greater than 90m and was most abundant in depths less than 35m. These fish spawn from February to September; spawning is most intense from April to August. Houde (1977b) estimated adult stocks of thread herring in the EGUL ranged $100-400 \times 10^3$ metric tons (1971-1973); estimates of annual potential yield of adults to a fishery range $60-121 \times 10^3$ metric tons (Table 8). Estimated probable daily mortality rates of thread herring larvae ranged 12.8 -22.7 in 1971, and 15.6 -26.3 in 1973. Houde (1977b) concluded that best estimate of larval mortality was approximately $20\% \cdot \text{da}^{-1}$ for both years.

Although round herring larvae had a lower estimated mortality rate than either scaled sardines or thread herrings they probably had slower growth rates at the cooler temperatures ($18^\circ-27^\circ\text{C}$) during which they are spawned. Houde (1977a) estimated numbers at 15.5mm to represent only 40-120 survivors per 10,000 spawned eggs; this is comparable to the estimate for thread herring (60-200 survivors per 10,000 eggs) but higher than the five survivors per 10,000 eggs estimated for scaled sardines (Houde 1977c).

Adult biomass of Spanish sardine in the EGUL is estimated at approximately 250×10^3 metric tons, with a potential yield of nearly 125×10^3 metric tons. If Spanish sardine abundance is similar throughout the shelf area of the entire Gulf, then the total biomass and yield may be three to four times those for the EGUL (Houde and Berkeley 1982).

Round scad was the most abundant carangid larva in EGUL samples. Its average standing stock, 20.4×10^{10} larvae, was more than ten times greater than any other carangid species. Round scad spawns year round at surface temperatures of $20-32^\circ\text{C}$ over the entire West Florida Shelf from May to November, but spawning during January and February is restricted to south of $26^\circ 15' \text{N}$. Mean abundance over the entire continental shelf ranged from a winter low of 1.8 larvae under 10m^2 of sea surface to a summer high of $53.0 \cdot 10^3 \text{m}^{-3}$.

Adult stock of round scad in the eastern Gulf of Mexico is estimated at 350×10^3 metric tons with a potential sustainable yield of $100 (5-20) \times 10^3$ (Leak 1981). Adult stocks of round scad and Atlantic bumper are approximately 27×10^3 each, with a potential sustainable yield of 7×10^3 metric tons (Leak 1981).

The most abundant fish larvae in the EGUL belonged to the families Clupeidae (herrings), Gobiidae (gobies), Bothidae (lefteye flounders), Myctophidae

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(lanternfishes), and Serranidae (seabasses). Sand perch, Diplectrum formosum was the most abundant serranid larva, followed by red barbier (Hemanthias vivanus). Serranid larvae were collected over the entire shelf area during all seasons, but the species that occurred (eleven genera and fourteen species or types) differed by area, season, and depth zone (Houde 1982).

CENTRAL GULF 0 3 ? MEXICO

FINFISH AND SHELLFISH

Available data on distributions of demersal fishes and penaeid shrimp on soft bottom habitats of the OCS (shoreward to a depth of 120m) from the Rio Grande to the Mississippi River Delta have been summarized by Darnell *et al.* (1983). This compilation represents one of the most thorough and succinct discussions of demersal biota of any major OCS area in the world. Species distributions are based on an extensive bottom trawling survey of shrimp and demersal fishes conducted by the National Marine Fisheries Service (NMFS) from 1961-1965. The demersal fish data base, which includes more than 200 species, is derived from monthly trawl surveys (1972-1974) of thirteen transects extending seaward from 7-1 10m depths (Moore *et al.* 1970). Much of the information on demersal fish stocks in the CGUL and WGUL has been derived from these sources.

Moore *et al.* (1970) report that average catch of bottom fish was approximately three times greater in the CGUL ($93\text{kg}\cdot\text{h}^{-1}$) than in the WGUL ($35\text{kg}\cdot\text{h}^{-1}$). The differences were most pronounced in the shallow areas and became less evident with increasing depths. Catches of bottom fish (all species combined) were similar in day and night tows, and differences in abundance between years at the same station were not statistically significant (although often large). Greatest densities of demersal fish were found in the winter and summer off Louisiana (CGUL), and in the spring and fall off Texas (WGUL). The largest catches were made at depths of 7-46m in the CGUL, and 27-110m in the WGUL.

Differences in species composition occur between CGUL and WGUL finfish populations (Moore *et al.* 1970). In general, the dominant fish of both areas are the Atlantic croaker (*Micropogonias undulatus*), an estuarine species, and the longspine porgy (*Stenotomus caprinus*), an offshore species -- together these constituted 47% of the total catch by weight. In addition to these two species, sand seatrout (*Cynoscion arenarius*) and sea catfish (*Arius felis*) dominated hauls from CGUL waters; inshore lizardfish (*Synodus foetens*) and silver seatrout (*Cynoscion nothus*) dominated hauls made in the WGUL.

There are major changes in finfish species assemblages proceeding from the Mississippi toward the Rio Grande. Darnell *et al.* summarize the ecological conditions as follows:

The eastern half of Louisiana is dominated by low salinity marshlands and large bays opening broadly to the continental shelf. There is an extremely large interface between marshland and brackish water.. The shelf off eastern Louisiana is influenced seasonally by the Mississippi River outflow which supplies nutrient rich waters and fine sediments. Surface sediments tend to be fine grained, and the nearshore bottom waters display intermediate salinities during seasons of high river outflow. Proceeding westward toward the Rio Grande there is a general reduction of low salinity coastal marshland and

CGUL Finfish and Shellfish

reduction in freshwater stream flow. From Corpus Christi Bay and south evaporation exceeds freshwater runoff, and the **Laguna** Madre of south Texas displays salinities greatly in excess of seawater.

Many of the species which spend part of their adult lives on the Gulf of Mexico OCS are estuarine dependent in the sense that the **larval** or juvenile stages require low-salinity nursery areas (**Darnell et al. 1983**). As a group, such estuary-related species are more prevalent in the **CGUL** and off eastern Texas than in the **WGUL** because of the availability of low-salinity coastal habitats from Galveston Bay eastward.

The Continental Shelf of the northwestern **Gulf** of Mexico contains numerous rock outcrops, coral or **calcareous** algal reefs toward the outer Shelf, and many artificial areas of hard substrate including shipwrecks, artificial fishing reefs, and drilling rigs. These reef areas are inhabited by characteristic groups of species. However, many reef-related species known to occur in this region are not represented in trawl collections, including groupers, snappers, grunts, etc., and pelagic predators such as sharks, jacks, barracudas, and mackerels.

Some fish species rarely are collected in shrimp trawls because of their pelagic habits and/or fast swimming abilities. These include various sharks, tarpons, **clupeids** (herrings), **carangids** (jacks), dolphins, mackerels, wahoos, tunas, **billfishes**, etc. Also underrepresented in trawl collections are cryptic species (e.g., **congers** and other eels) and very **small** species (e.g., **small** flounders).

It is known that many of the larger predatory fish occur in the northern Gulf of Mexico in spring and summer and migrate to warmer southern waters in the fall. The distribution patterns of other under-represented fish are not always well understood. Many of the Shelf residents move from shallower to deeper waters as they mature. However, this movement is often masked by the seasonal appearance of large numbers of juvenile fish in shallow waters (**Darnell et al. 1983**).

Especially in the **CGUL**, species tend to be widespread across the Shelf within their appropriate depth range. However, there are numerous cases of isolated fish populations off the Texas coast in the **WGUL**, particularly from Galveston Bay to the Rio Grande. **Darnell et al. (1983)** note that these population aggregates are usually found off the mouths of natural or **man-made** passes which connect the estuaries and lagoons to the waters of the OCS. Species which most clearly display this form of insularity include the dwarf sand perch (winter, spring, and summer), longspine porgy (summer), Atlantic cutlassfish (spring and summer), and bay whiff (summer); at least 20 other species have insular populations in the **WGUL** on at least a seasonal basis.

Demersal fish species exhibit high seasonal densities around passes and the mouths of bays and estuaries. Young of species spawned offshore (e.g., spot and croaker) may temporarily congregate in such habitats prior to entering inshore

CGUL Finfish and Shellfish

nursery areas -- such populations are not readily captured by bottom trawls. In the late summer and fall these maturing young depart the estuaries and bays and can form large aggregations outside the passes. Species involved in such behavior, as well as species associated with the mouths of the Mississippi and Rio Grande Rivers, are discussed by Darnell et al. (1983).

Commercial finfish landings for the CGUL OCS Planning Area (Alabama, Mississippi and Louisiana) and summarized in Table 1. Menhaden, Brevoortia patronus (and B. sunterii) dominated the fisheries, comprising from 97% to 99% of total landings. Commercial finfish landings in the CGUL were the largest in all the OCS Planning Areas for 1982 through 1984; total landings for the entire state of Alaska ranked second ranging from 334 to 415 thousand mt for that time period. Although menhaden, an industrial fish reduced to fish meal and fish oil is not very valuable on a per pound basis, \$0.04/lb, the sheer magnitude of the catch results in it being the most valuable fish in the CGUL in terms of total economic return. Louisiana ranked first in total finfish landings both in the CGUL Planning Area and among all the coastal states in the U.S. Mississippi ranked second in the CGUL Planning Area, third among all the coastal states in 1984 and fourth in 1983. Red snapper, the second most valuable fishery, brought the second highest dockside price on a per pound basis, \$1.60 in Louisiana; \$1.35 in Mississippi in 1984 (NMFS 1985 b). Swordfish brought the highest price; \$5.25 /lb., though only 3.6mt were landed in Louisiana. Numbers of fish caught by recreational fishermen during 1980-1982 in the CGUL area are summarized in Table 2. Saltwater catfishes, spotted seatrout and Atlantic croaker dominated catches in 1982; saltwater catfish, Atlantic croaker and red snapper were the most numerous fish caught in 1981; and Atlantic croaker, saltwater catfishes and spotted seatrout were the most numerous in 1980. Recreational catches of Atlantic croaker, and sand seatrout declined substantially from 1980 through 1982.

Table 3 summarizes commercial shellfish catches in the CGUL Planning Area. Shrimp dominated shellfish catches and were the most valuable shellfish in the CGUL Area; blue crabs ranked second in total landings, and oysters ranked second in economic value. Shellfish fisheries in the CGUL Planning Area were the most valuable among all the OCS Planning Areas and the entire states of California and Alaska. Shellfish landings in the CGUL ranked second in total shellfish landings among the OCS Planning Areas from 1982-1984. Louisiana ranked first in total shellfish landings among the CGUL states; ranked first in total shellfish landings among all coastal states in 1984 and second in total shellfish landings among all coastal states in 1983. The total economic value of the Louisiana shellfish catch ranked second among all coastal states for both 1984 and 1983.

CGUL Finfish and Shellfish

Table 1. Commercial catches and economic value of most important finfish in the CGUL OCS Planning Area (Alabama, Mississippi and Louisiana) (NMFS 1985b, 1984b, 1983a).

Species	Landings 10 ³ mt		Economic Value 10 ³ Dollars	
	1982-1984		1982-1984	
	Total	Average	Total	Average
Menhaden (Gulf)	2760.77	920.26	240,416	80,138.7
Red snapper	3.29	1.10	10,315	3,438.3
Mulletts	2.63	0.88	1,229	409.7
Spotted seatrout	1.49	0.50	3,188	1,062.7
King mackerel	1.03	0.34	1,821	607
Gulf flounders (and Atlantic)	1.03	0.34	1,186	395.3
Groupers	0.3	0.1	663	221
White seatrout (sand and silver)	0.74	0.25	451	150.3
Atlantic croaker	1.45	0.48	1,246	415.3
Other finfish	60.38	20.13	19,332	6,449
Total	2,833.47	944.49	280,078	93,359.3

CGUL Finfish and Shellfish

Table 2. Estimated total number of fish caught by marine recreational fishermen in the Central Gulf of Mexico (CGUL) Planning Area, 1980-1982 (NMFS 1984a; 1985a).

Species	Catch x 10 ³ 1980-1982	
	Total	Average
Saltwater catfishes	22,684	7,561.3
Atlantic croaker	22,805	7,601.7
Red snapper	8,360	2,786.7
Spotted seatrout	16,622	5,540.7
Sand seatrout	8,635	2,878.3
Red drum	5,244	1,748
Spanish mackerel	4,149	1,383
Tunas/mackerels	836	278.7
Other fishes	4,273	1,424.3
Kingfishes	1,866	622
Southern flounder	1,757	585.7
Finfish	1,579	526.3
Herrings	3,541	1,180.3
Black drum	2,280	760
Triggerfishes/filefishes	767	255.7
Little tunny/Atlantic bonito	1,162	387.3
Sheepshead	1,807	602.3
Mulletts	5,657	885.7
Total	121,748	40,582.7

CGUL Finfish and Shellfish

Table 3. Commercial catches and economic value of most important shellfish in the CGUL OCS Planning Area (Alabama, Mississippi and Louisiana) (NMFS 1985b, 1984b, 1983a).

Species	Landings 10 ³ mt 1982-1984		Economic Value 10 ³ Dollars 1982-1984	
	Total	Average	Total	Average
Shrimp	162.20	54.07	615,636	205,212
Blue crabs	32.15	10.72	21,816	7,272
Oysters (meats)	21.08	7.03	62,906	20,968.7
Squid	0.03	0.01	12	4.0
Other shellfish	2.59	1.30	2,193	1,096.5
Total	218.04	72.68	702,563	234,187.7

WESTERN GULF OF MEXICO

FINFISH AND SHELLFISH

Commercial finfish for the WGUL Planning Area (Texas) are summarized in Table 1. Red snapper ranked first both in total landings and in economic value. Because of their high dockside value, swordfish ranked second in economic value in 1984 and 1982 and fourth in 1983.

Table 2 summarizes marine recreational fisheries catches from 1980 through 1982. Saltwater catfish were the most numerous fish caught in 1980 and 1982 and ranked third in 1981. Spotted **seatrout** and pinfish ranked second and third in 1982; spotted seatrout and Atlantic croaker were the most numerous fish caught in 1981. Catches of Atlantic croaker, spotted **seatrout**, and kingfishes, *Menticirrhus spp.* were most numerous after saltwater catfish in 1980,

Shellfish landings for the WGUL are given in Table 3. Shrimp, chiefly brown shrimp, *Penaeus aztecus*, and pink shrimp, *P. duorarum*, dominated landings and were the most valuable shellfish landed in Texas.

WGUL Finfish and Shellfish

Table 1. Commercial catches and economic value of most important finfish in the WGUL OCS Planning Area (Texas) (NMFS 1985b; 1984b; 1983a).

Species	Landings 10 ³ mt 1982-1984		Economic Value 10 ³ Dollars 1982-1984	
	Total	Average	Total	Average
Red snapper	0.72	0.24	2,624	874.7
Groupers	0.23	0.08	531	177
Flounders	0.46	0.15	976	325.3
Swordfish	0.21	0.07	1,242	414
Mullets	0.14	0.05	33	11
Tilefish	0.02	0.02	58	58
Tunas	0.07	0.02	74	24.7
Sharks, unclass.	0.10	0.03	115	38.3
Other finfish	2.1	0.7	2,320	773.3
TOTAL	4.14	1.38	8,012	2,670.7

WGUL Finfish and Shellfish

Table 2. Estimated total number of fish caught by marine recreational fishermen in the Western Gulf of Mexico (WGUL) Subregion; 1980-1982 (From NMFS 1984a; 1985a).

Species	Catch x 10 ³ 1980-1982	
	Total	Average
Spotted seatrout	16,971	5,657
Atlantic croaker	17,800	5,933.3
Saltwater catfishes	21,699	7,233
Mulletts	6,559	3,279.5
Pinfish	10,778	3,592.7
Sand seatrout	8,003	2,667.7
Kingfishes	9,096	3,032
Red drum	4,832	1,610.7
Black drum	2,712	904
Silver perch	1,930	965
Sheepshead	2,942	980.7
Red snapper	2,239	1,119.5
Sharks	1,003	334.3
Pigfish	597	298.5
Other fishes	2,324	774.7
King mackerel	529	264.5
TOTAL	116,456	38,818.7

WGUL Finfish and Shellfish

Table 3. Commercial catches and economic value of most important shellfish in the **WGUL OCS** Planning Area (NMFS 1985b; 1984b; 1983a).

Species	Landings 10 ³ mt 1982-1984		Economic Value 10 ³ Dollars 1982-1984	
	Total	Average	Total	Average
Shrimps	105.34	35.11	525,580	175,193.3
Blue crabs (hard)	9.90	3.30	6,995	2,331.7
Oysters (meats)	6.43	2.14	20,568	6,856
Squid	0.03	0.01	18	6
Crab - other	0.01	0.01	7	7
TOTAL	121.68	40.56	553,168	184,389.3

S O U T H E R N CALIFORNIA

FINFISH AND SHELLFISH

Average commercial fisheries catch for the period 1971-75, based on California Dept. of Fish and Game catch statistics, were plotted in Graphic No. 6 (MMS 1984c). This report presented annual catches in three categories of abundance, each referenced to standard blocks of 5,760 acres (2304ha).

The most productive areas were U.S. waters off Baja California and off Orange, Los Angeles, Ventura, and the southeastern half of Santa Barbara Counties as well as waters surrounding San Clemente and Santa Catalina Islands. Nearshore catches, including waters out to the Channel Island region, were primarily composed of northern anchovy, Pacific bonito, jack mackerel, rockfish, and squid. Offshore of Baja California, tuna (albacore, skipjack, yellowfin, and bluefin) dominated the catch. The largest abalone catches came from waters surrounding San Clemente Island and the Channel Islands.

A more detailed summary of commercial fisheries landings in the SCAL, averaged for the years 1970-74, was presented in the U.S. Dept. of the Interior, BLM, 1977 (Visual No. 6). Average catches were summarized in eight abundance categories referenced to 278km² blocks. The most productive areas reported were between Point Fermin and Santa Catalina Island, the only two blocks with catches >9000 metric tons. Three blocks adjacent to these areas had catches between 1500-8550 metric tons; two of these extended offshore between Long Beach and Newport Beach, while the third was midway between Malibu Beach and Santa Monica and the western portion of Santa Catalina Island. Catch statistics for this Visual were obtained from California Fish and Game Origin Block Statistics 1970-1974. Visual No. 5 of the same series delineated artificial fishing reefs, major halibut and billfish fishing areas, general fishing areas, and dolphinfish and albacore/bluefin tuna areas.

Status reports on world tuna and billfish stocks are presented in National Marine Fisheries Service (1981). It is expected that this publication will be updated in 1985 or 1986 (A. Coan, Southwest Fisheries Center, pers. comm. 1984).

The eastern Pacific Ocean yellowfin tuna fishery is primarily conducted within an area known as the Eastern Tropical Pacific (ETP), bounded by 40°N and 30° S latitude, 150°W longitude, and the west coasts of North, Central, and South America. For management purposes, the Inter-American Tropical Tuna Commission (IATTC) divides the ETP into the Commission Yellowfin Regulatory Area (CYRA) and an outside subregion. As Figure 1 shows, this Area includes SCAL waters. Longline and surface gear are used to catch five species of tunas in the ETP: yellowfin, bigeye, bluefin, skipjack, and albacore (Herrick 1981).

SCAL Finfish and Shellfish

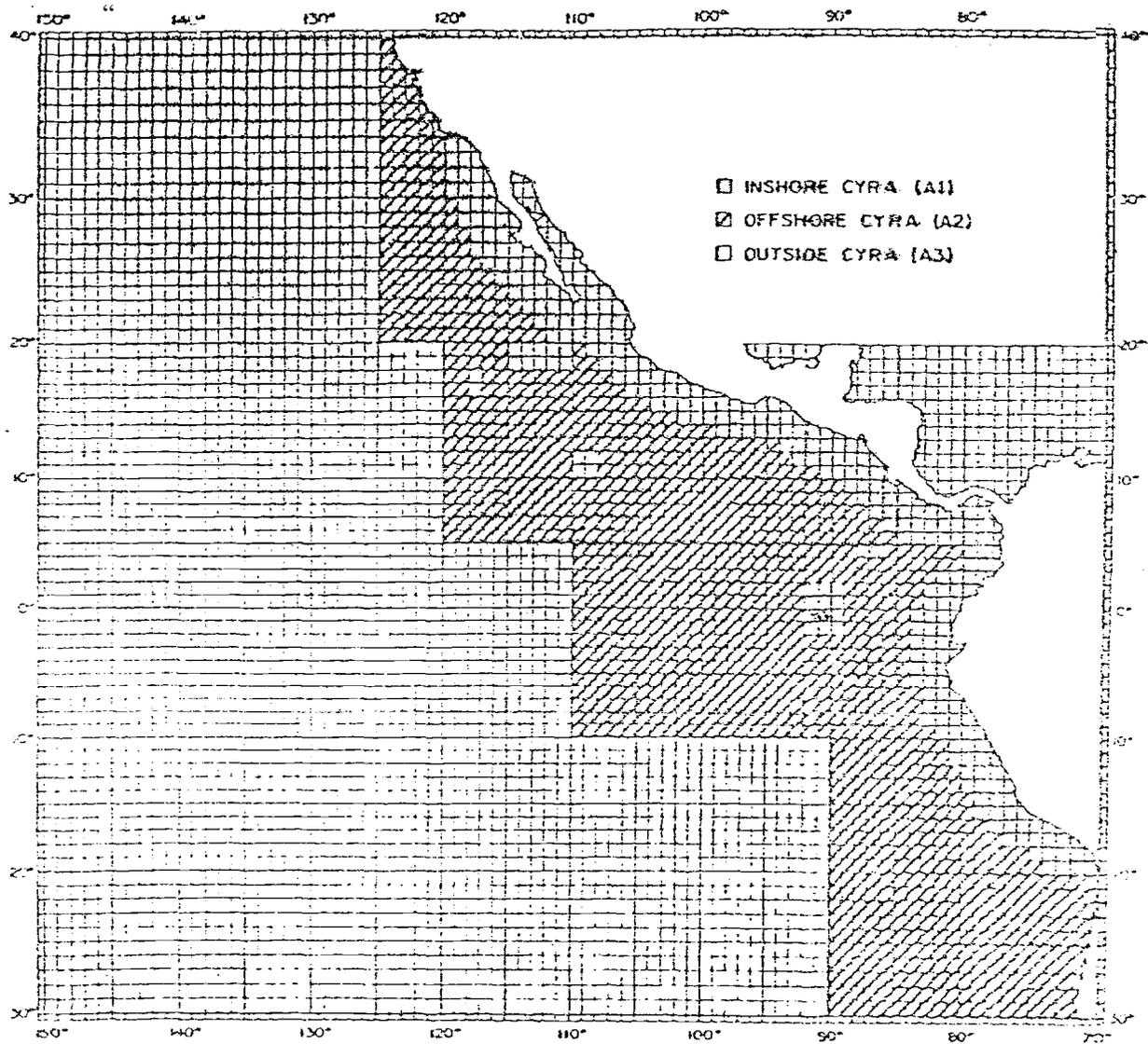


Figure 1. Eastern Tropical Pacific Ocean, showing management areas for yellowfin tuna as defined by the IATTC.

s **CAL** Finfish and Shellfish

In 1979, U.S. fishermen landed 61% of the total **yellowfin** catch in the ETP, followed by Mexico (13%) and Ecuador (5.5%). The 1979 CYRA quota was 159,000 metric tons. SCAL landings for 1977 (Table 1) were approximately 55% of this quota. Currently, the **yellowfin** tuna population is at its lowest known level and has become increasingly dependent upon one-year old fish. This will diminish potential yield and result in fishing success being heavily influenced by recruitment class strength (Herrick 1981).

The skipjack tuna fishery extends from about 33°N to 19°S latitude and from the North and South American coast to 150°W longitude. Thus, this fishery includes only a small portion of the SCAL. 80-95% of the catch is taken by purse seiners. The 1979 skipjack catch in the CYRA amounted to 129,400 metric tons; 53.8% of that catch was landed by U.S. fishermen, but most of the catch came from waters south of 15°N latitude (Rinaldo 1981). For comparison, 1977 skipjack landings for SCAL (Table 1) were only 13% of the 1979 CYRA total.

The U.S. fleet landed an annual average of 20,400 metric tons of albacore tuna between 1969 and 1978. Landings from the SCAL in 1977 (Table 1) were 16% of this annual average. The North American fishery has been declining since 1972, and preliminary data indicate a 1979 catch of only 4938 metric tons, one of the poorest years on record (Weber 1981). Preliminary tuna landings for 1982-1984 indicate that California fishermen landed 34.9 thousand mt of **yellowfin** tuna, 31.7 thousand mt of skipjack tuna, and 12.3 thousand mt of albacore tuna during 1984 (NMFS 1985).

SCAL shellfish landings for 1977 are summarized in Table 2.

The most recent commercial finfish landings (1982-1984) are for the entire state of California (. SCAL, CCAL, NCAL). Pacific mackerel dominated California landings in 1984 - 42.4 thousand mt, whereas **yellowfin** tuna ranked first in both 1983 and 1982 - 55.8 and 62.0 thousand mt respectively (NMFS 1985 b).

Yellowfin tuna and skipjack tuna ranked second and third in total landings during 1984; skipjack tuna and Pacific mackerel ranked second and third the previous two years. Total commercial landings dropped substantially from 1982 - 284.1 thousand mt to 1984 - 195.5 thousand mt. **Yellowfin** and **skipjack** tuna were the most valuable fisheries all three years. Commercial catches of shellfish in California also dropped substantially during the three-year period from 31.3 thousand mt in 1982 to 12.8 thousand mt in 1984. **Dungeness** crabs ranked first both in total landings and in economic value. Northern shrimp ranked second in both categories.

S **CAL** Finfish and Shellfish

Table 1. SCAL finfish statistics (San Diego, San Pedro Districts) for 1977
 (from NMFS 1984c).

Species	Total metric tons	Economic Ranking (All Calif.)	Catch in metric tons	
			San Pedro	San Diego
Anchovies	78,835	7	78,834	0
Yellowfin tuna	88,018	1	52,527	35,492
Jack mackerel	42,001	6	41,995	5
Skipjack tuna	16,196	2	21	16,175
"Soles"	1	5	0	0
Rockfishes	662	9	216	446
Bonito	10,143	8	7,628	2,515
Albacore tuna	3,171	4	850	2,321
Sablefish	730	11	726	4
Herring, Sea	0	12	0	0
Pacific mackerel	3,249		3,247	3
Bluefin tuna	3,123	10	2,130	993
Chinook salmon	0	3	0	0
Bigeye tuna	1,503	13	559	944
Pacific yellowtail	816		751	65
Lingcod	1		0	0
Total Fish	248,449		189,486	58,964

S **CAL** Finfish and Shellfish

Table 2. SCAL shellfish statistics (San Diego, San Pedro Districts) {from NMFS 1984c}.

Species	Total metric tons	Economic Ranking (All Calif.)	Catch in metric tons	
			San Pedro	San Diego
Crabs:				
Dungeness	0	1	0	0
Rock	265	8	230	36
Lobster, spiny	91	7	40	51
Shrimp	0	2	0	0
Abalone	40	5	23	16
octopus	0		0	0
Oysters	0	6	0	0
Squid	8,284	4	8,274	9
Sea urchins	1,388	3	751	637
Total Shellfish	10,068		9,318	750

CENTRAL CALIFORNIA

FINFISH AND SHELLFISH

CCAL commercial finfish and shellfish statistics for 1977 are summarized in Tables 1 and 2 of this section.

Commercial fishery areas for abalone, crabs, oysters, shrimp, squid, albacore tuna, anchovy (Pacific herring), and rockfish as well as salmon trolling areas, trap fishing areas (for sablefish), and trawling grounds off central and northern California were delineated in Visual No. 3 (BLM 1980 b). Tables 5 and 6 from this Visual summarize fishing areas and related information for flatfish and rockfish fisheries. Sport fishing areas are summarized in Visual No. 4 of the same series: this includes clam digging areas, prime salmon fishing areas and trolling areas, and salmon/steelhead streams.

Commercial fisheries catches in total weight of fish caught in each California Department of Fish and Game block of 2,304ha for Proposed Lease Sale No. 73- off central and northern California were summarized in MMS, Graphic No. 4 (1983c). Areas of CCAL with the largest catches, greater than 450 metric tons, were found in and near Monterey Bay (CCAL), and adjacent to Bodega Bay (CCAL). This Visual also shows major fishing ports and major anadromous fish streams.

Important commercial species in CCAL include Dover sole, English sole, Petrole sole, Rex sole, Pacific sandab, Arrowtooth sole and California halibut. Main Fishing areas for these species are centered off Monterey.

Eight species of rockfish (Sebastes melanops, S. paucispinis, S. goodei, S. pinniger, S. mystinus, S. serranoides, S. flavidus, and S. miniatus) are fished commercially in California. In CCAL, S. pavirpins and S. goodei are taken by trawl and longline in waters over 40 meters deep. S. mystinus is caught in shallower water (to 50 meters) and in CCAL is fished primarily by gill net (Miller and Gibe] 1973).

CCAL Finfish and Shellfish

Table 1. CCAL finfish statistics (Santa Barbara, Monterey, San Francisco) (from NMFS 1984c).

Species	Total Metric tons	Economic Ranking (All California)
Anchovies	21,495	7
Yellowfin tuna	0	1
Jack mackerel	5,235	6
Skipjack tuna	1	2
"Soles"	5,095	5
Rockfishes	5,989	9
Bonito	4	8
Albacore tuna	3,072	4
Sablefish	3,250	11
Herring, sea	5,223	12
Pacific mackerel	41	
Bluefin tuna	0	10
Chinook salmon	1,137	3
Bigeye tuna	0	13
Pacific yellowtail	0	
Lingcod	379	
Total Fish	50,921	

CCAL Finfish and Shellfish

Table 2. CCAL shellfish statistics (Santa Barbara, Monterey, San Francisco) (from NMFS 1984c).

Species	Total Metric tons	Economic Ranking (All California)
Crabs :		
Dungeness	145	1
Rock	222	8
Lobster, spiny	22	7
Shrimp	929	2
Abalone	90	5
octopus	3	
Oysters	335	6
Squid	4,426	4
Sea urchins	5,893	3
Total shellfish	12,065	

NORTHERN CALIFORNIA

FINFISH AND SHELLFISH

Approximately 562 species of **finfish** inhabit California coastal waters. About **500** species are found north of Point Conception and 400 species are found in **NCAL** (Jones and Stokes 1981a, b). Some 200 million pounds of finfish were landed in 1980 in ports north of Point Conception, with a commercial value of over 15 million dollars (**BLM** 1982 b).

Major estuaries in **NCAL** are important habitat for **anadromous** fish. Pacific herring spawn in Humboldt Bay and in Crescent City Harbor (Woodward-Clyde 1982a, b). The Smith River **estuarine** system is a nursery area for surf perch species and starry flounder (Blunt 1980).

Several rivers in **NCAL** are used by Pacific salmon species for breeding. These include the Eel, the **Klamath**, the Mad and the Smith Rivers. Salmon are a particularly important **gamefish** of the region, along with an **anadromous** variety of the rainbow trout (**steelhead**).

"*Sol es*" or **flatfish** dominated catch statistics by weight (Table 1). **Rockfishes**, sablefish and Chinook salmon were also important commercial species, and significant catches . of **lingcod** and albacore tuna were landed in **NCAL** ports (Table 1).

Dungeness crab (**Cancer magis**) is by far the most important shellfish harvested in **NCAL** (Table 2). Commercial fishing is done in 4 to 36 fathoms of water out of Crescent City. Humboldt Bay is an important **nursury** area for **Dungeness** crabs (Blunt 1980).

A clam fishery exists in Humboldt Bay and in Crescent City Harbor, but total catch is **small** and value is relatively low (Blunt 1980).

Other shellfish of commercial importance include oceanic shrimp, oysters and octopus.

Approximately **160** metric tons of sea urchins were harvested in **NCAL** in 1977. This unique fishery is assuming increasing importance as urchin gonads are becoming a "chic" item in the **urban** restaurant trade.

NCAL Finfish and Shellfish

Table 1. NCAL finfish statistics (Northern District) from
NMFS (19840).

	TOTAL metric tons	Economic Ranking (All Calif.)
Anchovies	0	7
Yellowfin tuna	0	1
Jack mackerel	2	6
Skipjack tuna	0	2
"Sbles"	8670	5
Rockfishes	4156	9
Bonito	0	8
Albacore tuna	914	4
Sablefish	2012	11
Herring, sea	20	12
Pac. mackerel	0	
Bluefin tuna	0	10
Chinook salmon	1386	3
Bigeye tuna	0	13
Pac. yellowtail	0	
Lingcod	383	
TOTAL FISH	17543	

NCAL Finfish and Shellfish

Table 2. NCAL shellfish statistics (Northern District) (from ~~NMFS~~ 1984C).

	TOTAL metric tons	Economic Ranking (All Calif.)
Crabs:		
Dungeness	14997	1
Rock	0	8
Lobster, spiny	0	7
Shrimp	8489	2
Abalone	0	5
Octopus	13	
Oysters	256	6
Squid	0	4
Sea urchins	160	3
TOTAL SHELLFISH	23915	

OREGON-WASHINGTON

FINFISH AND SHELLFISH

Commerical finfish catches are summarized in Table 1. Catches have decreased from 115 thousand metric tons in 1982 to 96 thousand metric tons in 1984, although 1980's catches are substantially higher than the 69 thousand metric tons landed in 1977 (NMFS 1983a; 1984b,c;1985b).

Rockfishes, whose catches decreased substantially during this three year peiod, dominated landings all three years. Flounders ranked second in total landings; rockfishes and flounders were the most valuable fishes in the region. Washington landings were approximately double those from Oregon. Rockfishes and flounders dominated Oregon landings whereas Pacific cod were the most abundant fish landed in Washington ports. Rockfishes were the most valuable fishery in Oregon; red salmon ranked first in Washington.

Shellfish landings are summarized in Table 2. Dungeness crab and northern shrimp ranked first and second in total landings during 1984; their order was reversed during 1983 and 1982. Dungeness crabs were the most valuable shellfish followed by northern shrimp and oysters (order reversed in 1984). Shellfish landings were more equally divided between the two states; 7.1 and 5.6 thousand mt in Washington and Oregon respectively, than total finfish landings. Dungeness crabs ranked first in total landings in Oregon. Oysters ranked first in Washington. Northern shrimp catches ranked a close second in Oregon and Dungeness crab landings were second in Washington. Dungeness crabs were the most valuable shellfish in both states (Table 2).

ICHTHYOPLANKTON

Ichthyoplankton assemblages off the Oregon coast have been examined in a series of studies from 1969 to 1975 (Richardson 1973; Richardson and Percy 1977; Richardson et al. 1980).

Fish larvae were enumerated from 354 samples collected during six cruises during May-October 1969. Three types of gear -- bongo nets, meter-nets, and Isaacs-Kidd midwater trawls -- were employed in sampling. Larval abundances are summarized in Table 3. Total water volumes filtered over the six cruises by the various gears ranged 1,938,820m³ for all the Isaacs-Kidd tows to 1 1,370m³ for all the meter-net tows. Thus, as seen in Table 3, total larval abundances are usually more reflective of abundances of larvae collected with the mid-water trawls than with the other sampling gear. The midwater trawl caught the greatest number of taxa (38 vs. 25 for the bongos and 18 for the meter-net tows) and also had the greatest frequency of occurrence of major taxa. However, the bongos caught the most larvae. 1000m⁻³ of water filtered. Richardson (1973) concluded that the small estimates of larval abundance for each cruise from the Isaac-Kidd tows were probably caused by a high incidence of escape through the net by small larvae.

ORWA Finfish and Shellfish

Table 1. Commercial catches and economic value of most important finfish in ORWA OCS Planning Area (NMFS, 1985^b, 1984^b, 1983^a).

Species	Landings 10 ³ mt		Economic Value 10 ³ Dollars	
	Total	Average	Total	Average
Rockfish, other	76.3	25.4	33,217	11,072
Flounders	54.4	18.1	30,561	10,187
Pacific cod	35.0	11.6	18,326	6,108
Sablefish	27.0	9.0	14,989	4,996
Red salmon	13.8	4.6	38,762	12,920
Pacific hake	17.3	5.8	1,271	423
Alaska pollock	4.4	1.5	1,067	355
Chum salmon	11.4	3.8	15,554	5,184
Lingcod	9.0	3.0	4,886	1,628
Silver salmon	13.2	4.4	28,847	9,615
Halibut	6.3	2.1	14,528	4,842
Pacific ocean perch	7.7	2.6	3,416	1,138
Dogfish sharks	5.8	1.9	1,232	410
Albacore tuna	3.9	1.3	5,079	1,693
Pacific herring	2.4	0.8	1,528	509
Chinook salmon	9.9	3.3	37,929	12,643
Other fish	6.6	2.2	6,404	2,135
Total	308.3	102.8	261,378	87,126

ORWA Finfish and Shellfish

Table 2. Commercial catches and economic value of most important shellfish in ORWA OCS Planning Area (NMFS 1985b, 1984b, 1983a).

Species	Landings 10 ³ mt		Economic Value 10 ³ Dollars	
	Total	Average	Total	Average
Dungeness crabs	14.7	4.9	42,815	14,271.7
Northern shrimp	20.0	6.7	24,576	8,192
Oysters (meats)	6.6	2.2	14,277	4,759
Clams (unclasp.)	2.2	0.7	3,349	1,116.3
Squid	0.7	0.2	343	114.3
Sea scallops	0.9	0.3	3,226	1,075.3
Hard clams (meats)	0.9	0.3	2,940	980
Soft clams (meats)	<0.03	<0.01	43	14.3
Other shellfish	0.9	0.3	881	293.7
Total	47	15.7	95,349	31,783

ORWA Finfish

Table 3. Mean abundances of fish larvae (number" 1000m^{-3} of total volume of water filtered) off the Oregon coast, arranged by type of gear and month (from Richardson 1973).

Gear	May	June	July	-Aug.	Aug.	Sept.	Oct.	TOTAL
Bongo net	---	11.2	303.4	---		12.5	0.7	110.4
Meter net	100.0	116.1	42.2	27.4		22.1	1.4	51.7
Isaacs-Kidd midwater trawl	4.0	0.7	32.4	14.2		2.3	0.4	7.2
TOTAL	4.8	2.2	65.3	14.3		3.3	0.4	13.7

OR WA Finfish and Shellfish

Fish larvae collected with surface shallow tows (upper 20m) were compared with those collected with deep oblique tows (from 200m) at the same stations during the June and July-August cruises. Approximately the same volume of water was filtered for each pair of samples. As Table 4 shows, greater mean larval abundances were obtained with the shallow bongo net tows. In contrast, the deep tows yielded the greater mean larval abundances for the Isaacs-Kidd trawls. Anchovies (89.4% of total) dominated the catches from the shallow tows, followed by lanternfish (5.7%) and smelts (2.9%). Anchovies also dominated catches from the deep tows, although they were relatively less abundant (73.1% of total catch). Lanternfish were taken more frequently in deep tows (23.8%) and again ranked second; scorpionfishes (scorpionfish and rockfish) ranked third in abundance.

Anchovy larvae accounted for 78% of total catch in this study. They were most abundant in the Columbia River plume waters in June and July-August, and were associated with water with a temperature greater than 14°C. Anchovies off the Oregon coast comprise the northern subpopulation of the northern anchovy -- the central and southern populations are found off California and Baja California, respectively. Spawning occurs primarily in the upper 10m of the water column at temperatures greater than 14°C and, in the northern subpopulation, appears to be restricted to the warm, near-surface waters of the Columbia River plume (Richardson 1973).

Larvae of the northern lumpfish, Stenobranchius leucopsarus (a myctophid), ranked second in abundance followed by the blue lanternfish (Tarletonbeania crenulosa) and various unidentified species of rockfish (Sebastes spp.) (Richardson 1973).

Richardson and Percy (1977) found two distinct larval assemblages in a 1.5-yr. survey of an upwelling area off Yaquina Bay, along the mid-Oregon coast. The "coastal" assemblage, found 2-28km offshore, was dominated by smelts (Osmeridae), English sole (Parophrys vetulus), butter sole (Isosetta isolepis), and Pacific tomcod (Microgadus proximus). Samples from this coastal assemblage averaged 82.6 larvae under 10m² sea surface. The "offshore" larval assemblage occurred 37-111km from shore and averaged 73.4 larvae·10km⁻² sea surface. This group was dominated by larval Sebastes spp., northern lumpfish, blue lanternfish, slender sole (Lyopsetta exilis), and northern anchovy. Peak abundances in both larval fish assemblages occurred between February and July when more than 90% of all larvae were caught.

Larvae comprising the coastal and the offshore assemblages form distinct, geographically separated groups. Ninety-three percent of the larvae in the 53 coastal taxa and 96% of the larvae in the 31 offshore taxa were collected 2-28km or 37-111km offshore, respectively. Both adult spawning locations and current distribution patterns (predominantly north-south rather than inshore-offshore) seem to account for these distinct assemblages (Richardson and Pearch 1977).

ORWA Finfish

Table 4. Comparison of fish larval abundances (numbers" $1000m^{-3}$) as obtained by paired shallow (<20m) and deep oblique (from 200m) tows during 2 sampling periods, summer 1969 (from Richardson 1973).

Gear	June		July-August		TOTAL	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Bonga nets	43.6	8.9	456.8	370.0	233.0	194.3
Isaacs-Kidd midwater trawl	0.3	0.3	23.1	55.5	10.0	16.1
TOTAL	4.8	1.2	75.0	78.0	34.0	36.1

ORWA Finfish and Shellfish

Consistent patterns of **larval** fish distributions were found along the Oregon coast between the Columbia River and Cape Blanco during the winter-spring months over a four-year period. Coastal, transitional, and offshore assemblages of larval fishes were present during each sampling period. The region of transition from coastal to offshore assemblages **roughly** paralleled the shelf slope break, i.e., the 200m **isobath**. Mean abundances of larvae mean number under 10m² sea surface) from all stations were as follows (Richardson et al. 1980):

Date ----- >	3/72	4/72	3/73	4/73	3/74	3/75
Abundance-->	56.7	70.3	96.3	47.7	43.6	357.2

The high abundance of larvae in March 1975 was due primarily to large numbers of smelts. The most abundant larvae caught during all six sampling periods are summarized in Table 5.

ORWA Finfish and Shellfish

Table 5. Most abundant fish larvae caught over a 4-year survey along Oregon coast, 1972-1975 (from Richardson et al. 1980).

KEY to assemblages: C = coastal; T = transitional; O = offshore.

Smelts (undetermined spp.)	c
English sole	c
Butter sole	c
<u>Sebastes</u> spp.	o
Northern lumpfish	T, O
Starry flounder (<u>Platichthys stellatus</u>)	c
Pacific sand lance (<u>Ammodytes hexapterus</u>)	C, T
Cods (undetermined spp.)	C
Slender sole	o
Sailfishes {unidentified Cyclopteridae}	T, O

GULF OF ALASKA

FINFISH AND SHELLFISH

The Gulf of Alaska OCS Planning Area includes the Yakutat and Southeastern Regulatory Areas of the North Pacific Fishery Management Council (see Introductory chapter, Gulf of Alaska Fisheries). Most of the data in this section will divide the northeast Gulf into three regions: Prince William (west of 144°30'W; Yakutat (from 144°30'W to 140°00'W); and Fairweather (east of 140°00'W).

Salmon

Five species of Pacific salmon are found in the GOAK: pink salmon (*Oncorhynchus gorbuscha*), sockeye salmon (*O. nerka*), chum salmon (*O. keta*), coho salmon (*O. kisutch*), chinook salmon (*O. tshawytscha*).

Life history data for these species are summarized in Table 1, and the average total salmon run, from 1955-1975, is depicted in Figure 1. The salmon run is greatest in Prince William Sound, where an average of nearly seven million fish have participated in the recent past. In 1979 the Prince William Sound area exhibited the largest commercial salmon catch (more than sixteen million fish) of the past two decades (Figure 2).

Generally, the commercial catch of salmon in the Yakutat region (Cape Suckling to Cape Fairweather) is small compared with that of the rest of Alaska, though it is important to the local economy. The largest catch reported in the period 1960-1978 was about 350,000 fish in 1977, although the fishery exhibited no obvious trend away from an average of more than 225,000 fish during this period (Figure 3). The commercial fishery off Yakutat utilizes set gillnets and trolling gear.

There is a small sport fishery for coho, chum, and chinook salmon in the Gulf of Alaska, but catches are not significant compared to the commercial harvest (Rogers et al. 1983 b).

Groundfish

Table 2 summarizes estimated biomass of demersal fish groups in the northeastern GOAK. Flatfish, the dominant group, were 58% of the total fish biomass. Average catch per unit effort (CPUE) for this fishery, summarized from NMFS research trawl surveys during the 1970's, are listed in Table 3.

Walleye pollock comprise the majority of the roundfish harvest of groundfish in the northeast Gulf of Alaska, accounting for 79% of the catch in the Prince William region, 55% in Yakutat, and 22% in Fairweather. Distribution of the pollock catch rates are summarized in Figure 4. The most abundant flatfish is arrowtooth flounder (turbot, *Atheresthes stomias*), with greatest CPUE in the Yakutat region (Figure 5) where it is 42% of the flatfish catch.

GOAK Finfish and Shellfish

Table 1. Life history information for five species of Pacific salmon occurring in the northeastern Gulf of Alaska {from Tamm 1980).

<u>Characteristics</u>	<u>Species</u>				
	<u>Pink</u>	<u>Sockeye</u>	<u>Chum</u>	<u>Coho</u>	<u>Chinook</u>
<u>Freshwater habitat</u>	Short streams	Streams, rivers, ● d lakes	Short and long streams	Streams and rivers	Large rivers
<u>Length of time young stay in fresh water after hatching</u>	several days to several weeks	1-4 years	Less than 1 month	1 to 2 years	3 to 12 months
<u>Length of ocean life</u>	1-1/3 years	1/2 to 4 years	1/2 to 5 years	1 to 2 years	1 to 5 years
<u>Year of life at ● aturity (years)</u>	2	3 to 7	2 to 6	2 to 4	3 to 8
<u>Average length at maturity (cm)</u>	50.8	63.5	63.5	61	91.4
<u>Average weight at maturity (kg)</u>	1.8	2.7	4.1	4.5	10
<u>Range of weight at maturity (kg)</u>	0.9 to 4.1	0.7 to 4.5	1.7 to 20.4	1.7 to 13.6	1.1 to 66.8
<u>Fecundity (number of eggs)</u>	2,000	3,700	3,000	3,500	4,800

GOAK Finfish and Shellfish

Table 2. Estimated biomass (metric tons) of **demersal** fish groups in northeastern **GOAK** (Prince William, **Yakutat**, and Fairweather regions combined). May-August, 1975 and April, 1976 (from **Ronholt et al.** 1978).

Depth interval (m)	Flat fish	Roundfish	Rockfish	Elasmobranchs	All fish
1 - 100	50,400	31,000	300	7,200	88,900
101-200	69,100	42,700	6,700	10,900	129,400
201-400	41,600	8,600	5,400	4,000	59,600
All depths	161,103	82,300	12,400	22,100	277,900

Table 3. Average catch rates (geometric means of **CPUE**) for demersal fisheries in northeastern **GOAK**, estimated from **NMFS** research trawl surveys for the period 1973-76 (from **Ronholt et al.** 1978).

Area	Flat fish	Roundfish	Rockfish	Sharks & Rays
Prince William	107	101	2	8
Yakutat	166	46	9	22
Fairweather	83	3	3	14

GOAK Finfish and Shellfish

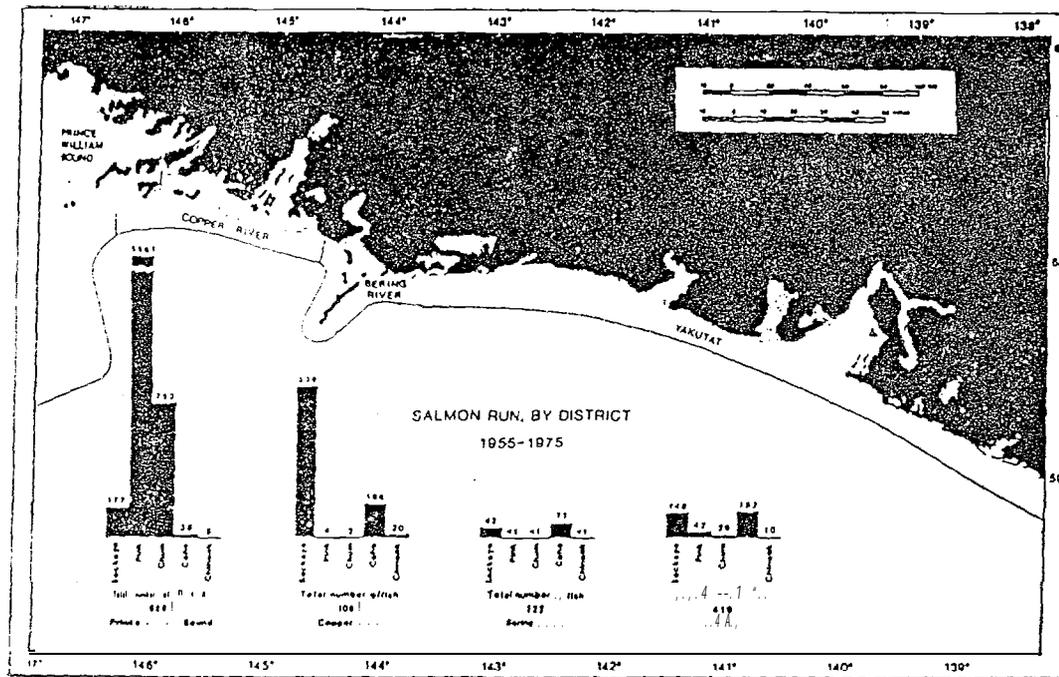


Figure 1. Estimates of average Pacific salmon run, 1955-1975. Note that these are organized by northeast Gulf of Alaska districts, Alaska Department of Fish and Game. Data in 1000's of fish (Tamm 1980).

GOAK Finfish and Shellfish

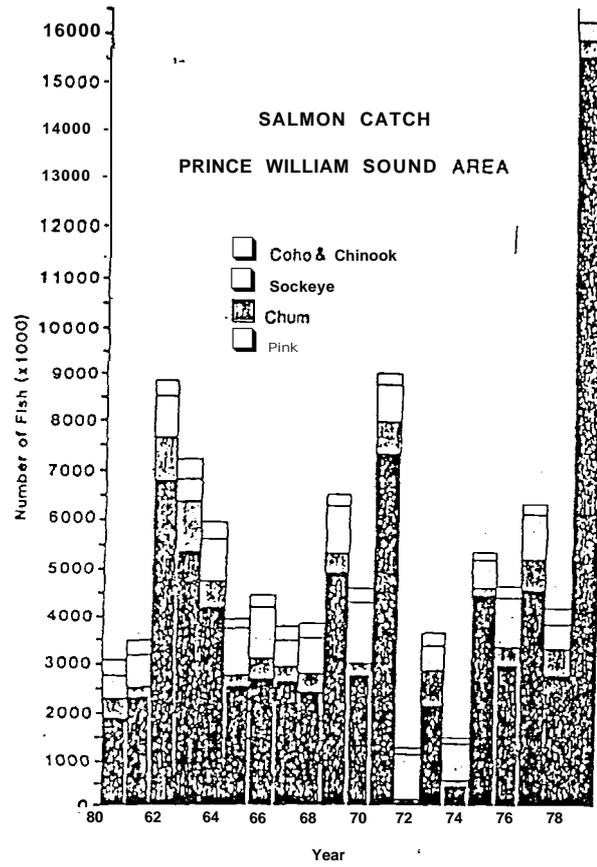


Figure 2. Annual salmon catch from the Prince William Sound area, GOAK (Tamm 1980).

GOAK Finfish and Shellfish

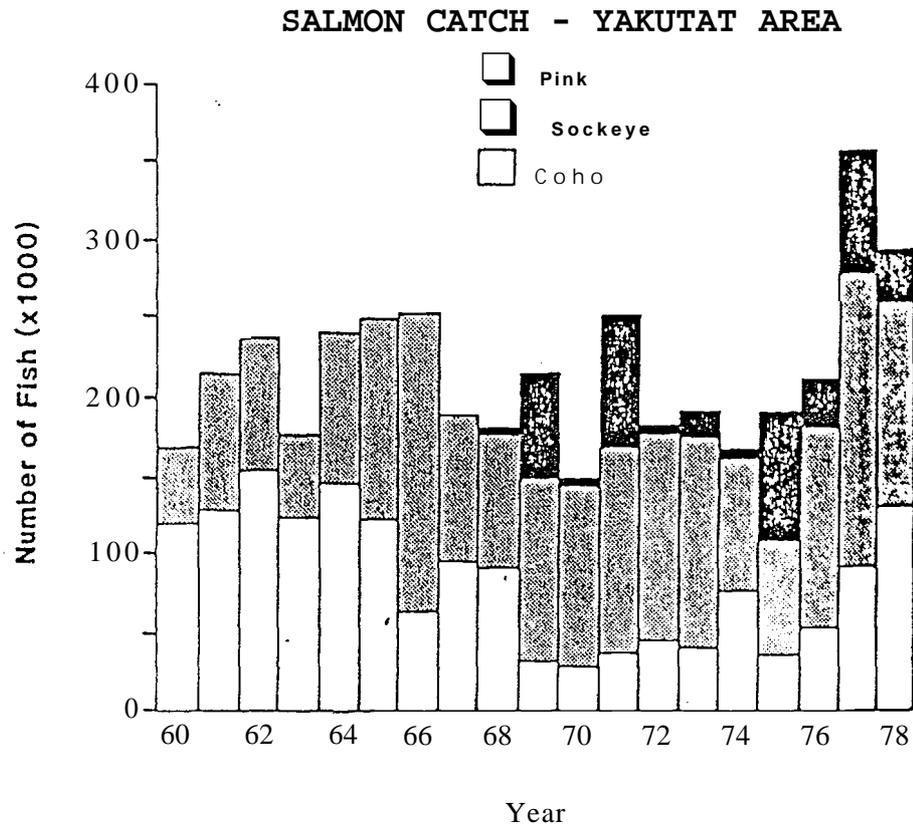


Figure 3. Annual salmon catch from Yakutat region, northeastern GOAK (Tamm 1980).

GOAK Finfish and Shellfish

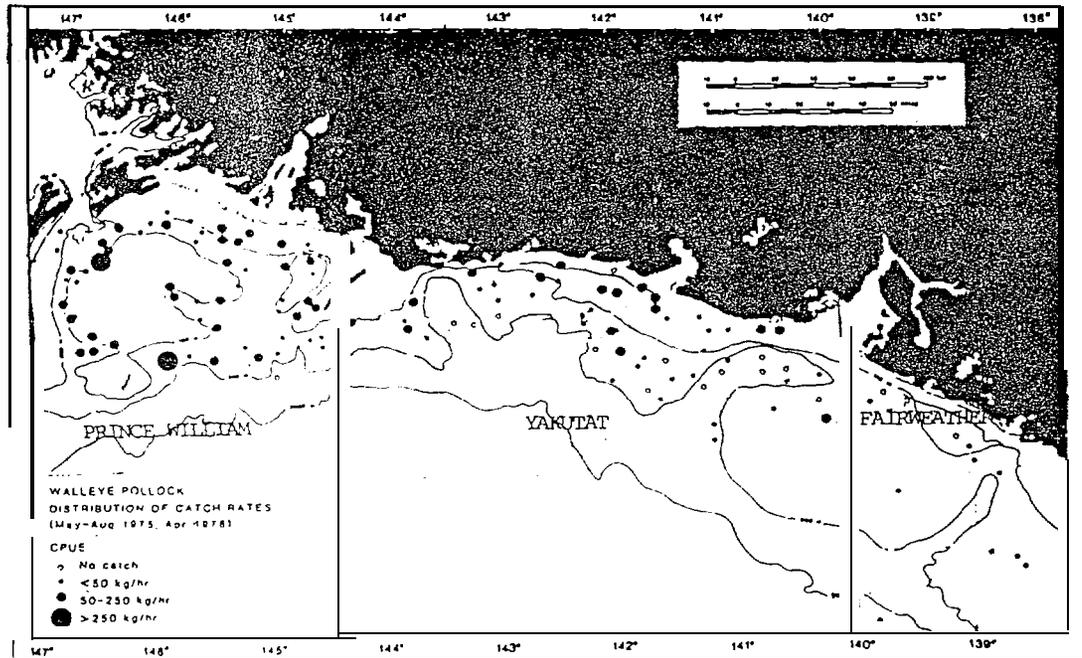


Figure 4. Distribution of standardized catch rates (CPUE) for walleye pollock according to NMFS survey data (from Ronholt *et al.* 1978).

GOAK Finfish and Shellfish

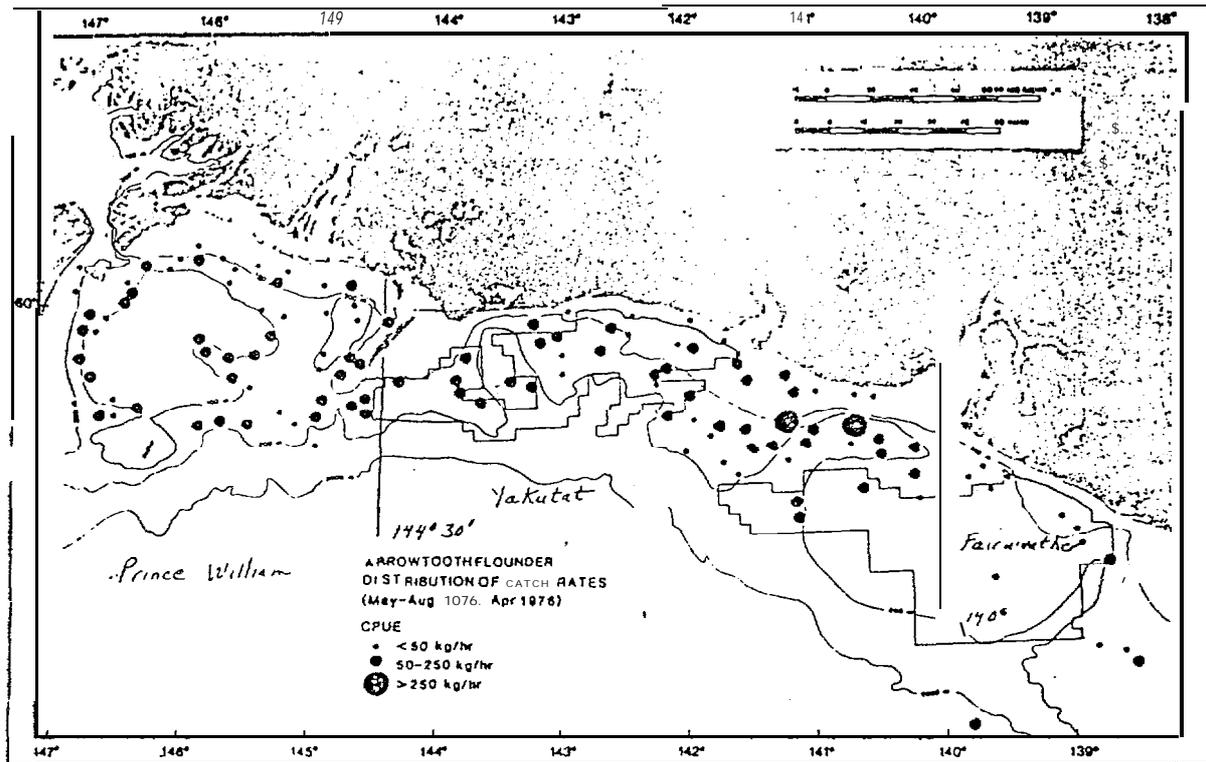


Figure 5. Distribution of standardized catch rates (CPUE) for arrowtooth flounder, according to NMFS survey data (from Ronholt *et al.* 1978).

GOAK Finfish and Shellfish

Arrowtooth flounder are most abundant in the 200-400m depth interval (Ronholt et al. 1978).

Prince William Sound (Figure 6) is a great embayment in the extreme North Pacific Rim, surrounded by the **Chugach** Mountains, **Kenai** Peninsula, and the Copper River delta. Major physiographic features of the region include mountains {which may rise sharply from the water's edge to summits over 900m high), the heavily wooded shoreline, and a rocky irregular coastline. Few sandy beaches are present, except on the southern shores of **Hinchinbrook** and Montague Islands (Rosenthal 1983}. Although the general climate in the northeastern **Gulf** of Alaska is generally temperate, there are frequent **cyclonic** storms. The temperature range in the upper 5m of the water column of Prince William Sound is 2-15°C {Rosenthal 1983}.

Rosenthal (1983) reported data from four sampling sites believed to be representative of key habitats in the region. Samples were taken on a seasonal basis, 1977-79, August and September, and April-August. These sites, the locations of which are shown in Figure 6, are described as follows:

Danger Island

In the extreme southwest of Prince William Sound, a major reef extends for approximately 4km off Latouche Point and eventually merges with Danger Island. The sampling site possesses a steep shore gradient, high wave and tidal energy, rocky kelp beds, and heavy algal cover.

Schooner Rock

This small rocky islet off the eastern end of Zaikof Point was the primary study site in **Hinchinbrook** Entrance. The site also has a steep shore gradient and nearshore kelp bed.

Constantine Harbor

This is a small embayment along the north shore of **Hinchinbrook** Entrance. The shore gradient is low, with medium wave and tidal energy, a **lush** eelgrass meadow, and a bottom substrate of sand, mud, and shell debris. Rockweed is common in the intertidal zone and laminarian kelps replace the eelgrass in the deeper parts of the Bay.

Zaikof Point

This site, a narrow rocky shelf on the south side of Zaikof Bay, is characterized by a moderate gradient, medium energy shoreline, rocky kelp bed, and heavy algal cover.

GOAK Finfish and Shellfish

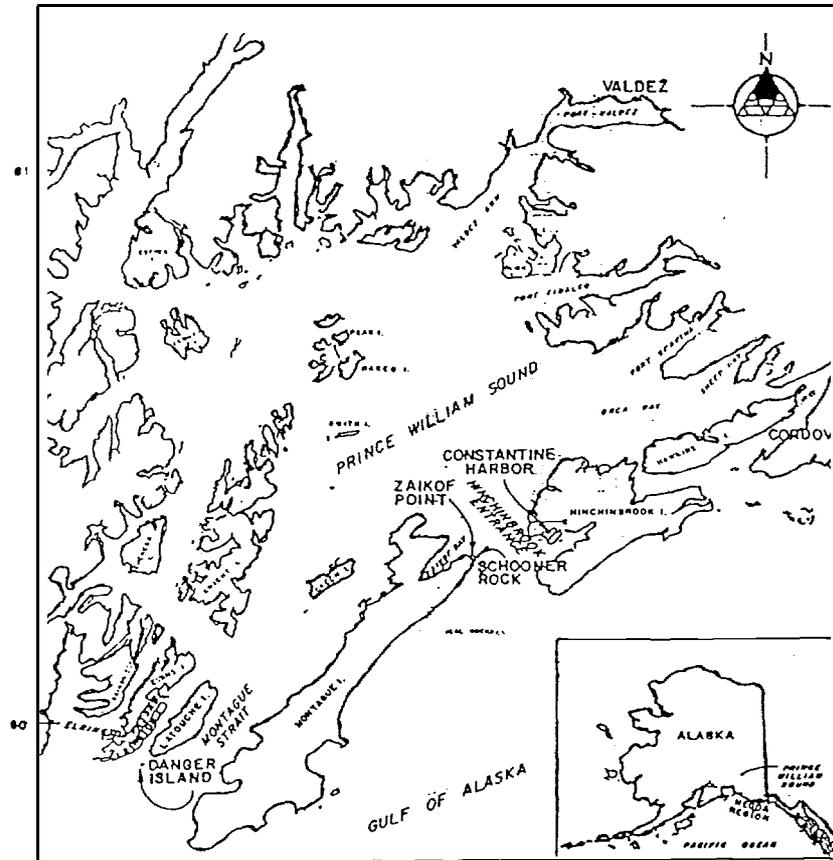


Figure 6. Prince William Sound, northeastern Gulf of Alaska (GOAK), showing locations of shallow water study sites used in the study of Rosenthal (1983).

GOAK Finfish and Shellfish

A total of 68 fish species from sixteen families were collected from these sites during the course of Rosenthal's (1983) study, most taken from the shallow sublittoral zone at depths of 2-30m. Species from Danger Island and Schooner Rock were associated with exposed rocky coastline habitats, but fishes from Constantine Harbor were more typical of those found in protected estuaries and embayments. Zaikof Point exhibited the highest fish diversity, undoubtedly reflecting its intermediate habitat types. However, biomass estimates and fish abundance were generally greatest at the exposed Schooner Rock and Danger Island sites, and there was a positive correlation between fish biomass and degree of bottom relief. The following summarizes diversity and biomass data for each of the study sites.

Zaikof Point 38 species
 1110.2 fish·ha⁻¹ (fixed-transect)
 biomass: 833 kg·ha⁻¹

 889.6 fish·ha⁻¹ (random-transect)
 biomass: 62.7-1350.4kg·ha⁻¹

Greenings (Hexagrammidae) were 56% of the total species taken; the kelp greenling (Hexagrammos decagrammus) was the most frequently encountered, accounting for 49% of the total abundance. Other abundant bottomfishes were Alaskan ronquil (Bathymaster caeruleofasciatus), rock greenling (H. lagocephalus), and red Irish lord (Hemilepidotus hemilepidotus). The most abundant schooling fishes were the black rockfish (Sebasters melanops) and dusky rockfish (S. ciliatus) which occupy the multi-layered kelp forest.

Danger Island 32 species

 5333.0 fish·ha⁻¹ (fixed-transect)
 biomass: 4803kg·ha⁻¹

 1526.9 fish·ha⁻¹ (random-transect)
 biomass: 313.9-3549.2kg·ha⁻¹

Danger Island ranked second in species abundance. Rockfish (Scorpaenidae) were represented by six regularly counted species; this group comprised 66% of the fish in the nearshore zone. As at Zaikof Point, black rockfish were the dominant species of this assemblage. The kelp greenling was the most abundant and widely distributed member of the solitary bottom fish guild; other important bottom species were longfin sculpin (Jordanea zonope), lingcod (Ophiodon elongates), and Alaska ronquil.

GOAK Finfish and Shellfish

Schooner Rock 29 species

7925.0 fish·ha⁻¹ (fixed-transect)
biomass: 5480.7 kg·ha⁻¹

4436.2 fish·ha⁻¹ (random-transect)
biomass: 133.7-6833.5 kg·ha⁻¹ (north face)
0.33 -3083.7 kg·ha⁻¹ (south face)

At this second most-exposed sampling site, black and dusky rockfish were again the most abundant schooling fish. The family Scorpaenidae dominated sampling sites on both the north and south faces of the islet. The most abundant bottom fishes were Alaskan ronquil, kelp greenling, wolf-eel (Annarrhichthys ocellatus), padded sulpin (Artedius fenestralis), and Pacific halibut (Hippoglossus stenolepis). Fish densities were highest in the shallow and sublittoral waters of the north end of the Rock. The large schools of black and dusky rockfish contributed to the highest biomass observed at the four sampling sites.

Constantine Harbor 27 species

1211.1 fish·ha⁻¹
biomass: 222.2-268.3 kg·ha⁻¹ (early September)
0.55 kg·ha⁻¹ (April)

Only ten of the 27 species collected were seen with any degree of regularity at this protected site. Greenings dominated the catch, even though in contrast to the other sites the kelp greenling did not occur. Whitespotted greenling (H. stelleri) accounted for 71% of the fish at this site. Other abundant solitary bottom species were starry flounder (Platichthys stellatus), Arctic shanny (Stichaeus punctatus), masked greenling (H. octogrammus), and crescent grunnel (Pholis laeta). Most abundant schooling fishes in the eelgrass meadow were juvenile yellowtail rockfish (Sebastes flavidus) and young Pacific tomcod (Microgadus proximus). The increase in summer fish biomass accompanied the influx of fish into the eelgrass meadows.

In summary, summer peaks in both density and species richness, followed by strong declines during oceanic winter, occurred at both exposed and protected sites. Bathymetric shifts in areas of distinct relief were very evident along the exposed rocky coastline. Seasonal horizontal movement of the fishes in these areas may have been less than a few hundred meters. In contrast, the inshore fish fauna were rarely encountered in the shallow embayments or along the extensive shores of Prince William Sound during winter. These fishes must travel considerable distances in order to find depths and sites suitable for winter habitat (Rosenthal 1983).

GOAK Finfish and Shellfish

The major fisheries in Prince William Sound, in order of economic value, have been salmon (**all** species), snow {Tanner} crab, and herring (roe and bait, as well as herring spawn on kelp, a Japanese delicacy). Landings and economic value of these fisheries are summarized in Table 4.

Herring spawn in the intertidal and high subtidal zone and egg densities on favorable substrates can be exceedingly high (Table 6).

If heavy egg deposition occurs in extensive kelp beds, a small length of beach can represent a large biomass of spawning herring. For example, studies at Boca de Quadra over a five-year period showed a range of 317.5 -2,630.9 metric tons of herring spawners per linear mile of beach receiving spawn. Herring apparently spawn over a larger **tidal** depth range (+3.7m to -11m) in southeastern Alaska than in the Bering Sea. Depths at which spawning occurs apparently depend upon availability of suitable habitat (i. e., kelp beds). Depth preference for herring spawning varies from year to year and from place to place, as is seen below (Blankenbeckler and Larson 1982, Table 7).

A research trawl survey was conducted in the spring of 1978 to determine if sufficient groundfish were available to keep processing plants busy during the slack periods of April-June, between the end of the Tanner crab season and the beginning of the salmon season. Mean CPUE and estimates of exploitable biomass are summarized in Table 5.

The trawl survey results indicated that groundfish abundance in Prince William Sound during the spring was very low relative to most coastal waters in the Gulf of Alaska. the groundfish taken during this survey were dominated by species of low economic value, and many of the individuals taken were juveniles. Parks and Zenger (1979) therefore concluded that there was poor potential for development of profitable trawl fisheries within the Sound.

SHELLFISH

The distribution of benthic invertebrates in the Prince William, Yakutat, and Fairweather regions of the northeastern GOAK is summarized in Figure 7. The greatest CPUE were in the Prince William area and off Yakutat Bay, Rogers et al.(1983b) have summarized life histories of the various important commercial shellfish species in this region and have reviewed historical catch statistics.

Reported commercial catches (metric tons) of snow {Tanner} crabs for portions of this region are summarized in Table 8.

Figure 8 depicts distributions and relative abundance of pink shrimp for the northeast Gulf of Alaska. The shrimp fishery was initiated in Yakutat Bay in the 1979-80 season after intense fishing effort overloaded the handling facilities at Kodiak. The Alaska Department of Fish and Game set a quota of

GOAK Finfish and Shellfish

Table 4. 1977 landings and economic values of the principal fisheries in Prince William Sound, GOAK (Parks and Zenger 1979).

Fishery	Landings (metric tons, except salmon)	Economic value \$ x 1000
Salmon (all species)	6,266,600. fish	17,000
Snow (tanner) crab ¹	2,180	1,947
Herring	2,260	1,044
Dungeness crab	334	221
King crab	39	117
Bottomfish ²	38	25
Shrimp	79	20
Razor clams	1	1.6
Marine whelks or snails	4	0.6

¹1977-78 season

²used primarily for crab bait

GOAK Finfish and Shellfish

Table 5. Mean CPUE and estimated exploitable biomass for demersal fish in Prince William Sound, GOAK, based on trawl survey data obtained in spring, 1978. Total distance trawled was 13,630km (from Parks and Zenger 1979).

Species	CPUE	Biomass, metric tons
FISH:		
Walleye pollock	162	15.6
Skates	59	5.8
Arrowtooth flounder (turbot)	40	4.0
Flathead sole	33	3.2
Pacific halibut	29	2.9
Eulachon	25	2.5
Spring dogfish	15	2.1
Sculpins	14	1.6
Yellowfin sole	13	1.1
Starry flounder	7	0.6
Rex sole	6	0.6
Sablefish	5	0.7
Pacific cod	5	0.4
TOTAL :	413	41.1
SHELLFISH:		
Snow (Tanner) crab	144	16.2
Red king crab	11	1.3
Sidestripe shrimp	5	0.3
TOTAL :	160	17.8

GOAK Finfish and Shellfish

Table 6. Estimates of densities of herring egg deposition on various substrates in the Boca de Quadra region near the southeastern Alaska border in the Gulf of Alaska (Blankenbeckler and Larson 1982).

Substrate type	High Estimate (m ⁻²)	Average Estimate (m ⁻²)	Z substrate utilization 1979-1980
<u>Fucus</u> (rockweed)	2.6x10 ⁶	519,120	15%
Mid to low tidal kelp and <u>Zostera</u>	3.5X10 ⁶	679,300	30%
Lower tidal large kelps (e.g. <u>Laminaria</u>)	4.2x10 ⁶	697,640	34%
Lower tidal	2.9x10 ⁶	1,500,000	19%

GOAK Finfish and Shellfish

Table 7. Depth preference for herring spawning (Blankenbeckler and Larson 1982).

Area and year	% Upper intertidal	Mid and low tidal	Sub-tidal	Total %
Boca de Quadra				
1979	15	27	58	100
1980	15	37	48	100
Juneau				
1980	3	0	97	100
Sikta				
1978	26	29	45	100
Seymour				
1980	40	11	49	100

GOAK Finfish and Shellfish

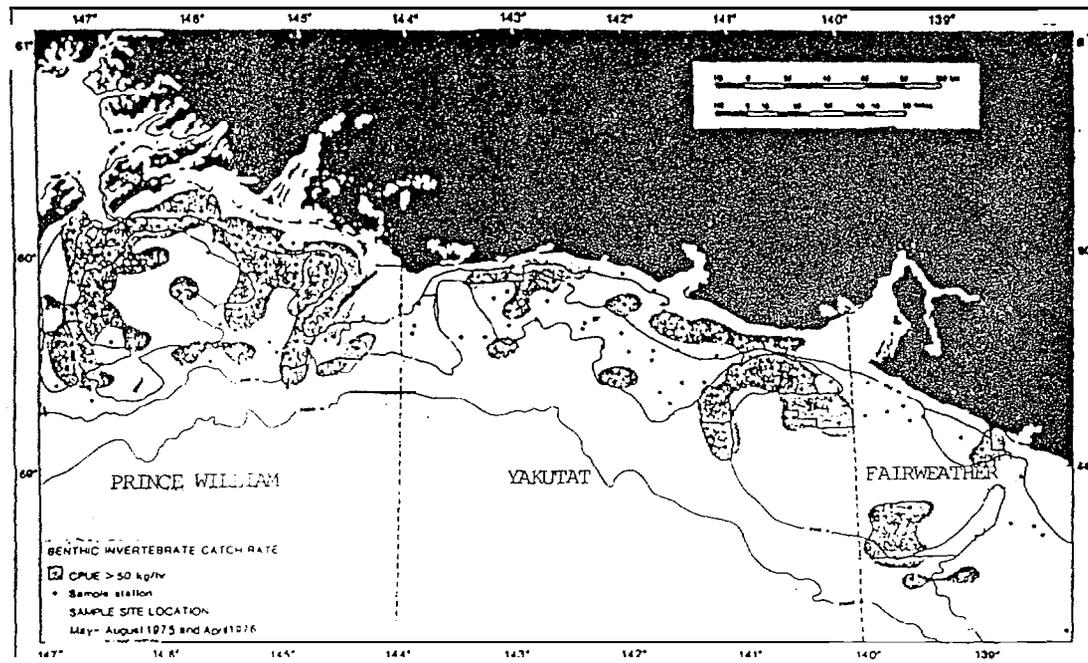


Figure 7. Benthic invertebrate catch rate based on trawl surveys in northeastern Gulf of Alaska, May-August 1975 and April, 1976. Shaded zones show areas where CPUE was greater than $50\text{kg}\cdot\text{hr}^{-1}$.

GOAK Finfish and Shellfish

Table 8. Reported commercial catches (metric tons) of snow {Tanner) crabs for **GOAK**.

Year	Yakutat	Fairweather	All Alaska
1971			5,842
1972	7	13	13,669
1973	94	133	27,996
1974	849	281	28,988
1975	917	526	21,254
1976	777		
1977	461		
1978	449		
1979	442		
1980	1,147		

¹Cape Suckling to Cape Fairweather

²Yakutat Bay to Cape Fairweather

GOAK Finfish and Shellfish

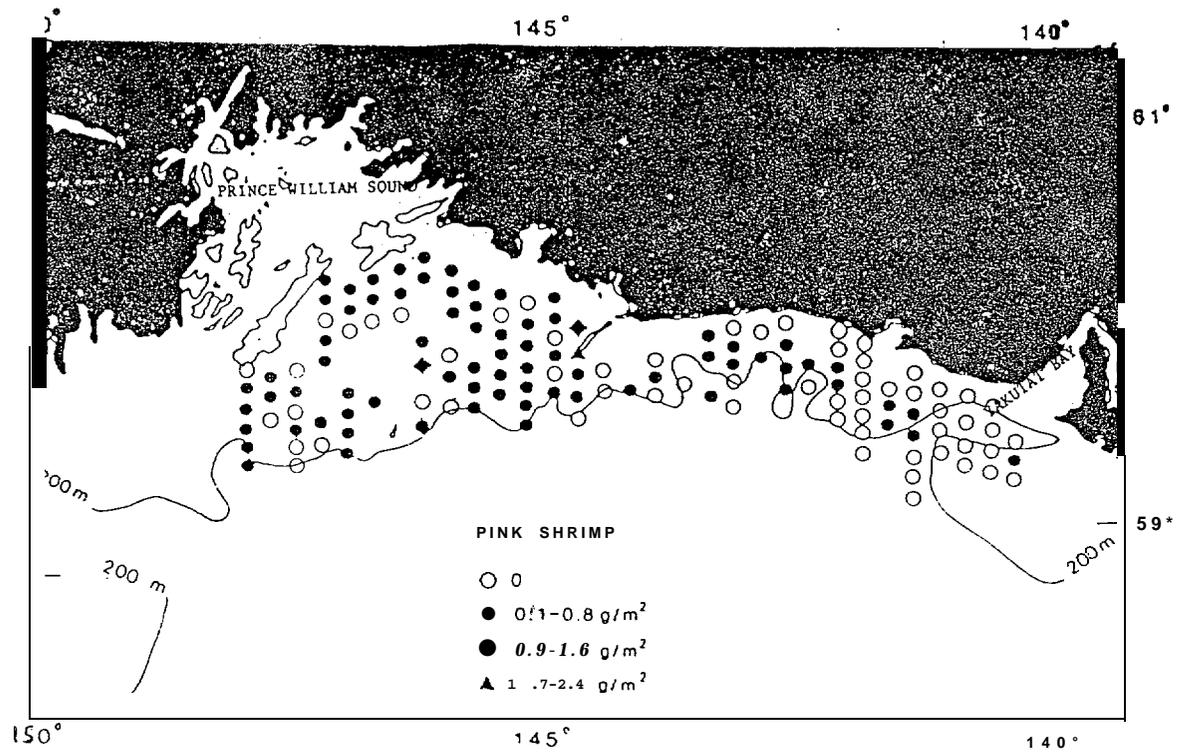


Figure 8. Distribution and abundance of pink shrimp (*Pandalus borealis*) from northeastern Gulf of Alaska trawl survey, summer 1975 (from Feder and Jewett 1979).

GOAK Finfish and Shellfish

680.4 metric tons, and after it was surpassed by 90.7 metric tons the Bay was closed to fishing for the year. Subsequent experimental trawling in Yakutat Bay indicated a shrimp density of 23.8 metric tons·km⁻² (Rogers et al. 1983 b).

Weathervane scallops (*Patinoplectin courinus*) occur from California to Alaska with commercially harvestable beds around Kodiak Island and in the Yakutat region. Scallops inhabit mud, clay, sandy, or gravel bottoms and are most abundant at depths of 37-128m with the majority taken around 90m. Commercially taken scallops range in age from 7-11 years; they are sexually mature by their third year at a size of 7.6-12.7cm in height (Rogers et al. 1983 b). Scallop distribution in the northeastern GOAK is shown in Figure 9. The Yakutat area was important during the first two years of the scallop fishery, and again in the 1974-77. The fishery was inactive during 1978 and 1979 due to a decline in the resource and adverse market conditions. The fishery then resumed in 1980, and this harvest was estimated at approximately 113 metric tons (Rogers et al. 1983b).

GOAK Finfish and Shellfish

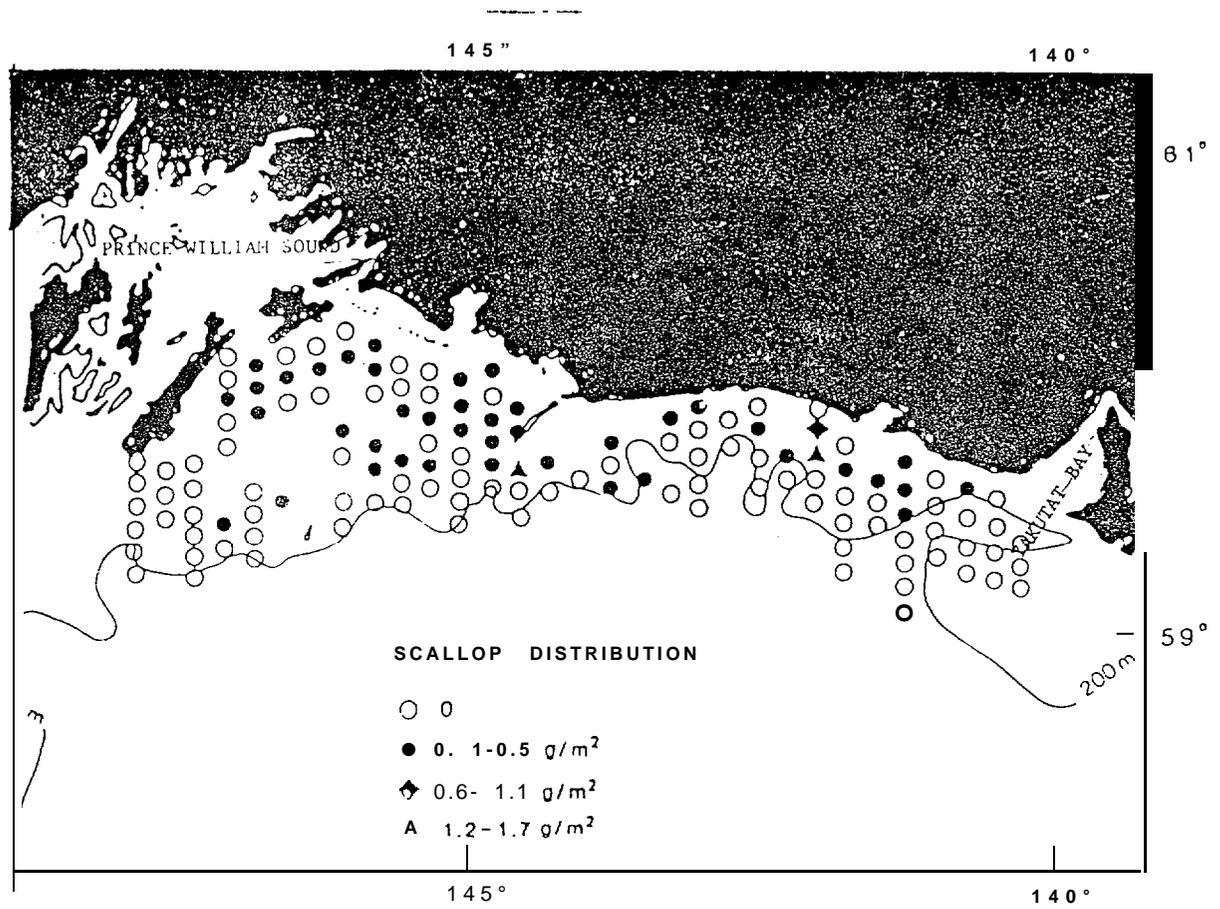


Figure 9. Distribution and abundance of the weathervane scallop (*Patinopecten caurinus*), based on northeastern Gulf of Alaska trawl survey, summer 1975 (from Feder and Jewett 1979).

KODIAK

FINFISH AND SHELLFISH

The continental shelf and nearshore waters of the Kodiak Archipelago are among the most productive in the world, supporting commercial fisheries for halibut, salmon, and crab (Rogers, et al. 1983a). The Archipelago (Figure 1) is located in the western Gulf of Alaska southeast of the Alaska Peninsula. It is composed of numerous islands, sixteen of which have an area larger than 18km²; Kodiak Island (9293km²) and Afognak Island (1813km²) are the largest. Mountains rise sharply from the ocean floor to elevations of more than 1200m and the coastline is carved by narrow bays and fjords. Most of the shoreline is composed of rocky bluffs and narrow beaches. Climate is maritime, with cloudy skies, moderately heavy precipitation, and average temperatures ranging from -5°C to 15°C. The continental shelf extends offshore of the Kodiak Archipelago to approximately 120km.

Fish Population Surveys of Kodiak Archipelago

Fish populations in the nearshore habitats of the Kodiak Archipelago have been extensively sampled under a comprehensive food habits study (Rogers, et al. 1983a). Study areas included four bays (Izhut, Kalsin, Kiliuda, and Kaiugnak) located on the eastern side of Afognak and Kodiak Islands (Figure 2). Fishes were collected using five types of gear: (beach seine, trammel net, townet, trynet, and otter trawl) according to the different types of habitat to be sampled (Figure 3). With the exception of the Dolly Varden and adult pink salmon, the beach seine, trynet, and townet sampled primarily small fishes, whereas larger fish were taken by the trammel net and otter trawl.

Table 3 summarizes average catch per beach seine haul. Catches were lowest during the winter; the high summer peak is due in part to an influx of immigrating pink salmon. Sculpins, greenings, and salmonids dominated these beach seine catches. Trammel net catches were dominated by rock greenling throughout the year (Table 4). The townet sampled surface-dwelling pelagic "forage fishes" (Table 5), although these were the most incompletely surveyed group due to the small catches of the net. The large summer catches were due to the abundance of Pacific sand lance.

Trynet hauls fished the banks and shelves of the study bays. Soles, primarily rock sole and yellowfin sole, and sculpins dominated the catches in all seasons (Table 6). Catches increased during spring, peaked in summer, and remained relatively high in the autumn. Table 7 summarizes otter trawl catches by season (note catch units in kg rather than g as in previous tables). The otter trawls fished the deepest portions of the bays, 70-100m; average catches exhibited less of a seasonal pattern in total biomass as compared with data obtained by other gear which fished the more nearshore component of the fish populations. Right-eyed flounders (soles) and sculpins (MYOXOCEPHALUS spp. and yellow Irish lord) dominated catches in all seasons (Rogers, et al. 1983a).

KODK Finfish and Shellfish

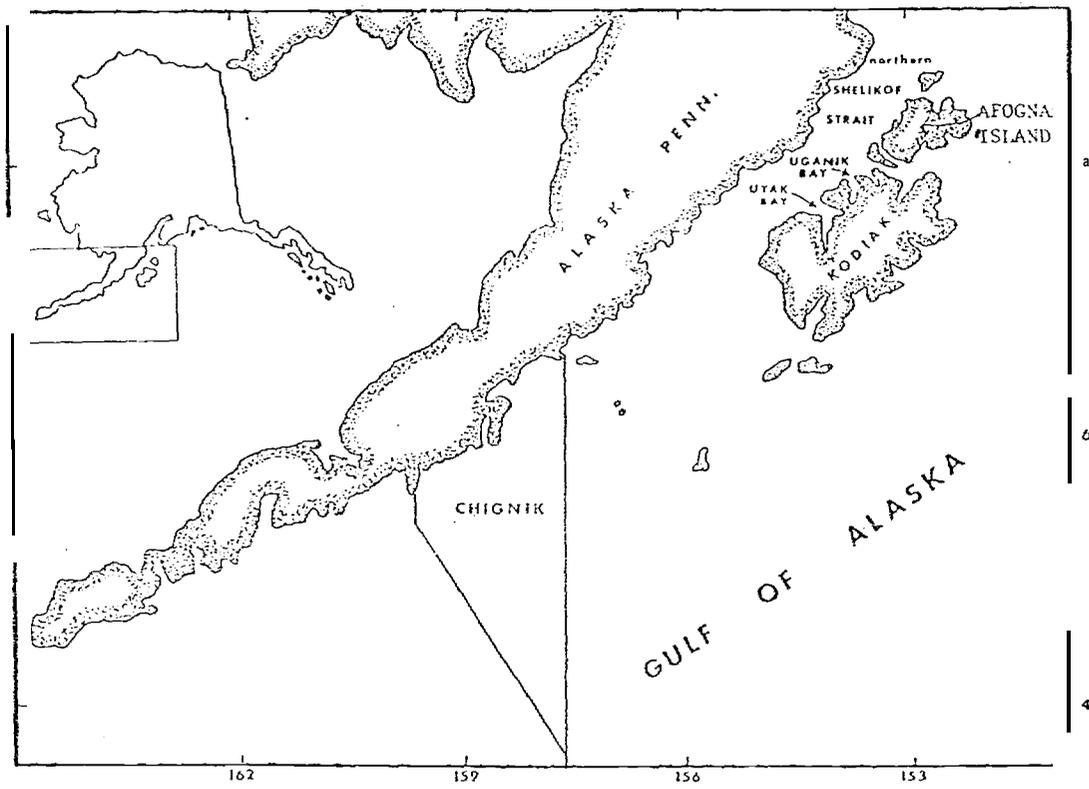


Figure 1. Western Gulf of Alaska and Kodiak Archipelago (from Colgate and Hicks 1983).

KODIAK Finfish and Shellfish

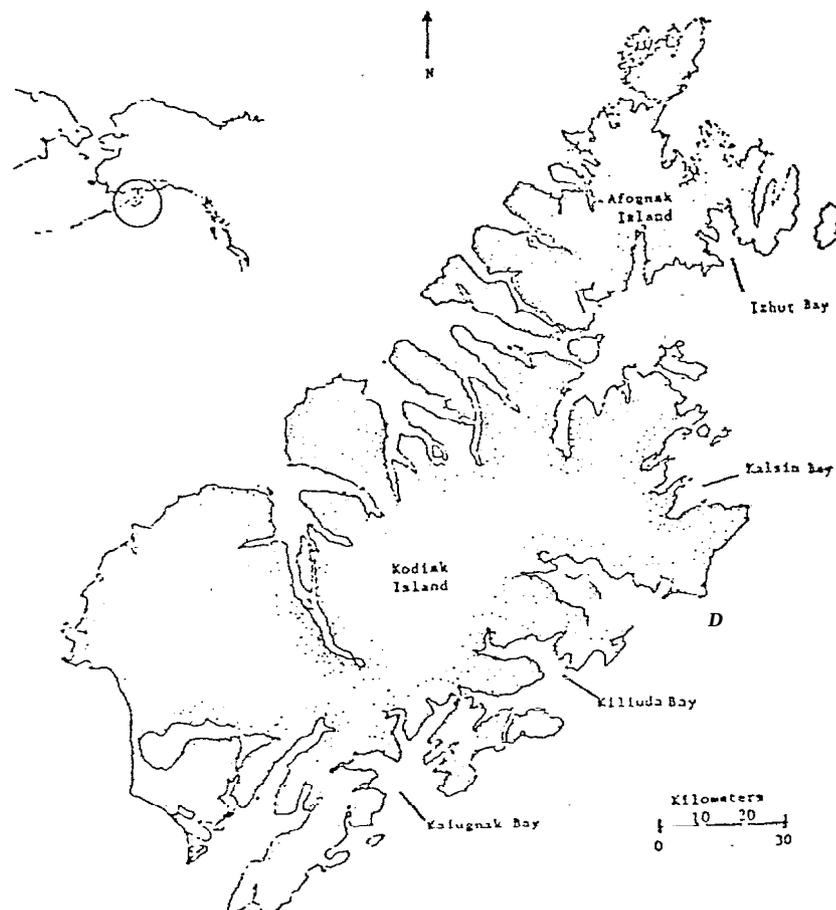


Figure 2. Locations of fish sampling sites for the Kodiak foodhabit surveys, 1978 and 1979 (from Rogers, et al. 1983a).

KODK Finfish and Shellfish

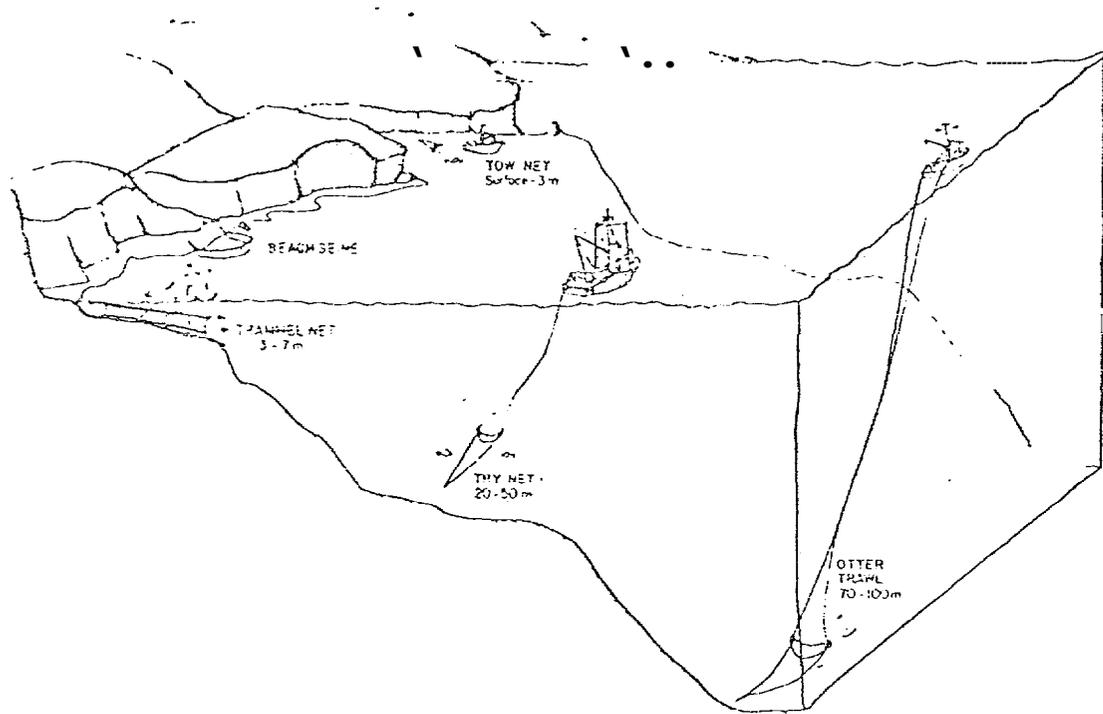


Figure 3. Sampling gear used in Kodiak food habits survey, showing major habitats sampled by each (from Rogers, *et al.* 1983a).

KODK Finfish and Shellfish

Table 3. Beach seine samples: average catch (g wet wt.) per haul in Kodiak food habits survey (from Rogers, et al. 1983a).

Species	Winter	Spring	Summer	Autumn
Masked greenling	9.0	45.7	77.7	26.4
<u>Myoxocephalus</u> spp.	6.6	124.5	52.2	152.4
Rock greenling	4.1	20.7	23.7	7.7
Dolly Varden	3.0	77.5	118.2	40.4
Rock sole	1.9	27.4	35.1	27.5
Pink salmon	1.4	26.7	2201.9	
Silverspotted sculpin	1.3			
Chum salmon		10.3		
Whitespotted greenling		9.1	55.8	3.3
Starry flounder		5.4	9.5	9.8
Staghorn sculpin			26.8	
Pacific sand lance		33.0	299.0	12.9
<u>Total Biomass</u>	31.3	406.4	2928.0	286.3

KODK Finfish and Shellfish

Table 4. Trammel net samples: average catch (g wet wt.) per 2-hr set in Kodiak food habits survey (from Rogers, et al. 1983a).

Species	Winter	Spring	Summer	Autumn
Masked greenling	12.7	894.9	4477.5	818.2
<u>Myoxocephalus</u> spp.	125.8	22.2	248.8	859.8
Rock greenling	437.5	6717.1	9951.9	2139.3
Dolly Varden			75.7	
Rock sole	117.1	674.3	61.0	78.3
Pink salmon			9.6	
Whitespotted greenling	2.1	334.9	1290.8	82.0
Starry flounder	1.7	2.8	3.3	
Staghorn sculpin		5.4	5.5	
Kelp greenling	3.2	34.4	20.8	68.0
Tomcod	1.9			
Yellowfin sole		5.3	11.5	
Pacific herring		4.9		
Halibut		4.6	3.9	
Pacific cod		3.6	51.0	3.2
Butter sole		1.5		
Red Irish lord			66.6	3.3
Unidentified sculpin				23.1
Buffalo sculpin				1.3
<u>Total Biomass</u>	747.2	0744.4	18,337.8	4076.5

KODK Finfish and Shellfish

Table 5. Townet samples: average catch (g wet wt.) per 10-min. haul in Kodiak food habits survey (from Rogers, et al. 1983). **a**

Species	Winter	Spring	Summer	Autumn
Pacific sand lance	1.4		80.6	
Threespine sticklebacks	1.3	1.1	0.4	
Cape lin	0.6	2.4	0.3	0.4
Chum salmon		4.6	0.2	
Pink Salmon		0.8	7.1	
Lingcod			1.1	
Prowfish			0.8	
Whites. patted greenling			0.3	
Silverspotted sculpin			0.1	
<u>Total Biomass</u>	3.3	8.9	90.9	0.4

KODK Finfish and Shellfish

Table 6. Trynet haul samples: average catch (g wet wt.) per 10-min. haul in Kodiak food habits survey (from Rogers, et al. 1983a).

Species	Winter	Spring	Summer	Autumn
Rock sole	240.8	1060.9	1834.4	1370.2
<u>Gymnocanthus</u> spp.	47.5	235.6	323.1	61.3
Yellowfin sole	12.9	1187.1	3576.0	626.1
<u>Myoxocephalus</u> spp.	12.4	102.3	849.1	177.3
WhiteSpotted greenling	3.6	76.1	120.1	69.1
Flathead sole	3.0	47.3	226.8	14.6
Undentified snailfish	2.8			
Starry flounder	2.0	13.9		
Staghorn sculpin	1.5	4.6		
Pacific cod	1.4	4.7		
Butter sole		15.6	56.1	12.9
Yellow Irish lord		14.4	184.7	
Hallibut		10.8	51.5	11.3
Pacific cod		4.7		
Arrowtooth flounder			22.5	3.9
Sand sole			10.3	
Lingcod				7.4
Ribbed sculpin				6.3
<u>Total Biomass</u>	338.5	2796.0	7302.8	2335.1

KODK Finfish and Shellfish

Survey of Tanner Crab Populations

A trawl survey program was initiated in 1980 to assess Tanner (snow) crab (Chionoecetes bairdi) populations in the Kodiak and Chignik Management Districts. Results from the 1982 surveys pertinent to the KODK OCS Planning Area are summarized below. Data from the Chignik District will be discussed under the SHUM OCS Planning Area. The Kodiak Management District is located south of the latitude of Cape Douglas on the Alaska Peninsula (58°52' N) east of the longitude of Cape Kumlik (157 °27'W) and west of 150°W.

Principal species caught during the otter trawl survey of northern Shelikof Strait, Uganik Bay, Uyak Bay (see Figure 1), and in the Chignik Shellfish Management District were flathead sole (Hippoglossoides elassodon), walleye pollock (Theragra chalcogramma), arrowtooth flounder (turbot, Atheresthes stomias), and Pacific cod (Gadus macrocephalus). Mean Catch rates for both fish and invertebrate species were as follows:

Shelikof Strait	1944. kg·hr ⁻¹
Uganik Bay	2366. “ “
Uyak Bay	1748. “ “

In Shelikof Strait, total catches were greater in shallow water than in deep water. In contrast, largest catches in Uyak and Uganik Bays were at depths of 130-164m.

The principal fish and invertebrate species caught in the Shelikof Strait (more precisely, the North Mainland fishing section of the Kodiak Tanner crab Management District; Figure 4) in the 1982 Tanner Crab survey are summarized in Table 8. Combined male and female Tanner crabs ranked third in average trawl biomass. Other commercially important shellfish: king crabs, shrimp, and Dungeness crabs -- ranked 12th, 15th, and 18th, respectively.

A similar otter trawl survey was conducted during the summer of 1981 in northern Shelikof Strait, offshore of the Alaska Peninsula near Chignik Bay, in Chignik and Kujulik Bays near the Semidi Islands, and in the Chiniak Gully. Principal species caught were the same as in the 1982 study, but pollock ranked first, followed by flathead sole, arrowtooth founder, and Pacific cod. Distributions and depth patterns for the total catches were not apparent within each study area. Estimates of the Pacific cod population in the Shelikof Strait was 6318-8881 metric tons; for walleye pollock, 10,636-20,851 metric tons (Owen and Blackburn 1983).

Commercial catches of Tanner crabs from the Kodiak Management District are summarized in Table 9. The 1981-82 Tanner crab harvest (6239 .75mt) surpassed the 1980-81 catch by more than 910 metric tons. Harvest was the second lowest in the last seven years. There were 221 vessels fishing in the Kodiak Management District during 1981-82, an all-time high. Declining king crab

KODK Finfish and Shellfish

Table 7. Otter trawl samples: average catch (kg wet wt.) per 20-min. trawl in Kodiak food habits survey (from Rogers, et al. 1983a).

Species	Winter	Spring	Summer	Autumn
Rock sole	43.49	102.60	38.98	30.93
Yellow fin sole	38.73	77.14	77.76	150.44
<u>Myoxocephalus</u> spp.	17.44	70.68	40.44	41.57
Halibut	4.57	10.85	31.84	20.01
Flathead sole	3.89	41.71	94.76	23.48
<u>Gymnocephalus</u> spp.	3.01	30.32	20.96	
Starry flounder	2.90	6.78	2.19	7.16
Pacific cod	1.67	31.30	7.12	19.60
Sand sole	1.07			3.86
Walleye pollock	0.37	3.16	26.23	22.23
Butter sole	0.25	0.67	3.25	10.41
Tomcod	0.20		0.84	22.74
Staghorn sculpin	0.17			17.24
Yellow Irish lord	0.17	50.61	46.06	150.44
Arrowtooth flounder	0.15	12.47	8.92	26.31
Sablefish		21.15	4.56	
Searcher		0.94	0.66	
Big skate		0.19		
Whitespotted greenling			0.55	
Herring				0.47
Undentified sculpins				0.19

KODK Finfish and Shellfish

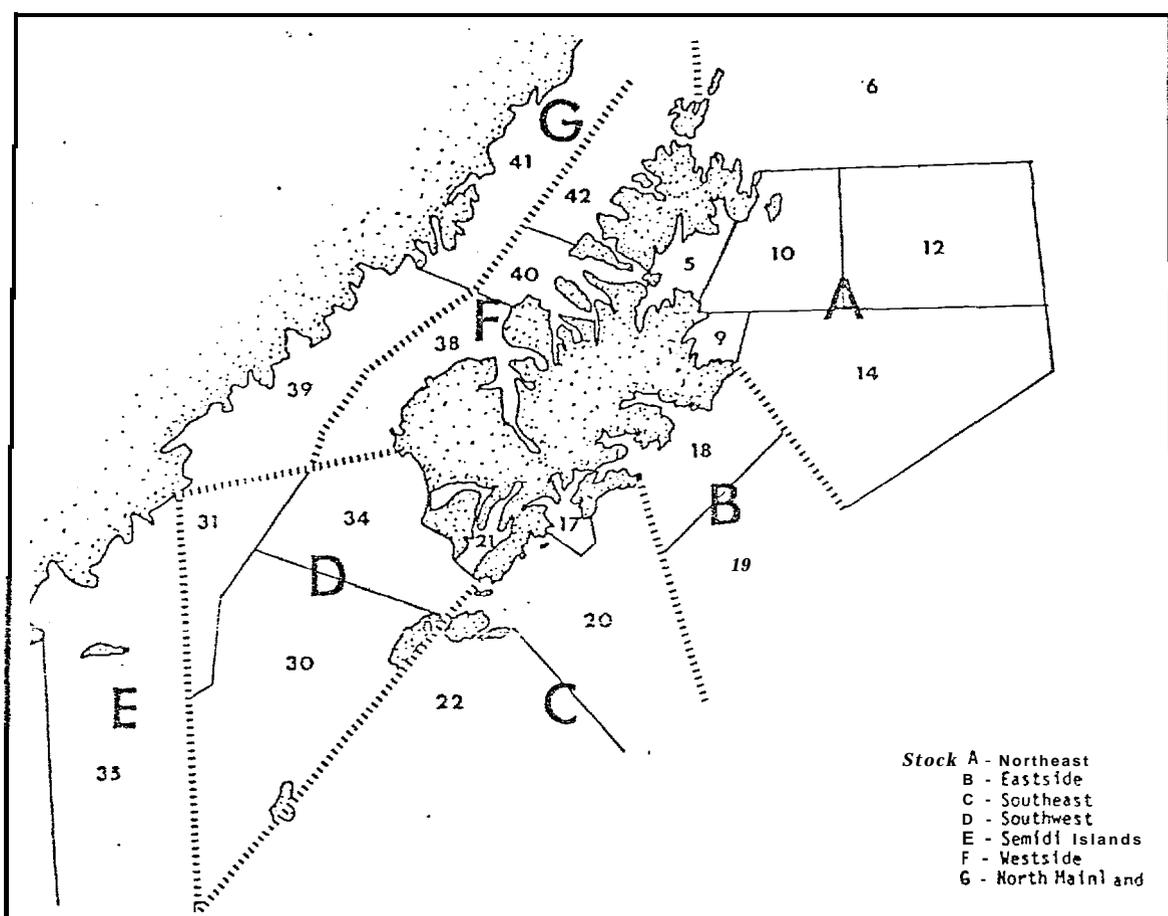


Figure 4. Major Tanner crab stocks in the Kodiak Management District (from Colgate and Hicks 1983).

KODK Finfish and Shellfish

Table 8. Rank and catch per unit effort (CPUE) of major fish and invertebrate species captured in North Mainland fishing section, 1982, Kodiak Management District Trawl Survey (from Colgate and Hicks 1983).

Species	Overall 1 rank	cpue (kg-hr ⁻¹)
FISH		
Walleye pollock	1	631
Flathead sole	2	306
Arrowtooth flounder	4	200
Pacific cod	5	161
Pacific halibut	6	92
Big skate	7	49
Sablefish	8	34
Eelpout	9	29
Eulachon	10	26
Great sculpin	11	24
Alaska plaice	14	14
Dover sole	15	12
Longnose skate	18	6
Skate	24	3
INVERTEBRATES		
Tanner crab	3	221. ¹
King crab	12	20. ²
Sponge	13	15
Shrimp	15	12
Mud starfish	17	7
Dungeness crab	18	6
Oregon triton	20	5
Northwest neptune	20	5
Sea anemone	20	5
Weatherwane scallop	23	4
Total kg·hr⁻¹		1944

¹179 male, 42 female

² male, 12 female

KODK Finfish and Shellfish

Table 9. Commercial catch of Tanner (snow) crabs in the Kodiak Management District of the Westward Region, Alaska (from Colgate and Hicks 1983).

Year	Metric tons	Catch per unit effort ¹
1969-70	2,817.8	42
1970-71	3,059.1	44
1971-72	4,298.2	59
1972-73	13,925.3	67
1973-74	13,526.7	59
1974-75	6,191.6	83
1975-76	12,399.9	64
1976-77	9,398.6	48
1977-78	15,096.4	49
1979-80	8,447.7	24
1980-81	5,329.1	25
1981-82	6,239.8	24

¹number of crabs per pot lift

●

KODK Finfish and Shellfish

● catches throughout Alaska and the high market price paid for Tanner crab contributed to the higher than normal fishing effort (Colgate and Hicks 1983).

●

KODK Finfish and Shellfish

ICHTHYOPLANKTON

Walleye pollock, *Theragra chalcogramma*, support the largest single-species commercial fishery in the Northern Hemisphere (Thorsteinson and Thorsteinson 1982). In the Gulf of Alaska this species undertakes a winter spawning migration into Shelikof Strait via the "gully" that runs between the Semidi and Chirikof Islands. By early spring the fish have moved into the deeper waters of Shelikof Strait to spawn. In the following discussion, Shelikof Strait is defined as the ocean area bounded by 58°30'-56°00'N and 157°00'-153°00'W (note that this area extends southwest of the area normally considered to lie within the Strait and includes a portion of the Shumagin (SHUM) OCS Planning Area.) (Dunn et al. 1984).

Walleye Pollock -- Eggs

Pollock eggs were found in low abundance in late fall and winter (October, November and February), and increased in abundance in the spring with catches peaking in late March and April and declining in May. Few eggs were encountered in June, July, or Sept. Progress of the spring spawning is illustrated in Figure 5; highest average egg densities occurred 31 March-9 April and 20-29 April.

Distribution and relative abundances of pollock eggs during the April spawning peak are shown in Figures 6 and 7. During early April, egg abundances were greater than 100,000 $\cdot 10m^{-2}$ at several stations in the northwest portion of Shelikof Strait and at one station in slope waters at 156°W (Figure 6). By late April, egg abundance had reached 10,000 -100,000 $\cdot 10m^{-2}$ in the center and at the west end of Shelikof Strait (Figure 7) (Dunn et al. 1984).

Walleye Pollock -- Larvae

Pollock larvae were found from March to June throughout the western Gulf of Alaska. Larval abundances increased from March-April, peaked in April, and declined thereafter (Figure 8). During late April, abundances of pollock larvae were between 10,000 and 100,000 $\cdot 10m^{-2}$ throughout much of the central Shelikof Strait and exceeded 100,000 $\cdot 10m^{-2}$ at one station (Figure 9). During the latter half of May, larvae were found throughout Shelikof Strait and in shelf and some upper slope waters (Figure 10). Abundances were relatively high, ranging from 10,000 to 100,000 larvae $\cdot 10m^{-2}$ at a few stations (Dunn et al. 1984).

KODK Finfish and Shellfish

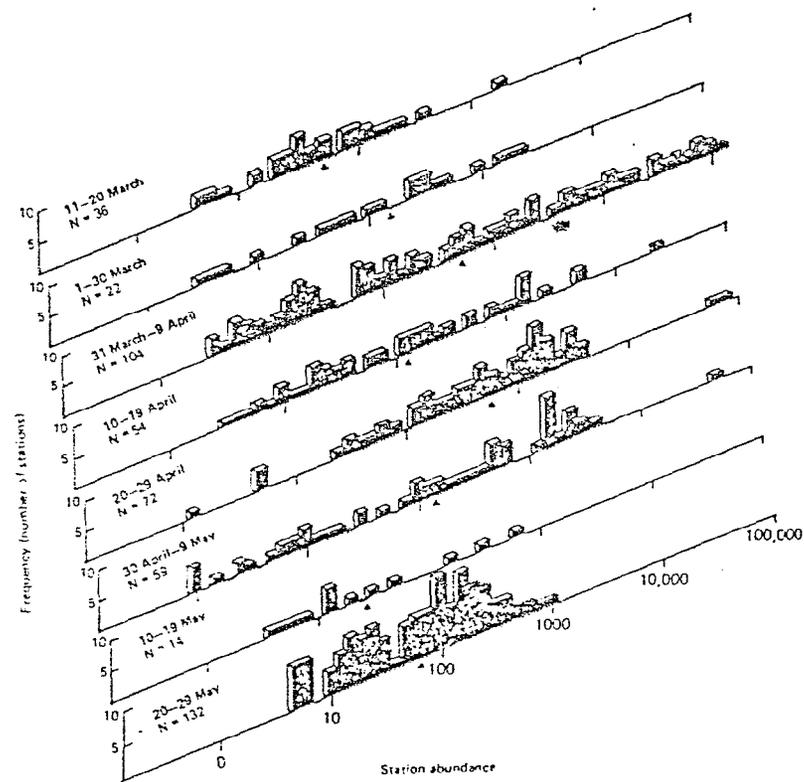


Figure 5. Progress of spring spawning of walleye pollock in the Gulf of Alaska, as illustrated by frequency distribution of station abundances of eggs by successive 10-day period. Triangles on abscissa denote logarithmic means (from Dunn et al. 1984).

KODK Finfish and Shellfish

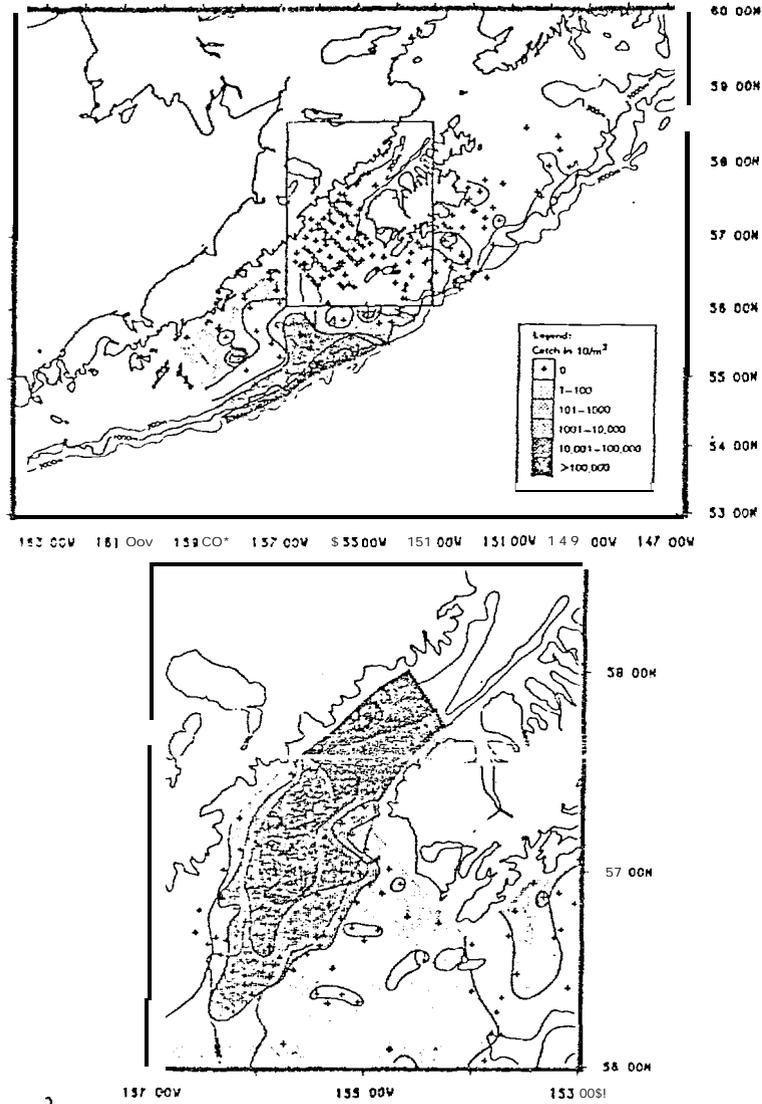


Figure 6. Distribution and relative abundance of walleye pollock eggs in KODK waters, April 1-15 (from Dunn et al., 1984).

KODK Finfish and Shellfish

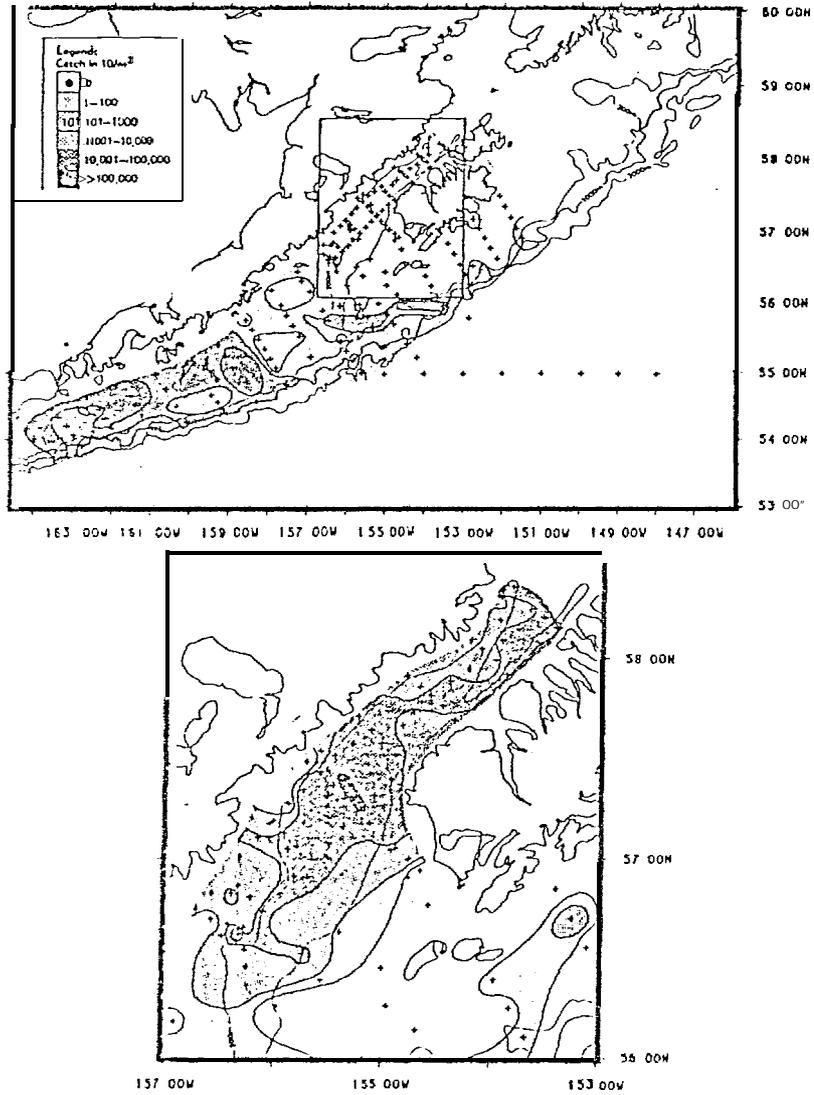


Figure 7. Distribution and relative abundance of walleye pollock eggs in KODK waters, April 16-30 (from Dunn et al. 1984).

KODK Finfish and Shellfish

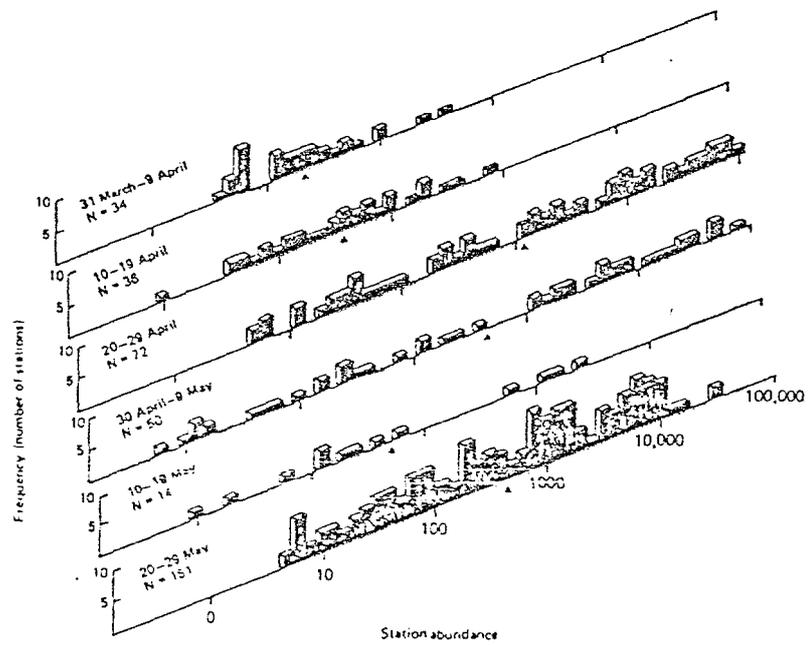


Figure 8. Frequency distribution (see Figure 5) of station abundance of walleye pollock larvae in KODK (from Dunn et al. 1984).

KODK Finfish and Shellfish

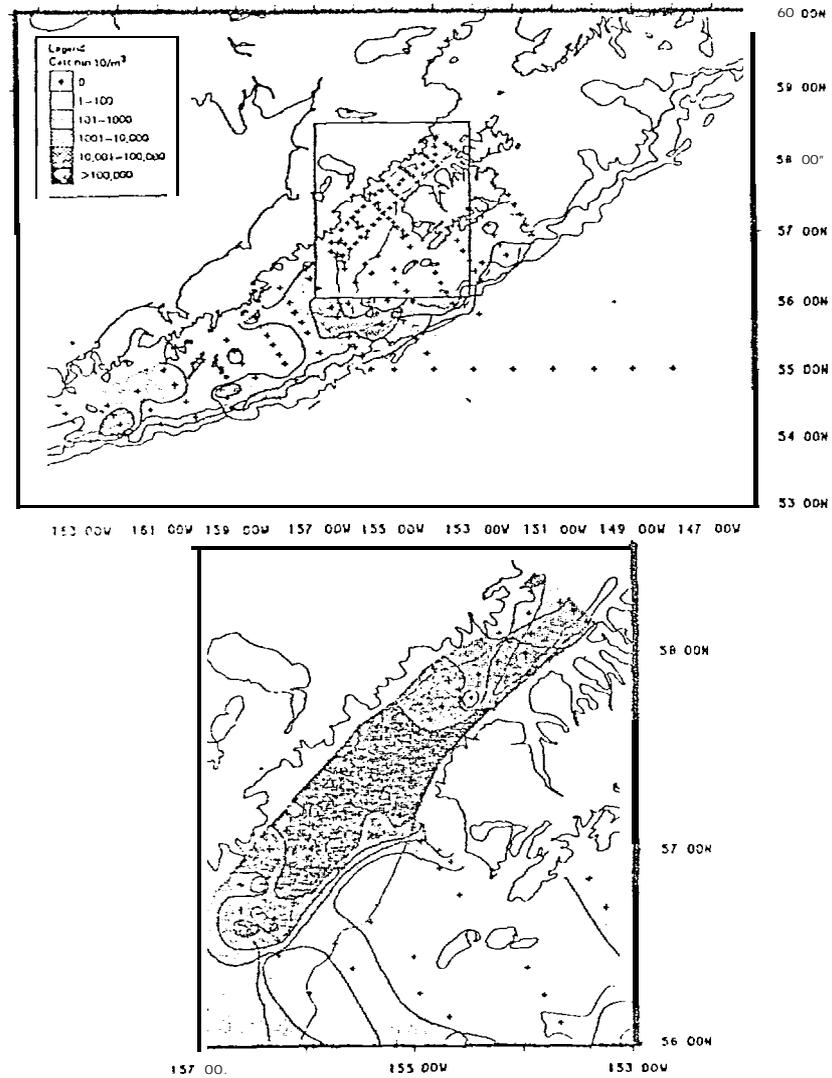


Figure 9. Distribution and relative abundance of walleye pollock larvae in KODK waters, April 16-30 (from Dunn et al. 1984).

KODK Finfish and Shellfish

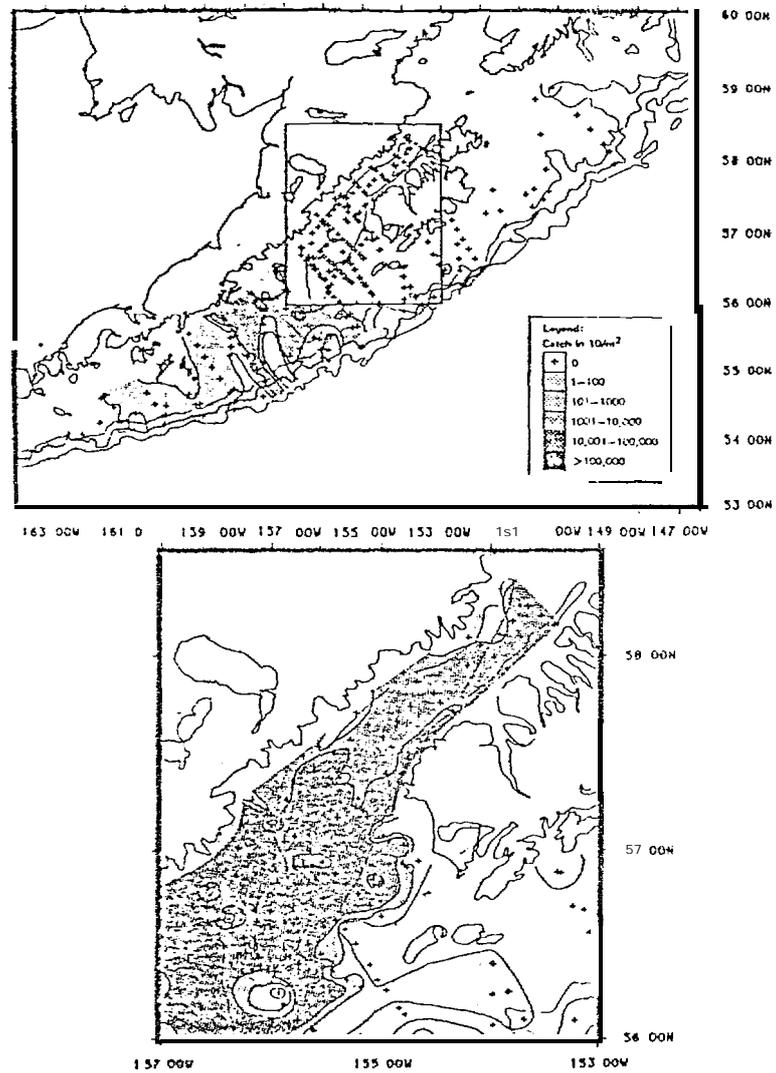


Figure 10. Distribution and relative abundance of walleyepollock larvae in KODK waters, May 16-31 (from Dunn et al. 1984).

KODK Finfish and Shellfish

Decapod Crustacean Larvae

Seasonal distribution and abundances of **decapod** crustacean larvae in the **KODK** OCS Planning Area have been summarized by **Wolotira et al. (1984)** for surveys conducted in 1978-79. Approximate boundaries of the study area were 55-59°N and 149-155°W, an area of 75,000km², which encompasses the continental shelf east of Kodiak and **Afognak** Islands from the headwaters of **Inhut, Chiniak, Kiliuda,** and **Kaiugnak** Bays (Figure 11) seaward to the 2,000m contour.

The **bathymetry** east of Kodiak and **Afognak** Islands consists of shallow banks separated by troughs which run to the continental shelf edge. Four major troughs -- **Amatuli, Stevenson, Chiniak,** and **Kiliuda** -- traverse the continental shelf, which ranges from 69 to 110km in width (see Figure 11). These troughs, except for **Amatuli**, are offshore extensions of deep water trenches out of **Izhut, Chinak,** and **Kiliuda** Bays, respectively, and range in depth from 100-140m. The troughs are separated by four banks -- **Portlock,** and **North, Middle,** and **South Albatross** Banks -- with depth ranges of 50-90m (**Wolotira et al. 1984**).

Abundances of ten different taxonomic groups of decapod crustacean larvae, including five commercial species, are summarized in the following tables. Table 10 lists mean normalized numbers in the inshore region (which includes **Izhut, Chiniak, Kiliuda,** and **Kaiugnak** Subareas). Table 11 provides similar information for the offshore region (**Portlock, Marmot, Albatross,** and **Sitkinak** Subareas).

Crab and shrimp larvae were two to three times more abundant inshore than offshore. Vertical distribution studies revealed that the 10-50m depth stratum contained the majority of the larvae sampled. Times of peak abundance varied through the spring and summer months according to taxonomic group. Mean densities from all cruises in the inshore region were highest for **hippolytid** shrimp, followed by **anomuran** crabs and **pea crabs** (Table 10). **Hippolytid** shrimp and **anomuran** crabs had two peaks of abundance in April and May, respectively, and again in **early** August. Highest abundances of **pea crabs** occurred June-early August. **Hippolytid** shrimp and **anomuran** crabs also ranked highest in mean biomass for all four seasons in the offshore region (Table 11) (**Wolotira et al. 1984**).

KODK Finfish and Shellfish

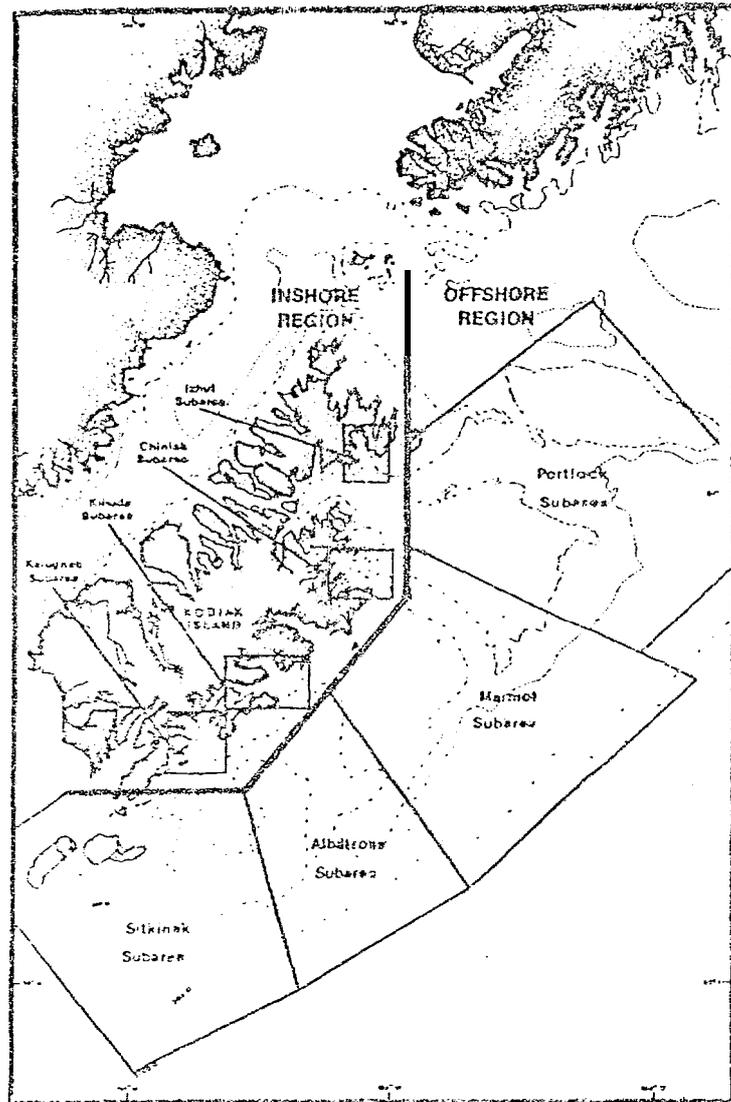


Figure 11. Study area for 1978-79 decapod crustacean larvae study in vicinity of Kodiak Island, KODK OCS Planning Area (from Wolotira et al. 1984).

KODK Finfish and Shellfish

Table 10. Mean abundances (numbers" 10m⁻² sea surface area) of decapod crustacean larvae in the inshore region of the Kodiak Island Study Area, 1978-1979 (from **Wolotira et al.** 1984).

TAXON	----- SPRING -----				----- SUMMER -----				----- FALL WINTER -----				
	3/29- 4/8	4/10- 4/17	4/21- 5/1	5/3- 5/28	5/31- 6/6	6/14- 6/26	7/18- 7/29	8/1- 8/9	8/15- 0/21	11/4- 11/13	3/4- 3/16		
Hippo lytid shrimps (Hippo lytidae)	48.9	472.4	306.	0116.9	97.5	50.9	440.4	560.1	613.0	364. 0	1.4	2.4	
Sand shrimps (Crangonidae)	0.5	4.8	1.4	10.1	5.5	11.8	18.3	10. EI	19.7	21.2	c1	0	
Pink or northern shrimp (Pandalus borealis)			2.3	23.8	24.5	10.8	1.6 0	1.6	0.5	1.0	0	0	0
Humpy shrimp (P. goniorus)	1.1	0.7	9.9	7.2	1.5	2.8	2.0	0	0	0	0	0	0
Anomuran crabs (Anomura sp.)	38.2	156. b	238.8	277.7	182.1	241.2	106.8	98.5	220.4	100.5	26.4	1.2	
Red king crab (Paralithodes camtschatica)	1.4		1.8	1.0	3<8	1.2	0	0	0	0	0	0	1.7
Dungeness crab (Cancer magister)	0	1.9	0.8	6.5	5.5	311.8	5.1	4.9	1.0	0	0	0	0.1
Cancer crab (Cancer sp.)	0	0	0.5	1.8	27.5	748.9	631.7	227.1	146.9	0. b	0	0	0
Tanner (snow) crab (Chionoectes bairdi)	n	o	1.9	93.	b	106.8	2.7	3.0	0	0	0	0	0.2
Pea crabs (Pinnotheridae)	0	0	0.8	155.0	339.4	297.9	367.7	207.5	339.4	158.2	0.9	0	

KODK Finfish and Shellfish

Table 11. Mean abundances (numbers" $10m^{-2}$ sea surface area) of decapod crustacean larvae in the offshore region of the Kodiak Island Study Area, 1978 and 1979 (from Wolotira et al. 1984).

TAXON	SPRING 3/28 - 4/20	SUMMER 6/19 - 7/9	FALL 10/25 - 11/17	WINTER 2/13 - 3/11
Hippo lytid shrimp (Hippo lytidae)	37.1	74.9	1.4	0.5
Sand shrimp (Crangonidae)	0.8	15.0	0.1	0
Pink or northern shrimp (Pandalus borealis)	0.6	1.9	0	0
Anomuran crabs (Anomura sp.)	26.4	158.2	0.4	0.5
Red king crab (Paralithodes camtschatica)	0.1	0.2	0	0
Dungeness crab (Cancer magister)	0	4.0	0	0
Cancer crab (Cancer sp.)	0	472.4	0.1	1.1
Tanner (snow) crab (Chionoecetes bairdi)	0.5	25.6	0	0.2
Pea crabs (Pinnotheridae)	0	180.3	0	0

COOK INLET

FINFISH

The commercial fishing industry of the Kodiak region and Lower Cook Inlet is characterized by high volume and low diversity. Major fishing ports are Kodiak, Homer, and Kenai. The following summarizes information for commercial finfish and shellfish productivity in the region proximal to Kodiak Island, including the Shelikof Strait and Lower Cook Inlet.

Salmon

Salmon are the most important and the most economically valuable fish caught in the KODK and CKIN OCS Planning Areas. The commercial salmon fishery uses set gillnets, drift gillnets, and purse seines. The fishing season runs from June through August or September and fisheries are usually located within the 3-mile (4.8km) limit. In 1980, the Kodiak/Cook Inlet salmon harvest totalled 24.2 million fish, or more than 42,638 metric tons (Representatives of the Oil/Fisheries Group of Alaska, 1983).

All five species of salmon are harvested in the Cook Inlet-Shelikof Strait area. Pink salmon predominate in both areas. Sockeye (red) salmon rank second in Cook Inlet and third in Kodiak, with opposite rankings for chum salmon. Cohos rank fourth and kings (chinook) fifth in both regions (Blackburn et al. 1983). Mean annual salmon catches are summarized in Table 2.

Salmon catches are distributed through most of the region, the major geographic areas of which are shown in Figure 3. Pink salmon harvests are greatest in the Kalgin Island Area, in Kachemak Bay, along Kodiak and Afognak Islands, and along the shores of the Alaska Peninsula. Harvest distributions of the other species are summarized in Blackburn et al. (1983).

A substantial portion of the regional catch comes from the Shelikof Strait area. Based on catches in the early 1970's, Shelikof Strait accounts for approximately 40% of the annual pink salmon catch, more than 80% of the sockeye catch, 40% of the chum catch, 55% of the coho, and most of the chinook salmon taken in the Kodiak area.

The outlook for the salmon fishery in this region is optimistic, although weather plays an important role in salmon production. Mild winters enhance freshwater survival; the early 1970's were relatively poor years due at least in part to their severe winters.

CKIN Finfish and Shellfish

Table 2. Mean annual salmon catches (thousands of fish) for the past two decades in the Kodiak and Lower Cook Inlet regions (from Blackburn et al. 1983).

Years	Pink	Sockeye	Chum	Coho	Chinook
KODIAK					
1960-1969	7,740	510	676	44	1.2
1970-1978	6,346	518	765	27	1.1
LOWER COOK INLET					
1960-1969	1,780	1,197	717	266	13.4
1970-1978	1,139	1,215	757	183	11.9

CKIN Finfish and Shellfish

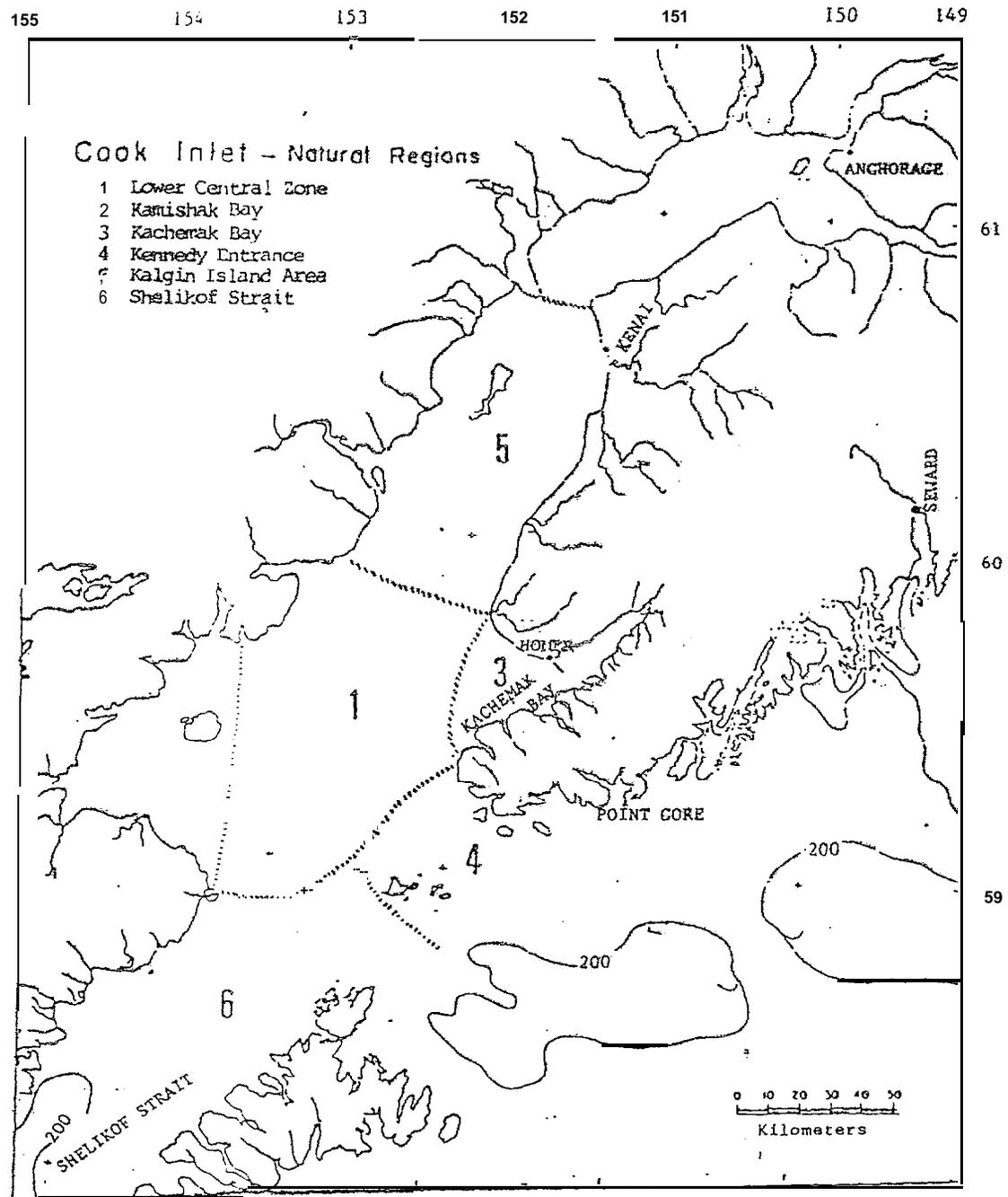


Figure 3. Major geographic regions of the Cook Inlet region (from Blackburn et al. 1983).

CKIN Finfish and Shellfish

Halibut

Halibut are taken by **longline** in both nearshore and offshore waters. Although the season extends across the summer months, **actual** fishing is limited to a short opening of only a few days within the period. The fishery is concentrated in the vicinity of Anchor Point, off the tip and along the south shore of the **Kenai Peninsula**, South of **Kachemak Bay**, near the Barren Islands, on the east side of Shelikof Strait (including the coastal bays), along the southwest tip of Kodiak Island, and in the wide bay area on the west side of Shelikof Strait (Blackburn et al. 1983).

Table 3 summarizes halibut catches in the region over the decade of the 1970's. The decline of the fishery early in the decade was due to incidental catch of juvenile halibut by foreign trawlers. The fishery has recovered somewhat, but not to historic levels.

Major halibut spawning sites in the Lower Cook Inlet area include Portlock Banks and Chirikof Island. Mature fish concentrate from November to March at depths of 180-450m along the edge of the continental shelf (Blackburn et al. 1983).

Groundfish

The **groundfish** fishery has been directed at walleye **pollock** and to a lesser extent Pacific Cod in the central Shelikof Strait. Foreign fisheries were not active in Shelikof Strait between 1969 and 1974 and the domestic fishery has just begun to exploit this resource.

Groundfish landings in the Kodiak management area were as follows:

1975	6.4	metric	tons	
1976	236	"	"	
1977	289	"	"	
1978	1048	"	"	
1979	2063	"	"	(through July)

Catches have averaged 80-90% walleye **pollock** and about 10% Pacific cod (Blackburn et al. 1983).

Herring

Commercial herring catches in the Cook Inlet area are summarized in Table 4. Herring is predominantly a spring fishery (primarily in May), as the fish are taken largely for their roe (Blackburn et al. 1983). Herring typically spawn in the intertidal zone, primarily upon submerged vegetation.

CKIN Finfish and Shellfish

Table 3. Halibut catches in metric tons {dressed weight) by IPHC statistical subareas in the Cook Inlet-Shelikof Strait region, 1969-1978 (from Blackburn et al. 1983).

Year	Cook Inlet except Kamishak	Northern Shelikof Strait	Kamishak Bay	Southern Shelikof Strait
1969	234	28	5	227
1970	158	218	36	247
1971	245	33	20	215
1972	189	142	29	451
1973	302	242	15	344
1974	298	100	---	111
1975	248	177	6	138
1976	293	148	17	267
1977	329	74	26	172
1978	309	30	46	57
AVERAGE	260	119	22	223

CKIN Finfish and Shellfish

Table 4. Commercial herring catches (metric tons) in Cook Inlet region, 1969-1979 (from Blackburn et al. 1983).

Year	Central (n. of Anchor Pt.)	District Kachemak Bay	Kamishak Bay
1969		551.5	
1970		2708.7	
1971		12.5	
1972		1.0	
1973	14.0	203.8	243.1
1974	36.6	110.2	2108.8
1975	6.0	24.0	4119.0
1976	[Inlet total: 4,086.3]		
1977	17.1	291.0	2917.5
1978	60.8	16.6	402.0
1979	17.1	13.1	417.6

CKIN Finfish and Shellfish

SHELLFISH

King Crab

The king crab fishery begins in August and extends through the winter. Principal fishery areas are depicted in Figure 4; catch statistics for the 1970's are summarized in Table 5.

King crab was first harvested in the Kodiak and Cook Inlet management areas in 1951. Catches increased to their historically high values in 1965 when approximately 43,545 metric tons were taken in Kodiak. The catch has declined since 1965 and now depends heavily upon newly recruited crabs, i.e., the success of a single preceding year class.

King crabs move into relatively shallow water in winter where the eggs hatch during February-April. Females then molt and mate again. King crabs are known to concentrate in Kachemak Bay for spawning and all the bays on surrounding Kodiak Island are known or suspected to harbor spawning crabs (Blackburn *et al.* 1983).

Tanner (Snow) Crab

Tanner crabs are caught in virtually all the lease area south of Anchor Point, as summarized in Figure 5. The fishery began in 1967 and by 1972-73 had become the predominant winter and spring shellfishery with 13,835 metric tons harvested in the Kodiak area. Since then the annual landings in Kodiak have varied between about 6000 and 15,000 metric tons, depending primarily on market price and competition with other fisheries.

Tanner crab catches in Kachemak have fluctuated from about 454 to 1270 metric tons since 1970. Catches in the Kamishak area of Lower Cook Inlet have yielded 907-132-61 metric tons since 1974-75; during that same period the Shelikof Strait lease area has yielded 1814-4536 metric tons per season (Blackburn *et al.* 1983).

Dungeness Crab

Dungeness crab fishery grounds are shown in Figure 6. Greatest catches occur in the outer Kachemak Bay, in the lower central Cook Inlet, and along both shorelines of Shelikof Strait (except on Afognak Island). The bulk of the catch is taken from July through October.

The fishery began in the Cook Inlet management area in 1961 and in the Kodiak area in 1962. Commercial harvests peaked in Kodiak between 1967-1970 with an average annual harvest of 2,858 metric tons. Catches declined during the early 1970's due to a combination of biological, environmental factors and market factors. The largest catch in the Cook Inlet area, 771 metric tons,

CKIN Finfish and Shellfish

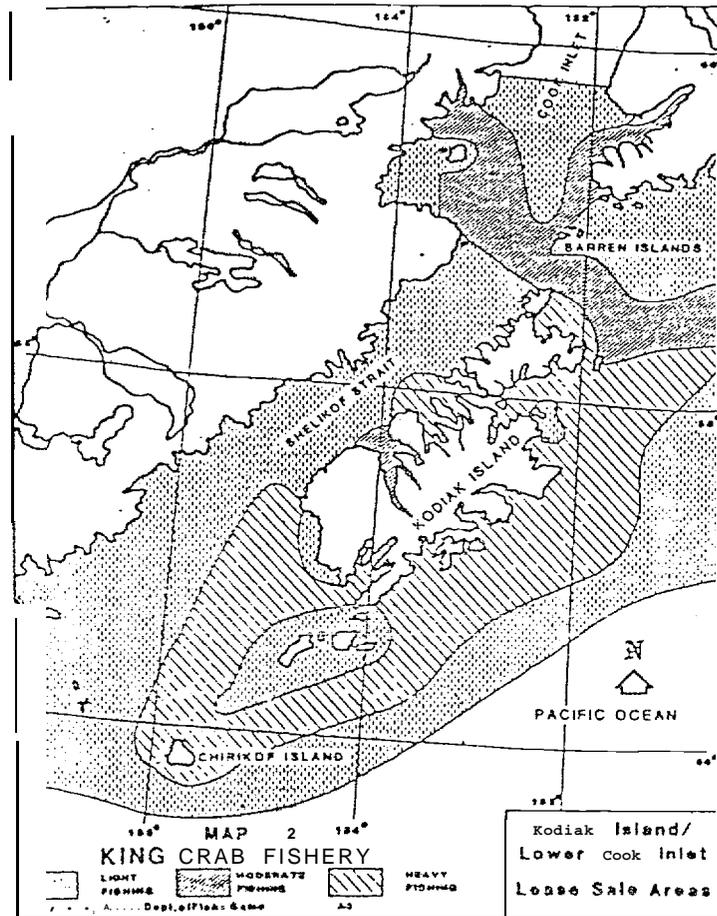


Figure 4. Locations of king crab fishery in vicinity of Kodiak Island (from Representatives of the Oil/Fisheries Group of Alaska, 1983).

CKIN Finfish and Shellfish

Table 5. King crab harvest (metric tons) northern and central Shelikof Strait region (from **Blackburn et al.** 1983).

Fishing Season	Conk Inlet District		Kodi ak Stöck	
	Southern (Kachemak Bay)	Kamishak (Barren Island)	51 (Central Shelikof)	62 (Northern Shelikof)
1969-1770	664	766	793	358
1770-1971	698	960	394	652
1971-1972	906	1301	107	117
1772-1973	631	1250	93	240
1973-1774	890	1014	163	175
1974-1975	821	1345	474	71
1975-1976	756	831	527	138
1976-1977	444	1420	327	142
1977-1778			111	64
1778-1979	302		158	53
Average	679	1111	315	201

¹Catch primarily from Vieköda Bay and Kupreanof Strait

²Vicinity of Cape Douglas

CKIN Finfish and Shellfish

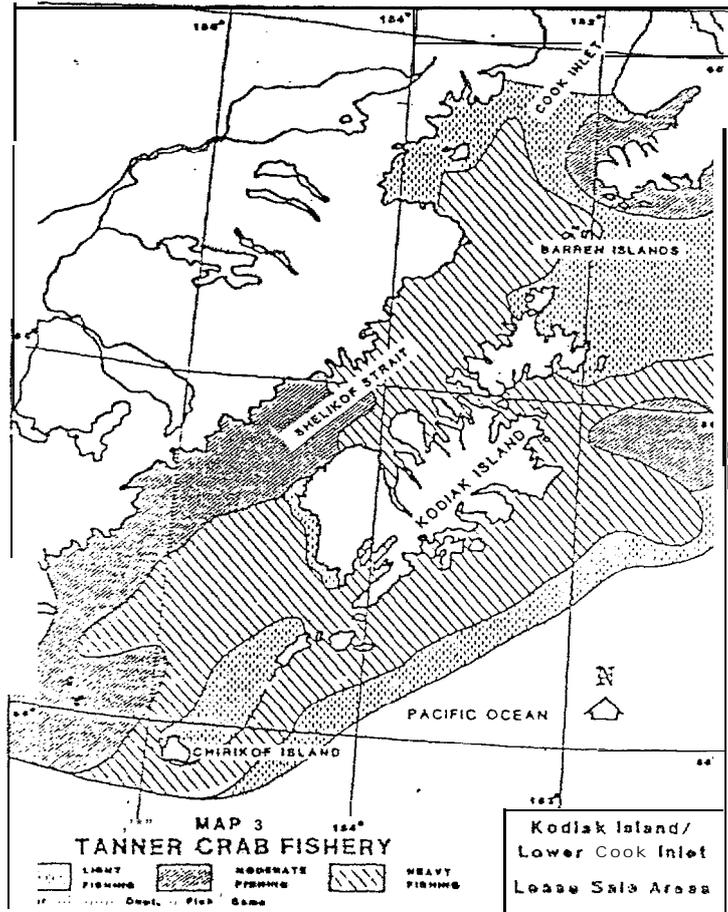


Figure 5. Locations of Tanner Crab Fishery in vicinity of Kodiak Island and Lower Cook Inlet (from Representatives of the Oil/Fisheries Group of Alaska, 1983).

CKIN Finfish and Shellfish

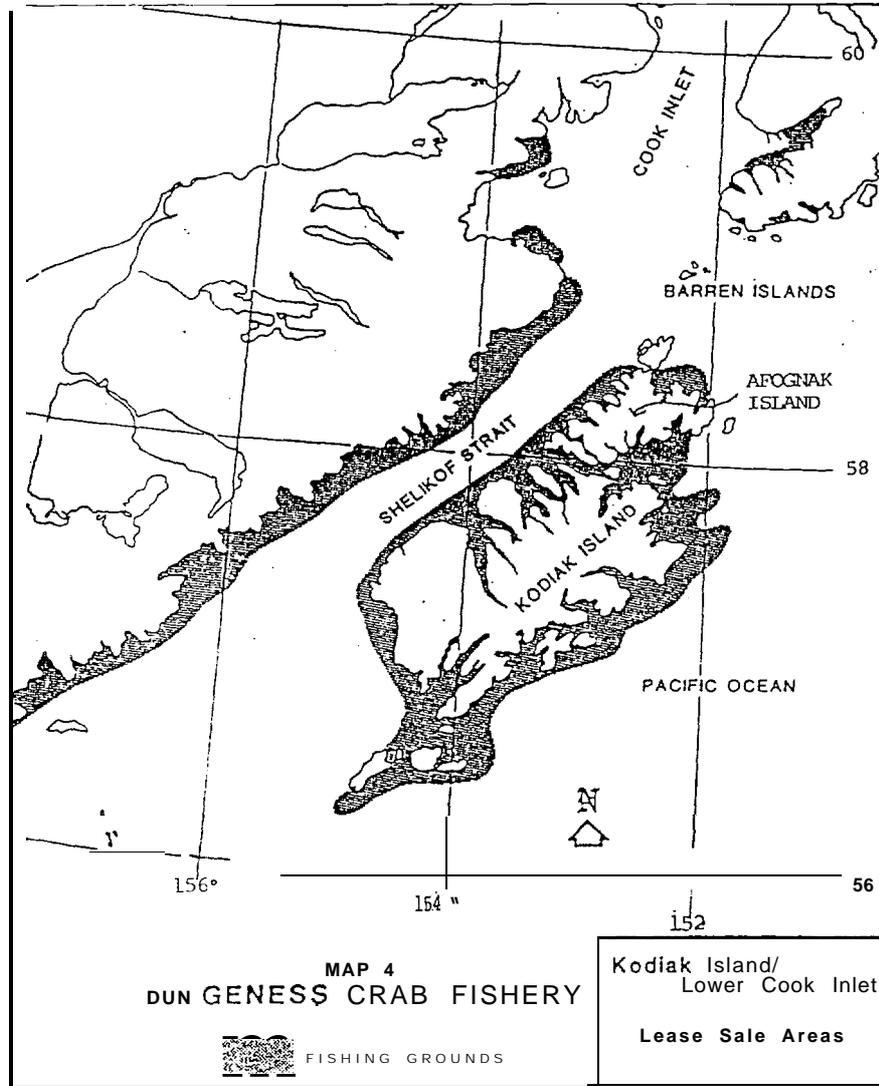


Figure 6. Locations of dungeness crab fishery in vicinity of Kodiak Island and Lower Cook Inlet (from Representatives of the Oil/Fisheries Group of Alaska 1983).

CKIN Finfish and Shellfish

occurred in 1963; since then catches have fluctuated widely from about 3 to 340 metric tons.

The dungeness crab catch in the **Shelikof** Strait portion of the Kodiak area averaged 576 metric tons between 1962-1969. From 1969-1977 catches decreased to an average of 213 metric tons though they fluctuated widely, e.g., the 1977 catch was less than 4.5 metric tons but the 1978 catch was 206 metric tons (Blackburn *et al.* 1983).

Shrimp

Pink shrimp, *Pandalus borealis*, is the primary species harvested in this region, with smaller catches of humpback shrimp (*P. hypsinotus*), spot shrimp or prawn (*P. platyceros*), and sidestripe shrimp (*Pandalopsis dispar*). Shrimp are harvested in Kachemak Bay, in Kukak Bay on the Alaska Peninsula, and in virtually all of the bays on the west side of the Kodiak Archipelago, including the north end of Afognak Island.

The Kodiak shrimp fishery began in 1958, with a peak catch of 37,195 metric tons in 1971. Catch quotas were established in 1972 and the fishery was closed during the period of egg hatch (females carry developing eggs for approximately six months) beginning in 1973. The catch declined to approximately 9300 metric tons during the 1978-79 season. The **Shelikof** Strait south of Cape Douglas produced an average shrimp catch of 2359 metric tons from 1973-74 through 1978-79. Catches in Kachemak Bay ranged from 1996-3266 metric tons during the 1970's (Blackburn *et al.* 1983).

Razor Clams

There is extensive recreational and subsistence digging for razor clams (*Siliqua patula*) in the region; clams are also taken as bait for **Dungeness** crab pots. A commercial fishery exists in Swikshak Beach, just south of Cape Douglas, and on Polly Creek Beach north of Tuxedni Bay.

Most of the digging in the Kodiak area has occurred on **Swikshak** Beach, where there have been four distinct periods with different catch levels:

1960-63	135-191	metric	tons	dug	annually
1964-69	0-9	"	"	"	"
1970-74	60-90	"	"	"	"
1975-	1-2	"	"	"	"

These fluctuations in catch are not related to clam population levels, but to regulations, market conditions, and the logistics of harvesting in a remote area on a National Monument (Blackburn *et al.* 1983).

CKIN Finfish and Shellfish

Weatherwane Scallop

The scallop fishery began in 1967, expanded to 676 metric tons in 1970 in the Kodiak area, and decreased thereafter. The **last** landings were made in 1976. The fishery centered on the east side of Kodiak Island.

DECAPOD LARVAE

Outer Kachemak Bay is a major release and settling area for larvae of king crab and pandalid shrimp. Surveys in 1972 and again in 1976 revealed similar distributional patterns and areas of greatest abundance for king crab, northern shrimp, and bumpy shrimp larvae. Samples from the central portion of outer Kachemak Bay had the greatest larval numbers of each species, while samples from the inner Bay and Lower Cook Inlet had fewer larvae. Areas of greatest abundance of larval **coonstripe** shrimp, however, were markedly different from larvae of the other species. Coonstripe shrimp larvae were most numerous in samples collected along the northern shore of the outer Bay, off Bluff Point, and the inner Bay near Homer Spit. Larvae of sidestripe shrimp were distributed in a pattern similar to that of **larval** king crab, northern shrimp, and bumpy shrimp, except that sidestripe larvae were not taken from inner Bay waters.

Dispersal patterns of king crab, northern shrimp, bumpy shrimp, and sidestripe shrimp larvae were similar. Larvae of **all** four species were dispersed into the inner Bay, primarily along the southern shore, and out of the Bay westward toward Flat Island. Some larvae were also dispersed northeastward toward Anchor Point. Likewise, dispersal of **coonstripe** shrimp larvae in outer Kachemak Bay was southwestward, similar in direction to that of the other larvae. However, coonstripe larval dispersal from the inner Bay was probably seaward along the northern shore of the outer Bay toward Bluff Point (Haynes 1983).

Relationships to Current Patterns

Seawater enters Cook Inlet through Kennedy Entrance, then flows northward along the east side of the Inlet, eventually mixing with turbid, low-salinity waters from sediment-laden rivers. It then flows southward along the western shore, around Cape Douglas, and into Shelikof Strait (Haynes 1983). Two large gyres, one counterclockwise in the eastern **half** and one clockwise in the western half, dominate water circulation in outer Kachemak Bay (Figure 7). Although this **two-gyre** system is generally stable, it can be altered by strong winds. Water in the gyres has a typical residence time of one to two weeks, and net transport in outer Kachemak Bay is northward whether or not the gyres are well-established.

Water circulation in inner Kachemak Bay is dominated by two counterclockwise **gyres**, one near Homer Spit and other near the head of the

CKIN Finfish and Shellfish

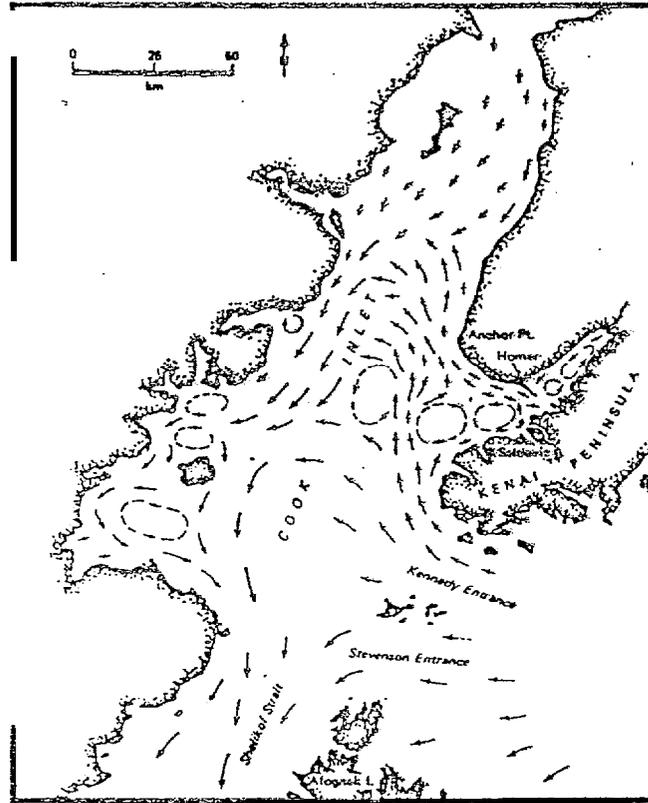


Figure 7. General circulation patterns of surface water in Kachemak Bay and lower Cook Inlet, as discerned from data collected during spring and summer seasons (from Haynes 1983).

CKIN Finfish and Shellfish

Bay (Figure 7). Surface waters, mostly riverine in origin, flow westward into the outer Bay whereas deeper waters below 30 m flow from the outer into the inner Bay, primarily along the southern shore.

Observed dispersals of king crab and pandalid shrimp larvae from areas of greatest abundance in Kachemak Bay were only in partial accord with water currents. Larval behavior seems to influence the direction and extent of dispersal. These crucial behavior patterns are essentially unknown (Haynes 1983).

King Crab Larvae

Outer Kachemak Bay is a major release area for larval king crabs. Stage I larvae first appear in April; high abundance occurs in May. As Figure 8 shows, highest larval densities in early May are found off Bluff Point in outer Kachemak Bay. By late May the larvae have dispersed into the inner Bay, and highest densities occur throughout a major portion of the outer Bay. Two areas of high density are reported for early June; the entire cross section of the inner Bay from Homer Spit, and the southwest portion of the outer Bay (Figure 9).

Greatest abundance of glaucothoe larvae has been reported to lie between Anchor Point and Bluff Point. This must be a major settling area for king crab.

Northern Shrimp Larvae

Dispersal patterns of northern and bumpy shrimp were similar, although northern shrimp released their larvae earlier (early April) than bumpy shrimp (mid-April). Only the dispersal patterns of larval northern shrimp will be presented here.

Larval release occurs in the central portion of outer Kachemak Bay (Figure 10) (bumpy shrimp release their larvae somewhat farther seaward). Dispersal to the inner Bay is primarily along the southern shore (Figure 4); dispersal out of the Bay is in a southwestward direction toward Flat Island (Figures 10 and 11). During both 1972 and 1976, late-stage larvae (stages V and VI) of both northern and bumpy shrimp were most abundant in outer Kachemak Bay (Figures 11 and 12).

Larvae of both northern and bumpy shrimp probably settle in outer Kachemak Bay. Settling may be dependent upon factors other than changes in morphology, as there is only a slight morphological change in transition from zoea to megalopa (Haynes 1983).

CKIN Finfish and Shellfish

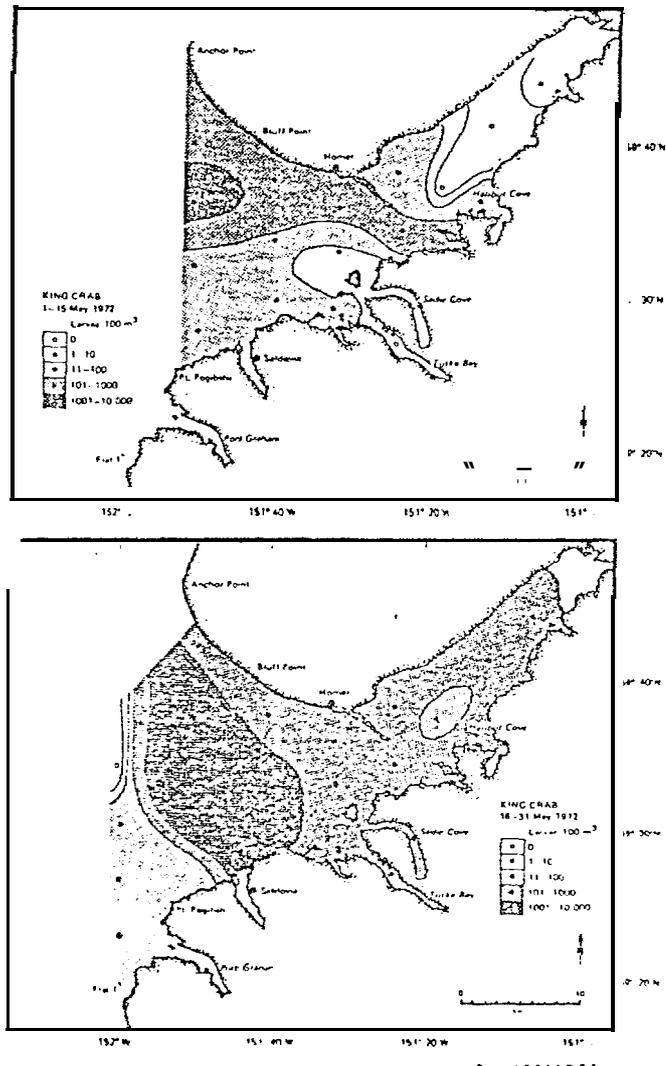


Figure 8. Abundance and distribution of king crab larvae in Kachemak Bay in 1972; upper, 1-15 May; lower, 16-31 May (from Haynes 1983).

CKIN Finfish and Shellfish

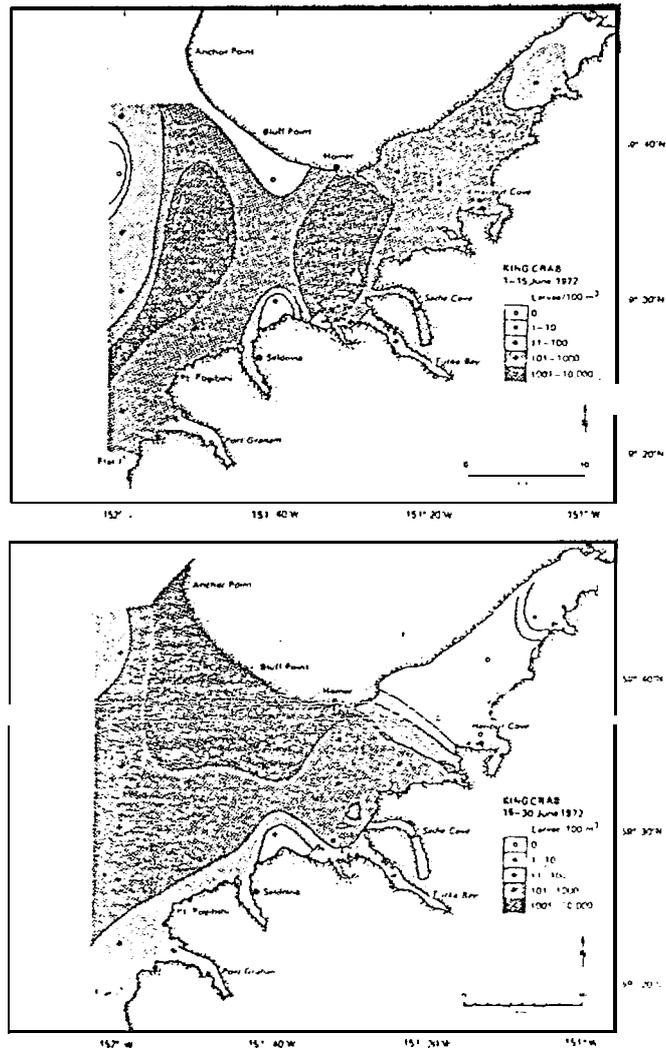


Figure 9. Abundance and distribution of king crab larvae in Kachemak Bay, 1972: upper, 1-15 June; lower, 16-30 June (from Haynes 1983).

CKIN Finfish and Shellfish

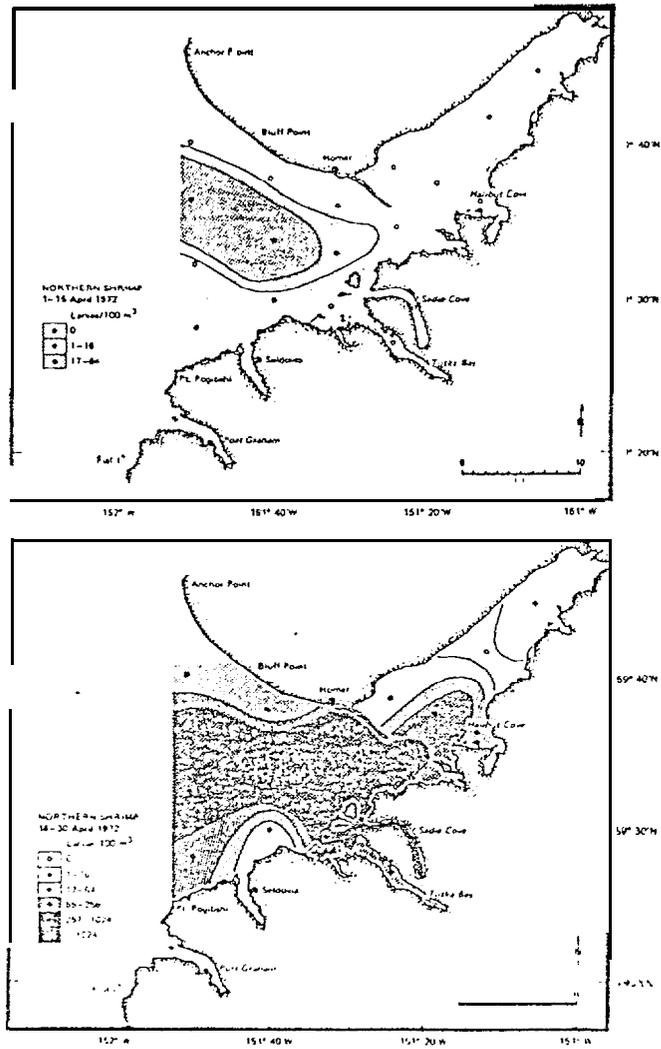


Figure 10. Abundance and distribution of northern shrimp larvae in Kachemak Bay, spring 1972: upper, 1-15 April; lower, 16-30 April (from Haynes 1983).

CKIN Finfish and Shellfish

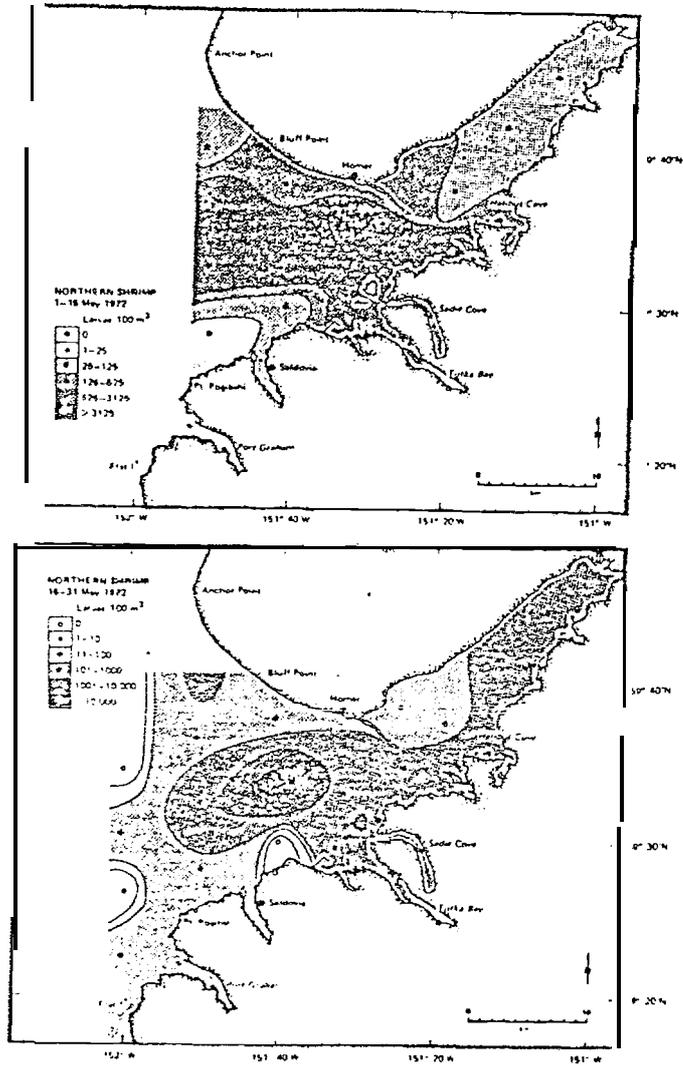


Figure 11. Abundance and distribution of northern shrimp larvae in Kachemak Bay, spring 1972: upper, 1-15 May; lower, 16-31 May (from Haynes 1983).

CKIN Finfish and Shellfish

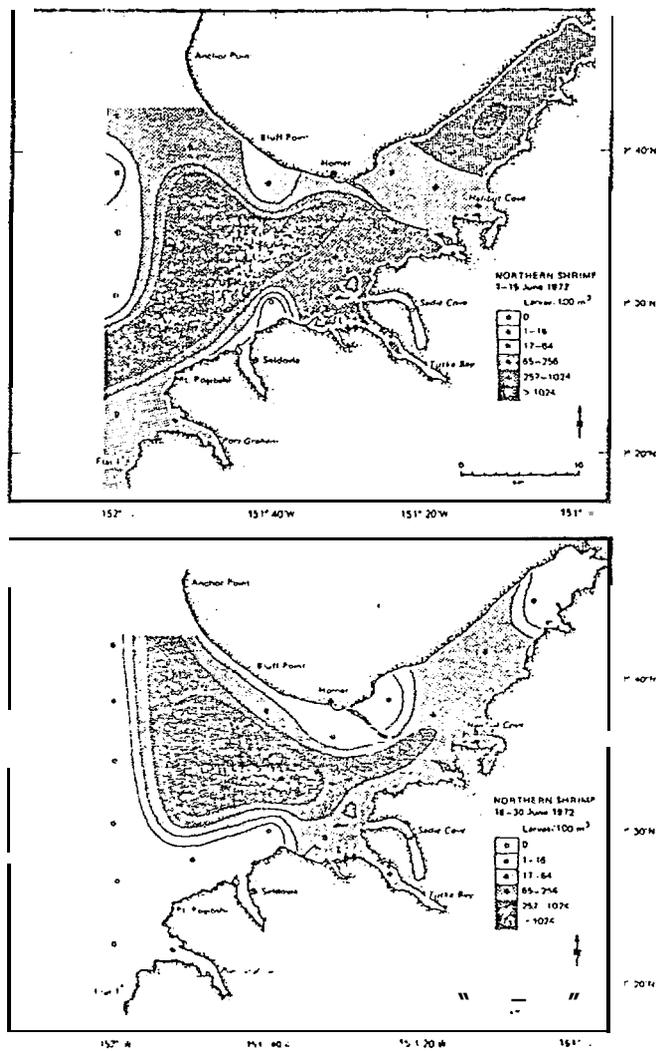


Figure 12. Distribution and abundance of northern shrimp larvae in Kachemak Bay, spring 1972: upper, 1-15 June; lower, 16-30 June (from Haynes 1983).

SHUMAGIN

FINFISH AND SHELLFISH

The Shumagin OCS Planning Area includes two of the six Tanner Crab Management Districts of the Westward Region Registration Area "J" (Figure 1): the South Peninsula Management District and the Chignik Management District. Fisheries data from the Kodiak Management District to the east are discussed under the KODK OCS Planning Area. These regions are important not only for information on the Tanner crab fishery, but also as the sites of recent trawl surveys which provide information on demersal fish and invertebrates.

A trawl survey program (30-minute tows with a 400-mesh eastern otter trawl) was initiated in 1980 to assess Tanner crab (Chionoecetes bairdi) populations in the Kodiak and Chignik Management Districts. Areas surveyed in 1981 and 1982 are shown in Figure 2; results from 1982 are summarized in Table 1.

A similar survey was conducted during the summer of 1981 in the northern Shelikof Strait (KODK OCS Planning Area) and offshore of the Alaska Peninsula near Chignik Bay, in Chignik and Kujulik Bays near the Semidi Islands, and in the Chignik Gully. Results were comparable to those of the 1982 survey. Mean catch rates for both fish and invertebrates were $2147\text{kg}\cdot\text{hr}^{-1}$ offshore of Chignik, $1817\text{kg}\cdot\text{hr}^{-1}$ om Chignik Gully, and $1242\text{kg}\cdot\text{hr}^{-1}$ in Chignik and Kujulik Bays. The Pacific cod population in the Chignik Management District was estimated at 39,143-75,499 metric tons; that of walleye pollock, 74,529-135,615 metric tons (Owen and Blackburn, 1983).

Tanner Crab Harvests

The Tanner crab harvest for 1981-82 in the South Peninsula Management District was 2081.6 metric tons, a 30% increase from the previous season's catch. Fishing effort. in this district was at a 9-year high of 72 vessels. The harvest for the Chignik Management District was 1469.9 metric tons, an 11% decrease from the 1980-81 season. Fishing effort. in this District was at an all-time high, with 45 participating vessels (Colgate and Hicks 1983).

Tanner Crab harvests since 1973 for the two Tanner Crab Management Districts included within the bounds of SHUM are summarized in Table 2.

SEIUM Finfish and Shellfish

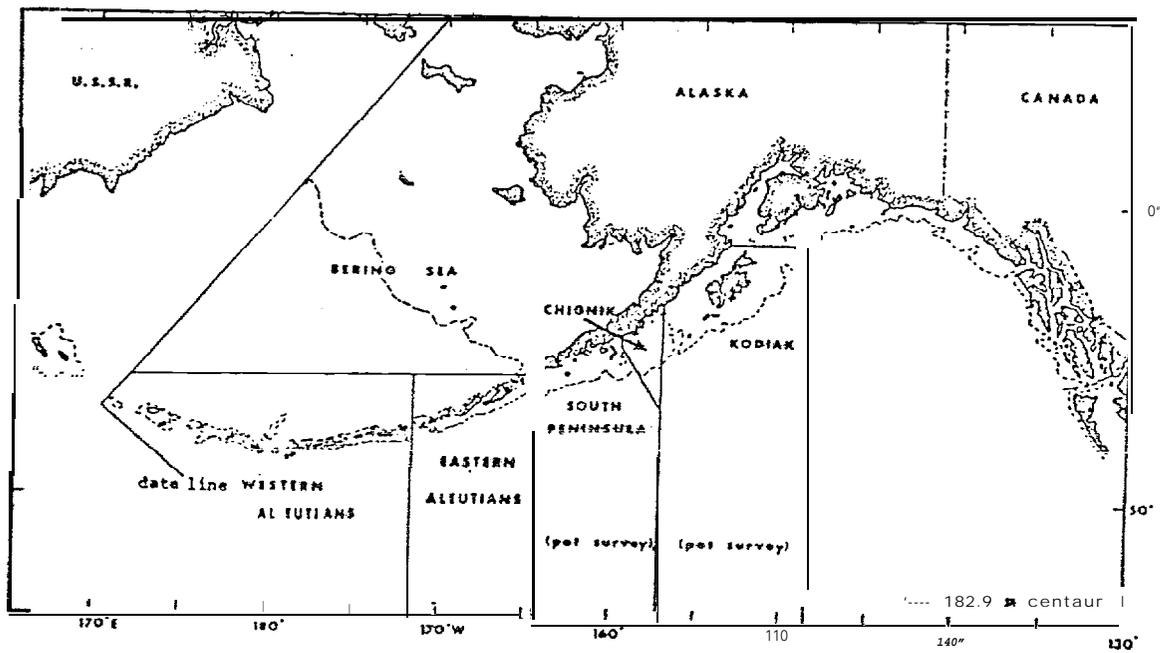


Figure 1. Overview of Tanner Crab Management Districts of the Westward Region, Alaska (from Colgate and Hicks 1983).

SHUM Finfish and Shellfish

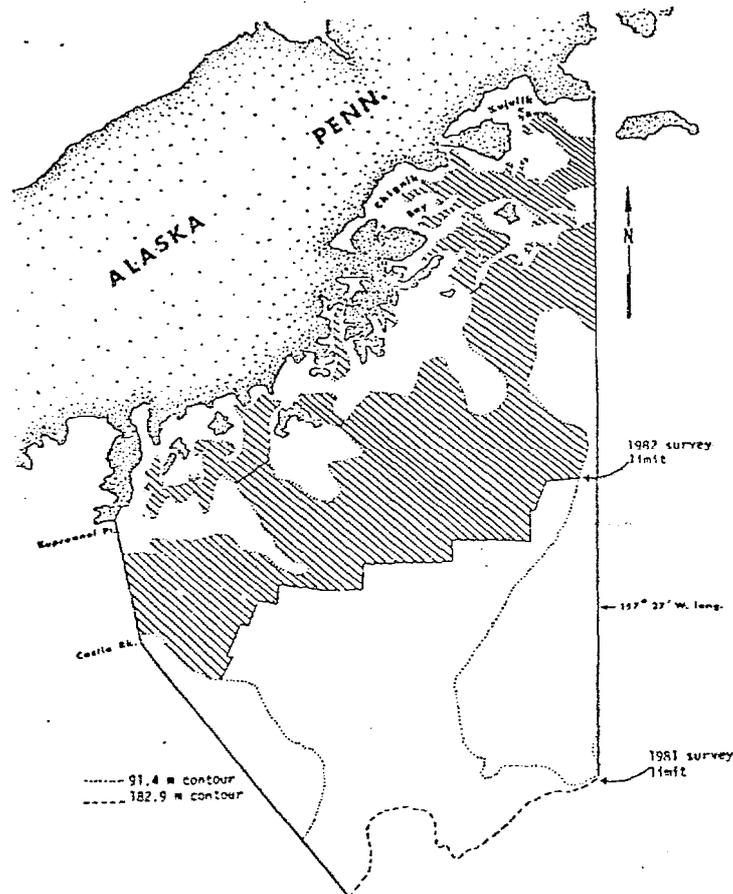


Figure 2. Survey areas for 1981 and 1982 (shaded) otter trawl surveys in the Chignik Tanner Crab Management District (from Colgate and Hicks 1983).

S HUM Finfish and Shellfish

Table 1. Rank and catch per unit effort (CPUE) of major fish and invertebrate species captured in the 1982 Chignik Tanner Crab Management District Trawl Survey (from Colgate and Hicks 1983; Owen and Blackburn 1984).

Species	Overall 1 rank	CPUE (kg·hr ⁻¹)
FISH		
Walleye pollock	1	491
Flathead sole	2	420
Arrowtooth flounder	3	265
Pacific cod	4	147
Yellowfin sole	5	78
Pacific halibut	7	55
Rock sole	8	36
Great sculpin	9	31
Sablefish	10	24
Bigmouth sculpin	11	18
Eelpout (unidentified spp.)	12	15
Big skate	13	10
Yellow Irish lord	15	7
Rougheye rockfish	16	6
INVERTEBRATES		
Tanner crab	6	68. ¹
Starfish (unidentified spp.)	14	8
Shrimp	17	5
Weathervane scallop	20	4
Mud starfish	21	4
Dungeness crab	22	3
Oregon triton	23	3
Hermit crab	24	3
Red crab	27	2
Total kg·hr ⁻¹		1781

¹63 males, 5 females

SHUM Finfish and Shellfish

Table 2. Commercial harvest of Tanner crabs in the Tanner Crab Management Districts included within the SHUM OCS Planning Area (from Colgate and Hicks 1983).

Year	South Peninsula		Kodiak	
	metric tons	CPUE ¹	metric tons	CPUE ¹
1973-74	4310.7	57	1906.3	51
1974-75	2356.8	54	1566.4	63
1975-76	5081.2	75	3141.7	52
1976-77	3072.6	40	2573.2	52
1977-78	3377.6	40	2129.1	45
1978-79	3939.2	40	1150.4	33
1979-80	1976.8	27	1595.7	25
1980-81	1494.2	21	1657.3	35
1981-82	2081.6	22	1469.9	28

¹no. of crabs per pot lift

GULF OF ALASKA SUBREGION

(GOAK, KODK, SHUM OCS PLANNING AREAS)

FINFISH

The Gulf of Alaska is bordered by the Alaskan coast from Dixon Entrance to Unimak Pass. This vast region includes three OCS Planning areas, Plus Cook Inlet (CKIN) directly north. The coast is rugged and mountainous, deeply indented by fjords and inlets. Like the rugged coastline, the continental shelf is irregular and frequently interrupted by submarine valleys. These deep valleys separate broad bank areas, such as Albatross and Portlock Banks near Kodiak Island and the Davidson Bank south of Unimak Island (Figure 1); these plateaus are broader and occur more frequently in the western Gulf (Alton 1981).

Commercial shell- (crabs and shrimp) and bottom-fishing in the Gulf of Alaska can be divided into three historical periods (Alton 1981). The first, from 1867 through the 1950's, saw the development of the cod, halibut, and sablefish fisheries by North American fishermen. The 1960's saw the development of the U.S. crab and shrimp fisheries and foreign fisheries for bottomfish. The third and current period began with the Magnusen Fishery Conservation and Management Act of 1976 which established the 200-mile (320km) Fishery Conservation Zone (FCZ) outside the 3-mile (4.8km) territorial sea and placed all fishery resources under the jurisdiction of the Federal Government.

The State of Alaska retains jurisdiction over domestic Gulf of Alaska fisheries in inshore waters and the territorial sea. The state also has jurisdiction over those offshore fisheries for which a Federal Fisheries Management Plan has not yet been implemented: at present, king crab and shrimp fisheries (Alton 1981).

Catch data for both foreign and domestic fisheries in the Gulf of Alaska are reported by the North Pacific Fishery Management Council (NPFMA). These data are summarized by Regulatory Areas which in some cases are approximately congruent with OCS Planning Areas (Figure 2).

In the tables which follow, no attempt will be made to correct for boundary incongruities and the Regulatory Areas (combined, if necessary) will be used to estimate fishery harvests from the OCS Planning Areas as defined. "Groundfish" include any marine fish, except halibut (Hippoglossus stenolepis), osmerids (smelts), herring, and salmonids. Halibut are excluded from these tabulations because this fishery has been managed historically by the International Pacific Halibut Commission (IPHC, Rigby 1984). Sablefish catches will be reported in dressed weight; all others will be in round weight (dressed wt. /0.7). All weight values are reported in metric tons.

GULF OF ALASKA (Subregica) Finfish and Shellfish

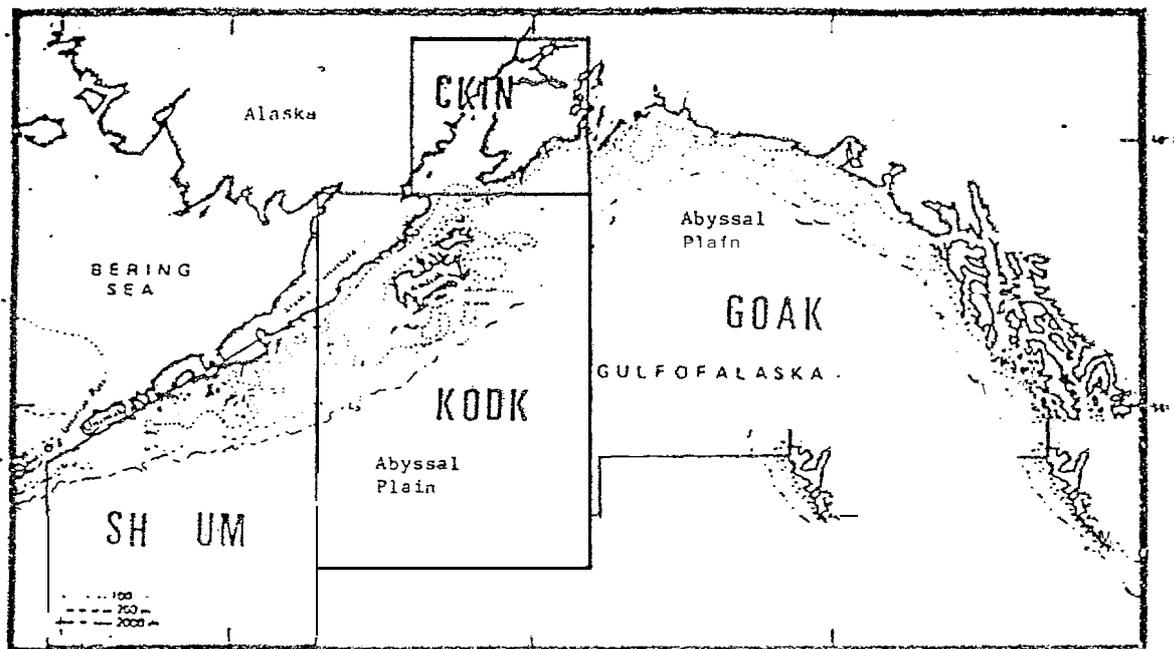


Figure 1. Principal geographical locations and bathymetry of the Gulf of Alaska, with OCS Planning Area boundaries superimposed (after Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

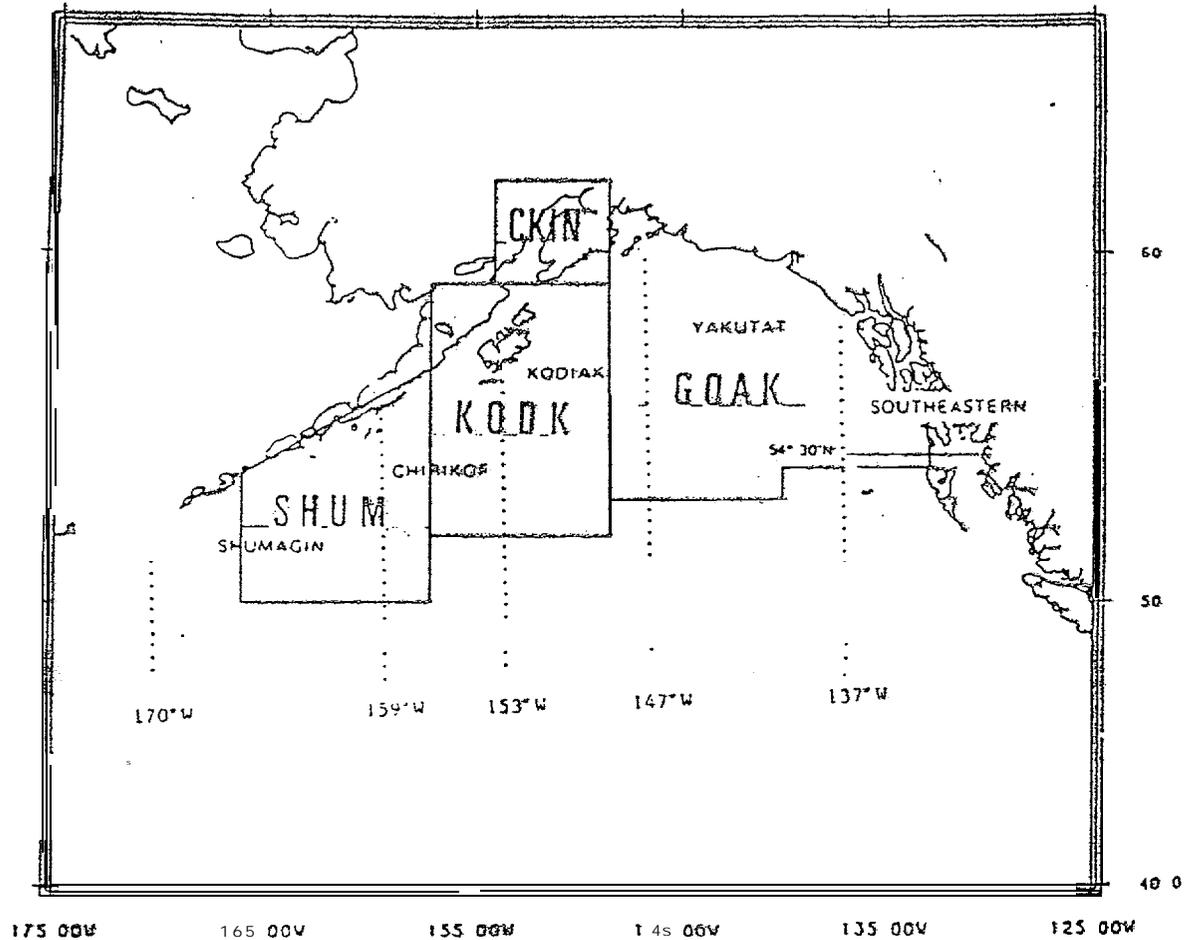


Figure 2. North Pacific Fishery Management Council (NPFMC) Regulatory Areas in Gulf of Alaska, with OCS Planning Area boundaries superimposed (after Shippen and Stauffer 1983).

GULF OF ALASKA (Subregion) Finfish and Shellfish

The Effect of Joint Venture Fisheries

Table 1 summarizes domestic groundfish catches for the entire State of Alaska for the decade, 1970-1980. Two important features are relevant to the Gulf of Alaska:

1. (Walleye) pollock, Pacific cod, and flounders constitute the principal groundfish harvests.

2. A sharp increase in total harvest occurred in 1979-80; this was the result of joint-venture fisheries (foreign processing of catch from U.S. vessels) which were permitted under the Magnusen Act of 1976. The principal groundfish listed above figured significantly in this increase.

After an initial catch of 44.6 metric tons in 1978, joint-venture fisheries grew very rapidly to a total of 37,296 metric tons by 1980. Although 95% of the 1980 catch came from the Bering Sea and Aleutians area, significant increases also occurred in the Gulf of Alaska (Rigby 1984).

The contribution of joint-venture harvests makes it difficult to establish trends in fishery "productivity" for Alaskan waters. Post-1977 harvest data will be emphasized in the summaries which follow.

Groundfish Harvest Data

Table 2 summarizes domestic groundfish harvests from the three OCS Planning Areas in the Gulf of Alaska (assuming the OCS Planning Area Boundaries and those of the NPFMC Regulatory Areas approximately coincide). Principal components of the harvest, broken down into domestic, foreign, and joint-venture catches, are presented in more detail in Tables 3, 4, and 5. Although domestic groundfish catches have sharply increased, especially with the contribution of joint-venture fisheries, foreign harvests still dominate the total groundfish catch.

Walleye pollock (Theragra chalcogramma) accounted for the greatest portion of the commercial groundfish landings, with largest catches from the Chirikof and Kodiak International North Pacific Fisheries Commission (INPFC) regions (KODK OCS Planning Area). The foreign catch of pollock has steadily decreased since 1978 while the U.S. portion of the catch has drastically increased, again the result of joint-venture fisheries.

GULF OF ALASKA (Subregion) Finfish and Shellfish

Table 1. Annual Alaska groundfish harvest in metric tons -- all Alaskan catches, all areas, all gears (from Rigby 1984).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Pollock	42.0	---	2.4	24.1	32.4	---	185.8	227.8	1064.1	261.6	12842.8
Sablefish	407.9	270.7	759.1	875.5	776.9	1088.7	804.7	825.0	1239.1	2488.3	1730.5
Pacific cod	77.5	44.2	65.8	59.0	145.4	130.3	222.1	249.6	819.6	2281.2	217392.0
Yellowfin sole	---	---	---	---	---	---	---	6.7	2.1	0.8	0.1
Dover sole	0.8	---	---	---	---	0.3	---	---	0.6	1.1	---
English sole	---	---	---	---	---	---	---	---	0.7	7.2	---
Flathead sole	---	---	---	---	---	---	2.8	2.4	28.0	16.5	---
Butter sole	---	---	---	---	---	---	---	---	0.1	1.6	---
Rex sole	0.4	---	---	---	---	---	---	---	0.0	---	---
Rock sole	---	---	---	---	---	---	---	5.0	19.0	0.2	45.4
Petrale sole	---	---	---	---	---	---	---	0.3	---	.9	0.5
Turbot	91.0	---	---	---	---	---	---	---	2.6	6.2	---
Starry flounder	---	---	---	---	---	---	---	---	637.2	720.8	325.0
Flounder	17.5	0.8	70.2	450.7	328.4	3.8	151.3	32.8	75.9	92.7	12669.2
Alaska plaice	---	---	---	---	---	---	---	---	1.8	2.7	0.3
Pacific ocean perch	537.0	---	---	---	---	---	---	12.4	4.6	172.1	75.4
Rockfish	6.7	27.1	71.7	86.2	88.2	98.9	128.7	143.3	102.5	270.5	222.4
Ling cod	19.4	20.5	38.4	54.3	74.3	47.2	31.3	22.2	24.3	32.9	21.7
Bullhead	11.5	13.2	---	0.7	26.2	2.3	17.3	2.9	41.0	---	24.8
Skates	---	---	---	---	---	---	1.7	0.9	90.8	---	29.3
Unspecified	4.1	---	---	---	---	17.8	113.5	127.6	148.5	322.2	1470.9
TOTAL	1217.7	376.4	1007.5	1550.5	1472.2	1389.3	1659.3	2316.0	4385.8	8633.5	47162.6

GULFOF ALASKA (Subregion) Finfish and Shellfish

Table 2. Total annual groundfish harvests (metric tons) from Gulf of Alaska regions (prepared from data in Rigby 1984).

OCS Planning Area	NPFMC Regulatory Area(s)	1977	1978	1979	1980
GOAK Southeastern + Yakutat	1942.0	2940.6	3783.5	2545.2	
KOOK Kodiak +Chirikof	320.0	1302.4	4200.8	3202.9	
SHUM Shumagin	53.0	82.9	37.6	209.0	

GULFOFALASKA (Subregion) Finfish and Shellfish

Table 3. Total catches (metric tons) of principal groundfish from GOAK OCS Planning Area (Southeastern + Yakutat NPFMC Regulatory Areas) (data for foreign catches from Stauffer 1983a; domestic catch data from Stauffer 1983a and Rigby 1984; halibut data from IPHC Annual Reports, 1978, 1979, 1980).

	Pollock	Sablefish	Paci fi c Cod	Atka Mackerel	Paci fi c Ocean Perch	Flatfish	Hal ibut
1978							
total foreign	3520		265	290	2504	5471	
joint venture							
total domestic	534	1238	110			760	3457
1979							
total foreign	5372		406	11	6434	5632	
joint venture							
total domestic	528	2417	112		45	329	4372
1980							
total foreign	4631		2043	171	7616	5684	
joint venture							
total domestic	420	1637	194		2		4335
1981							
total foreign	0574		2326	1303	6674	5441	
joint venture							
total domestic			32			412	
1982							
total foreign	26		2070	1	17	58	
joint venture							
total domestic	26		44			94	

GULF OF ALASKA (Subregion) Finfish and Shellfish

Table 4. Total catches (metric tons) of principal groundfish from KODK OCS Planning Area (Kodiak + Chirikof NPFMC Regulatory Areas) (data for foreign catches from Stauffer 1983a; domestic catch data from Stauffer 1983a and Rigby 1984; halibut data from IPHC Annual Reports, 1978, 1979, 1980).

	Pol lock	Sablefish	Paci fi c Cod	Atka Mackerel	Paci fi c Ocean Perch	Flatfish	Hal ibut
1978							
total foreign	61,498		5505	18,808	2022	6312	
joint venture							
total domestic	490	1	610			86	3705
1979							
total foreign	67,597		8797	10,520	2371	5026	
joint venture			700				
total domestic	2061	72	874		126	55	3138
1980							
total foreign	11718		23,581	11,273	3987	6885	
joint venture	1023		453			198	
total domestic	483	49	444		21	46	2743
1981							
total foreign	74,189		21,327	13,952	4268	5759	
joint venture	16,836		50			18	
total domestic			721			66	
1982							
total foreign	52,357		171836	3595	6223	7516	
joint venture	73,772		172			12	
total domestic	2129		1910			51	

GULFOFALASKA (Subregion) Finfish and Shellfish

e Table 5. Total catches (metric tons) of principal groundfish from SHUM OCS Planning Area (Shumagin NPFMC Regulatory Area) (data for foreign catches from Stauffer 1983a; domestic catch data from Stauffer 1983a and Rigby 1984; halibut data from IPHC Annual Reports, 1978, 1979, 1980).

	Pollock	Sablefish	Pacific Cod	Atka Mackerel	Pacific Ocean Perch	Flatfish	Halibut
1978							
total foreign	31,301		5520	488	3643	2530	
joint venture			7				
total domestic			64			6	157
1979							
total foreign	30,218		3970	419	944	2817	
joint venture			11				
total domestic	22				1		25
1980							
total foreign	46,647		8621	1718	842	3022	
joint venture	114		13			8	
total domestic		i	70				54
1981							
total foreign	47,560		11314	3471	1234	3224	
joint venture	20						
total domestic			230				
1982							
total foreign	40,229		7030	3163	1746	1412	
joint venture	145		21			6	
total domestic	82		4480				

GULF OF ALASKA (Subregion) Finfish and Shellfish

Important Fisheries of the Gulf of Alaska

The discussion which follows reviews the condition of the major commercial groundfish fishery stocks in the Gulf of Alaska. "Productivity" of these stocks will be estimated on the basis of maximum sustainable yield (MSY) and optimum yield (OY). As with preceding text, these estimates refer only approximately to the areas covered by the OCS Planning Areas.

Walleye Pollock

Yields in metric tons x 10 ³	<u>MSY</u>	<u>OY</u>	
	1978-1982	1983	
GOAK	14-29	16.6	16.6
KODK	95.2-191	95.2	143
SHUM	57-114	57	57

Pollock (Theragra chalcogramma) are a semidemersal schooling fish of the cod family. Most of the Gulf of Alaska resource lies in the KODK and SHUM OCS Planning Areas (i.e., the Central and Western NPFMC Regulatory Areas) from the vicinity of Prince William Sound west to Unimak Pass (Figure 3). The Gulf stock is apparently separate from that of the Bering Sea and Aleutians. Major spawning occurs in the Shelikof Strait Region near Kodiak Island, where pollock from various parts of the west and central Gulf migrate during the winter and spring months (Alton and Deriso "1983).

Four successive strong year-classes (1975-1979) resulted in a **substantial** increase in stock biomass and fishable biomass for the years 1979-82. The range of surplus production for this period was 484-524x10³ metric tons and exceeded the annual harvest by the fisheries (106-169x10³ metric tons). The 1983 estimate of fishable pollock biomass was approximately two million metric tons, less than the 1982 estimate of 2.6 million metric tons but still greater than the average for the years 1976-82 (1.4 million metric tons). The 1984 fishery condition will depend to a great degree on the abundance of the 1980 year class as 4-year olds. This class had a poor showing in both 1983 trawl surveys and joint-venture fisheries, but it remains to be seen whether these data accurately reflect the condition of the fishery (Alton and Deriso 1983).

The good condition of the pollock stocks in the Gulf of Alaska is indicated by the OY'S being in the upper- portion of the range for the MSY'S.

GULF OF ALASKA (Subregion) Finfish and Shellfish

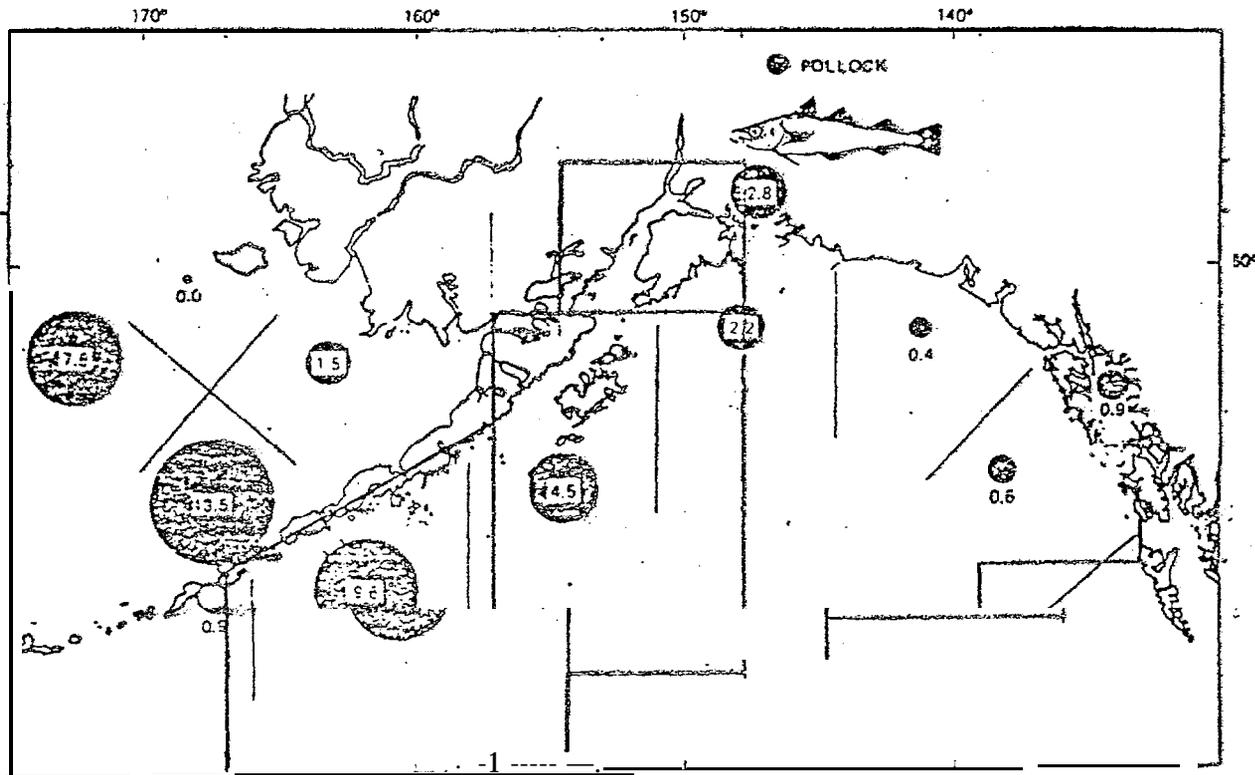


Figure 3. Apparent density (metric tons·km⁻²) of walleye pollock in the Gulf of Alaska and eastern Bering Sea as suggested from NMFS bottom trawl surveys (1973-78) at depths less than 400m (from Alton 1981).

GULFOF ALASKA (Subregion) Finfish and Shellfish

Sablefish

Yields in metric tons x 10 ³	<u>OY -- 1983</u>
GOAK	3.5 - 4.75
KODK	3.06
SHUM	1.67

Sablefish (*Anoplopoma fimbria*) have been harvested by U.S. and Canadian commercial fishermen since early in this century, but catches initially were relatively small and generally limited to areas near fishing ports from California to Alaska. Catches in the Gulf of Alaska averaged 1500 metric tons from 1930 to 1950. Exploitation rates increased markedly when Japanese longliners began fishing in the Eastern Bering Sea in 1958. This fleet expanded operations to the Aleutian region and the Gulf of Alaska in 1963. Catches from the Gulf rapidly increased to a maximum of 36,500 metric tons (95% from Japanese vessels) in 1972 (Figure 4). Catches have been declining since that time. The distribution of Japanese sablefish catches in the Gulf are shown in Figure 5.

The decline in sablefish harvests have resulted in substantial restrictions on the fishery since 1977. These include prohibition of all foreign fisheries east of 140°W longitude, the most productive region of the Japanese longline fishery. Annual Gulf of Alaska sablefish landings have averaged 9187 metric tons over the period 1978-1982 (Stauffer 1983 b). The U.S. sablefish catch has averaged about 2200 metric tons since 1976, and exceeded 3000 metric tons in 1979 and 1982.

Optimum yield of sablefish throughout the Gulf of Alaska was set at 22,000 metric tons in 1977, but has been substantially reduced from this value in an attempt to preserve and rebuild the fishery. In 1983, Amendment 11 of the Groundfish Fishery Management Plan established the OY, 5230-9480 metric tons, at 75% of the estimated EY. This conservative approach is being repeated in 1984 to promote fishery recovery to its former levels.

Actual landings of sablefish have averaged 68% of the OY from 1977 - 1982.

GULF OF ALASKA (Subregion) Finfish and Shellfish

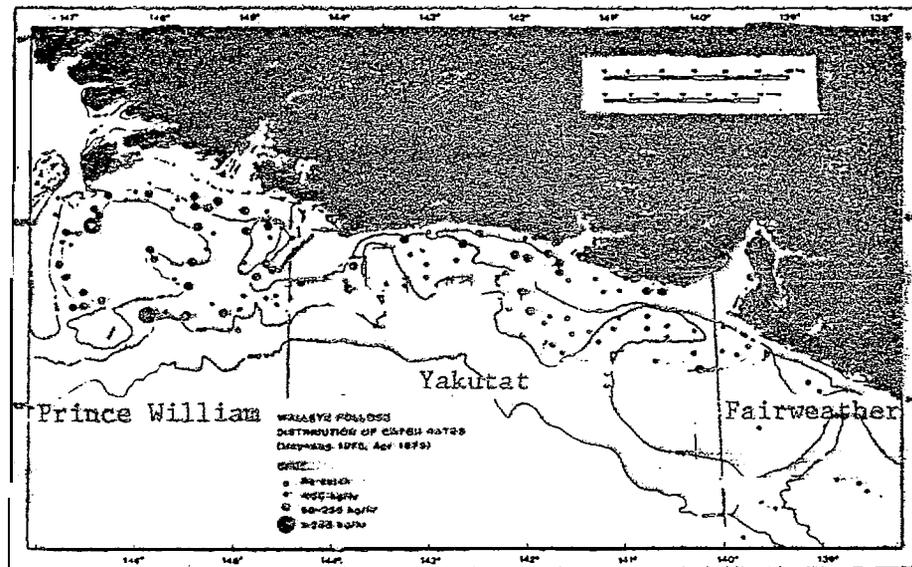


Figure 4. Foreign catch of sablefish in Gulf of Alaska, 1967-1978 (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

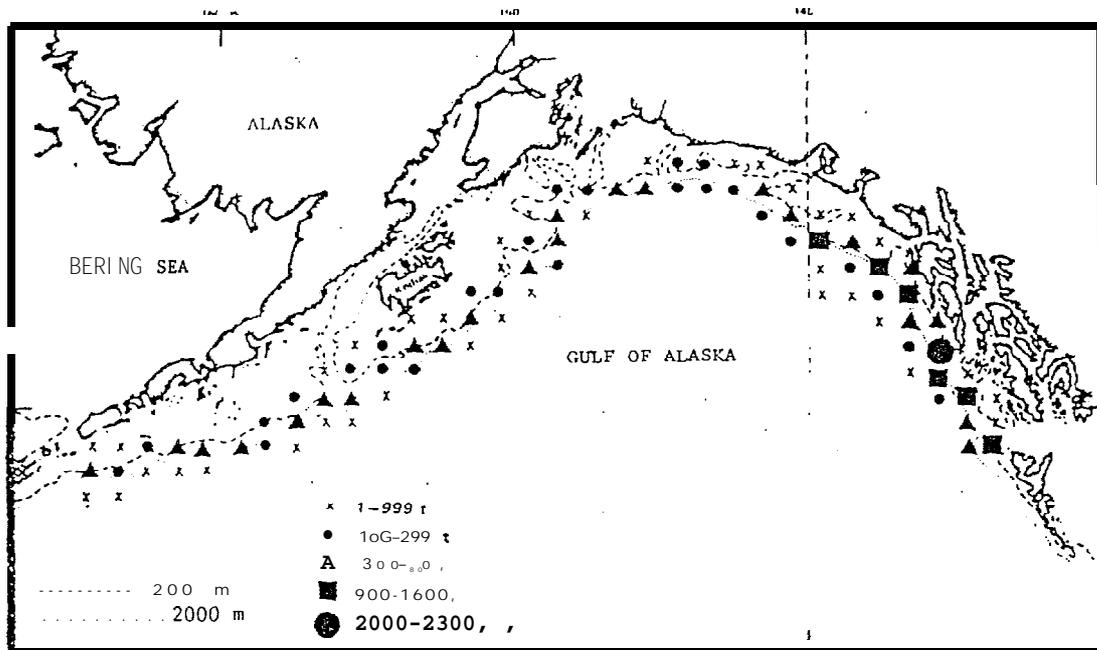


Figure 5. Distribution of Japanese sablefish catches in the Gulf of Alaska in 1972, the year in which the annual longline fishery peaked (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

Pacific Cod

Yields in metric tons x 10³ OY--1982

GOAK	9.90
KODK	33.54
SHUM	16.56

The importance of Pacific cod (Gadus macrocephalus) in commercial groundfish harvests from the Gulf of Alaska has grown in recent years, increasing from 2223 metric tons in 1977 to 36,018 metric tons in 1981, then dropping to 33,563 metric tons in 1982. Domestic landings of cod increased six-fold between 1981 and 1982, from 991 to 6434 metric tons. Preliminary figures from the Alaska Department of Fish and Game indicate that the Pacific cod fishery landed 2460 metric tons in the first five months of 1983, nearly a three-fold increase over the same time period in 1982. Best estimates of the foreign catch by the end of May 1983 were 10,660 metric tons, about 41% of the current total allowable level of foreign fishing allocation (Zenger 1983).

Japan, Korea, the U.S. and a number of U.S.-foreign joint ventures harvested Pacific cod in the Gulf of Alaska in 1982. Japanese vessels accounted for the majority (73% of the total catch of 33,563 metric tons); approximately half of Japan's catch came from the Chirikof NPFMC Regulatory Area (western KODK OCS Planning Area). The U.S. catches were greatest in the Shumagin and Kodiak Regions (SHUM and eastern KODK OCS Planning Areas). The combined Shumagin and Chirikof areas (roughly the KODK and SHUM OCS Planning Areas) produced 77% of the 1982 cod catch in the Gulf of Alaska in 1982 (Zenger 1983).

The distribution of OY'S are roughly mirrored in the distribution of harvests for 1982. For the Western, Central, and Eastern Regulatory Areas, respectively, the OY'S are distributed as 28%, 56%, and 16%; the actual catches were distributed as 34%, 60%, and 6%. Research trawl surveys indicated that 59% of the available cod biomass was located in the Western, 39% in the Central, and 2% in the Eastern Regulatory Area. Apparent Pacific cod densities summarized from earlier trawl surveys are shown in Figure 6.

The estimated 1982 MSY for the Gulf of Alaska was 95-190 x10³ metric tons. Pacific cod stocks apparently are in stable condition, though no strong year classes have been identified following the dominant 1977 cohort (Zenger 1983).

GULF OF ALASKA (Subregion) Finfish and Shellfish

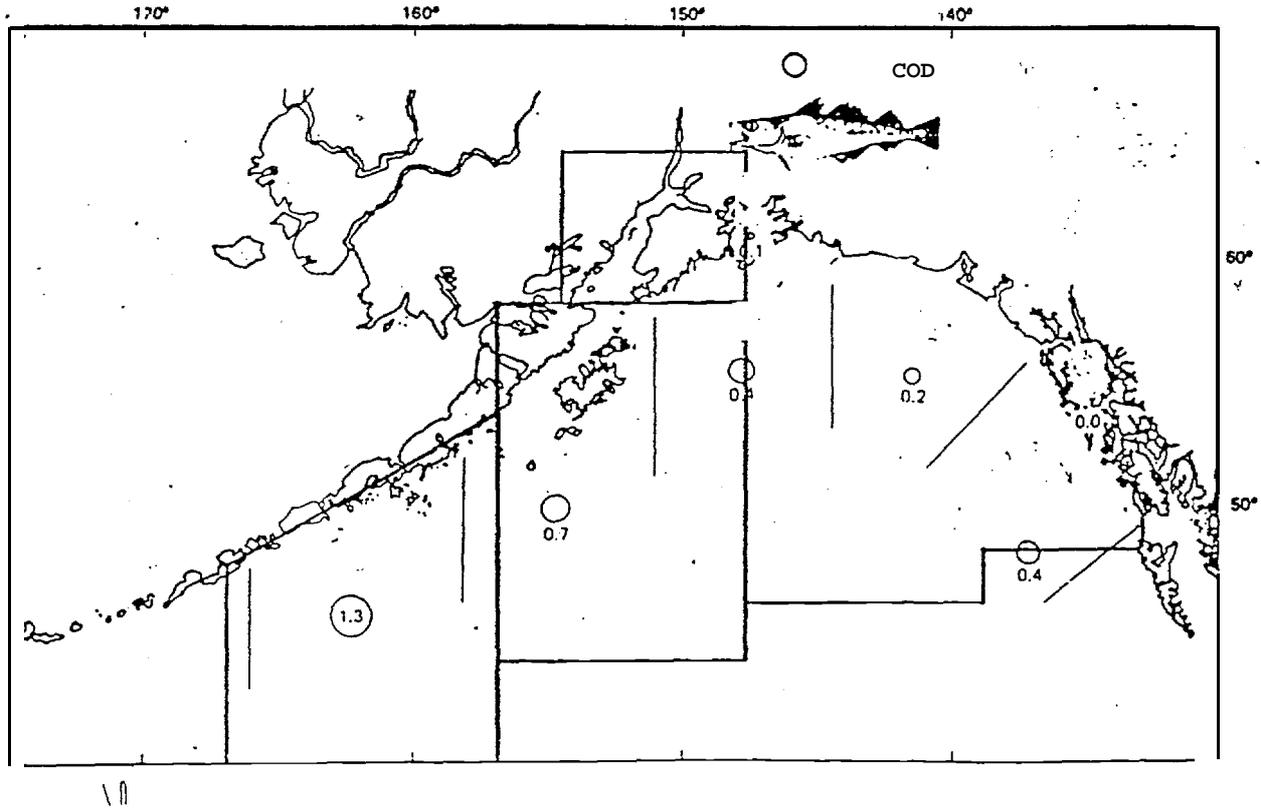


Figure 6. Apparent density (metric tons·km⁻²) of Pacific cod in the Gulf Of Alaska, based on NMFS bottom trawl surveys, 1973-1978, at depths less than 400m (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

Atka Mackerel

Atka mackerel (Pleurogrammus monopterygius) are found throughout the Gulf of Alaska, with highest concentrations in the NPFMC Regulatory Areas corresponding to the SHUM and KODK OCS Planning Areas, at depths of 50-350m. Spawning occurs in the KODK OCS Planning Area from July to October in the vicinity of Albatross Bank (see Figure 1). The Gulf stock apparently is separate from that of the Aleutians (Ronholt 1983a).

These fish are harvested exclusively by foreign fisheries. From 1972-1980 the catch was dominated by the Soviets; Korea and Japan dominated the catch in 1981-1982. As Table 6 shows, there has been a net downward trend in Atka mackerel landings in recent years. Catches have declined in relative importance from second in 1978 to last in 1982, when the catch was at its lowest level since 1974. KODK normally produces 75% of the annual catch.

Estimated range for MSY, based on average biomass of the early 1970's, is 16,610 - 26,750 metric tons. Two prominent year classes (1976 and 1977) dominated the Soviet fishery in 1980. Since 3- or 4-year old fish appear to dominate the commercial fishery, available surplus yield is expected to decline until the occurrence of strong recruitment (Ronholt 1983a).

GULF OF ALASKA (Subregion) Finfish and Shellfish

Table 6. Major foreign landings (metric tons) from the Gulf of Alaska, 1978-1982 (from Ronholt 1983a).

Year	Walleye pollock	Atka mackerel	Flounders (all)	Pacific cod	Pacific ocean perch
1978	96,327	19,585	14,314	11,369	8,169
1979	103,187	10,195	13,474	13,174	9,750
1980	112,996	13,162	15,496	34,243	12,447
1981	130,323	10,727	14,442	34,968	12,177
1982	92,612	6,750	8,986	26,936	7,988

GULF OF ALASKA (Subregion) Finfish and Shellfish

Pacific Ocean Perch

OY--1982

14,475

The category "Pacific ocean perch" as employed in the current Gulf of Alaska Groundfish Management Plan includes five Sebastes species. Although each has its unique range, all overlap broadly in the Gulf (Table 7).

Pacific ocean perch were the dominant rockfish and a prominent member of the demersal fish community during the 1950's and early 1960's. A resource assessment of the Gulf of Alaska made by the International Pacific Halibut Commission (IPHC) and the Bureau of Commercial Fisheries (BCF, now NMFS) in 1961 indicated high abundances of this species. But similar surveys from 1973-1976 by NMFS revealed marked decreases in stocks (Figure 7).

During the interval between the 1961 and the 1973-76 surveys, the USSR and Japan conducted trawl fisheries in the Gulf of Alaska which targeted Pacific ocean perch. Foreign catches from the Gulf peaked at 348,598 metric tons in 1965. Results of a cohort analysis of the catch-at-age data for the foreign fishery from 1963 to 1973 indicated that the exploitable stock decreased 92% during that time frame. Thus, annual harvests apparently exceeded surplus production and prevented any increase in abundance (to 1982). Today the Pacific ocean perch population remains severely depressed and shows little sign of significant recovery in the immediate future. The NPFMC has set MSY at 125,000 metric tons but recognizes that current stock levels are well below the size required to support such a harvest.

The Gulf of Alaska management plan set the equilibrium yield (EY -- the annual harvest that allows the stock to be maintained at approximately the same level of abundance over a period of several years) at 50,000 metric tons. The allowable biological catch (ABC) may be set lower than the MSY to help rebuild the depleted stock, although at present it is the same as the MSY. The OY may deviate from the ABC for economic, social, or ecological objectives. Various management allowances are compared with the actual foreign catches for 1981 and 1982 in Table 8.

GULF OF ALASKA (Subregion) Finfish and Shellfish

Table 7. Sebastes species included in the "Pacific ocean perch" complex.

Scientific name (m)	Common name	Geographic Range	Depth Range
<u>S. alutus</u>	Pacific ocean perch	Japan to Bering Sea to s. California	55 - 640
<u>S. polyspinis</u>	northern rock fish	Bering Sea to Yakutia	70-360
<u>S. aleutianus</u>	rougheye rockfish	Aleutian islands to s. California	180-730
<u>S. borealis</u>	short raker rock fish	Kamchatka to n. California	to 305
<u>S. zacentrus</u>	sharpchin rockfish	Gulf of Alaska to s. California	911-320

GULF OF ALASKA (Subregion) Finfish and Shellfish

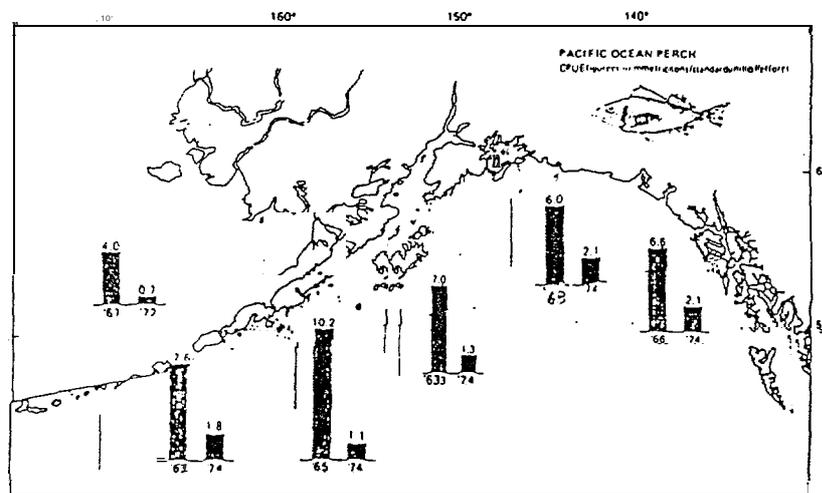


Figure 7. Decline in catch-per-unit effort (CPUE) of Pacific ocean perch in the Japanese trawl fishery in the Gulf of Alaska and Bering Sea in the 1960's and early 1970's. Data in metric tons/standard unit of effort (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

Flatfish

OY--1982

Metric tons

GOAK	8,400
KODK	14,700
SHUM	10,400

With the exception of Pacific halibut, flatfish catches in the Gulf of Alaska primarily have been either incidental to those for other fish, or the result of a low-priority alternate fishery. Although it includes many species, the fishery is managed as a single stock. Major species, which account for 99% of the total flatfish catch, include the following: arrowtooth flounder (Atheresthes stomias), flathead sole (Hippoglossoides elassodon), rock sole (Lepidopsetta bilineata), rex sole (Glyptocephalus zachirus), Dover sole (Microstomus pacificus).

While total flatfish catch has fluctuated between 12,000 and 15,000 metric tons in recent years, the 1982 catch was only 9,000 metric tons. One apparent cause of this drop was an amendment to the Fishery Management Plan which closed all waters east of 140°W longitude to foreign fishing and limited foreign trawlers between 140° and 147°W to midwater trawling only (Rose 1983).

The MSY of flatfish in the Gulf has been estimated at 67,000 metric tons, based on an exploitable biomass of 770,000 metric tons. The allowable biological catch (ABC) is presently considered to equal the MSY, largely because flatfish are not heavily exploited. However, to protect halibut stocks, OY has been set at 50% of the ABC. The 1982 OY'S established for the NPMFC Management Regions, which are summarized for OCS Planning Areas above, are similar to those of the last five years.

GULF OF ALASKA (Subregion) Finfish and Shellfish

Pacific halibut

The North American halibut (*Hippoglossus stenolepis*) fishery operates in both the northwest Pacific and the eastern Bering Sea, although 70-75% of the catch comes from the Gulf of Alaska (Alton 1981). The American portion of the Gulf catch has dropped from slightly under 15,000 metric tons in 1960-61 to 7100 metric tons in 1980 (Figure 8). Greatest catches have come from the NPFMC Regulatory Regions corresponding to the KODK and GOAK OCS Planning Areas.

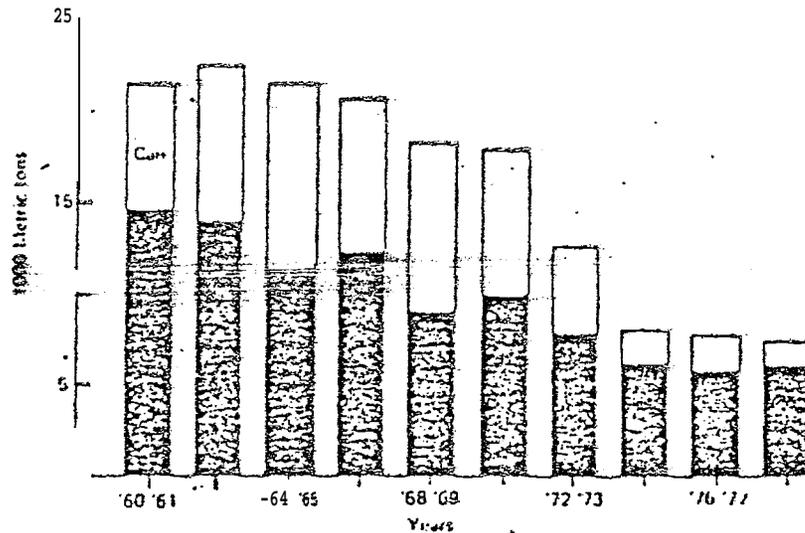


Figure 8. Annual landings (2-yr. average) of Pacific halibut from Gulf of Alaska, US, and Canadian fisheries (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

SHELLFISH

Dungeness crab

Dungeness crabs (*Cancer magister*) occur in bays, inlets and nearshore waters along the open coast. Males grow to a carapace width of 15-18 cm; females are smaller. These crabs are caught primarily with circular steel mesh-covered pots fished at bottom depths of less than 40m (Alton 1981).

Annual catches from the Gulf of Alaska reached 4000-6000' metric tons during the years 1963-1970 and are now cycling between lower yields (Figure 9). These changes in annual catch do not reflect changes in crab abundance per se, but appear to relate more to extraneous factors such as market conditions (Alton 1981).

Figure 10 illustrates the principal fishing regions. The greatest yields have come from southeast Alaska and off Kodiak Island, regions corresponding to the GOAK and KODK OCS Planning Areas.

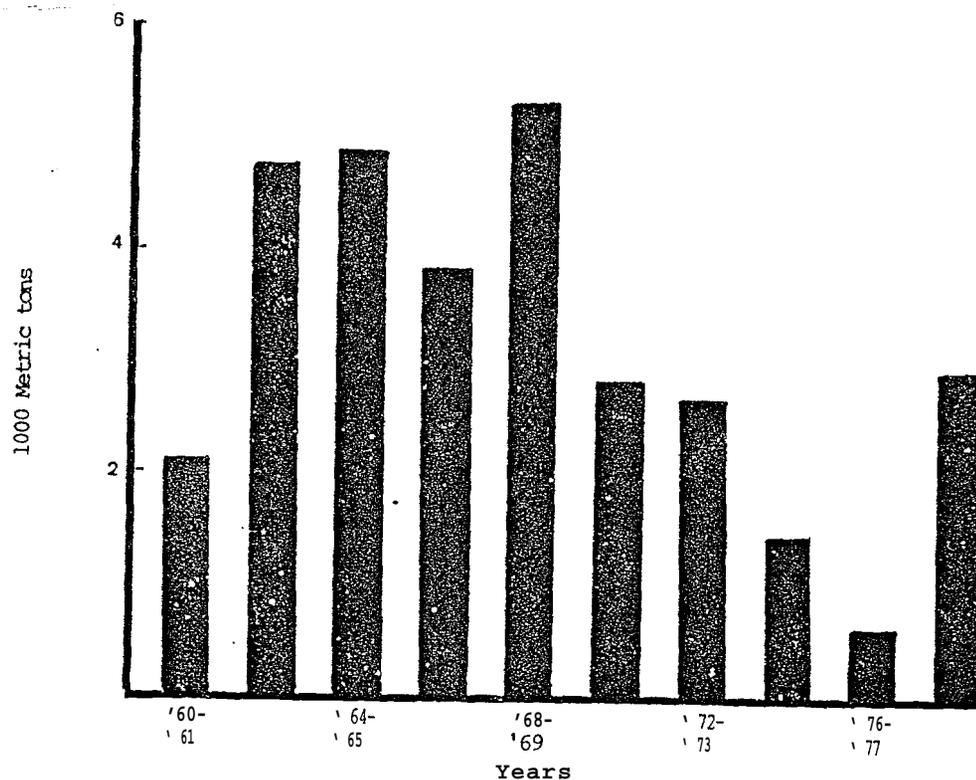


Figure 9. Annual landings of Dungeness crab from the Gulf of Alaska (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

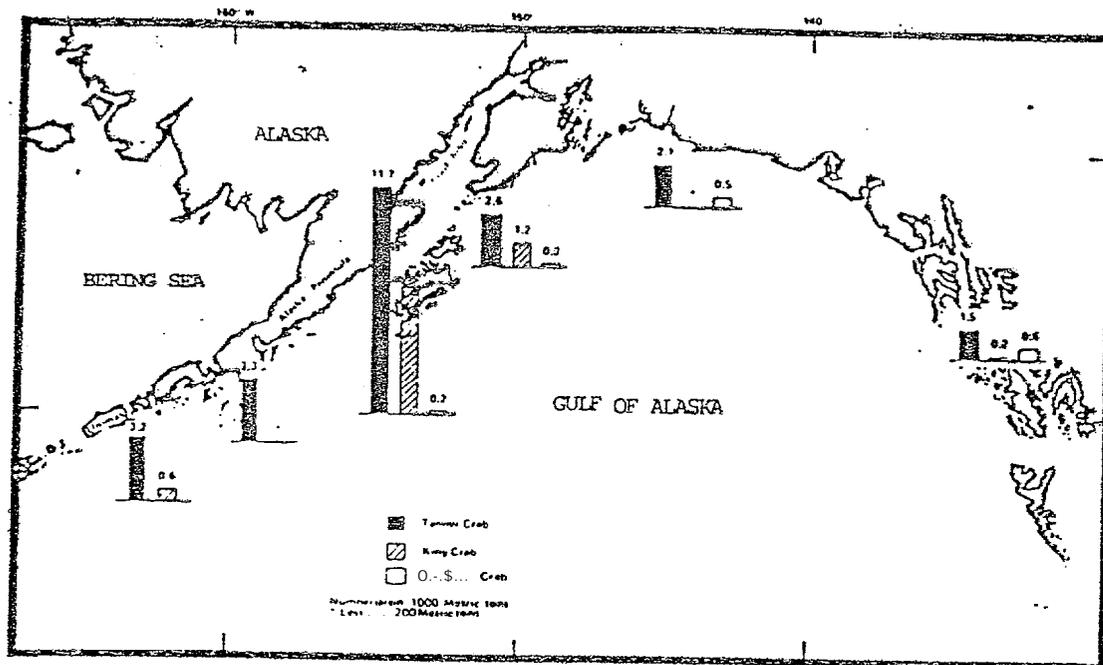


Figure 10. Average annual U.S. catch of three most commercially important crab species in Gulf of Alaska, 1976-78 (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

King crab

Red king crab (Paralithodes camtschatica) is the most important of the three king crab species (red, blue, and brown) taken in the Gulf of Alaska fishery. Individuals of this species, the largest of the king crabs, may measure 1.5m across spread legs and weigh as much as 11kg, although most commercially taken crabs (only males are taken) average only 3kg in weight. Red king crabs are found in the Gulf, Bering Sea, and northwestern Pacific Ocean. Preferred habitat is over the continental shelf, though some occur at depths greater than 400m. The crabs are taken with heavy, triangular pots. The Gulf of Alaska king crab fishery is exclusively a U.S. fishery regulated by the state of Alaska.

Annual catches in the Gulf peaked at 38,000-54,000 metric tons in the mid-1960's, but have declined since to less than 8000 metric tons (Figure 11). The fishery is centered around Kodiak Island, corresponding to the KODK OCS Planning Area (see Figure 10). Abundances in this region are now low due to poor recruitment (Alton 1981).

Snow (Tanner) crab

Several species of snow crab are found in the Gulf of Alaska, but only Chionoecetes bairdi is fished commercially. Males reach a larger size than females, up to 19.0cm carapace width, though in the Kodiak fishery males average 15.1-15.5cm.

The snow crab fishery operates on the continental shelf to depths of 400m, using various types of specially constructed pots. This is a relatively recent fishery; the first significant catch, 54 metric tons, was taken in 1967. Catches peaked at 27,600 metric tons in 1973 and remained more than 18,000 metric tons from 1974-78 (Figure 12). The most important snow crab fisheries are in the vicinity of Kodiak Island, corresponding with the KODK OCS Planning Area (see Figure 10).

GULF OF ALASKA (Subregion) Finfish and Shellfish

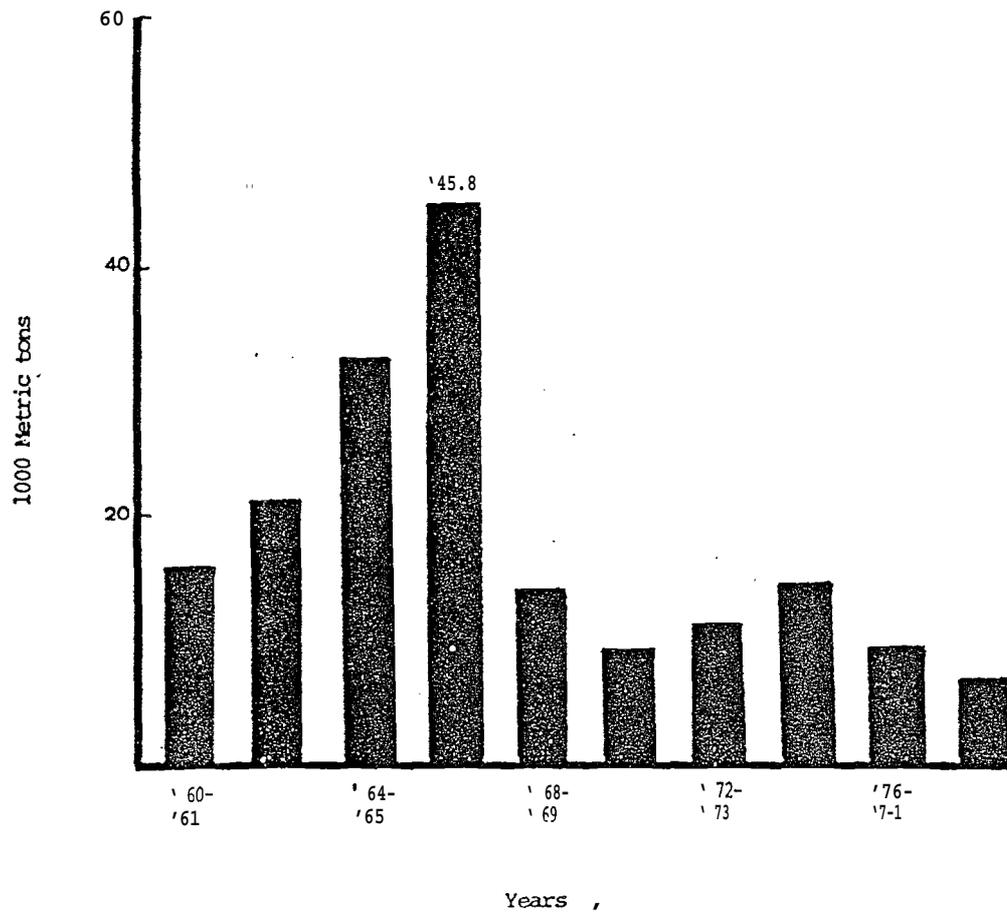


Figure 11. Annual landings (2-yr. average) of king crab in the Gulf of Alaska (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

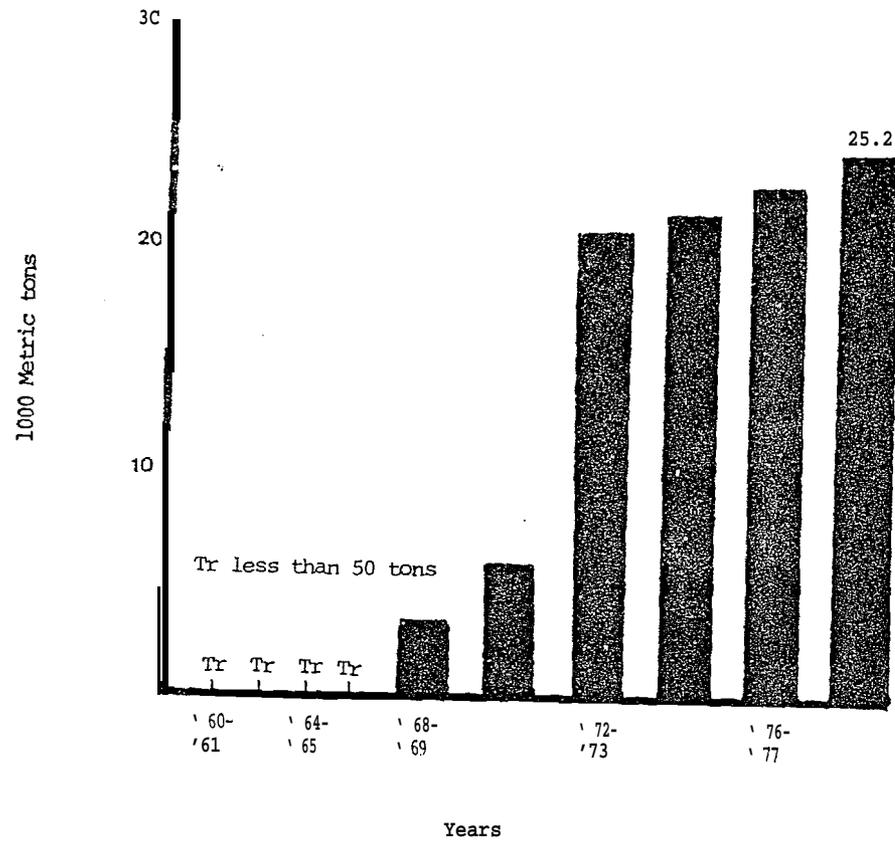


Figure 12. Annual U.S. landings of snow (Tanner) crab in Gulf of Alaska (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

Shrimp

Commercially fished shrimp (family Pandalidae) in the Gulf of Alaska include several species, all belonging to the same family. Pink shrimp (Pandalus borealis) are the most important, comprising more than 85% of the commercial landings. Harvesting of these small shrimp (0.5kg consists of 60-160 individuals) is primarily by trawling. Most of the fishing occurs within 20km of the coastline at bottom depths of 50-200m (Alton 1981).

Although the shrimp fishery in the Gulf dates back to 1915, it expanded rapidly in 1958 when a combination of favorable market conditions and development of mechanical peeling machines occurred. Landings peaked at 56,700 metric tons in 1976, and now appear to be declining somewhat (Figure 13).

Although shrimp are fished throughout the Gulf of Alaska, greatest harvests have been taken from the region offshore of Cook Inlet and west, corresponding to the KODK and SHUM OCS Planning Areas (Figure 14). Although more than 90% of the annual catch came from the vicinity of Kodiak Island, reduced catch quotas in recent years (due to major declines in stock abundance) have forced fishermen to shift their efforts westward along the Alaska Peninsula. By 1977 the Kodiak Island catch was reduced to 14,400 metric tons, while the 1977 catch from waters west of Kodiak increased to 33,700 metric tons. Since that time, however, the annual catch from this entire region has declined (Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

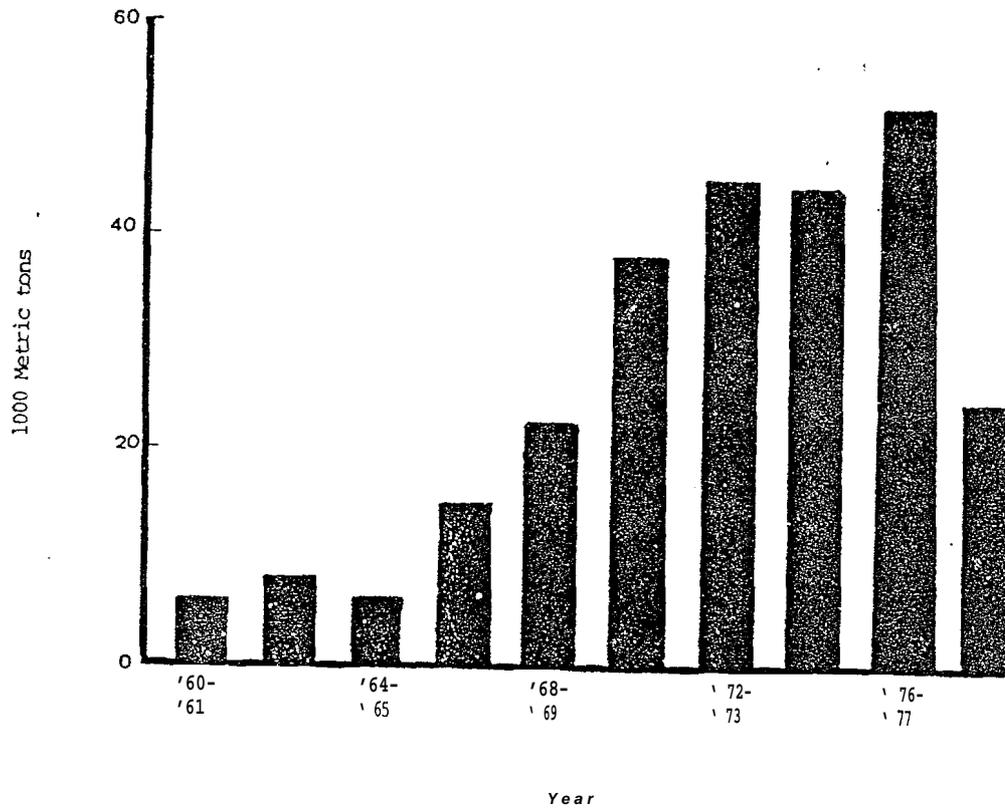


Figure 13. Annual U.S. landings (2-yr. average) of shrimp in the Gulf of Alaska (from Alton 1981).

GULF OF ALASKA (Subregion) Finfish and Shellfish

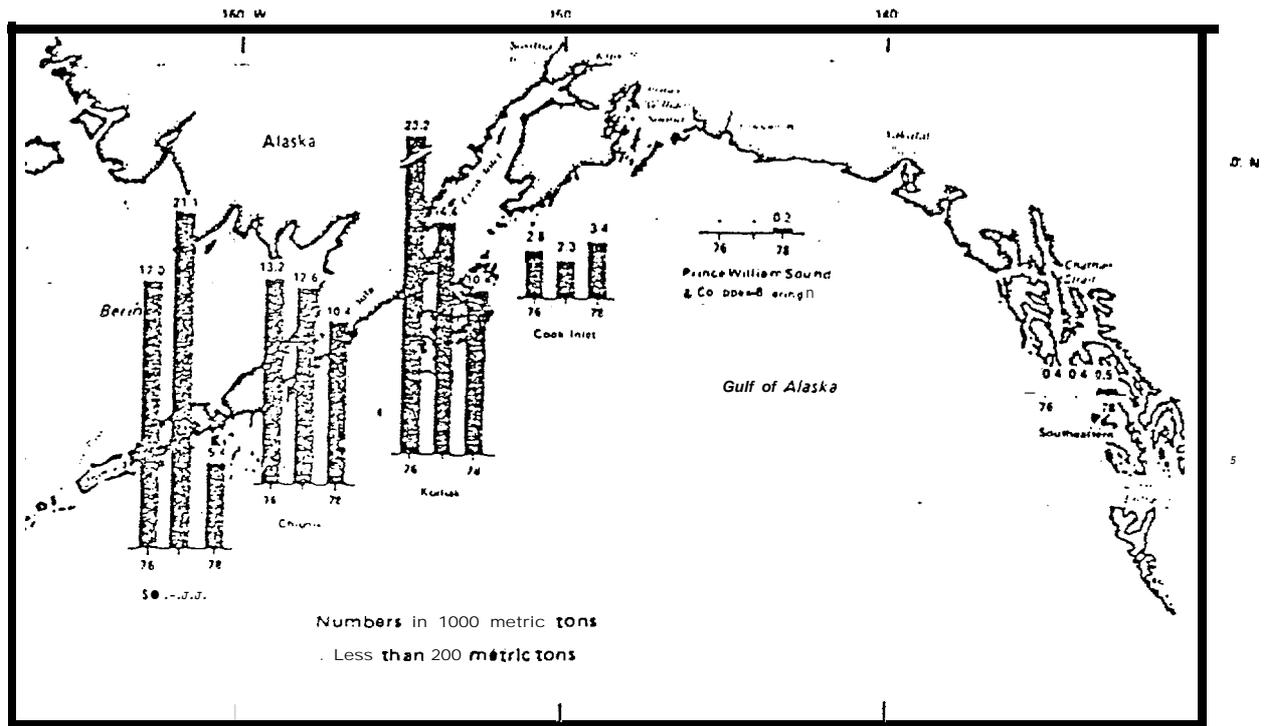


Figure 14. Regional annual U.S. landings of shrimp in the Gulf of Alaska, 1976-78 (from Alton 1981).

NORTH ALEUTIAN BASIN

FINFISH AND SHELLFISH

Much information relevant to fisheries in the NABA is summarized under the **SGBA** OCS Planning Area. Both the major commercial fish species and the gear employed in the fisheries are similar in both regions (see SGBA Finfish and Shellfish, Table 1).

Bristol Bay in the NABA supports the largest **salmon** fishery in Alaska, with an average annual harvest of 13.8 million fish between 1973 and 1982. Sockeye (red) salmon (*Oncorhynchus nerka*) are 80% of the catch, with the remainder divided among the other four salmon species: pink (*O. gorbuscha*), coho (*O. kisutchi*), chum (*O. keta*), and king (chinook, *O. tshawytscha*). This is primarily a gillnet fishery, using both drift- and fixed-net methods. The season commences with the king salmon run in early June; the major sockeye run follows, extending from late June to mid-July. Pink and chum salmon runs extend into August and September (Representatives of the Oil/Fisheries Group of Alaska, 1983).

Bristol Bay is also the center of the domestic herring fishery in NABA. A total of 27,836 metric tons of herring were taken from the Bering Sea in 1982. Most of this harvest goes to the Japanese roe market, although significant quantities are used for food and bait in the Alaska Peninsula area. Both gillnets and purse seines are employed in the Bristol Bay fishery, although only gillnetting is permitted in fisheries further north (Representatives of the Oil/Fisheries Group of Alaska, 1983).

Halibut fisheries are restricted to domestic **longline** fishermen. Most of Bristol Bay is a "halibut savings area" where fishing for this species is prohibited.

Crab fisheries for both king and Tanner crabs occur throughout most of the NABA OCS Planning Area (Figures 1 and 2). Although there is considerable overlap, the most heavily fished areas for king crab lie to the north of the principal Tanner crab fishing grounds (Representatives of the Oil/Fisheries Group of Alaska 1983).

NABA Finfish and Shellfish

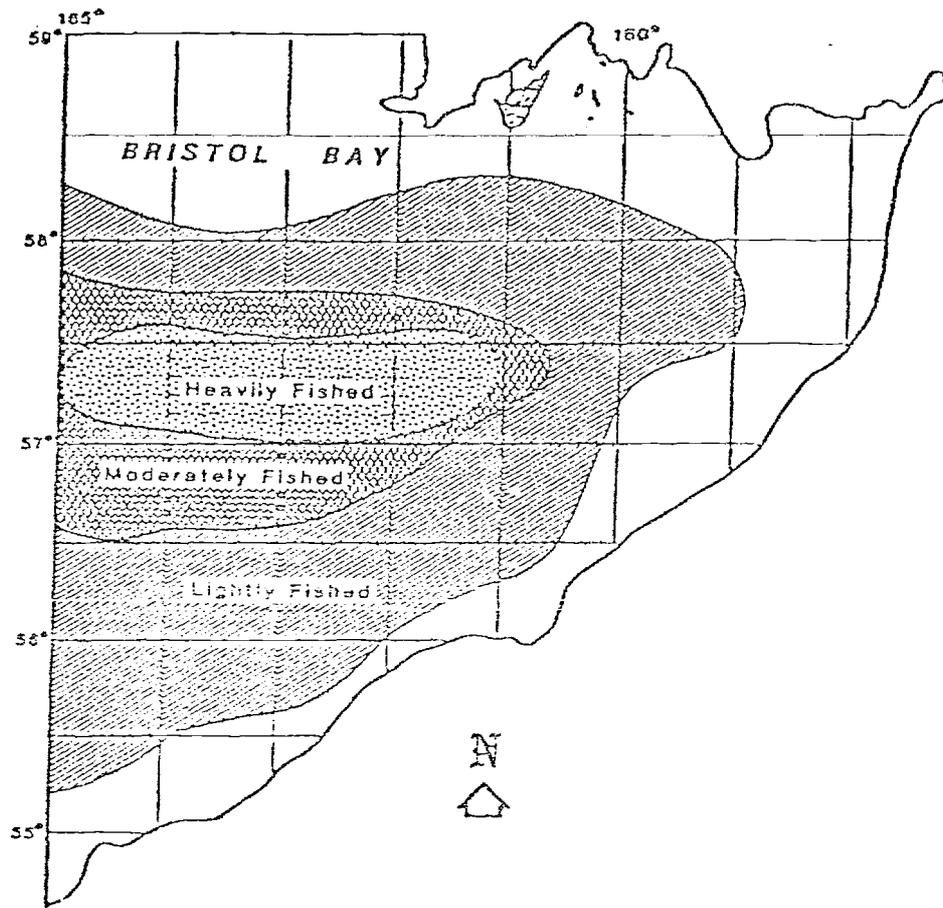


Figure 1. Locations of major king crab fishing grounds in the NABA OCS Planning Area (from Representatives of the oil/Fisheries Group of Alaska, 1983).

NABA Finfish and Shellfish

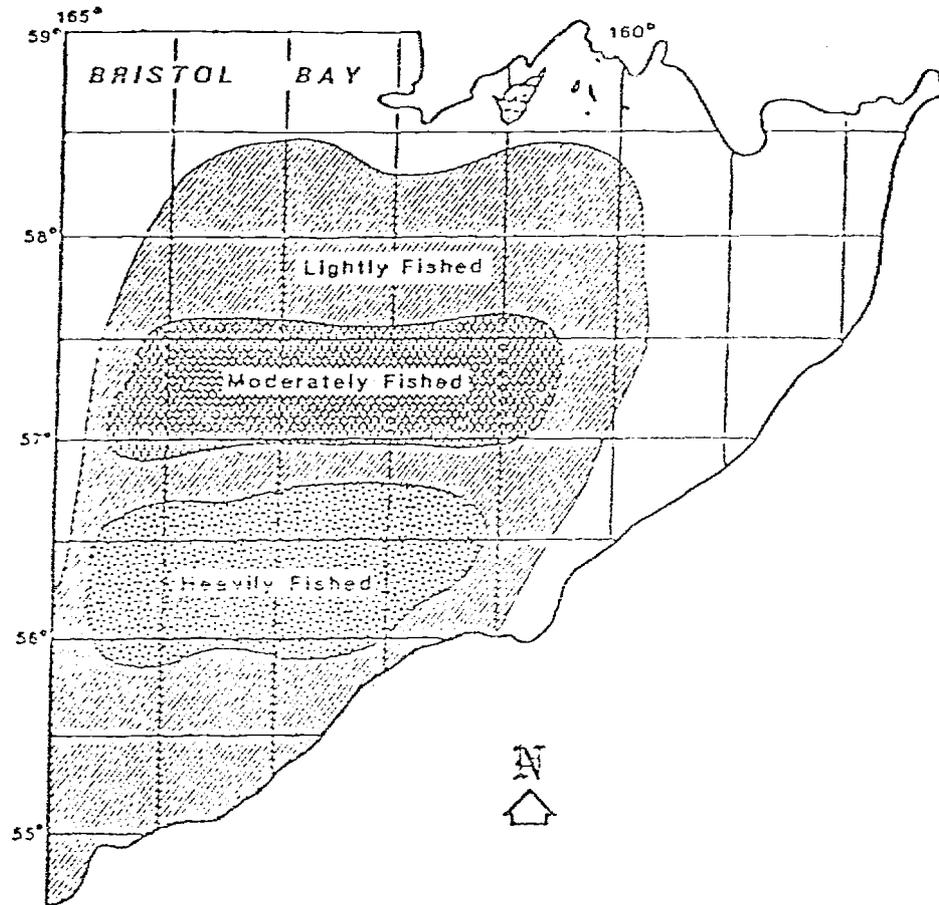


Figure 2. Locations of major Tanner crab fishing grounds in the NABA OCS Planning Area (from Representatives of the Oil/Fisheries Group of Alaska, 1983).

ST. GEORGE BASIN

FINFISH AND SHELLFISH

Commercial fisheries in the St. George Basin and North Aleutian Basin OCS Planning Areas are diverse, both in the species taken and in the types of vessels employed. Table 1 summarizes the major fisheries and gear employed in the SGBA OCS Planning Area. Salmon and herring are taken by small boat fisheries within Alaskan state waters (less than three miles from shore); medium-sized boats are used in halibut and crab fisheries both within state waters and within the Fisheries Conservation Zone (three to two hundred miles offshore). Large trawlers fish offshore for groundfish (Representatives of the Oil/Fisheries Group of Alaska, 1983).

King and Tanner crab fisheries also operate in these waters; the principal fishing areas are shown in Figures 1 and 2. Fishing activity for king crabs centers around the Pribilof Islands and around the Aleutians. Tanner crabs are lightly fished around the Pribilofs and the southwestern section of SGBA within the two hundred mile Fishery Conservation Zone.

Salmon

The salmon fishery is a nearshore fishery that extends from Unalaska Island in the Aleutians to Norton Sound (Figure 3). Major fishing grounds are located around Unalaska, False Pass, Cold Bay, Port Moller, Bristol Bay, around the mouths of the Kuskokwim and Yukon Rivers, and Norton Sound (NORB OCS Planning Area). The Bristol Bay fishery, the largest salmon fishery in Alaska, is described under the North Aleutian Basin (NABA) OCS Planning Area. All five salmon species are taken, although sockeye (red) salmon (Oncorhynchus necks) comprise nearly 80% of the total catch.

Herring

The domestic fishery for herring, Clupea harengus pallasii, is centered in Bristol Bay. The fishery is discussed under the NABA OCS Planning Area.

S GBA Finfish and Shellfish

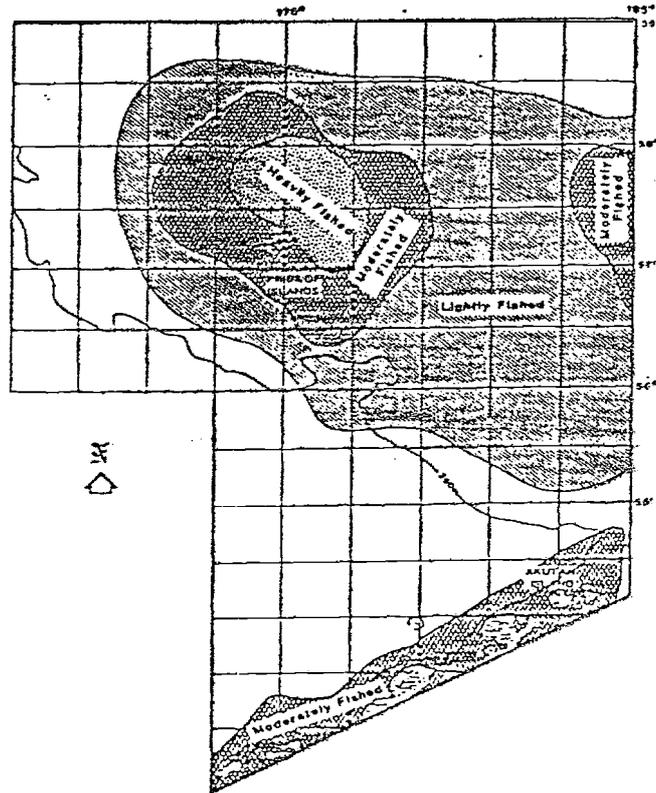


Figure 1. Principal fishing areas for king crabs, SGBA OCS Planning Area (Representatives of the Oil/Fisheries Group of Alaska, 1983).

S GBA Finfish and Shellfish

Table 1. Major existing commercial fisheries in the St. George Basin.

Species	Gear	Type
Whitefish (ground fish)		
Walleye pollock	Trawl	Foreign/Domestic
Pacific cod	Longline/Trawl	Foreign/Domestic
Flounders (others)	Trawl	Foreign/Domestic
Yellowfin sole	Trawl	Foreign/Domestic
Turbot	Trawl	Foreign/Domestic
Pacific halibut ¹	Longline	Domestic
Pacific Ocean perch	Trawl	Foreign
Rockfish (other)	Trawl	Foreign
Sablefish	Longline/Trawl	Foreign/Domestic
Atka mackerel	Trawl	Foreign/Domestic
Other whitefish species	Trawl	Foreign/Domestic
Pelagic Fish		
Salmon ¹	Gillnet/Seine	Domestic
Herring ¹	Seine/Gillnet/ Trawl	Domestic
Shellfish		
Tanner crab	Pot	Domestic
<u>C. opilio</u>		
<u>C. bairdi</u>		
King crab	Pot	
Red king crab		Domestic
Blue king crab		Domestic
Korean hair crab	Pot	Domestic
Snails	Pot	Foreign
Shrimp	Trawl	No Fishery
Pink shrimp		
Humpy shrimp		
Squid	Gillnet/Longline	Foreign
octopus	Trawl/Pot	Domestic

¹ Incidental foreign catch (by foreign fleets targeting on other species) of these species in 1979 was 3,230 metric tons of halibut, 1,162,949 king crabs (mostly brown), 10,269,582 Tanner crabs, 110,473 salmon and 6,547 metric tons of herring.

Source : Dames & Moore 1983

S GBA Finfish' and Shellfish

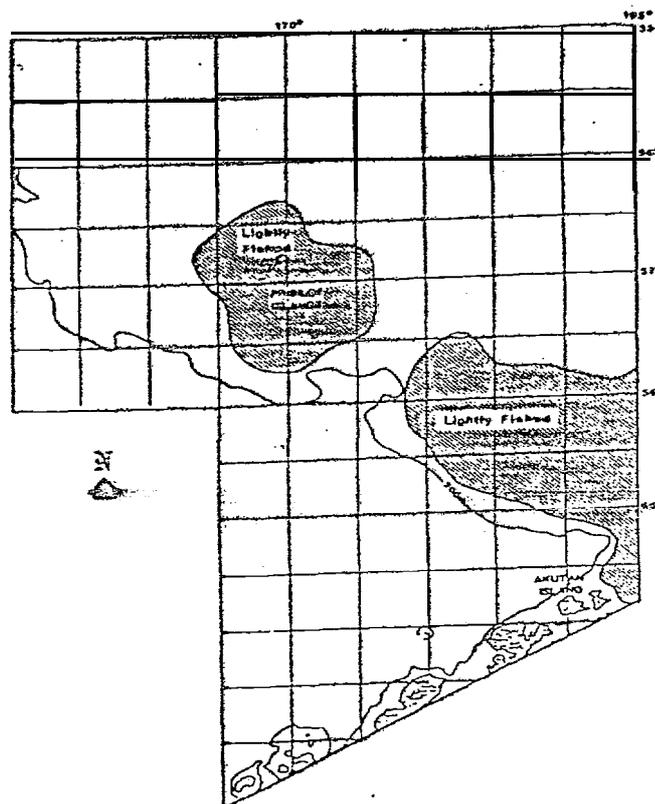


Figure 2. Locations of Tanner crab fishery, SGBA OCS Planning Area (Representatives of the Oil/Fisheries Group of Alaska, 1983).

S GBA Finfish and Shellfish

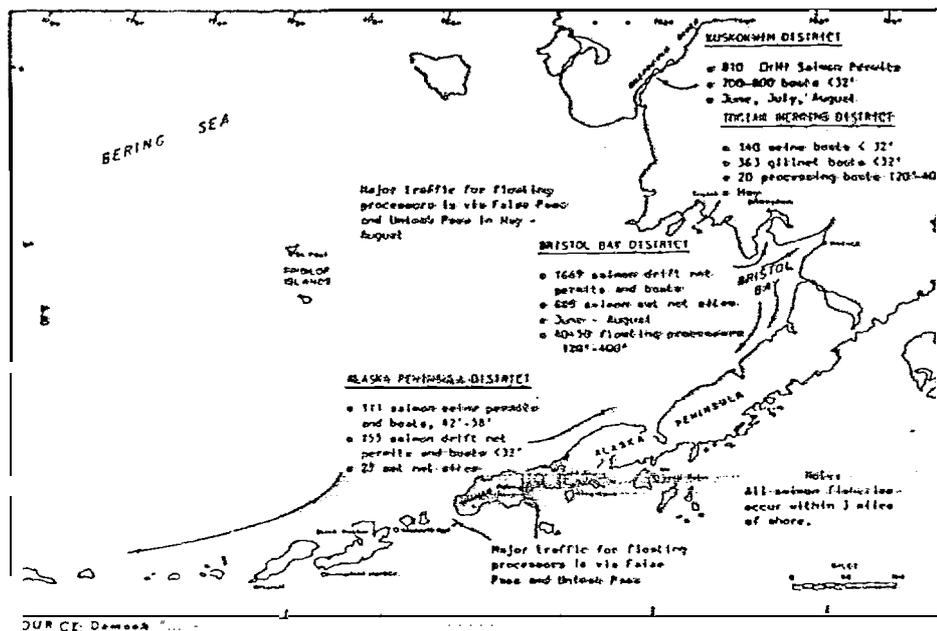


Figure 3. Major salmon fishing districts in the Bering Sea (1981 data; Representatives of the Oil/Fisheries Group of Alaska, 1983).

S GBA Finfish and Shellfish

Groundfish

Areas used by the summer and winter groundfisheries in the Bering Sea are depicted in Figures 4 and 5. This fishery is dominated by Japanese, Korean, and Russian trawlers. Walleye pollock (Theragra chalcogramma) is the principal target species. Under present regulations, foreign trawlers are prohibited from fishing south of 55°30' from December through May. During the winter season most foreign fishing activity occurs north of the Pribilof Islands in waters over 75m deep. Target species are pollock, cod (Gadus macrocephalus), and turbot (arrowtooth flounder, Atheresthes stomias). Foreign longline fisheries are permitted to operate south of the Pribilofs during the trawl closure; however, proposed regulations would prohibit all foreign fishing in this area throughout the year. Cod are targeted by the winter foreign longline fisheries with activity concentrated south of the Pribilofs and north of Unimak Pass.

Foreign fishing activity increases in late April and early May with the arrival of Japanese mothership fisheries. These fleets fish for pollock and yellowfin sole throughout the summer and depart for home ports in October.

Domestic harvests of groundfish have just begun. There were no domestic landings of groundfish in the Bering Sea in 1976; by 1982, 108,566 metric tons were landed. Most of these fish were pollock, yellowfin sole, Pacific cod, and Atka mackerel (Pleurogrammus monopterygius). Much of this harvest was made through joint venture fisheries (Representatives of the Oil/Fisheries Group of Alaska, 1983).

SHELLFISH

The southeastern Bering Sea, including the St. George Basin, supports lucrative foreign and domestic fisheries for king crab, Tanner {snow} crab, Korean hair crab, shrimp, and snails. Shrimp are harvested by trawling techniques; all other shellfisheries utilize set pots.

King Crab (Paralithodes spp.)

King crabs occur in the northern Pacific Ocean at water temperatures of 0-10°C. In the eastern Bering Sea, red king crab (P. camtschatica) inhabit the continental shelf region offshore from the continental slope, being most abundant up to 160km offshore between Unimak Pass and Port Heiden in Bristol Bay (Figure 6). This species forms the basis for the commercial king crab fishery in the SGBA. Second in abundance is the blue king crab (P. platypus) with a more limited distribution in colder waters along the Asian coast from the Kurile Islands to the Chukchi Sea. Major centers for the blue king crab in the Bering Sea are near the Pribilof Islands, St. Matthew Island, and St. Lawrence Island (Curl and Manen 1982).

S GBA Finfish and Shellfish

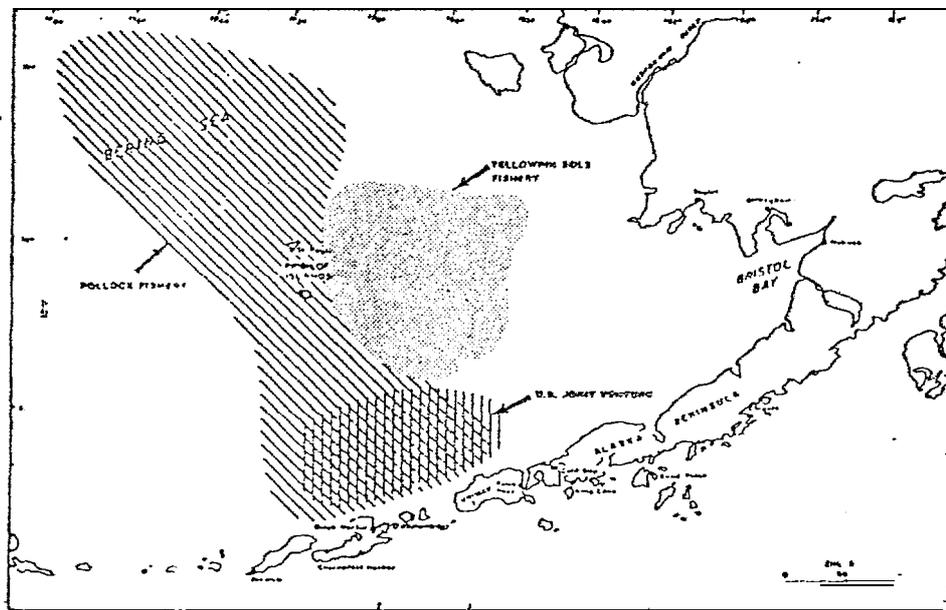


Figure 4. Locations of summer (May-November) groundfishery in the Bering Sea {Representatives of the Oil/Fisheries Group of Alaska, 1983}.

SGBA Finfish and Shellfish

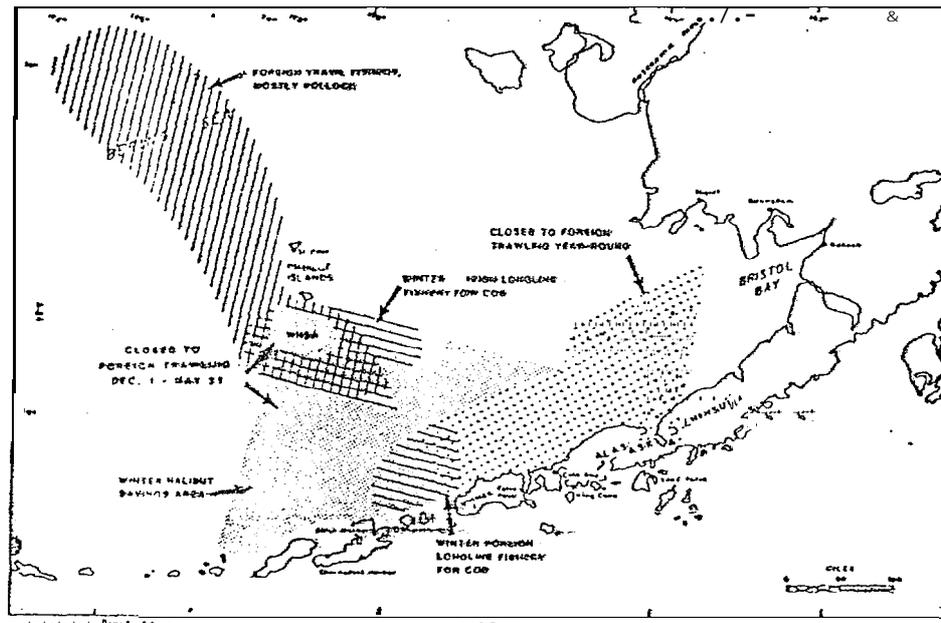


Figure 5. Locations of winter (December-April) groundfish fisheries in Bering Sea, showing areas closed to foreign fishing (Representatives of the Oil/Fisheries Group of Alaska, 1983).

SGBA Finfish and Shellfish

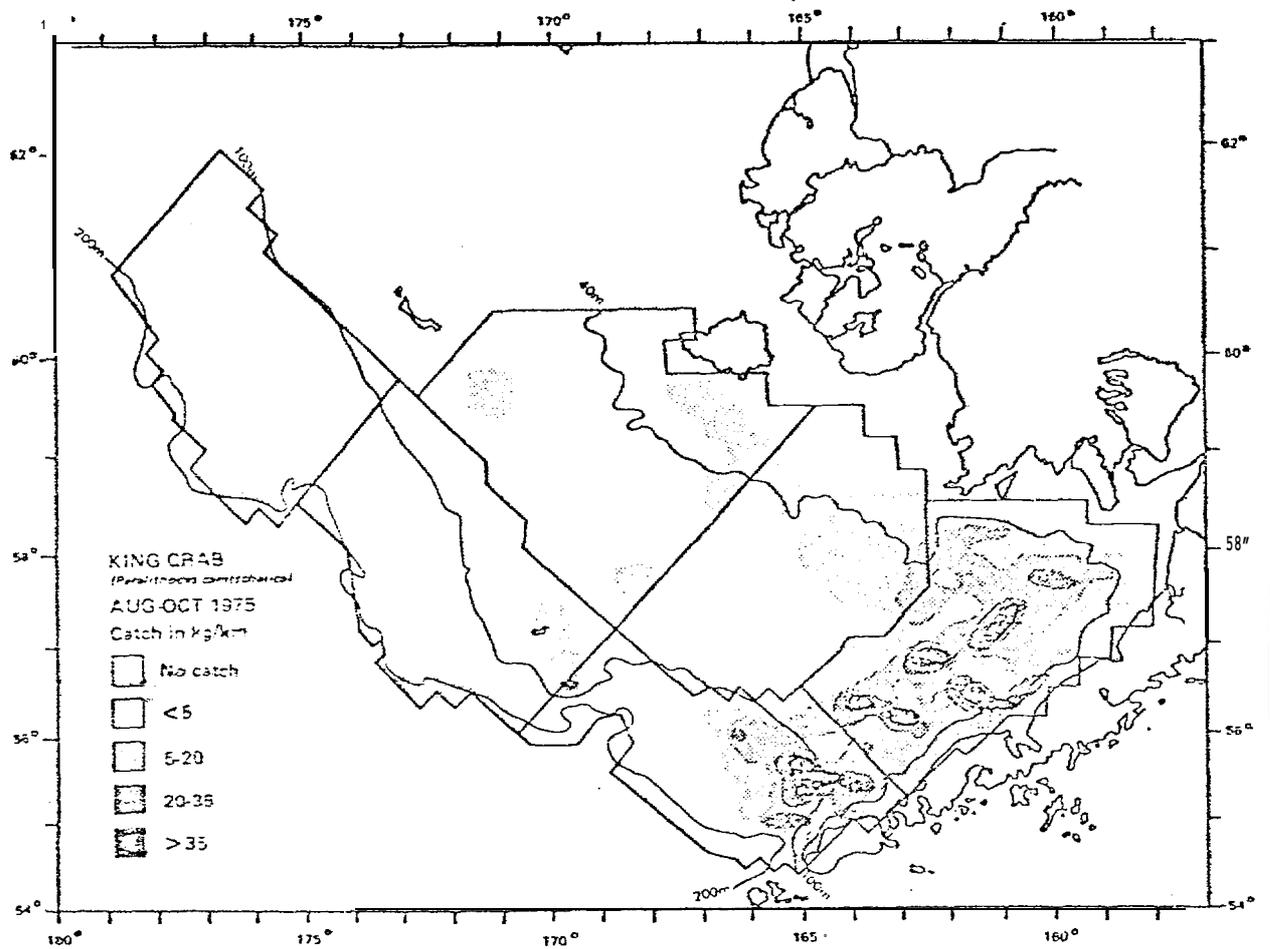


Figure 6. Distribution and relative abundance (by weight of catch) in the eastern Bering Sea (from Curl and Manen 1982).

SGBA Finfish and Shellfish

Red king crabs, the most valuable shellfish in the Bering Sea, have been harvested by U.S. crabbers since 1947. The most intense fishing occurs within Bristol Bay and south of the Pribilof Islands, especially in the region bounded by 56°-57.5°N and 163°-166°W. Over 37% of the 1980-1981 Bering Sea red king crab catch occurred in the St. George Basin.

Approximately 75% of the total 1980-1981 blue king crab catch occurred in the fishing grounds surrounding St. Paul and St. George Islands with 14.5% coming from the western part of SGBA due east of the Pribilof Islands (Curl and Manen 1982).

Tanner crabs were first caught in the Bering Sea in 1968 incidental to the king crab catch. The fishery concentrated on *C. bairdi* stocks until they declined and in 1977-1978, effort was shifted to *C. opilio* stocks. Both species of Tanner crabs are abundant along the eastern—and northern portions of St. George Basin.

Foreign fleets have been prohibited from taking king and Tanner crabs off Alaska since 1979, although many are still caught as a by-catch in trawling or groundfish.

The U.S. domestic hair crab fishery began around the Pribilofs in 1979 and is expanding rapidly. National Marine Fishery Service biologists have estimated that approximately 14 million male hair crabs of harvestable size are present in the Bering Sea (Curl and Manen 1982).

The Japanese initiated the shrimp fishery northwest of the Pribilofs in 1961 and were briefly joined by the Soviets in 1963. By 1968 stocks were exhausted and today the only commercial shrimping in the southeastern Bering Sea is done by a few U.S. trawlers in Makushin and Skan Bays in the southern portion of St. George Basin.

In 1971 the Japanese also initiated a snail fishery on the continental shelf around and northwest of the Pribilof Islands. From 1972-1975 approximately 3000 metric tons of edible meats were harvested annually. The snail fishery presents a potential new harvest for U.S. fishermen (Curl and Manen 1982).

ICHTHYOPLANKTON

Walleye pollock, *Theragra chalcogramma*, spawn over a large area of the southeastern Bering Sea. Primary spawning grounds lie between the Pribilof Islands and Unimak Pass at depths of 100-200m. Spawning begins commences in mid-February, peaks in mid-April, and continues through June (Kim and Kendall 1983).

S GBA Finfish and Shellfish

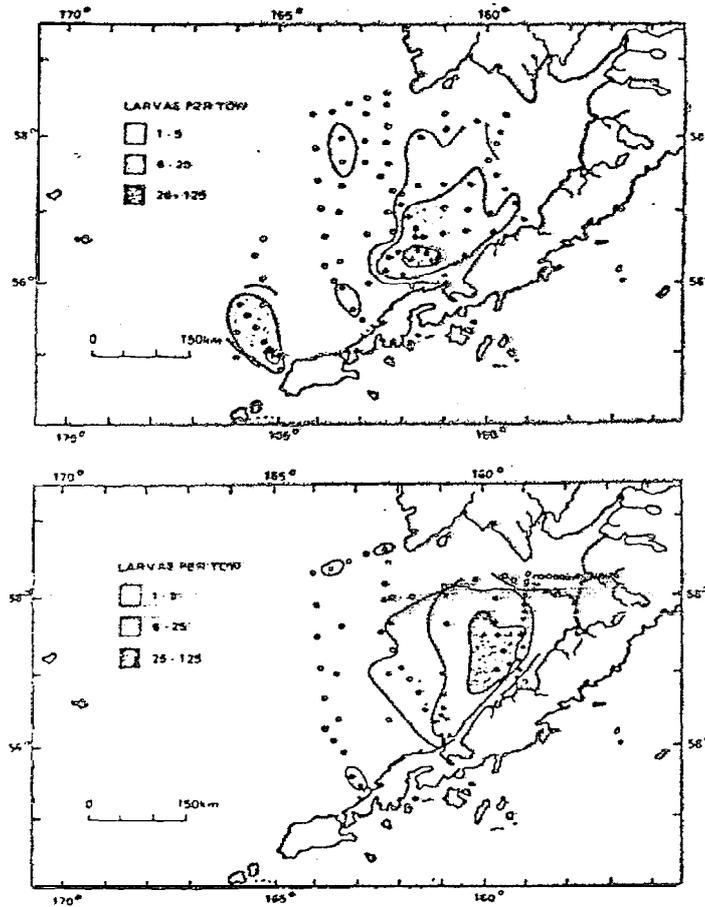


Figure 7. Distribution and abundance of king crab larvae in 1969 and 1970 (top - May; bottom - June), SGBA and NABA OCS Planning Areas (from Curl and Manen 1982).

SGBA Finfish and Shellfish

Tanner (snow) crab (*Chionoecetes* spp.)

The circumarctic range of Tanner crabs extends into the temperate waters on the east and west coasts of North America and Eurasia, respectively. In the eastern Bering Sea they are found over the continental shelf from the intertidal zone to at least 450m. The two species, *C. opilio* and *C. bairdi*, are apparently segregated by water temperature. *C. bairdi* are usually found in the warmer slope and outer continental shelf waters (average temp. 4.5° C) of the southern Bering Sea whereas *C. opilio* prefers the colder waters (average temp. 2.4°C) to the north.

Tanner crabs apparently make seasonal, sexually segregated movements related to reproduction. Immature crabs of both sexes congregate by age group. After reaching maturity and mating the males leave the aggregation, whereas the females remain together throughout their lives (Curl and Manen 1982). Mating season in the Bering Sea is from February to early June. The 30,000 to 80,000 fertilized eggs are carried by the female for approximately eleven months. Peak hatching period occurs in mid-May (*C. bairdi*) and mid-April (*C. opilio*). Tanner crab larvae have an average 3-month pelagic life which encompasses two zoeal and one megalops stage. Larval densities in the southern Bering Sea are shown in Figure 8.

Sexual maturity is reached at five to six years. Commercially harvested males are usually seven to eleven years old and weigh 0.9-1.8kg (Curl and Manen 1982).

Korean hair crab (*Erimacrus isenbeckii*)

The Korean hair crab is found throughout the Aleutian islands and as far north as St. Matthew Island. The largest concentrations are found in the shallow waters along the northern shore of the Alaskan Peninsula and around the Pribilof Islands.

Females reach sexual maturity at age two (4cm), males at age four (7-8cm). Males may achieve 12-13cm in length, females are somewhat smaller (10cm). Only males larger than 8cm are harvested commercially. The fishery is active all year in the Pribilof Islands, but is restricted to winter and early spring elsewhere (Curl and Manen 1982).

S GBA Finfish and Shellfish

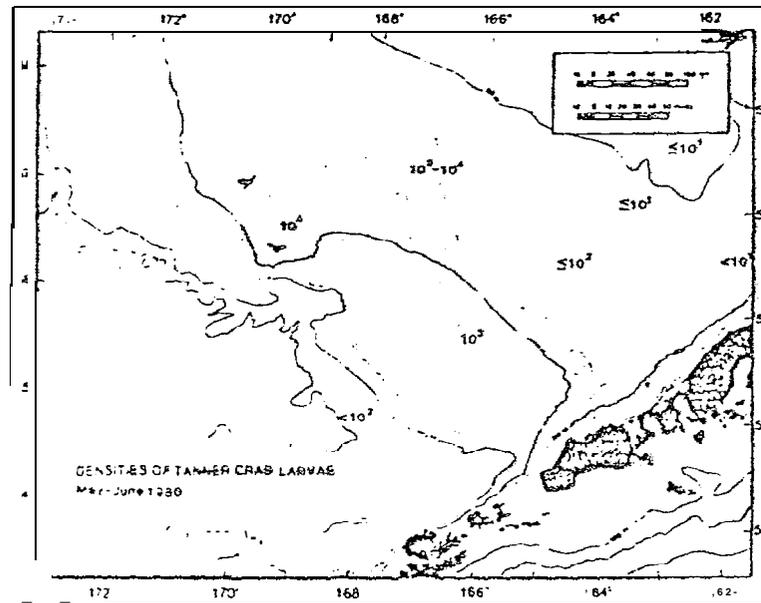


Figure 8. Tanner crab larval densities (number- $1000m^3$) in upper 60m of water column in vicinity of SGBA OCS Planning Area (from Curl and Manan 1982).

SGBA Finfish and Shellfish

Shrimp (Pandalus spp.)

Two species of pandalid shrimp, pink (P. borealis) and bumpy (P. gonuirus) shrimp, are of commercial interest in SGBA. These species are most abundant along the center outer shelf and slope of the Bering Sea on relatively smooth sand and mud bottoms (Figure 9).

Pandalid shrimp are protandric hermaphrodites. Pink shrimp become sexually mature as males when two to three years old. By the fifth year most have changed into females. Pink shrimp are known to live six to seven years.

Spawning occurs in September and October. Just prior to spawning the female molts and grows a shell specialized for carrying the eggs. Pandalid shrimp produce 900-3000 eggs per brood; eggs are carried for seven to eight months and hatch in the spring. Larvae spend approximately three months in the plankton during which time they molt perhaps six times. By the end of the summer they resemble miniature adults and spend part of their time feeding in the water column and the remaining time on the bottom (Curl and Manen 1982).

Snails (Gastropoda)

The most important commercial species of large marine gastropod in the SGBA is Neptunea pribiloffensis. This species accounted for 70% of the Japanese snail catch in the eastern Bering Sea in 1973. Two species of Buccinum were also well represented in this harvest: B. scalariforme (16%), and B. angulosum (11%).

Distributions of at least 35 species of snail on the Bering Sea shelf are mapped in Figure 10. Distribution is patchy, but areas of highest density also support a large biomass of fish and other invertebrates. Snail biomass in some areas exceeds $35 \cdot \text{km}^{-1}$ and accounts for 1.7% of total biomass and 6.6% of invertebrate biomass. Snails are long-lived; Neptunea may live longer than 10 years (Curl and Manen 1982).

Commercial Shellfisheries

Table 2 summarizes the size and economic value of commercial shellfish catches in the St. George Basin. Since the decline of crab stocks in the Gulf of Alaska during the late 1960's, U.S. fishing activity in the Bering Sea has increased on an annual basis. Altogether Bering Sea shellfish resources are worth more than \$150 million annually, nearly 70% of the estimated ex-vessel value of the Alaska shellfish catch in 1980. Foreign trawlers harvest additional millions of crabs each year as by-catch with pollock and other groundfish (Curl and Manen 1982).

SGBA Finfish and Shellfish

Table 2. Total shellfish catch (U.S. and foreign) in St. George Basin call area in southeastern Bering Sea {Curl and Manen 1982).

Species	Number	Metric tons	Estimated ex-vessel value
King crab			
red	6,863,329	22,484	\$44,610,874
blue	1,138,607	3,779	7,914,217
Tanner crab			
<u>g. bairdi</u>	1,831,341	2,062	2,364,359
<u>C. opilio</u>	9,706,408	6,836	3,164,733
Foreign catch			
king crab	639,760	2,089	4,191,708
Tanner crab	13,327,721	9,673	6,397,306
Korean hair crab	24,937	25	30,418
Pandalid shrimp	-----	698	446,559
TOTALS			
		U s .	\$58,531,160
		foreign	10,589,014

SGBA Finfish and Shellfish

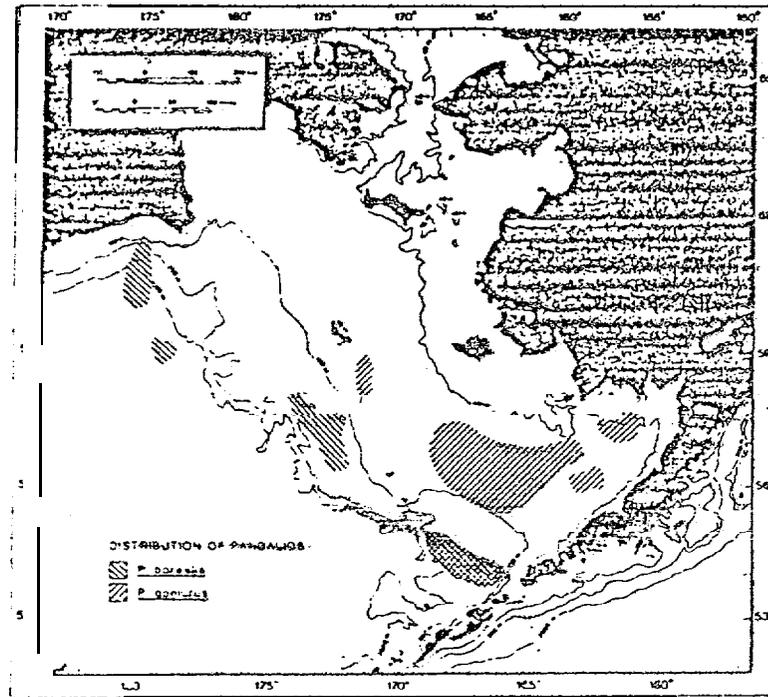


Figure 9. Distribution of two species of pandalid shrimp in eastern Bering Sea, August-November 1975 (from Curl and Manan 1982).

S **GBA** Finfish and Shellfish

Red king crabs have a spring mating and spawning migration and a summer/fall feeding migration. During January, females move from offshore waters into shallower embayments near the Amak Island-Black Hills-Port Moller area along the north shore of the Alaska Peninsula. Males follow a month or so later. Females molt on the breeding grounds between February and May; copulation follows soon after molting. The largest females may produce up to 400,000 eggs. After the ova are extruded and fertilized, they are carried by the female for approximately eleven months. Free-living zoea are released when the females return to the breeding grounds the following breeding season. King crab zoea molt through four instars, sinking lower in the water column with each molt and then metamorphose into glaucothoe larvae. The latter finally metamorphose into juveniles which resemble the adults in most features except for size (Curl and Manen 1982).

Larval hatching and peak larval abundance occur from early May through mid-July in the eastern Bering Sea. Peak larval abundances are found along the North Aleutian shelf from Unimak Island into Bristol Bay. During the ten weeks of larval development, the center of abundance may move northeastward (Figure 7). Juveniles settle in shallow coastal areas at depths less than 30m during their second and third years, with those less than 15mm forming large aggregations ("pods") containing thousands of crabs. Such juvenile aggregations may persist at least into the fourth year, after which the crabs disperse and, like adults, move offshore to feed in summer and return to shallower waters in spring.

Sexual maturity occurs at four to six years of age. Male king crabs reach legal commercial size at about seven years of age. Most crabs taken commercially are 8-9 years old and weigh approximately 3kg each. Female king crabs cannot be taken legally.

Little is known regarding the biology of blue king crabs. The populations in the southern Bering Sea are centered around the Pribilof Islands. Recent data indicate that, unlike red king crabs, blue king crabs may spawn biennially. Blue king crab juveniles do not seem to form extensive pods (Curl and Manen 1982),

S **GBA** Finfish and Shellfish

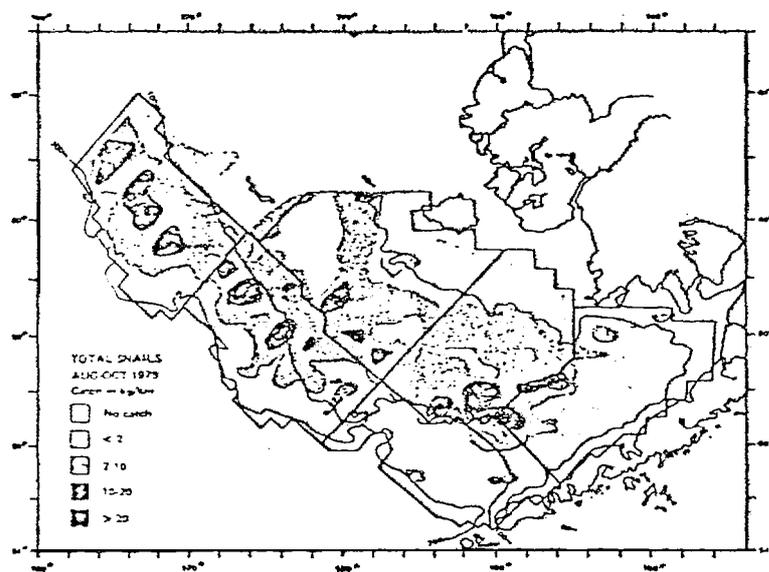


Figure 10. Distribution and relative abundance (by weight of catch in $\text{kg}\cdot\text{km}^{-2}$) of snails in eastern Bering Sea (from Curl and Manan 1982).

S GBA Finfish and Shellfish

Walleye **pollock** accounted for 97% of the 24,611 fish eggs and 59% of the 14,171 fish larvae collected at 64 locations in the eastern Bering Sea (principally in SGBA waters, although three stations east of 164°W are in NABA) from 16 April-15 May 1977. These data, plus a set from one cruise in 1978, are summarized in Figures 11 and 12. Greater numbers of **pollock** eggs were taken with **neuston** nets (which sampled the upper 0.25m of the water column) than with bongo nets. Nevertheless, standardization of catches on a unit of surface area basis indicated that more eggs were found at depths greater than 0.25m. Virtually all (96%) of the **pollock** larvae were caught in bongo nets, also indicating a distribution below the 0.25 surface layer (Waldron and Vinter 1978).

Pollock spawning apparently centers on the upper slope area during March, then moves northwestward later in the season. Based on ichthyoplankton survey data such as summarized in Figure 1, Kim and Kendall (1983) estimated the total number of **pollock** eggs produced during an annual spawning season in these waters at 3.6918×10^{13} , or approximately 283 $\text{eggs} \cdot \text{m}^{-2}$. **Pollock** egg production based on fecundity data suggested that spawning occurred outside the survey area, and that matchability of eggs was significantly less than 100% (Kim and Kendall 1983). As Figure 12 shows, greatest larval densities observed on these survey cruises were found seaward and to the west of the highest egg densities.

Flatfish Eggs and Larvae

Righteye flounder eggs ranked second in abundance to **pollock** eggs in ichthyoplankton surveys conducted in these waters in 1977. However, righteye flounder larvae were only fourth in overall abundance.

Rock sole (*Lepidopsetta bilineata*) larvae were the most numerous flatfish larvae taken in these surveys, with 157 individuals present in 31% of the bongo samples (none were taken in neuston nets). Rock sole larvae were found at depths of 100-200m over the continental shelf and were distributed from the Alaska Peninsula-Aleutian Islands northward to the Pribilof Islands (Waldron and Vinter 1978).

Arrowtooth flounder (*Atheresthes* sp.), the second most abundant flatfish larvae caught (131 larvae in 36% of bongo net samples), were found primarily at water depths greater than 200m. Arrowtooth flounder larvae were taken from the vicinity of the Aleutian Islands northward to near the Pribilof Islands during both April and May 1977.

A total of 117 Greenland turbot (*Reinhardtius hippoglossoides*) larvae were collected in 34% of the bongo net samples. These larvae were also found along or beyond the continental slope at water depths greater than 200m from near the Aleutian Islands northwestward to north of St. George Island in the Pribilofs. Eggs of two species of flounder, flathead sole (*Hippoglossoides elassodon*), and Alaska plaice (*Pleuronectes quadrituberculatus*) were also caught, primarily during the first half of May. Both species of eggs were found over

S GBA Finfish and Shellfish

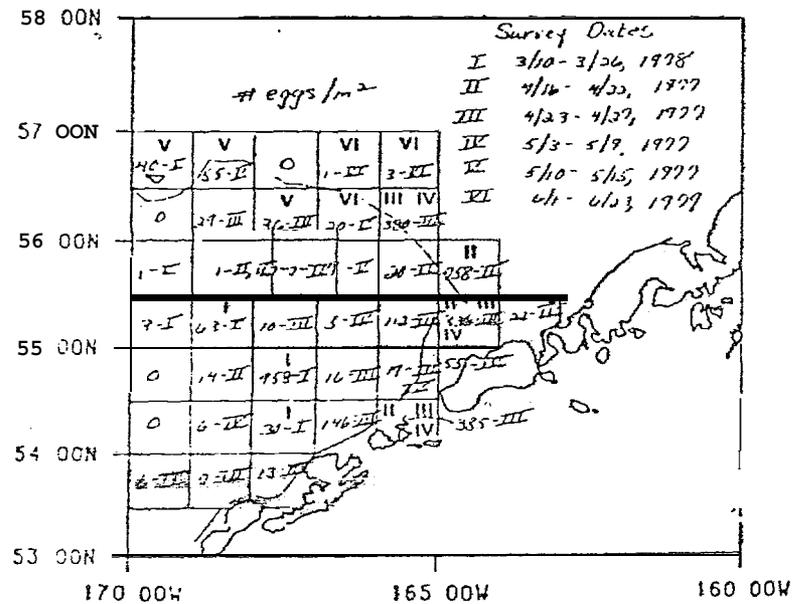


Figure 11. Greatest densities of walleye pollock eggs from six surveys in the southeastern Bering Sea. Size of each subarea is 0.5° latitude by 1° longitude. The three subareas with the greatest densities during each survey are indicated. Irregular line shows 100m isobath (from Kim and Kendall 1983).

SGBA Finfish and Shellfish

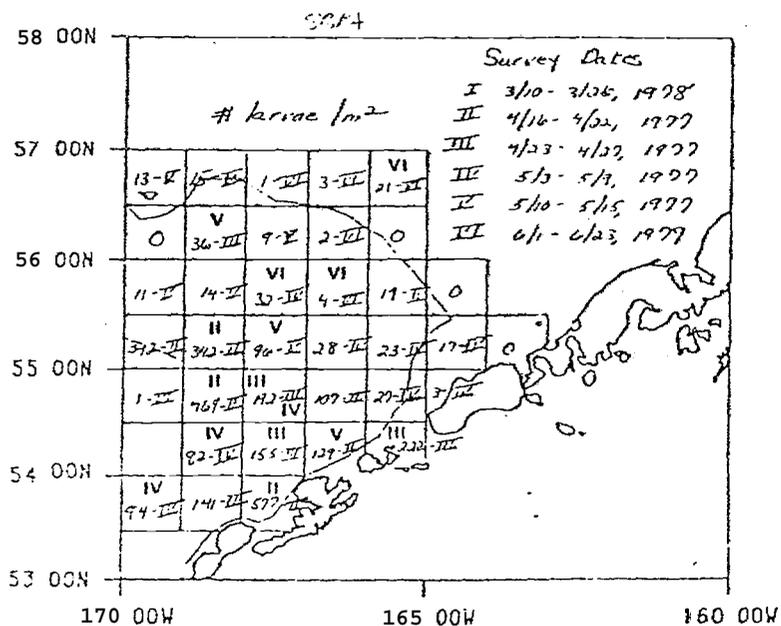


Figure 12. Greatest densities of walleye pollock larvae from six surveys in the southeastern Bering Sea. See Figure 1 for explanation of subareas and nomenclature.

SGBA Finfish and Shellfish

the continental shelf. Greatest concentrations of flathead sole eggs were found between 55 °30'-56°30'N and 165°-168°W. Most Alaska plaice eggs were caught at stations with water depths less than 100m (Waldron and Vinter 1978).

Larvae of Other Fish Families

The two families found in greatest numbers during 1977 ichthyoplankton survey cruises were greenings (*Hexagrammidae*) and sculpins (*Cottidae*), followed by sand lance (*Ammodytidae*), smelt (*Osmeridae*), rockfish (*Scorpaenidae*), pricklebacks (*Stichaeidae*), deep-sea smelt (*Bathylagidae*), and searchers or ronquils (*Bathyrnasteridae*). Rockfish and one of the greenlings, Atka mackerel (*Pleurogrammus monopterygius*), are of commercial importance; the others are important mainly as forage fish (especially the sand lance and smelt).

Greenings were the second most numerous larvae caught (1,820 larvae); 99% were taken by the neuston nets, i.e., from the upper 0.25m of the water column. Greenling larvae were also the most widely distributed, being taken at all but two stations (at which no other larvae were taken). Larvae of the genus *Hexagrammos* were the most numerous (1,275); the remainder of the greenings were Atka mackerel, which were caught at stations throughout the survey area in both April and May, over the continental shelf as well as beyond the continental slope. Areas of high abundance of *Hexagrammos* larvae were close to Unalaska and Akutan Islands and over the continental shelf at depths greater than 100m (Waldron and Vinter 1978).

Sculpins were the third most abundant family present in the ichthyoplankton samples (1,574 larvae, of which 94% were from the neuston samples). A total of 410 sand lance larvae were caught, 400 of which were collected in the bongo net samples. Most sand lance larvae were taken in April, primarily from waters just north of the middle of Unimak Island and the tip of the Alaska Peninsula. Capelin (*Mallotus villosus*) were the only smelt collected and ranked sixth in abundance. Capelin distributions were restricted to within approximately 120km of Unimak Island and were generally found over the continental shelf.

Rockfish larvae ranked seventh in abundance and were generally distributed over the continental slope and deeper waters. Areas of high abundance were between Unimak Pass and Unalaska Island during April and May west of the Pribilof Islands during May. No eggs were collected because rockfish are ovoviviparous (Waldron and Vinter 1978).

NAVARIN BASIN

FINFISH AND SHELLFISH

The Navarin Basin OCS Planning Area is almost equally divided between shallow continental shelf waters 40-200m in depth and slope and deep waters off the shelf which reach depths of up to 3500m. NAVB is probably the most poorly known of the Planning Areas due to its distance from human habitation and seasonal ice cover. It is, however, of extreme importance to foreign and domestic fisheries. Information on fishery resources is available as a result of studies conducted by the Northwest and Alaska Fisheries Center (NWAFC) of the National Marine Fisheries Service (NMFS).

Finfish

Finfish species of commercial importance found in the Navarin Basin are listed in Table 1. Figure 1 summarizes the distribution and relative abundance of total flatfish catch in the region; roundfish densities for the same area are shown in Figure 2. Note that the highest abundances (especially of the roundfish) generally follow the continental shelf break.

Groundfish species that occupy inner shelf regions during the summer (e.g., yellowfin sole, rock sole, Alaska plaice, and Pacific halibut) migrate to deeper waters in the winter and spring. As a result of shifts to deeper water and some southward movements, commercially important demersal fishes are more abundant in the central Bering Sea during the winter and spring than in the summer. The importance of groundfish in NAVB as compared to the Bering Sea can be seen in Table 2, which gives the percentage of the foreign groundfish catch from the Bering Sea taken from the Navarin Basin. Pollock comprised most (84%) of the Navarin Basin catch and also the greatest portion (37%) of the entire Bering Sea harvest. All told, the Navarin Basin accounted for nearly 33% of the total Bering Sea fish harvest during 1977-1979 (Thorsteinson et al. 1984).

NAVB Finfish and Shellfish

Table 1. Commercially important finfish species found in the Navarin Basin Region (from Thorsteinson et al. 1984).

Common name	Scientific name
Herrings	Clupeidae
Pacific herring	<u>Clupea harengus pallasii</u>
Salmon	Salmonidae
Chinook salmon	<u>Oncorhynchus tshawytscha</u>
Chum salmon	<u>O. keta</u>
Coho salmon	<u>O. kisutch</u>
Pink salmon	<u>O. gorbuscha</u>
Sockeye salmon	<u>O. nerka</u>
Codfishes	Gadidae
Pacific cod	<u>Gadus macrocephalus</u>
Walleye pollock	<u>Theragra chalcogramma</u>
Rockfishes	Scorpaenidae
Blue rockfish	<u>Sebastes mystinus</u>
Darkblotched rockfish	<u>s. crameri</u>
Dusky rockfish	<u>s. ciliatus</u>
Pacific ocean perch	<u>S. alutus</u>
Rougheye rockfish	<u>S. aleutianus</u>
Shortraker rockfish	<u>S. borealis</u>
Silvergray rockfish	<u>s. brevispinis</u>
Shortspine rockfish	<u>Sebastolobus alascanus</u>
Thornyhead rockfish	<u>S. altivelis</u>
Sablefishes	Anoplopomatidae
Sablefish	<u>Anoplopoma finbria</u>
Greenings	Hexagrammidae
Atka mackerel	<u>Pleurogrammus monopterygius</u>
Flounders	Pleuronectidae
Alaska plaice	<u>Pleuronectes quadrituberculatus</u>
Arrowtooth flounder	<u>Atheresthes stomias</u>
Bering flounder	<u>Hippoglossoides robustus</u>
Flathead sole	<u>H. elassodon</u>
Greenland turbot	<u>Reinhardtius hippoglossoides</u>
Pacific halibut	<u>Hippoglossus stenolepis</u>
Rock sole	<u>Lepidopsetta bilineata</u>
Yellowfin sole	<u>Limanda aspera</u>

NAVB Finfish and Shellfish

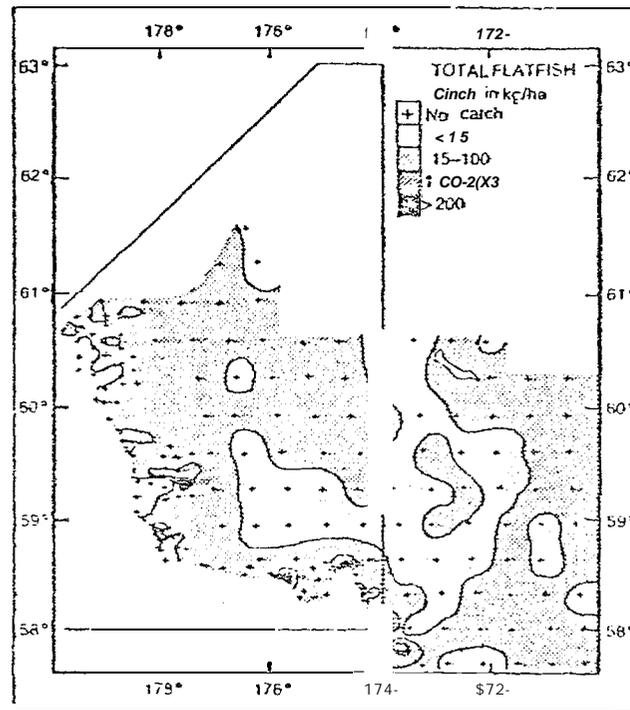


Figure 1. Distribution and relative abundance of flatfish (all spp.) taken during the NWAFC eastern Bering Sea survey, 1981. NAVB OCS Planning Area boundaries are outlined (from Thorsteinson et al. 1984).

NAVB Finfish and Shellfish

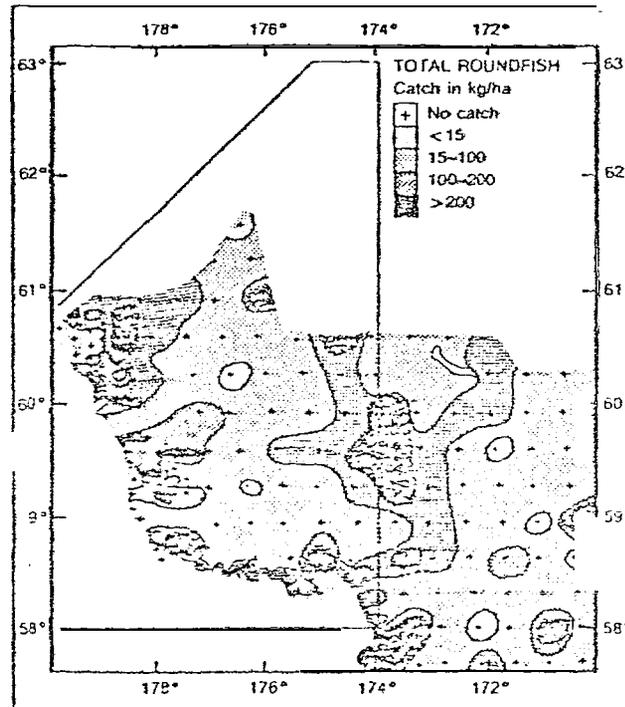


Figure 2. Distribution and relative abundance of roundfish (all spp.) taken during the NWAFPC eastern Bering Sea survey, 1981. NAVB OCS Planning Area boundaries are outlined (from Thorsteinson *et al.* 1984).

NAVB Finfish and Shellfish

Table 2. Comparison of commercial finfish harvests from Bering Sea and Navarin Basin, as measured by average groundfish catches of foreign nations, 1977-79 (from Thorsteinson et al. 1984).

Species	Mean Bering Sea Catch (metric tons)	Navarin Basin Catch		
		Mean	% of mean Bering catch	% of total Navarin Basin catch
Walleye pollock	9171533	340,600	37.1	93.8
Pacific cod	40,033	11,867	29.6	2.9
Yellowfin sole	90,567	3,467	3.8	0.1
Greenland turbot	8,967	2,033	22.7	0.5
Other flounders	83,530	23,800	28.5	5.9
Pacific ocean perch	5,833	733	12.6	0.2
Other rock fishes	12,166	1,733	14.2	0.4
Sablefish	2,800	290	10.4	0.1
Atka mackerel	22,867	20	0.1	<0.1
Others	60,300	21,800	36.2	5.4
<u>TOTAL</u>	1,244,596	406,343	32.6	

NAVB Finfish and Shellfish

The most abundant species of demersal fishes taken during the 1981 cooperative U.S.-Japan survey in the Navarin Basin are as follows:

Species	Catch Per Unit Effort (kg·ha ⁻¹)
Walleye pollock	63.0
Greenland turbot	15.5
Pacific cod	15.0
Flathead sole	4.0
Arrowtooth flounder	2.6
Sablefish	1.7
Pacific halibut	0.2
Rock sole	0.2
Alaska plaice	0.2
Pacific herring	<0.1

Yellowfin sole were not caught during the summer cooperative survey although they are found seasonally in NAVB (winter and spring, as is evidenced by presence in the commercial catch summarized in Table 2; Thorsteinson *et al.* 1984).

Commercial Fisheries

The Navarin Basin is an area of productive fisheries and intense foreign fishing effort. Under the Fishery Conservation and Management Act of 1976, six nations were permitted to fish these waters in 1980-81. Combined catches of the Japanese mothership and South Korean groundfish fisheries accounted for approximately 97% of the foreign catch in 1981 and 95% in 1980. The largest catches (>20,000 metric tons) in NAVB generally occurred along the continental shelf break. Since Japan conducts the major foreign fishery in the eastern Bering Sea, Japanese catch statistics provide a reasonably good index of fishing effort (Table 3). As seen in Table 3, fisheries within NAVB accounted for 32% of the pollock, 25% of the cod, and 58% of the Pacific herring caught in the Bering Sea. Herring was designated a prohibited species in 1978, hence the cessation of the catch of this species by 1980. Additional conservation measures included prohibiting foreign fishing fleets from taking halibut and king crabs (1977) and Tanner crabs (1979). Large numbers of these prohibited species are caught as by-catch, but all must be returned to the sea.

Japan also has a directed gillnet fishery for salmon in NAVB. Most of the pink and chum salmon caught in this fishery are thought to be of Asian origin. About 75% of the sockeye salmon caught are immature; of these, about 40% are from Bristol Bay stocks. The chinook catch is of special concern since nearly all the fish are immature and ultimately destined for western Alaska rivers, primarily the Yukon and the Kuskokwim (Thorsteinson *et al.* 1984).

NAVB Finfish and Shellfish

Table 3. Annual mean groundfish catches (metric tons) by Japanese within the Navarin Basin, 1972-1981 (from Thorsteinson *et al.* 1984).

Year	Walleye Pollock	Flat fishes	Pacific Cod	Pacific Herring	Other Commercial Species	Total Catch
1977	294,225	17,846	9,504	31,417	1,777	336,775
1978	288,140	27,117	131,393	1,953	1,522	354,132
1979	199,846	151,943	6,478	11,310	1,169	235,239
1980	303,117	17,579	5,737	47	2,204	338,056
1981	124,022	2,218	1,079	0	93	128,375
Mean NAVB catch, 1972-1981	348,557	17,037	9,004	11,818	1,747	389,100
Mean Bering Sea catch, 1972-1981	1,078,033	141,684	35,353	3,164	8,804	1,267,038
% Bering Sea catch within NAVB:	32%	12%	25%	56%	20%	31%

NAVB Finfish and Shellfish

Commercial Shellfisheries

Currently there is no foreign commercial fishery for shellfish NAVB waters. As mentioned above, both king and Tanner crabs are prohibited species and must be returned to the sea when caught. Estimated biomass of the potentially commercially important crab species, based on a comprehensive NMFS-Japan cooperative summer survey in 1981, are provided in Table 4 . Tanner crabs were the most frequently caught crab species during these trawl surveys. Greatest concentrations of Chionoecetes opilio were found in water deeper than 120m; all C. bairdi were taken a depths of 120-200m.

Locations of the domestic fishing grounds are shown in Figures 3 (king crab) and 4 (Tanner crab).

NAVB Finfish and Shellfish

Table 4. Estimated biomass (metric tons) of crab species of potential commercial importance, based on 1981 comprehensive NWAFC-Japan cooperative survey covering eastern Bering Sea shelf and slope waters to 1, 100m depth (from Thorsteinson et al. 1984).

Species	Navarin Basin biomass	Total survey area biomass
Red king crab <u>Paralithodes camtschatica</u>	0	121,500
Blue king crab <u>P. platypus</u>	1,200	27,500
Tanner crab <u>Chionoecetes opilio</u>	55,400	292,520
Tanner crab <u>c. bairdi</u>	20,500	97,900

NAVBFinfish and Shellfish

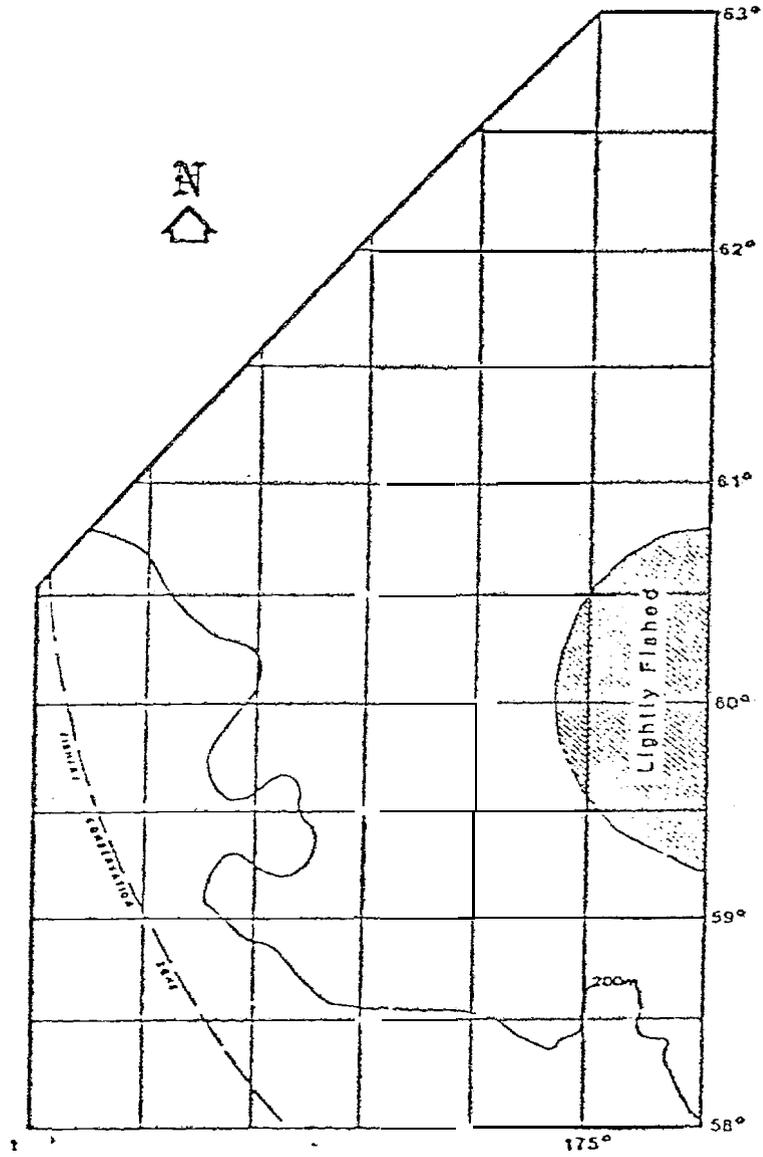


Figure 3. Former location of king crab fishery in NAVB OCS Planning Area (Representatives of the Oil/Fisheries Group of Alaska, 1983).

NAVB Finfish and Shellfish

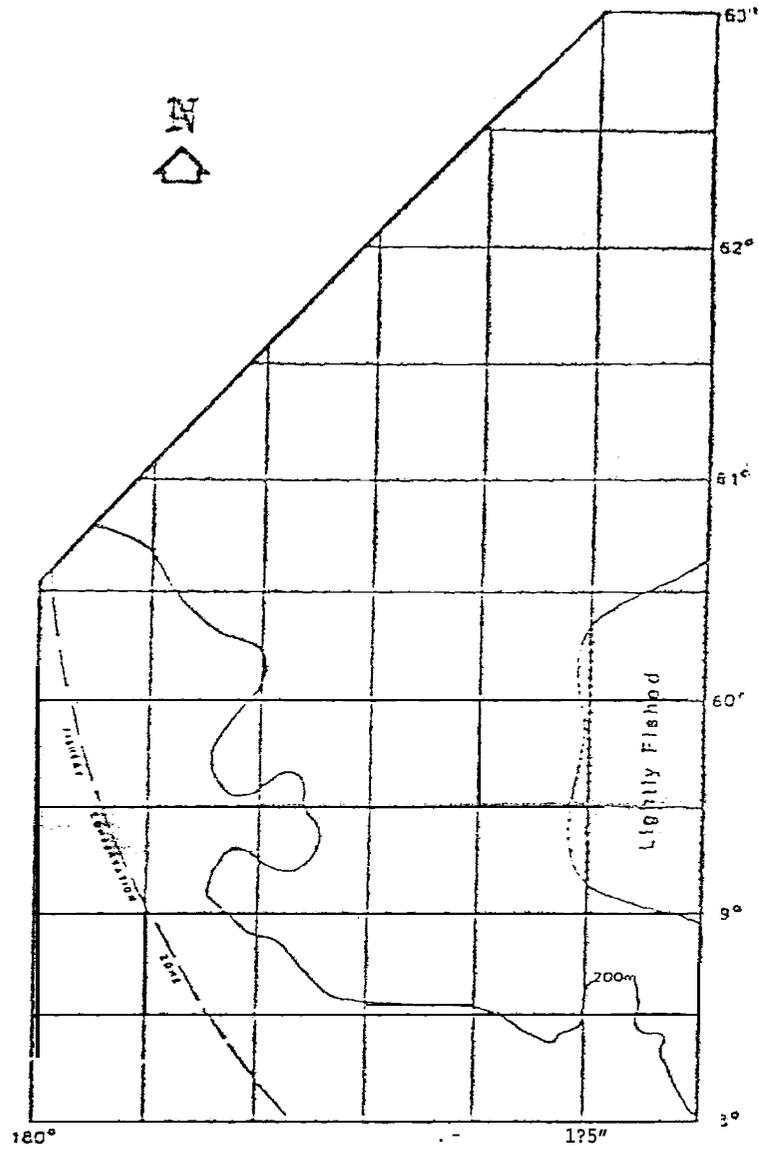


Figure 4. Former location of Tanner crab fishery, NAVB OCS Planning Area (Representatives of the Oil/Fisheries Group of Alaska, 1983).

NORTON B A S I N

FINFISH AND SHELLFISH

The following discussion pertains to the northern Bering Sea, with Norton Sound as its principal focus. NORB is the main OCS Planning Area in this region. A 1976 BLM/OCS survey cruise and its resulting data base covered this region plus the Bering Strait and Hope Basin to the north. Additional fishery and invertebrate fauna information will therefore be found in this discussion and under the HBAS OCS Planning Area.

Figure 1 illustrates the northern Bering Sea region. South of Norton Sound is the Yukon Delta, the northwestern portion of the vast Yukon-Kuskokwim deltaic complex which extends into the Bering Sea. In relation to proposed OCS development in Norton Sound the Yukon Delta is defined as the section of the Alaska coastline extending from Stebbins (near Stuart Island) west and south to Cape Romanzof.

A moderate-scale commercial salmon fishery exists in the Yukon Delta and Norton Sound region. Yukon River stocks are also heavily used for subsistence in the interior of Alaska, the Yukon Territory, and British Columbia. Other fishes taken from the Delta region include herring, smelt, whitefish, saffron cod, tom cod, and Arctic (blue) cod. Crabs, squid, and mussels are also taken (Menzel and Wright 1982).

The commercial fishery in Norton Sound proper is small, targeting four species of salmon, herring, and king crab. Except for a small subsistence king crab fishery through the winter ice, all fishing occurs from late spring through early fall. The king crab fishery is centered in the eastern portion of NORB, as shown in Figure 2.

Bottomfish in the Norton Basin OCS Planning Area are substantially less abundant than in other Alaskan regions despite the abundance of benthos present. As a result, there is no commercial fishery for groundfish in the NORB. Although Norton Sound contains approximately 15% of the continental shelf of the eastern Bering Sea, bottomfish comprise less than 3% of the potential eastern Bering Sea resource. Likewise, although Norton Sound has nearly twice the continental shelf area of the northeast Gulf of Alaska, its bottomfish resources are about 35% smaller.

Fish Fauna

Norton Sound and the southeastern Chukchi Sea support about 87 fish species in fifteen families; 78 spp. are considered marine forms. The following families comprise more than 85% of the total fish fauna (Wolotira et al. 1977):

<u>Family</u>	% of total spp.
Cottidae (sculpins)	23
Salmonidae (trout]	16

NORB Finfish and Shellfish

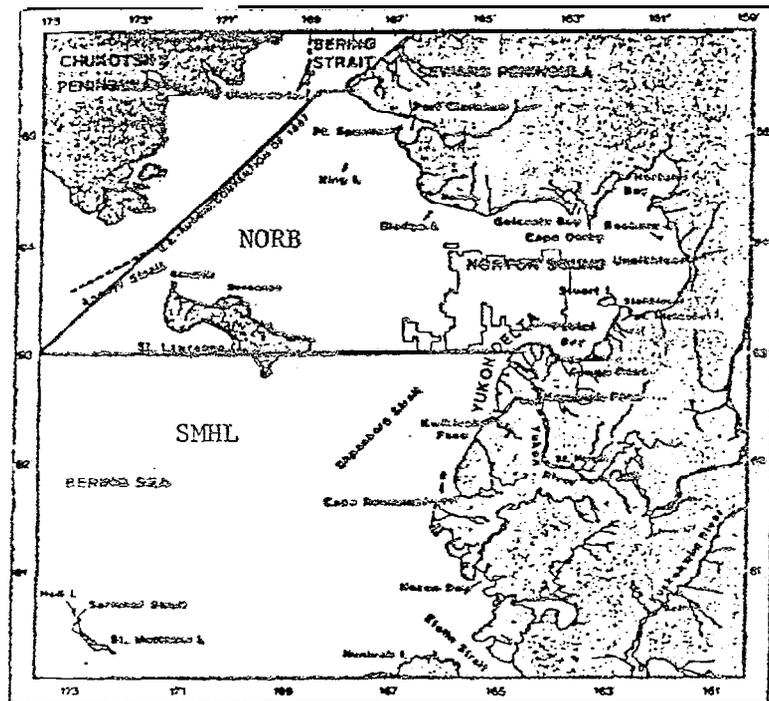


Figure 1. principal geographic features of the northern Bering Sea region, with OCS Planning Area boundaries superimposed (after Zimmerman 1982).

NORB Finfish and Shellfish

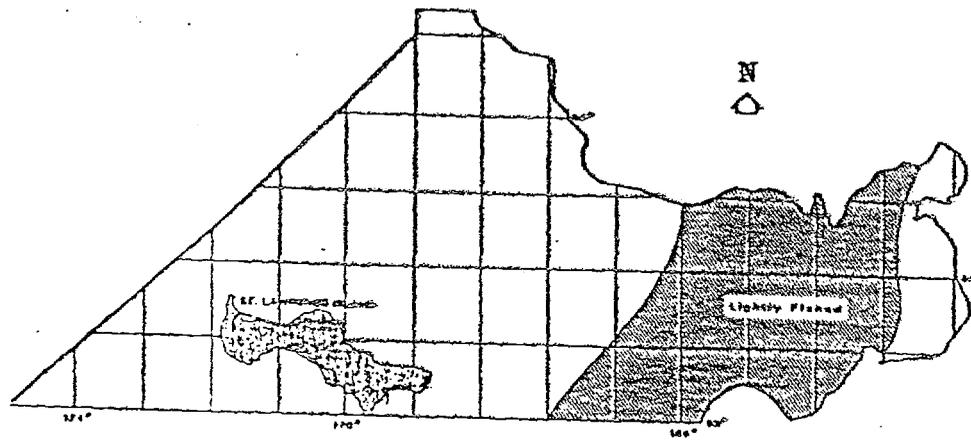


Figure 2. Location of commercial king crab fishery in NORB OCS Planning Area (from Representatives of the Oil/Fisheries Group of Alaska, 1983).

NORB Finfish and Shellfish

Pleuronectidae (righteye flounder)	13
Zoarcidae (eelpouts)	11
Strichaeidae (pricklebacks)	8
Agonidae (poaches)	7
Cyclopteridae (sailfishes)	7

The majority of the fish (74%) are benthic species. Due to the relatively shallow waters of the region (maximum depth rarely exceeds 50m), there are no deep benthic species. The remainder can be considered pelagic, including a substantial number of anadromous and euryhaline species. Most pelagic species are of commercial importance, including such genera as Clupea (herrings), Osmerus (smelts), Oncorhynchus (salmon), and Salvelinus (trout).

The fish fauna of Norton Sound, the southeastern Chukchi Sea, and adjacent waters are characterized by three distinct groups: (1) those coldwater groups indigenous to Arctic marine waters including such taxa as Arctic cod, longhead dab, Arctic flounder, and a number of cottoid and blennioid species; (2) a subarctic boreal group whose distribution is centered south of the study area in the Bering Sea or regions of the eastern and western Pacific which includes saffron cod, sole, Alaska plaice, starry flounder, Pacific herring, and others; and (3) an anadromous fresh-water group with several forms such as char, whitefish, and smelt whose marine distribution occurs only in the estuarine and other near-shore environments. (Wolotira et al. 1977).

Commercial and Subsistence Fisheries

Commercial fisheries in Norton Sound and the southeastern Chukchi Sea are limited to harvesting salmon, herring, and king crab. Subsistence fisheries also rely heavily on these species; in addition they utilize limited amounts of groundfish and other shellfish. The major species of finfish and shellfish harvested in both commercial (*) and subsistence fisheries are as follows:

*Chum salmon	*Pink salmon
*King (chinook) salmon	*Coho (silver) salmon
*Red (sockeye) salmon	Whitefish (<u>Coregonus</u> spp.)
Sheefish	*Pacific herring
Toothed smelt	Arctic cod
Saffron cod	Greenling (<u>Hexagrammus</u> sp.)
Sculpins	Halibut
Flounder (righteye)	Clams
*King crab	

Salmon -- Gillnetting is the principal commercial fishery in Norton Sound. All five species are harvested, though pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon comprise the majority of fish taken. Annual salmon catches in both commercial and subsistence fisheries are summarized in Table 1. Salmon harvests for the entire Yukon River system averaged 860,000 fish (3,600 metric

NORB Finfish and Shellfish

Table 1. Commercial and subsistence salmon harvests (numbers of fish) in Norton Basin, 1970-1979 (Alaska Dept. of Fish and Game, 1979a).

<u>Year</u>	<u>Commercial</u>	<u>Subsistence</u>	<u>Total</u>
1970	178,218	61,328	239,546
1971	141,977	44,581	186,558
1972	149,494	34,588	184,082
1973	176,797	25,201	201,998
1974	315,829	24,635	340,464
1975	251,861	26,886	278,747
1976	193,060	33,753	226,813
1977	257,325	50,189	307,514
1978	531,948	60,711	592,599
1979	350,344	49,176	399,520
<u>AVERAGE</u>	254,685	41,105	295,790

NORB Finfish and Shellfish

tons) from 1960-1979, approximately three times the harvest from the Norton Basin region. Adults of 'all salmon species are found nearshore or in bays or estuaries from the time of ice breakup until mid-August. Principal salmon rivers in the region include the Unalakleet, Shaktoolik, Koyak, Kwiniuk, Tubutulik, Kochavik, the Nuikluk-Fish Rivers which empty into Norton Sound, and the Kuzitron, Agiapuk, and Pilgrom Rivers which flow into Port Clarence (Burns *et al.* 1982).

Pacific herring -- This is the most important pelagic marine species in Norton Basin. Herring move into inshore waters in dense schools during ice breakup in early June. Spawning occurs in the littoral zone among Fucus and Zostera beds and eggs hatch in about three weeks. Most Pacific herring overwinter offshore to the south of Norton Sound. The presence of two independent herring stocks has been hypothesized: one in Port Clarence and northward into the Chukchi Sea, and a second found in Norton Sound and southward into the eastern Bering Sea (Burns *et al.* 1982). Commercial harvests are summarized in Table 2. Domestic herring catches have been small and sporadic. Japanese fishing effort increased dramatically in 1969-1971, but subsequent catches, even under heavy fishing effort, have not reached the 1969 peak of 1270 metric tons.

Relative Abundance and Apparent Biomass of Fish and Invertebrate Species

NOTE: Certain of the summary figures that accompany this text are germane to both NORB and HBAS OCS Planning Areas.

The major geographic features of NORB and HBAS are delineated in Figure 4. Wolotira *et al.* (1979) obtained biological samples from both these OCS Planning Areas. NORB can be subdivided into two sections. The northern Bering Sea, an area of nearly 47,000km², includes waters with depths of 9-65m from 165°W west to the US-USSR Convention Line of 1867 and from St. Lawrence Island north to the Bering Strait (including Port Clarence). The Norton Sound subarea, containing more than 31,000km², includes waters of 9-30m deep in most of Norton Sound east of 166°W. The latter subarea is the occasional site of substantial foreign herring fisheries as well as the location of commercial salmon fishing and subsistence fisheries for the residents of coastal towns and villages such as Nome, Unalakleet, St. Michael, and Stebbins (Wolotira *et al.* 1977).

Total apparent biomass of all fishes and invertebrates in NORB was estimated at, approximately 210,000 metric tons (Table 3). Fish were 17.5% of the apparent biomass, and invertebrates 82.5%. Cods were the dominant fish family (10% of total biomass) followed by righteye flounders (3.5%) and sculpins (2.8%). Echinoderms were the dominant invertebrate phyla, and starfish the dominant taxa accounting for 50% of the total estimated biomass. Commercially important (or potentially important) invertebrates were 9.1% of estimated total biomass (Wolotira *et al.* 1977).

NORB Finfish and Shellfish

Table 2. Commercial harvests of herring (metric tons) for U.S. domestic and Japanese fisheries in Norton Sound (Wolotira et al. 1977).

Year	U.S. domestic	Japanese
1968		125
1969		1270
1970	7.3	54
1971	17.7	621
1972	15.3	11
1973	32.3	25'
1974	3.1	720
1975	NA	5
1976	7.7	5

NORB Finfish and Shellfish

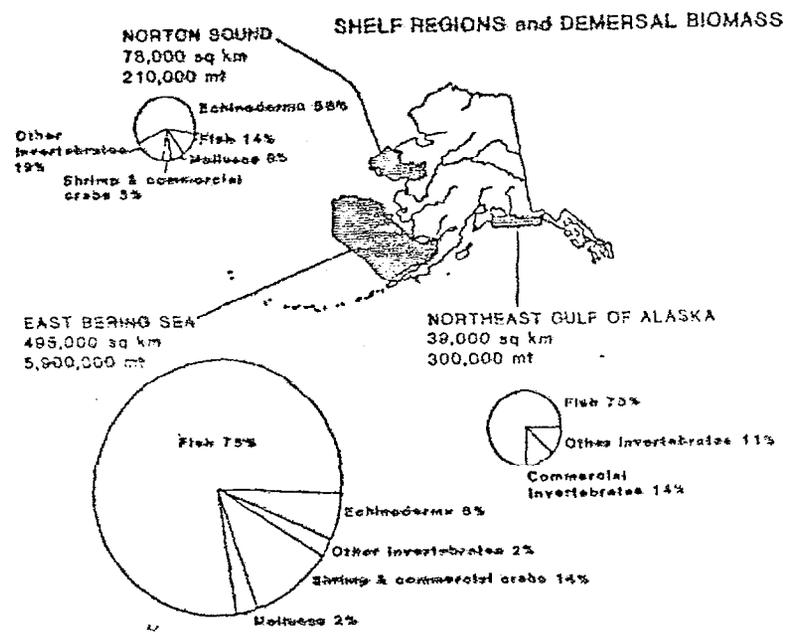


Figure 3. Comparison of bottomfish resources for various regions of the Alaska continental shelf (various sources, compiled by Zimmerman 1982).

NORB Finfish and Shellfish

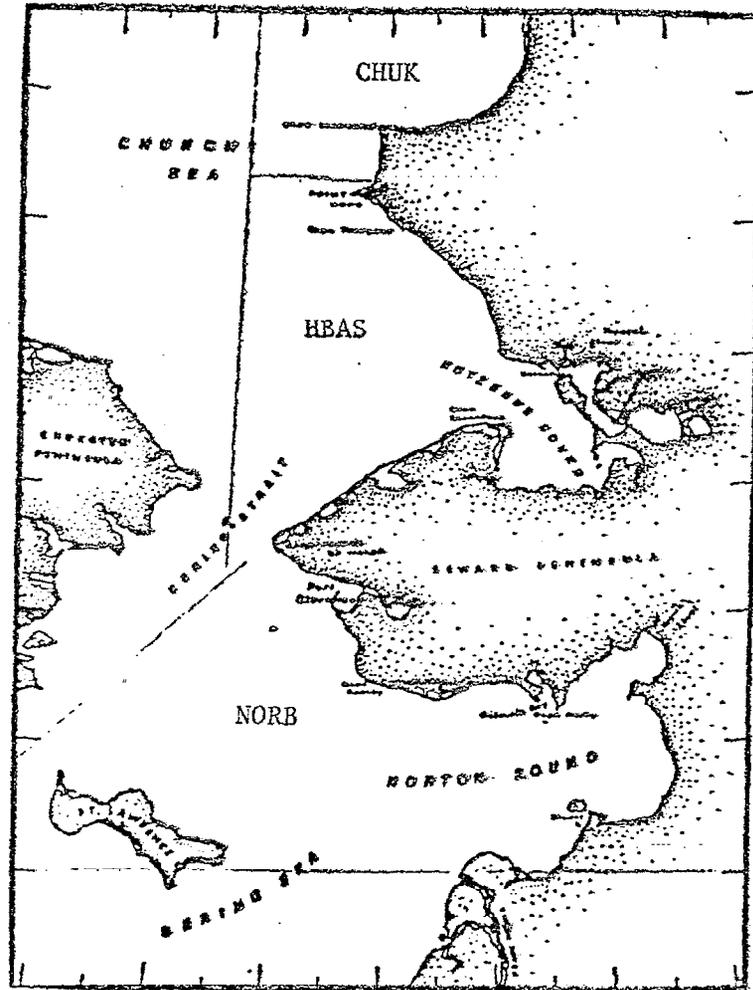


Figure 4. Major geographic features of NORB and HBAS OCS Planning areas in northern Bering Sea and southern Chukchi Sea (from Wolotira et al. 1977).

NORB Finfish and Shellfish

Based on CPUE'S, saffron cod dominated fish catches in both subareas of NORB, followed by staghorn sculpin in the northern Bering Sea and starry flounder in Norton Sound. Starry flounder ranked third in the northern Bering Sea and yellowtail sole, another righteye flounder, ranked third in Norton Sound. Invertebrate taxa were dominated by Neptunea heros, a large gastropod snail and one of the species commercially harvested in the eastern Bering Sea by the Japanese snail fishery (Macintosh 1980), and by red and blue king crabs.

Average 1976 survey catch rates for all taxa combined in NORB and HBAS OCS Planning Areas are shown in Figure 5. Norton Sound had the highest rate of all subareas, $57.5\text{kg}\cdot\text{km}^{-1}$. Average catch rate for the entire survey area was approximately $43.2\text{kg}\cdot\text{km}^{-1}$ trawled. Distribution and relative abundance of the total fish catch for these two OCS Planning Areas are summarized in Figure 6. Again, Norton Sound provided the highest catch rates, $10.9\text{kg}\cdot\text{km}^{-1}$ (Wolotira et al. 1977).

Distribution and relative abundance of all invertebrate taxa are shown in Figure 7. The invertebrate fauna contributed 81-93% of the total catch rates by subarea. As with fish, Norton Sound provided the highest invertebrate catch rate. Rates were lowest in the northern Bering Sea, $31.3\text{kg}\cdot\text{km}^{-1}$ (see Table 3).

Echinoderms were the most abundant component of the demersal invertebrate community in both the NORB and HBAS OCS Planning Areas, accounting for more than 180,000 metric tons. Starfish comprised most of the echinoderm catch and were most abundant in Norton Sound (Figure 8), where the catch rates averaged $38.2\text{kg}\cdot\text{km}^{-1}$. Ten shrimp species of possible economic importance were caught during the 1976 BLM/OCS survey. Shrimp catches in NORB averaged $0.3\text{kg}\cdot\text{km}^{-1}$ and were even lower ($0.2\text{kg}\cdot\text{km}^{-1}$) in the vicinity of Kotzebue Sound.

Total molluscan biomass for the entire 1976 survey was estimated at more than 200,000 metric tons, of which 97% consisted of snails. Snail and clam distributions are depicted in Figures 9 and 10, respectively. Average snail catches were greater in the offshore areas of both NORB and HBAS. Pelecypod mollusc (clam) catches were small throughout the study area, with the greatest catches, $0.2\text{kg}\cdot\text{km}^{-1}$, taken from Norton Sound (Wolotira et al. 1977).

NORB Finfish and Shellfish

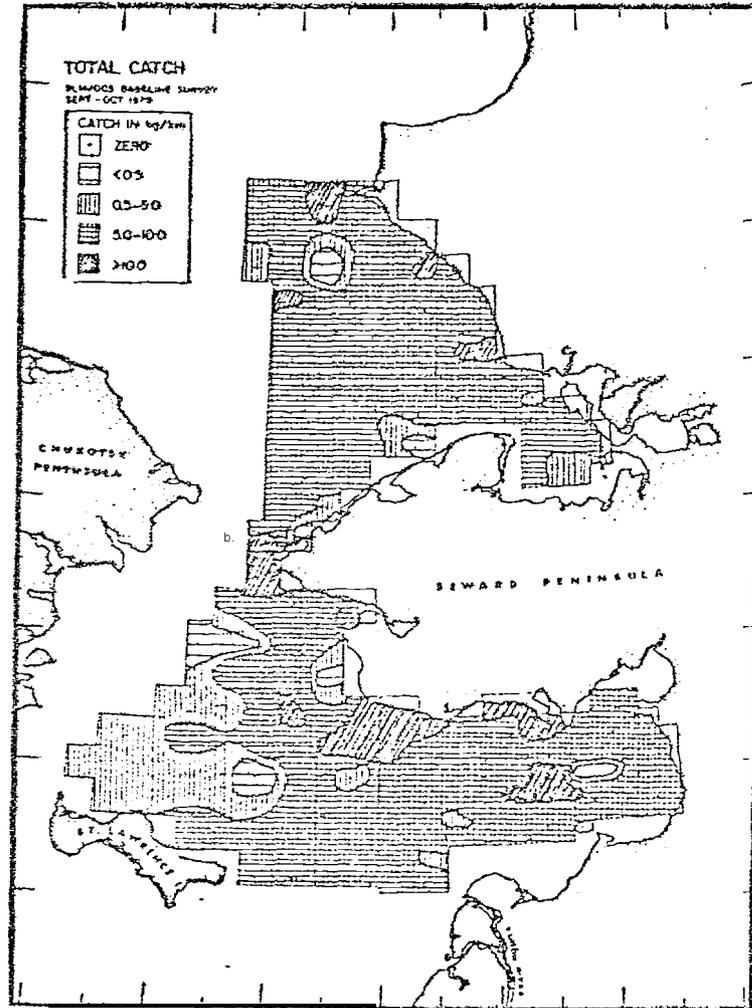


Figure 5. Distribution and relative abundance (by weight) of total fish and invertebrates in NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

NORB Finfish and Shellfish

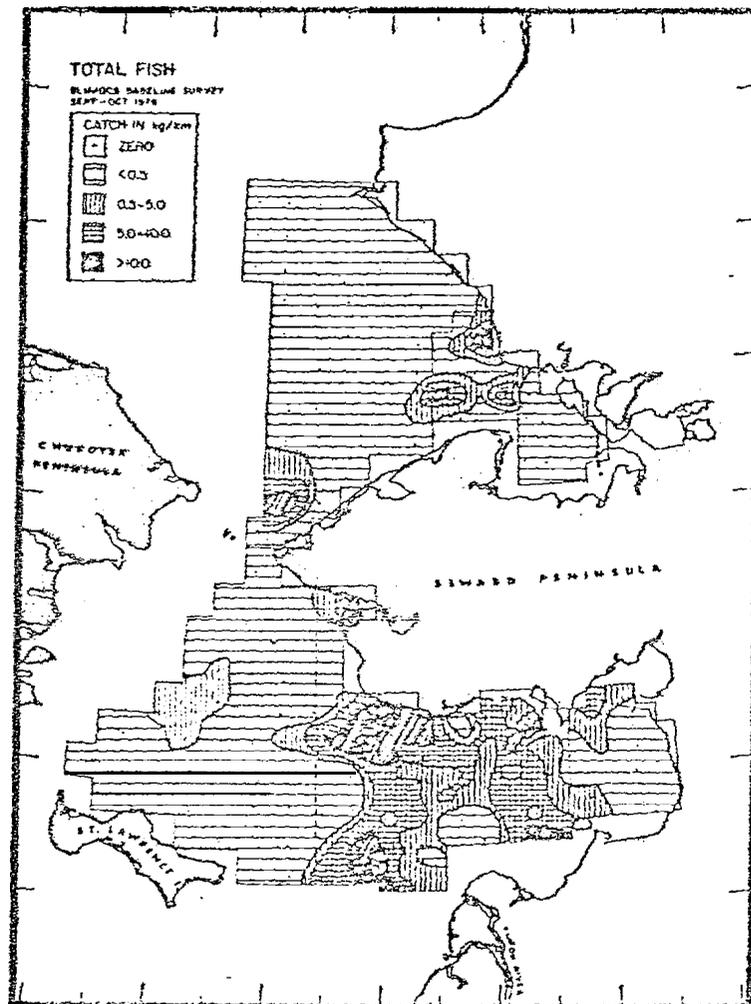


Figure 6. Distribution and relative abundance (by weight) of total fish in NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

NORB Finfish and Shellfish

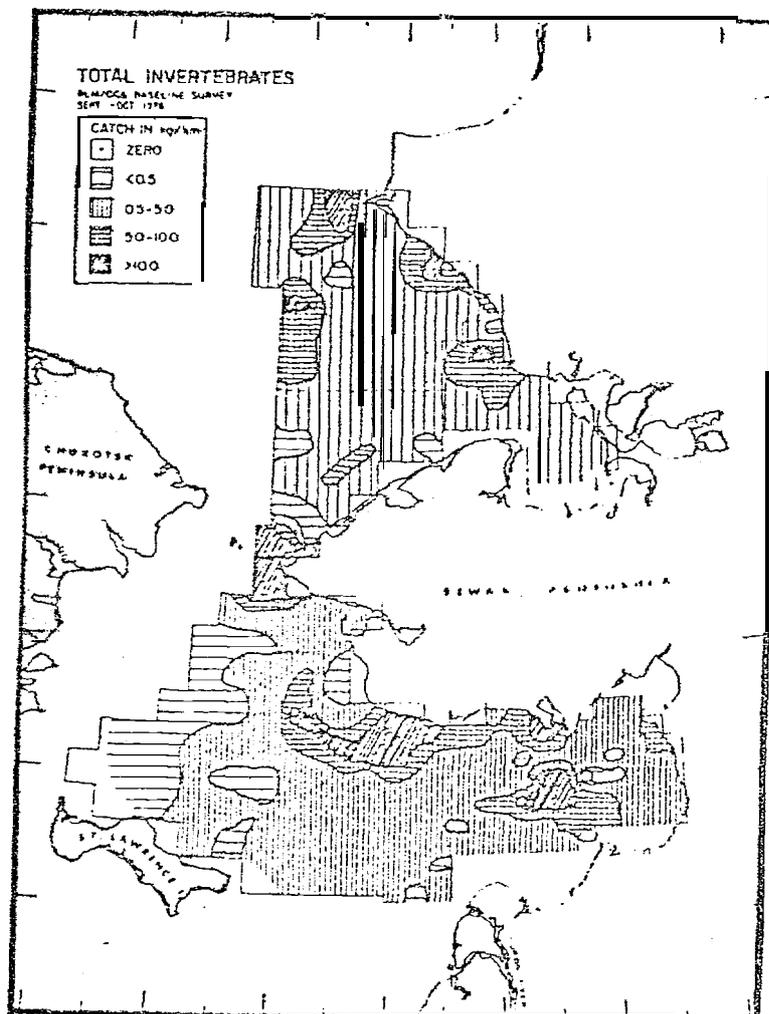


Figure 7. Distribution and relative abundance (by weight) of total invertebrates in NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

NORB Finfish and Shellfish

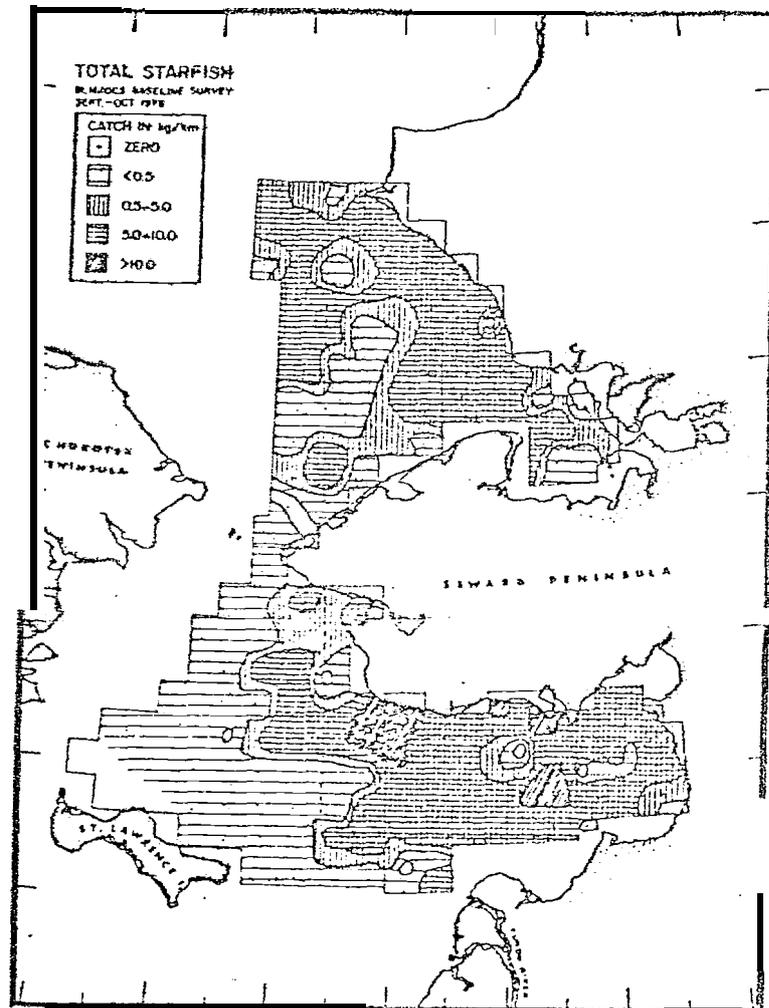


Figure 8. Distribution and relative abundance (by weight) of total starfish in NORB and HBAS OCS Planning Areas, based in 1976 BLM/OCS survey (Wolotira et al. 1977).

NORB Finfish and Shellfish

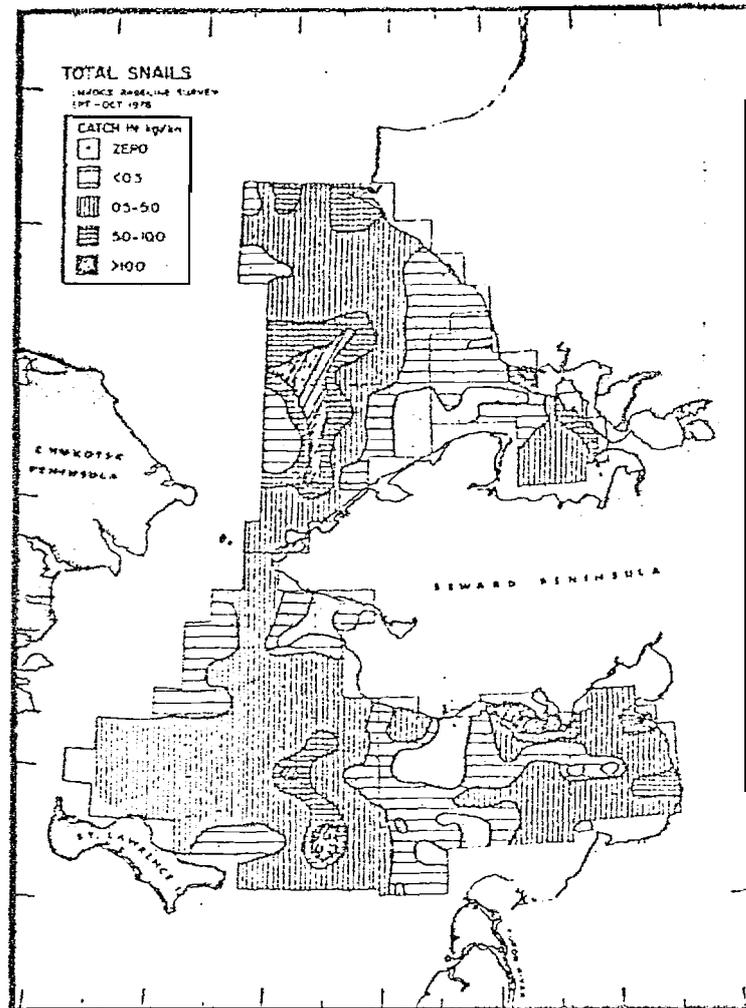


Figure 9. Distribution and relative abundance (by weight) of snails in NORB and HBAS, based on 1976 BLM/OCS survey (Wolotira *et al.* 1977).

NOR B Finfish and Shellfish

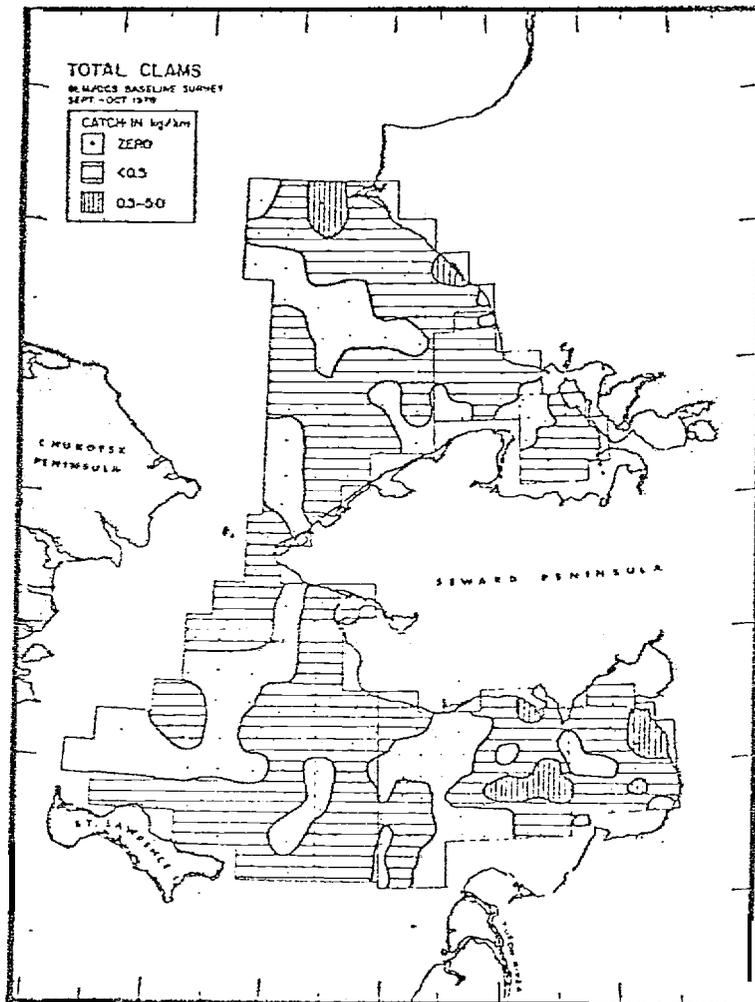


Figure 10. Distribution and relative abundance (by weight) of total clams in NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

NORB Finfish and Shellfish

Table 3. Apparent biomass (metric tons) and average Catch Per Unit Effort (kg/km-l) for major taxonomic groups in the NORB OCS Planning Area, as estimated from 1976 BLM/OCS survey (Wolotira *et al.* 1977).

Taxon	Northern Bering Sea Biomass	Sea CPUE	Norton Sound Biomass	Sound CPUE	Total Biomass
<u>FISH</u>					
Gadidae (cods)	7,674	2.75	12,544	6.74	20,218
Pleuronectidae (rt. eye flounder)	1,999	0.72	5,328	2.86	7,327
Cottidae (sculpins)	4,547	1.63	1,356	0.73	5,903
Clupeidae (herrings)	453	0.16	181	0.10	634
Zoarxidae (eelpouts)	387	0.14	186	0.10	573
Cyclopteridae (snail fishes)	224	0.08	10	0.01	234
Stichaeidae (prick lebacks)	23	0.01	130	0.07	153
Agonidae (poaches)	79	0.03	78	0.04	157
Other fish	211	0.07	50	0.02	261
<u>TOTAL FISH</u>	<u>16,632</u>	<u>5.97</u>	<u>20,231</u>	<u>10.87</u>	<u>36,863</u>
<u>INVERTEBRATES</u>					
Gastropod molluscs	6,368	2.29	3,071	1.65	9,439
Pelecypod molluscs	99	0.04	302	0.16	401
Crustaceans:					
Chironomocetes sp.	1,210	0.43	55	0.03	1,265
Paralithodes sp.	1,515	0.54	3,588	1.93	5,103
Telmessus sp.	330	0.12	1,023	0.55	1,353
Total commercially important invertebrates	10,458	3.75	8,661	4.45	19,119
Starfish	34,264	12.30	70,893	38.10	105,157
Other echinoderms	22,626	8.12	121	0.06	22,747
Other invertebrates	19,243	6.90	7,011	3.78	26,254
<u>TOTAL INVERTEBRATES</u>	<u>86,591</u>	<u>31.08</u>	<u>86,686</u>	<u>46.58</u>	<u>173,277</u>
<u>TOTAL CATCH</u>	<u>103,223</u>	<u>37.05</u>	<u>106,917</u>	<u>57.46</u>	<u>210,140</u>

H O P E B A S I N

FINFISH AND SHELLFISH

Certain of the finfish and shellfish data for the Hope Basin OCS Planning Area were obtained from surveys which included the northern Bering Sea to the south. Therefore, fishery information germane to HBAS can also be found in the "Finfish and Shellfish" summary for the Norton Basin (NORB) OCS Planning Area. Norton Sound and the southeastern Chukchi Sea support about 87 fish species in 15 families; 78 species are considered marine forms. The following families comprise more than 85% of the total fish fauna (Wolotira et al. 1977):

Family	% of total spp.
Cottidae (sculpins)	23
Salmonidae (trout)	16
Pleuronectidae (righteye flounder)	13
Zoarcidae (eelpouts)	11
Strichaeidae (pricklebacks)	8
Agonidae (poaches)	7
Cyclopteridae (snailfishes)	7

The majority (74%) of these fish are benthic species.

HBAS can be subdivided into the southeastern Chukchi Sea and Kotzebue Sound (see NORB "Finfish and Shellfish", Figure 4). The southeastern Chukchi subarea contains approximately 41,000km² and includes mostly offshore waters from 25-60m in depth from the Bering Strait to Point Hope. The subarea also encompasses nearshore areas along the north coast of the Seward Peninsula and north of Kotzebue Sound in waters deeper than nine meters. The Kotzebue Sound subarea, approximately 12,000km², includes all waters of Kotzebue Sound deeper than nine meters, and waters outside the Sound west to approximately 166°W and north to 67°30'N (Wolotira et al. 1977).

Total apparent biomass and average catches of major finfish and invertebrate taxa from HBAS are summarized in Table 1. The total apparent biomass, 127.5 metric tons, was 61% of the apparent biomass of the NORB OCS Planning Area south of the Bering Strait. This is close to the apparent areal ratio of the two Planning Areas (68%), suggesting that the average fish and invertebrate biomasses are similar in these two regions. Kotzebue Sound (HBAS) ranked below Norton Sound (NORB) in total CPUE (42.9kg·km⁻¹ trawled vs. 57.5kg·km⁻¹ trawled, respectively; Wolotira et al. 1977). Finfish accounted for 8.396 of the total apparent biomass. Cods, righteye flounders, and herrings were the dominant fish families in HBAS. Starry flounder, Pacific halibut, and saffron cod dominated fish catches in the southeastern Chukchi Sea whereas herring, saffron cod, and toothed smelt were the most abundant in catches from Kotzebue Sound.

As with NORB to the south, starfish were the most abundant invertebrates in HBAS, accounting for 44% of the total apparent biomass and 48% of the

Table 1. Apparent biomass (metric tons) and average catch per unit effort (kg-km⁻²) for major taxonomic groups in the HBAS OCS Planning Area, estimated from 1976 BLM/OCS Survey (from Wolotira et al. 1977).

Taxon	Chukchi Sea Biomass	CPUE	Kotzebue Sound Biomass	CPUE	Total Biomass
FISH					
Gadidae (cods)	1,447	0.59	1,027	1.40	2,474
Pleuronectidae (rt. eye flounder)	2,783	1.14	399	0.55	3,182
Cottidae (sculpins)	695	0.28	101	0.14	796
Clupeidae (herrings)	637	0.26	1,607	2.20	2,244
Zoarxidae (eelpouts)	250	0.10	65	0.09	315
Cyclopteridae (snail fishes)	333	0.14	7	0.01	340
Stichaeidae (prick lebacks)	45	0.01	24	0.03	69
Agonidae (poaches)	83	0.03	8	0.01	91
other fish	8	0.02	2	- .-	10
<u>TOTAL FISH</u>	<u>6,601</u>	<u>2.71</u>	<u>3,980</u>	<u>5.44</u>	<u>10,581</u>
INVERTEBRATES					
Gastropod molluscs	8,649	3.54	1,253	1.71	9,902
Pelecypod molluscs	191	0.08	40	0.06	231
Crustaceans:					
<u>Chionoectes</u> sp.	3,879	1.59	37597	4.91	7,476
<u>Paralithodes</u> sp.	76	0.03	13	0.02	89
<u>Telemessus</u> sp.	1,199	0.49	217	0.30	1,416
Total commercially important invertebrates	151165	6.20	5,295	7.24	20,460
Starfish	38,842	15.89	17,252	23.57	56,094
Other echinoderms	4,221	1.73	42	0.06	4,263
Other invertebrates	31,337	12.81	4,804	6.56	36,141
<u>TOTAL INVERTEBRATES</u>	<u>891545</u>	<u>36.63</u>	<u>27,393</u>	<u>37.43</u>	<u>116,958</u>
<u>TOTAL CATCH</u>	<u>96,166</u>	<u>39.33</u>	<u>31,373</u>	<u>42.87</u>	<u>127,539</u>

HBAS Finfish and Shellfish

invertebrate biomass. Commercially important invertebrates, led by tanner crabs and the gastropod Neptunea heros, were 16% of the estimated total biomass.

Distribution of Tanner crab catches during the 1976 survey are shown in Figure 1. These crabs were most abundant in Kotzebue Sound and the southeastern Chukchi Sea, where catches averaged $4.9\text{kg}\cdot\text{km}^{-1}$ and $1.6\text{kg}\cdot\text{km}^{-1}$, respectively.

Ten shrimp species of possible economic importance were taken during the 1976 survey. Largest shrimp densities were found in the southeastern Chukchi Sea (Figure 2), where the catch averaged $0.5\text{kg}\cdot\text{km}^{-1}$. Average catches in Kotzebue Sound were only $0.2\text{kg}\cdot\text{km}^{-1}$ trawled.

HBAS Finfish and Shellfish

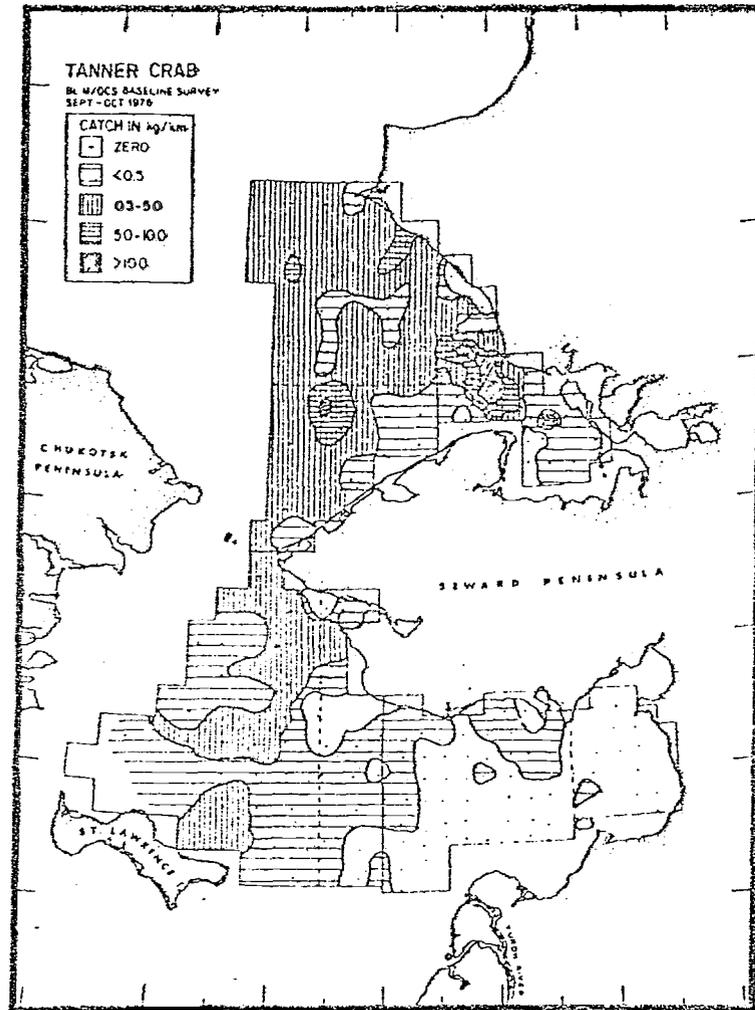


Figure 1. Distribution and relative abundance (by weight) of Tanner crabs in NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

HBAS Finfish and Shellfish

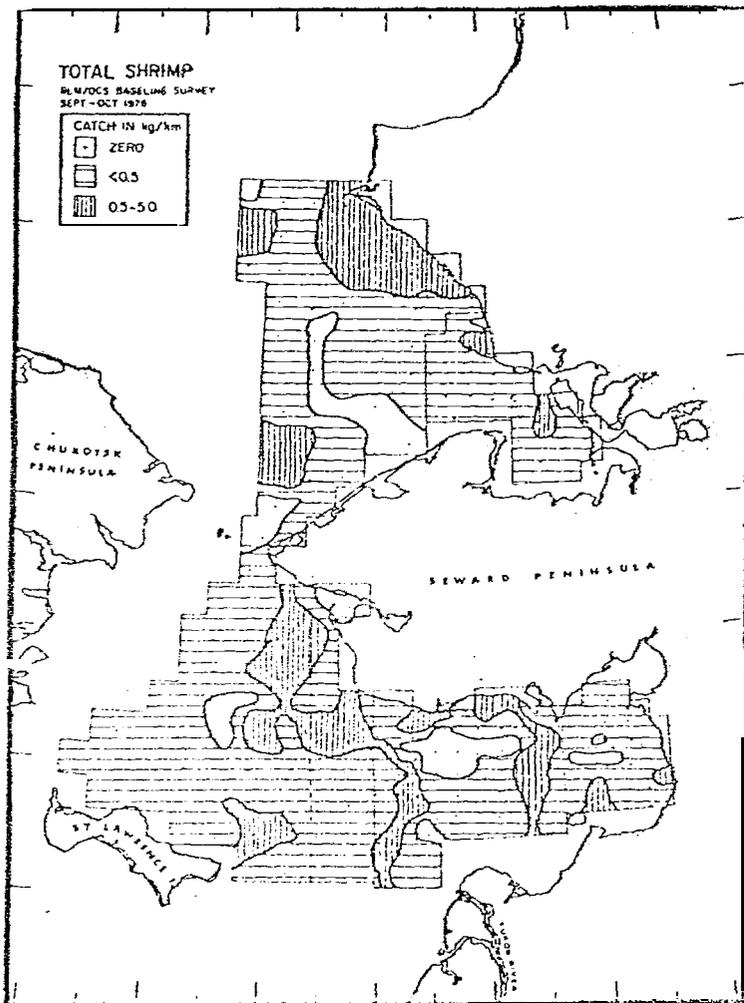


Figure 2. Distribution and relative abundance (by weight) of total shrimp from NORB and HBAS OCS Planning Areas, based on 1976 BLM/OCS survey (Wolotira et al. 1977).

CHKS Finfish and Shellfish

CHUKCHI SEA

FINFISH AND SHELLFISH

The Chukchi Sea (formerly Barrow Arch) OCS Planning Area occupies much of the continental shelf overlying the northeastern Chukchi Sea. The northeastern Chukchi Sea is a transition zone between the Arctic and Pacific Oceans and their associated fish communities. The fish fauna of CHKS is basically Arctic in origin but is enriched by a continental input of southern species from the Bering Sea which probably disperse northward with the Alaskan Coastal Current (Craig 1984a).

The northeastern Chukchi Sea possesses three major aquatic environments, each characterized by a somewhat distinctive water mass (Craig 1984a).

- 1) outer shelf waters: cold offshore and bottom waters variously composed of Bering Sea water, the relatively cold offshore portions of Alaskan coastal water, and, on occasion, Arctic Ocean water.
- 2) nearshore shelf waters: dominated by relatively warm, inshore portions of the Alaska Coastal Current.
- 3) still warmer brackish waters: found adjacent to the coast, these persist only in lagoons.

The outer continental shelf water of CHKS is cold (<3°C) and saline (approximately 31ppt), and is normally found several tens of kilometers or more offshore. However, the water may intrude closer inshore in bottom waters during periods of wind-induced upwelling.

Nearshore shelf waters are dominated by parts of the Alaskan Coastal Current which flow parallel to the shore toward the northeast during summer months. The core of nearshore shelf waters are found from 20-30km seaward of the shore along most stretches of coast to as far as 100km off Ledyard Bay. The main water mass is usually found at the surface, remaining less than 30m deep. Water temperatures can reach 5-10°C in the summer; salinities are usually less than 31.5ppt (Craig 1984a).

The warmest and least saline aquatic habitats occur very near the coast, particularly in the three largest lagoons: Peard Bay, lower Kuk River (Wainwright Inlet), and Kaseguluk Lagoon. Lagoon waters are warmed by the sun, and freshened by stream discharge and in situ ice melt in summer months. Low flushing rates allow the warm, brackish waters of the lagoons to be retained in spite of coastal upwelling conditions. Water conditions are, however, highly variable. For example, during the summer months water temperatures in the Kaseguluk Lagoon range from 5 to 13°C, salinities from 1 to 26ppt, and turbidity from 1 to 140 NTU (clear to very turbid). Lagoon waters may also become stratified, with a layer of warm brackish water overlying cold marine waters after winds push surface waters offshore (Craig 1984a).

CHKS Finfish and Shellfish

Table 1. Principal demersal fish species ($\geq 5\%$ of numerical catch) taken from offshore CHKS OCS Planning Area waters.

Fish Species	Bottom Trawl*		Bottom Trawl† <i>n</i> = 10	Surface & Midwater Trawls‡ <i>n</i> = 81	Gill Net* <i>n</i> = 16
	Deep (> 14 m) <i>n</i> = 19	Shallow (< 14 m) <i>n</i> = 10			
Arctic staghorn sculpin <i>Glyptocephalus cynoglossus</i>	55	55			
Arctic cod <i>Boreogadus saida</i>	17	5	54	85	
Shorthorn sculpin <i>Myoxocephalus scorpius</i>	9	16			
Hamecon <i>Arctiellus scaber</i>	7	10	7		
Polar eelpout <i>Lycodes polaris</i>			23		
Snailfish <i>Liparis</i> sp.		5			
Spatulate sculpin <i>Icelus spatula</i>			5		
Pacific sand lance <i>Ammodytes hexapterus</i>				10	
Pacific herring <i>Clupea harengus pallasii</i>					100
Others	12	9	11	5	
Number of fish caught	20,721	599	192	—	24

CHKS Finfish and Shellfish

Table 2. Principal fish species (>5% of numerical catch) taken from nearshore waters of the northeastern Chukchi Sea; data in percent. composition (from Craig 1984a).

Fish Species	Point Lay				Wainwright	Peard Bay
	Gill Net*	Fyke Net*	Gill Net†	Misc. Nets‡	Gill Net†	Fyke Net§
Pacific herring <i>Clupea harengus pallasii</i>	53		5			
Rainbow smelt <i>Osmerus mordax</i>	19		6		9	
Fourhorn sculpin <i>Myoxocephalus quadricornis</i>	11	20	29	32	29	24
Arctic flounder <i>Liopsetta glacialis</i>	10	13	55	12		
Arctic cod <i>Boreogadus saida</i>		39		42		70
Capelin <i>Mallotus villosus</i>		25				
Saffron cod <i>Eleginus gracilis</i>						6
Least cisco <i>Coregonus sardinella</i>					61	
Others	7	3	5	14	1	1
Number of fish caught	1,002	13,335	150	4,684	51	11,896

CHKS Finfish and Shellfish

Table 3. Catch per unit effort (CPUE) of fish taken by fykenet, comparing various locations along the Chukchi and Beaufort Sea coastlines; data in fish-net-day-1 (from Craig 1984a).

	Chukchi Sea		Beaufort Sea			
	Point Lay (1983)*	Peard Bay (1983)†	Simpson Lagoon (1978)‡	Prudhoe Bay (1981)§	Sagavan- irktok Delta (1982)¶	Eastern Beaufort Sea (1982)#
Anadromous fishes						
Least cisco	0.1	1	25	24	13	0.1
Arctic cisco	0	0	17	55	154	6
Arctic char	0.1	0	19	9	28	5
Broad whitefish	0	0	3	3	30	0
Others	<u>5</u>	<u>1</u>	<u>16</u>	<u>?</u>	<u>1</u>	<u>0.1</u>
Total	5	2	80	91	225	11
Marine fishes						
Arctic cod	183	408	390	180	148	80
Fourhorn sculpin	9 3	142	369	86	147	40
Others	191	39	<u>14</u>	<u>?</u>	<u>3</u>	<u>0.2</u>
Total	467	598	773	266	298	120

CHKS Finfish and Shellfish

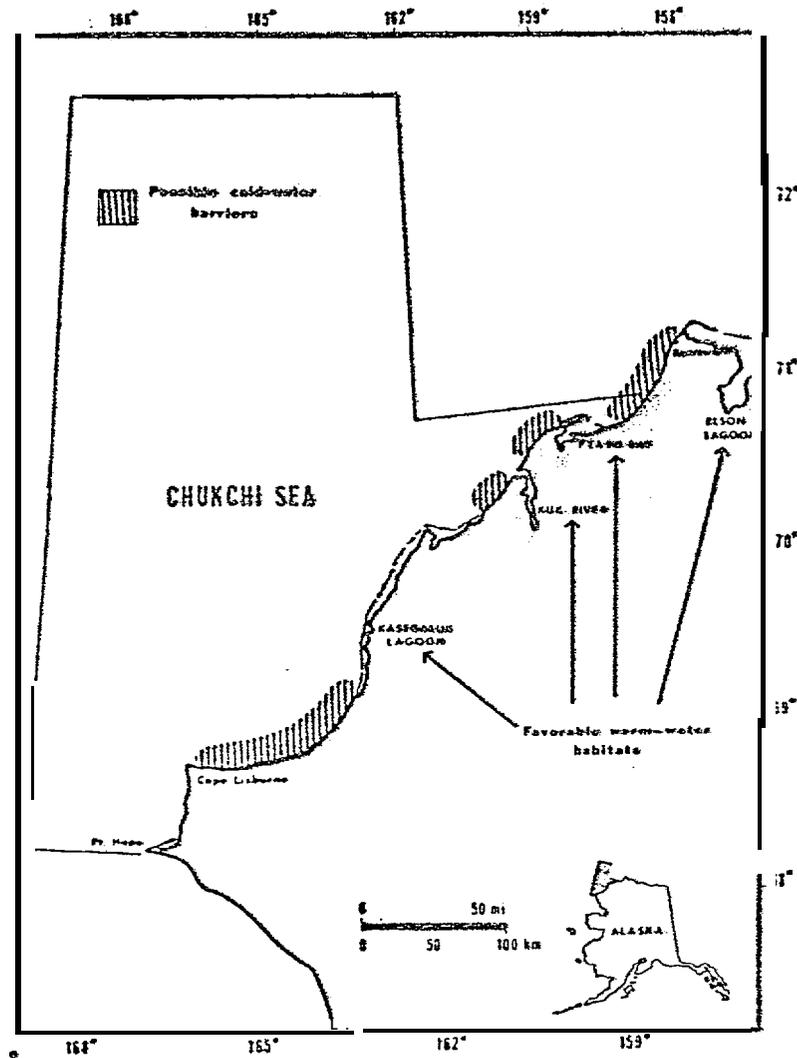


Figure 2. Locations of principal "warm-water" areas along coast of CHKSOCs Planning Area, also showing postulated cold-water barriers which are believed to hinder the dispersal of anadromous ciscoes and white fishes between these more favorable habitats (from Craig 1984a).

CHKS Finfish and Shellfish

The fish fauna of the northeastern Chukchi Sea strongly resembles that of the western Beaufort Sea. Both areas have a very low diversity of fish species, about 20% of the number of species present in the Bering Sea and the northern Pacific Ocean. Only 72 species have been recorded in or near the CHKS OCS Planning Area, and 74% of these are common to the Beaufort Sea. An additional 25 species are found in Chukchi Sea waters south of Point Hope (HBAS OCS Planning Area) which are more directly influenced by northward flow from the Bering Sea. At least some of the marine fish species of the Chukchi Sea are thought to maintain their populations only through continual recruitment of eggs and larvae transported north from the Bering Sea. It is hypothesized that population levels are kept low by cold winter water temperatures and consequent high mortalities (Craig 1984a).

Fish species composition differs between nearshore and offshore waters in the northeastern Chukchi Sea. The nine principal species in offshore waters are marine: four sculpins, Arctic cod, polar eelpout, sand lance, snailfish, and Pacific herring (Table 1). Juvenile Arctic cod (mostly young-of-the-year) and Pacific sand lance were virtually the only fish caught by surface and mid-water night trawls in the eastern Chukchi Sea between Icy Cape and Cape Lisburne. Average density of juvenile cod was 281000m⁻³ or about 0.7 metric tons·km⁻² of sea surface (Quast 1974). Quast (1974) described Arctic cod as a key element in the Arctic Ocean ecosystem.

Major fish in nearshore habitats consisted of two species also common in offshore waters - Pacific herring and Arctic cod - and six other species, rainbow smelt, least cisco, capelin, saffron cod, fourhorn sculpin, and Arctic flounder (Table 2).

Most of the inshore fish species are marine rather than anadromous, which distinguishes the nearshore fish component of the northeast Chukchi Sea from that of the southeast Chukchi and the Beaufort Seas. The scarcity of anadromous fish in the Chukchi relative to the Beaufort Sea is apparent in Table 3. Craig (1984a) noted that this difference may be, in part, an artifact, since virtually all the Chukchi Sea data used in these comparisons were gathered during a single summer (1983) and may or may not be representative of typical conditions. There are, however, two factors (whicrical catch) taken from offshore CHKS OCS Planning Area waters.

1) Small local stocks of anadromous fishes: streams flowing into the northeastern Chukchi Sea are relatively small drainages having marginal significance as anadromous fish streams. Also, fish use of these drainages is thought to be restricted by limited availability of overwintering habitat.

2) Cold-water barriers to coastal dispersal: Another source of anadromous fish stocks to CHKS is their dispersal from adjacent coastal regions, the Beaufort Sea, and the southern Chukchi Sea. In the Beaufort Sea the coastal dispersal of anadromous fishes is apparently dependent on the occurrence of a narrow band of relatively warm, brackish water (5-10°C; 10-25ppt salinity) which lies immediately adjacent to the shoreline during summer months. A similar warm-water band is apparently not as persistent along the

CHKS Finfish and Shellfish

northeastern Chukchi Sea except in isolated pockets: Kasegaluk Lagoon, Kuk River, and Peard Bay (Figure 2) (Craig 1984a).

There is no commercial fishery in the **CHKS** OCS Planning Area, and sport fishing is extremely limited. Subsistence fishing is important, however, in the villages of Wainwright, Point Lay, and Point Hope. During the summer gill nets are set along the shore to catch salmon (mostly pink) and varying proportions of Arctic char, ciscoes, and white fishes. In the fall, villagers travel inland to fishing camps on the Kuk, Utukok, and Kukpowruk Rivers to catch both anadromous and freshwater fishes. Rainbow smelt are taken in the winter, especially in the lower Kuk River (Wainwright Inlet: Craig 1984a).

One of the most significant aspects of fish resources in the **CHKS** OCS Planning Area is their important position in the marine food web. Forage fishes are the mainstay of large populations of marine mammals and seabirds in the northeastern Chukchi Sea. It has been estimated that as many as 25 million Arctic cod are consumed annually by seabirds at Cape Thompson alone. Changes in availability of forage fish species are thought to be the primary reason for observed fluctuations in the distribution and reproductive **success** of these seabirds and marine mammals (Craig 1984a).

BERING SEA SUBREGION

(NABA, SGBA, NAVB, SMHL OCS PLANNING AREAS)

FINFISH AND SHELLFISH

The southeastern Bering Sea is one of the world's major fishing grounds. Historically, most of the past harvests in the region have been taken by foreign fleets from Japan, South Korea, Taiwan, and, until 1980, the U.S.S.R. Today, U.S. trawlers fish in the southeastern Bering Sea in joint venture with the U. S. S. R., Korea, Japan, East Germany, and West Germany. **Although** many of the stocks were overfished during the 1960's and early 1970's, present evidence suggests that most of the resources in the Bering Sea-Aleutian management system are in good condition; this includes stocks of **pollock**, cod, most flatfishes, and mackerel. Stocks of Pacific cod and **yellowfin** sole are at historically high levels of abundance. However, Pacific ocean perch and **sablefish** stocks are in relatively poor condition at present and appear to be remaining at low levels of abundance (Bakkala and Low 1983).

The St. George Basin (roughly equivalent to the **SGBA OCS** Planning Area) constitutes a major portion of the Bering Sea fishing grounds and contributes approximately one-third of the total catch from this region. In 1977, for example, of the total international catch of 1.15 million metric tons taken in the southeastern Bering Sea, 453,000 metric tons were caught in the St. George Basin (Thorsteinson and Thorsteinson 1982).

The Bering Sea region has been divided into a number of subareas for the purpose of fishery management or survey. None of these subareas are congruent with the OCS Planning Areas as presently defined. In general, the southeastern Bering Sea OCS includes virtually all of the continental shelf waters of the North Aleutian Basin (NABA), St. George Basin (**SGBA**), and portions of the Navarin Basin (**NAVB**) and St. Matthew-Hall (**SMHL**). This includes portions of Statistical Areas 1 and 2 of the International North Pacific Fisheries Commission (INPFC; Forrester et al. 1983; Figure 1) and Subareas 1, 2, 3N, 3S, 4N, 4S, and 5 of trawl surveys conducted by the Northwest and Alaska Fisheries Center (NWAFC, NMFS; Figure 2). Unfortunately, most summary statistics from the above and other data bases have not been categorized by OCS Planning Area. For this reason, and because of, major foreign catches in the region, it is difficult to provide a detailed evaluation of the fishery "productivity" of the individual Bering Sea Planning Areas.

The approaches taken here are: (1) to examine biomass and relative abundance of demersal fish in the region as provided by extensive annual trawl surveys (RACE data base), and (2), because, as will be shown, comparisons between years may introduce uncertainties due to changes in sampling area, gear, or both, to estimate equilibrium yield (EY, the harvest that would result in an unchanged population size on the average) for the most abundant species. The last parameter, which is based on estimates of current stock size and recent recruitment data, provides some indication of future commercial productivity of a fishery.

BERING SEA Finfish and Shellfish

The Resource Assessment and Conservation Engineering (RACE) Division of the NWAFC has conducted annual surveys for crabs and groundfish in the eastern Bering Sea since 1971. Catch statistics of groundfish, shrimp, and herring for the years 1971-1976 are summarized in Forrester et al.: 1983. It was not until 1975, however, that the eastern Bering Sea OCS was sampled in a comprehensive multi-vessel survey under this program (Pereyra et al., 1976). This 1975 study has served as a model for subsequent surveys. Care should be taken, however, in comparing the summary results of these studies from year to year, as coverage was not always the same. More will be said about this below.

The 1980 survey (see coverage in Figure 2) is summarized here. Trawl samplings for demersal fish were made from May through July in continental shelf waters less than 200m in depth. Two vessels were used to sample 329 stations over a total area of 467,524km² {average sampling density: 1,421km²·station⁻¹}. Estimated abundance based on biomass of the various categories are summarized in Table 1. Total biomass was estimated at 8.72 million metric tons; finfish accounted for 6.25 million metric tons, or 72% of the total (Umeda and Bakkala 1983).

Based on estimates from subareas 1-4, which were sampled both in 1980 and the previous year, total biomass (fish plus invertebrates) decreased 14% from 9.98 million metric tons in 1979 to 8.56 million metric tons in 1980. Total fish declined from 7.32 to 6.16 million metric tons (16%); all major fish groups with the exception of flatfish and skates decreased in abundance as measured by biomass.

Relative productivity of the region can also be estimated by examining sampling or fishing success, i.e., catch per unit effort (CPUE). Figure 3 depicts distribution and relative abundance in CPUE of total fish taken during the 1980 NWAFc survey. The relative richness of the NABA and SGBA OCS Planning Areas are obvious from this figure. Figure 4 depicts distribution and abundance of cods, primarily walleye pollock and Pacific cod, from the 1980 NWAFc survey. Cods are widely distributed over the Bering Sea outer continental shelf and slope. Figure 4 shows abundance (CPUE) of all flounders. Greatest densities were at depths between 40 and 100m in the NABA and SGBA OCS Planning Areas. Together, cods and flounders account for over 86% of the total estimated fish biomass from the 1980 survey (Table 1).

BERING SEA Finfish and Shellfish

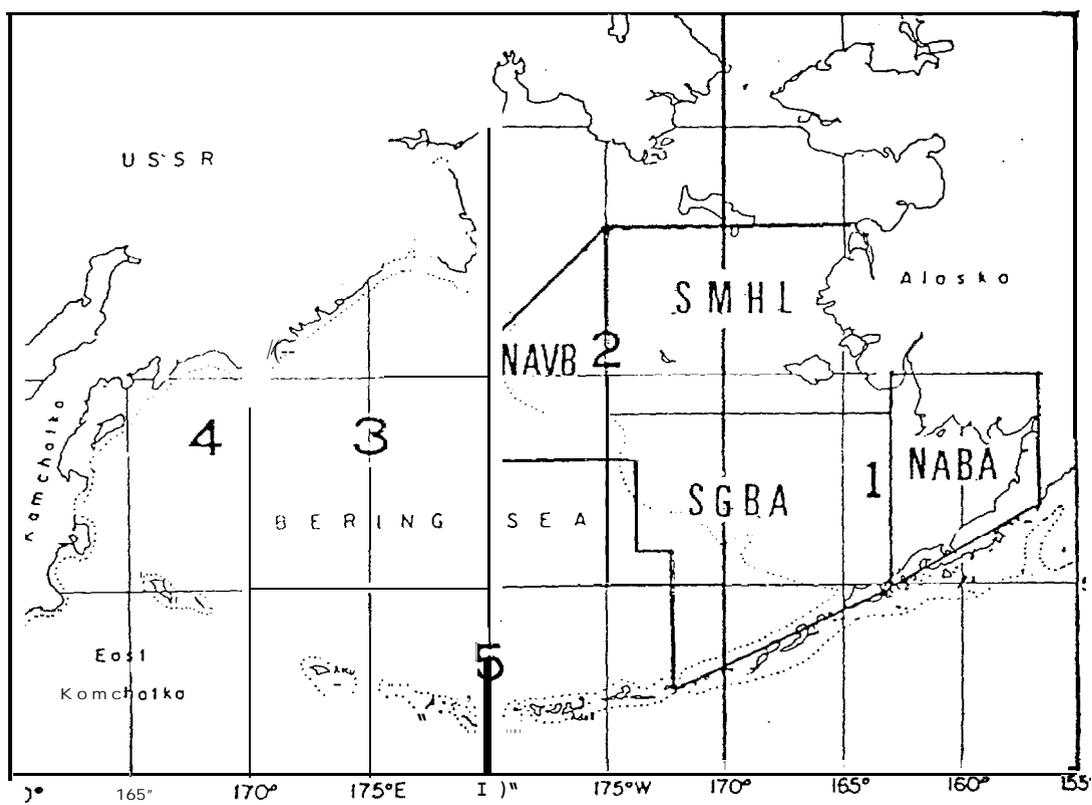


Figure 2. International North Pacific Fisheries Commission (INPFC) Statistical Areas for the Bering Sea and Aleutian Islands (from Bakkala and Low 1983).

13 ERING SEA Finfish and Shellfish

Table 1. Summary of apparent biomass of major taxonomic groups from the NWAFIC (Umeda and Bakkala 1983).

Taxon	Estimated biomass for total survey area (t)	Proportion of of total biomass
Gadidae (cods)	2,419,193	0.277
Pleuronectidae (flounders)	2,995,395	0.343
Cettidae (sculpins)	281,052	0.032
Zoarcidae (eelpouts)	371,461	0.043
Agonidae (poachers)	17,340	0.002
Rajidae (skates)	114,858	0.013
Other fish	55,285	0.006
Porifera (sponges)	24,327	0.003
Coelenterata (coelenterates)	12,024	0.001
Mollusca	167,196	0.019
Gastropoda (snails)	148,734	0.017
Pelecypoda (bivalves)	762	<0.001
Cephalopoda (squids & octopuses)	17,395	0.002
Other mollusks	304	<0.001
Crustacea	1,317,039	0.151
Chionocetes sp. (Tanner crab)	808,006	0.093
Paralithodus sp. (king crab)	381,052	0.044
Other crab	117,391	0.013
Total crab	1,306,451	0.150
Total shrimp	10,490	0.001
Other crustaceans	98	<0.001
Echinodermata	702,705	0.081
Asteroidea (starfish)	607,114	0.070
Ophiuroidea (brittlestars)	55,726	0.006
Echinoidea (sea urchins etc.)	30,913	0.004
Holothuroidea (sea cucumbers)	8,952	0.001
Ascidiacea	46,240	0.005
Other invertebrates	197,775	0.023
Total invertebrates	2,467,306	0.2863
Total catch	8,721,890	
Geographical area (km ³)	467,524	

BERING SEA Finfish and Shellfish

The relative order of abundance of the twenty most abundant species taken in the 1980 survey is provided in Table 2. These twenty species were 70% of the catch for the total area. For the most part, the catches from the various subregions were dominated by the same fish species (Table 3). **Yellowfin** sole was the most abundant species in the inner shelf areas, where CPUE ranged from 37.4 to **98.6 kg·ha⁻¹**, but became less abundant over the outer shelf bottom (average CPUE 26.1 -57.3 **kg·ha⁻¹**) where walleye **pollock** dominated the catch. **Umeda** and **Bakkala** (1983) have reviewed commercial fishery and other data and conclude that the 1980 survey seriously underestimated **pollock** abundance, possibly because of the semi-demersal nature of this species. Thus, the apparent walleye **pollock** biomass for 1980 (1.51 million metric tons) is only 50% of the estimate for 1979 (3.05 million metric tons), although no severe reduction in commercial fishing success was observed.

The comprehensive trawl surveys also provide the most recent biomass estimates of **demersal** fish populations that are available for the eastern Bering Sea (Sample 1984). Table 4 summarizes trawl survey data by species for approximately the last decade. Once again, care should be taken in establishing clear trends by comparing different years, as the discussion above for walleye **pollock** indicates. For example, Sample {1984} suggested that the three-fold increase in **pollock** biomass between 1982 and 1983 could well have been due to increased fish vulnerability to sampling gear employed. It is clear, however, that the most abundant fish in terms of CPUE also contribute the largest part of the total **demersal** fish biomass in this region.

Equilibrium **yield** (EY) is defined as the amount of harvest which will result in an unchanged population size on the average. The EY for the entire groundfish complex in the eastern Bering Sea has been estimated at 2.0-2.1 million metric tons (1981 & 1982; **Bakkala** and Low 1983). Estimated EY's for important components of this complex are summarized in Table 5. Additional information regarding the biomass and distribution of these fish is presented below.

Walleye pollock

EY = 1.3 million metric tons (1981)

Walleye **pollock** (*Theragra chalcogramma*) in the eastern Bering Sea supports the largest single species fishery in the North Pacific (**Bakkala** and **Wespestad** 1983a). **Pollock** became a highly sought-after species with the successful implementation of mechanized minced-fish processing on Japanese commercial vessels in the mid-1960's. As a result, **pollock** catches increased from 175,000 metric tons in 1964 to 1.9 million metric tons in 1972. Catches since then have declined, due both to catch restrictions placed on the fishery and to declining stock abundance. Reported 1981 catches were 973,000 metric tons in the eastern Bering Sea (**Bakkala** and **Wespestad** 1983a). These authors estimated **total** biomass at 10-12 million metric tons. However, low recruitment of the 1979-1981 year classes has caused a decline of overall **pollock** biomass from 11.0 million metric tons in 1979 to 7.8 million metric tons in 1982. **Pollock**

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Table 2. Rank order of abundance of twenty most abundant species of fish taken during the 1980 demersal trawl survey in the southeastern Bering Sea (after Umeda and Bakkala 1983).

Rank	Species	CPUE (kg-ha-1)	Proportion of total CPUE
1	Yellowfin sole	40.92	0.219
2	Walleye pollock	32.27	0.173
3	Pacific cod	19.41	0.104
4	Alaska plaice	7.46	0.040
5	Rock sole	6.05	0.032
6	Wattled eelpout	4.41	0.024
7	Greenland turbot	3.68	0.020
8	Flathead sole	2.75	0.015
9	Sparse toothed lycod	1.63	0.009
10	Shortfin eelpout	1.63	0.009
11	Skate (unidentified)	1.45	0.008
12	Plain sculpin	1.08	0.006
13	Longhead dab	1.03	0.006
14	Arrowtooth flounder	1.02	0.005
15	Pacific halibut	0.92	0.005
16	Yellow Irish lord	0.92	0.005
17	Butterfly sculpin	0.84	0.005
18	Sculpin (unidentified)	0.73	0.004
19	<u>Myoxocephalus</u> sp.	0.61	0.003
20	Shorthorn sculpin	0.56	0.003

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Table 4. Biomass estimates of demersal fish taken during comprehensive trawl surveys of the eastern Bering Sea by NWAFC (Sample 1984).

Species	Year					
	1975	1979	1980	1981	1982	1983
Walleye pollock	2,426,400	2,876,500	1,508,600	2,543,600	2,666,600	6,050,600
Pacific cod	64,500	734,600	907,300	840,100	1,013,900	1,126,400
Yellowfin sole	1,038,600	1,907,700	1,913,000	2,065,100	3,322,500	3,951,500
Rock sole	170,300	182,800	283,000	287,400	557,100	869,700
Flathhead sole	113,000	101,800	128,400	185,200	204,300	279,200
Alaska plaice	127,300	283,000	348,800	438,300	654,100	745,400
Greenland turbot	126,700	143,300	172,200	87,400	37,700	35,100
Arrowtooth flounder	28,000	42,000	47,200	50,200	70,000	149,300
Pacific halibut	30,600	64,200	43,200	46,500	70,500	90,100
Sculpins	122,500	269,200	281,000	284,400	291,300	277,000
Salpouts	98,600	360,500	371,500	147,400	118,500	68,600
Poachers	12,800	28,200	17,300	11,200	13,800	13,800
Skates	42,000	74,000	114,900	239,000	167,900	188,200
Other fish	133,700	193,700	117,500	97,500	193,000	14,300
TOTAL	4,535,000	7,261,000	6,254,800	7,293,300	9,421,200	13,859,200

BERING SEA Finfish and Shellfish

Table 5. Equilibrium yield (EY) estimates for leading commercial demersal fish in the eastern Bering Sea.

Species	EY (metric tons)	Reference
Walleye pollock	1,200,000	Bakkala & Wespestad (1983a)
Pacific cod	55,000	Bakkala <u>et al.</u> (1983)
Yellowfin sole	200,000	Bakkala & Wespestad (1983b)
Greenland turbot	65,000	Bakkala & Sample (1983)
Arrowtooth flounder	20,000	Bakkala & Sample (1983)
Miscellaneous flatfish	61,600	Bakkala (1983)
Sablefish	2>000	Narita (1983)
Pacific ocean perch	1,700	Ito (1983a)
Miscellaneous rockfish	3,100	Ito (1983b)
Atka mackerel	25,000	Ronholt (1983b)

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Arrowtooth flounder	20,000	Bakkala & Sample (1983)
Miscellaneous flatfish	61,600	Bakkala (1983)
Sablefish	2,000	Narita (1983)
Pacific ocean perch	1,700	Ito (1983a)
Miscellaneous rockfish	3,100	Ito (1983b)
Atka mackerel	25,000	Ronholt (1983b)

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biomass in 1983 is believed to be at least 7.8 million metric tons and possibly higher (Bakkala and Traynor 1984).

Pacific cod

EY = 55,000 metric tons

Like the walleye pollock, Pacific cod (*Gadus macrocephalus*) is widely distributed over the Bering Sea continental shelf and slope north of St. Lawrence Island, although the greatest numbers are found south of the latitude of St. Matthew and Nunivak Islands. Juvenile cod (<1 year) apparently inhabit nearshore waters; age four and older cod are primarily found on the outer shelf and slope (Bakkala 1984 b). Since 1970, total catches in 1980 and 1981 (49,286 and 59,916 metric tons, respectively) increased markedly, primarily because of the new joint-venture and U.S. domestic fisheries (Bakkala et al. 1983). Japanese fisheries continue to account for the major portion of the catch, as they have since 1964. Abundance in the region has also increased: biomass estimates for 1975 were 64,500 metric tons, compared with 1,013,900 metric tons in 1982; CPUE increased from $2.7\text{kg}\cdot\text{ha}^{-1}$ in 1975 to $22.2\text{kg}\cdot\text{ha}^{-1}$ in 1982 (Bakkala et al. 1983). A strong 1977 year class has placed the Pacific cod at a high point in its natural cycle of abundance. Commercial harvests cannot be adjusted to maintain the stock at this high level, but should be increased to take advantage of the available surplus before it is lost to natural mortality. Wespestad et al. (1982) projected that catches of 228,000 metric tons could be taken from the eastern Bering Sea population in 1983 and 118,000 metric tons in 1984, after which catches might have to be reduced below 100,000 metric tons. Survey results from 1983, however, indicated that Pacific cod biomass in the eastern Bering Sea remained about the same as for 1982 (1 million metric tons). Thus Bakkala and Wespestad (1984a) revised the allowable 1984 catch upward to 232,500 metric tons. Projected acceptable eastern Bering Sea catches for 1985 and 1986 are 142,400 and 111,400 metric tons respectively, and projected acceptable catches in the Aleutian Islands for 1984 through 1986 are 58,800, 36,000 and 28,200 metric tons (Bakkala and Wespestad 1984a).

Yellowfin sole EY = 310,000 metric tons

The population of yellowfin sole (*Limanda aspera*) in the eastern Bering Sea was substantially reduced by foreign exploitation in the early 1960's. The resource began to recover in the early 1970's and abundance in 1982 (biomass = 3,300,000 metric tons) was estimated to be as high or higher than pre-1960 levels (Bakkala and Wespestad 1983b; 1984b). Similarly, CPUE from the NWAFC trawl surveys has increased, doubling from 1975 ($20\text{kg}\cdot\text{ha}^{-1}$) to 1979 ($41\text{kg}\cdot\text{ha}^{-1}$), with levels for 1982 and 1983 at $70.3\text{kg}\cdot\text{ha}^{-1}$ and $86.5\text{kg}\cdot\text{ha}^{-1}$, respectively. Some of the data for recent years may reflect sampling gear modification, however. The primary reason for the increase in yellowfin sole since the early 1970's has been the strength of the 1966-70 year-classes. Results of NWAFC surveys in 1980, 1981 and 1983 indicate that a new series of strong year-classes for 1973-77 have entered the population as well. Abundance projections based on long-term average recruitment levels indicate that the yellowfin sole population can be expected to remain at about its present level through 1985, supporting

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annual catches at an EY of more than 200,000 metric tons (Bakkala and Weststad 1983 b). Because survey biomass estimates for 1982 and 1983 exceeded projected biomass for these years, Bakkala and Weststad (1984b) estimated EY for 1984 at 310,000 metric tons.

Turbots

EY = 67,500 metric tons

The turbot, arrowtooth flounder (Atheresthes stomias) and Greenland turbot (Reinhardtius hippoglossoides) have similar bathymetric distributions in the eastern Bering Sea. Adults are generally taken in waters of the continental slope, but juveniles are restricted to the shelf region. Greenland turbot are distributed throughout the eastern Bering Sea with highest concentrations along the continental slope at depths greater than 200m. Arrowtooth flounder are restricted to the southern portion of the eastern Bering Sea and along the slope, with highest abundance at depths of 100-700m (Bakkala and Sample 1983). A long period of relatively small turbot catches in the 1960's was followed by substantial increases, to an all-time high of 103,000 metric tons (combined species) in 1974. Catches declined to combined levels of 71,000 and 74,000 metric tons for 1980 and 1981, respectively. Maximum sustainable yield (yield that can be sustained when the population is fully exploited and reduced to half its virgin biomass) for Greenland turbot in the eastern Bering Sea has been estimated at 72,000 metric tons. Catch rates and biomass estimates for Greenland turbot declined sharply in 1981 and 1982, and remained low in 1983, as a result of poor recruitment of the 1979-1981 year-classes. From 1983 to 1984, EY decreased from 65,000 to 47,500 metric tons. The adult arrowtooth flounder population appears stable, with good juvenile recruitment. The 1983 and 1984 estimated EY's were 20,000 metric tons; estimated MSY is 24,200 metric tons (Sample and Bakkala 1984).

Miscellaneous flatfish

EY = 61,600 metric tons

The following small flatfish, all of which are primarily found in continental shelf waters, are lumped in this category:

flathead sole	<u>Hippoglossoides elassodon</u>
rock sole	<u>Lepidopsetta bilineata</u>
rex sole	<u>Glyptocephalus zachirus</u>
Dover sole	<u>Microstomus pacificus</u>
starry flounder	<u>Platichthys stellatus</u>
longhead dab	<u>Limanda proboscidea</u>
butter sole	<u>Isopsetta isolepis</u>

Biomass estimates based on trawl survey data taken since 1975 suggest an increase in this species complex in the eastern Bering Sea from 421,400 metric tons (1975) to 1,631,800 metric tons (1982). Again, the apparent increase since 1981 may reflect changes in sampling gear. Evidence suggests that the populations of most of these species are in good condition and should be

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capable of supporting harvests at approximately **the** upper end of the maximum sustainable yield; this is the basis of the estimated EY.

Alaska plaice

EY = 70,000 metric tons

Alaska plaice (*Pleuronectes quadrituberculatus*) have not been exploited at the same rate as other **flatfish** until fairly recently, probably because their inshore distribution has kept the species separated geographically from the main fishing areas (Bakkala 1984a).

Sablefish

EY = 6185 metric tons

Sablefish (*Anoplopoma fimbria*) are found along the continental shelf and slope of the North Pacific, including the Bering Sea, from **Hokkaido**, Japan, to Baja, California. The eastern Bering Sea fishery was initiated by Japanese **longliners** in 1958. Catches peaked in 1962 at 28,520 metric tons. As the fishing grounds were preempted by the expanding trawl fisheries, new **longlining** areas were established in the Aleutian region (where catches peaked at 3,580 metric tons in 1972). Declining stock abundance has now reduced catches in both regions; catches by all nations in the eastern Bering Sea were **only** 2,578 metric tons in 1981, and 3,839 metric tons in 1982. The combined maximum sustainable yield for this region has been estimated at 15,100 metric tons. However, because some stocks are depleted, and because sablefish productivity is thought to be related to overall condition of the resource throughout the extent of its range, the EY has been set much **lower**, especially for the eastern Bering Sea (Narita 1983; 1984).

Pacific ocean perch

EY = 12,160 metric tons

Technically a **rockfish**, Pacific ocean perch (*Sebastes alutus*) are found in commercially **useable** concentrations along the outer continental shelf and upper slope regions of the North Pacific and the Bering Sea. Two main stocks have been identified in the latter, one along the eastern Bering Sea slope, the other around the Aleutian Islands (Figure 4). Stocks were seriously depleted by Japanese and Russian fisheries in the 1960's. Catches in the eastern Bering Sea peaked at 47,000 metric tons in 1961 (the peak catch in the Aleutian region was 109,000 metric tons in 1965). By 1982, Pacific ocean perch harvests were but a small fraction of historic levels: 600 metric tons from the eastern Bering Sea slope and 1,500 metric tons from the Aleutian region. Cohort analysis of stocks indicated that mean stock biomass in the eastern Bering Sea fell 84.6% from 1963-1976 (Ito 1982). Biomass estimates for 1979 (6,400 metric tons) and 1981 (9,800 metric tons) remained low, and decreased further, to 5,505 metric tons, in 1982, although these must be taken as underestimates because the fish are known to occupy the water column above the area sampled by bottom **trawls**. The low EY may still be too high (Ito 1983a; 1984a); both the eastern Bering Sea and Aleutian stocks are in very poor condition, and there is no consistent evidence to suggest that either is rebuilding to former levels of abundance.

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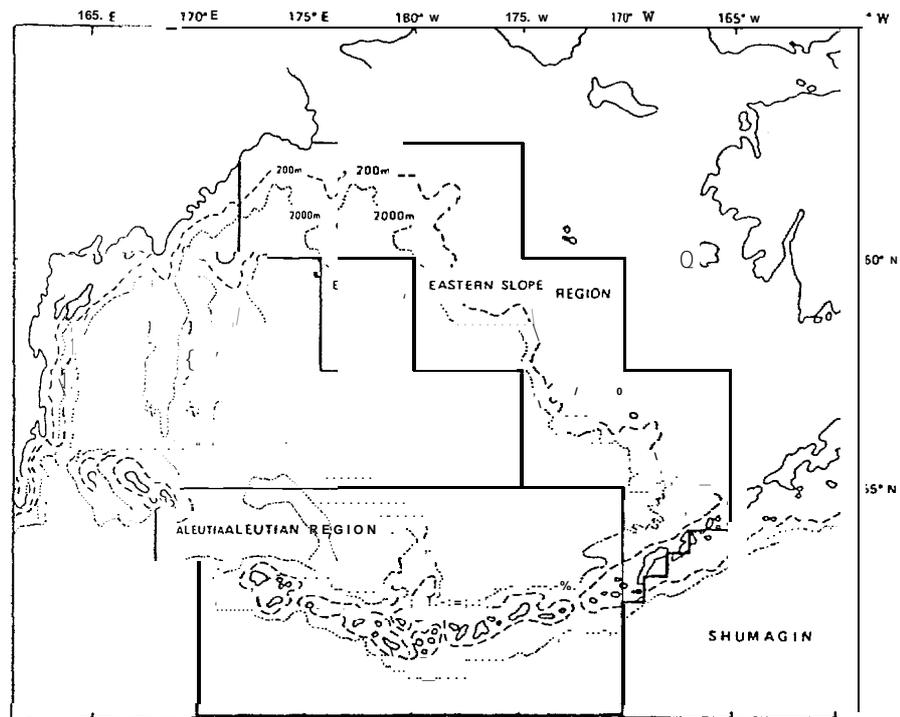


Figure 4. The two main stock areas of Pacific ocean perch in the Bering Sea (Ito 1983a).

B E R I N G **SEA** Finfish and Shellfish

Miscellaneous rockfish

EY = 14,100 metric tons

This category includes all species of Sebastes (except S. alutus, the Pacific ocean perch) and Sebastolobus. Although historically they have been lumped together in commercial catch statistics, since 1977 rockfish species have been identified in commercial catches by U.S. observers. The Aleutian region has accounted for the largest portion of Bering Sea rockfish during 1977-81, with a range of 17,700-20,000 metric tons. The next most productive area was Bering Sea INPFC Area 2 (see Figure 1), where total catches ranged from 1,300 metric tons (1977) to 13,100 metric tons (1981). Rockfish biomass estimates based on a 1981 U.S.-Japan cooperative trawl survey were 12,600 metric tons in the eastern Bering Sea. Higher estimates (e.g., Ikeda 1979) have been questioned as to the accuracy and validity of underlying assumptions in extrapolating from limited data. The rather conservative EY for the eastern Bering Sea is based on a population 28% smaller than that in the Aleutians, where the EY is estimated at 11,000 metric tons (Ito 1983b; 1984 b).

Atka mackerel

EY = 25,500 metric tons

Atka mackerel, Pleurogrammus monopterygius, are found throughout the Aleutian and Komandorskiye Islands, westward to the east coast of Kamchatka, northward to the Pribilof Islands, and eastward throughout the Gulf of Alaska to southeastern Alaska. Most of the commercial catches come from the Aleutian region, which produced more than 76% of the total Bering Sea landings from 1978-1981. Atka mackerel is apparently the third most abundant species in the Aleutian Islands region after the walleye pollock and the grenadiers (rattails, family Macrouridae; Ronholt 1983b). Total landings increased throughout the 1970's, peaked at 24,250 metric tons in 1978, and then declined to 19,700 metric tons in 1981. Landings have generally increased in the eastern Bering Sea and declined in the Aleutian region. Maximum sustainable yield, based on a joint U.S.-Japanese trawl survey in 1979-1981, ranges from 22,666 to 28,300 metric tons. As there is no evidence to suggest that the population is radically changing, the recommended EY is based on the midpoint of the range of maximum sustainable yield (Ronholt 1984).

ICHTHYOPLANKTON

In terms of biomass and density in the nearshore region of the southeastern Bering Sea, the dominant marine fishes are Pacific herring (Clupea harengue pallasii), capelin (Mallotus villosus), and yellowfin sole (Limanda aspera).

Pacific herring

Herring abundance in the eastern Bering Sea appears to have increased since 1978 in all major coastal areas. Estimates of spawning biomass were 187,210-334,723 metric tons in 1978 and 258,079-637,583 metric tons in 1979. Bristol Bay contains the largest assemblage of spawning herring in the entire state of Alaska. Most spawning in northern Bristol Bay occurs from the

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intertidal zone down to a depth of 5m. Herring shed their adhesive eggs primarily onto rocks covered with Fucus, though almost any substrate is used under conditions of dense spawning. The fish also spawn in shallow bays, beaches, or slough areas where Zostera, rye-grass (Elymus sp.) roots, and sedges (Carex sp.) are exposed at low tide (Kinnetic Laboratories Inc. 1984).

Capelin

During 1976 capelin were the most geographically widespread forage fish species found in the eastern Bering Sea and ranked second in abundance (next to herring) at onshore stations between Ugashik Bay and Unimak Island. Capelin spawn along clean, fine gravel beaches (Kinnetic Laboratories Inc. 1984).

Yellowfin sole

Yellowfin sole dominates the biomass of marine fishes within the nearshore zone of the North Aleutian Basin. Current biomass estimates are two to four million metric tons. This species is the dominant flatfish on the eastern Bering Sea shelf and ranks second in biomass only to walleye pollock. Yellowfin sole are found on the outer continental shelf and slope at water depths greater than 100m during the winter and early spring. They migrate to inner shelf waters (15-75m) where spawning occurs in summer. Young remain in the shallow nearshore nursery areas for several years before dispersing to more offshore waters at 3-5 years of age (Kinnetic Laboratories Inc. 1984a).

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Table 3. Rank order of abundance in each of the southeastern Bering Sea subareas of five most abundant fish taken in 1980 demersal survey (data from Umeda and Bakkala 1983).

Rank	Species	Ranking in sampling subareas (see <u>Figure 2</u>)						
		inner continental shelf			outer continental shelf			
		1	4N	4S	2	3N	3s	5
1	Yellowfin sole	1	1	1	3	20	7	e
2	Walleye pollock	2	2	2	1	1	1	6
3	Pacific cod	3	3	4	2	2	2	4
4	Alaska plaice	5	4	3	16	18	13	5
5	Rock sole	4	12	5	h	20	6	20

BEAUFORT S E A

FINFISH AND SHELLFISH

The fish fauna of the Alaskan Beaufort Sea is typical of the "Inuit fauna," a fairly distinct assemblage of marine and **anadromous** species extending from the central Canadian Arctic westward through Chukchi Sea and Siberian coastal waters. A total of 37 fish species has been collected in nearshore brackish waters, and 40 in offshore marine waters (Craig 1984 b).

Southern Beaufort Sea drainages support nine major species of **anadromous** fishes: Arctic char, broad and humpback whitefish, least and Arctic cisco, chum and pink salmon, rainbow smelt, and inconnu (Table 1). **Anadromous** species generally spawn in the larger North Slope rivers in the fall and winter (Figure 1). Their young remain in fresh water for a variable period, depending upon species, after which time they migrate to coastal waters. The immature fish enter coastal streams each summer to feed, and return to streams and lakes in fall to **overwinter** and, when mature, to spawn (Craig 1984 b).

The two largest drainages, the Mackenzie and Colville Rivers, support the largest numbers of **anadromous** species. Each river has spawning populations of Arctic char, **ciscoes**, **whitefishes**, and smelt, and each supports relatively small salmon runs. Between these two large rivers is a 400km distance over which almost no **anadromous** stocks (with the exception of Arctic char) are found. Streams in this region have been classified as "mountain streams" since they originate in the Brooks Range. These streams commonly contain perennial springs which are associated with the spawning grounds of Arctic char (Craig 1984b).

Streams to the west of the Colville River (Figure 3) differ importantly from mountain streams in both habitat and fish fauna. These streams drain the tundra-covered slopes of the Arctic foothills and coastal plain **physiographic** provinces and support spawning populations of whitefishes, ciscoes, and small runs of salmon (Table 1).

The occurrence of a band of turbid, brackish (10-25 ppt), and relatively warm (5-10°C) water is characteristic of the Beaufort Sea coastline during the open-water season (July-September). This estuarine band varies in depth and width with freshwater input from spring runoff, nearshore currents, prevailing winds, and topographical features (Craig 1984 b). Seasonal use of these nearshore waters by **anadromous** and marine species varies. The **anadromous** species - char, whitefishes, **ciscoes**, salmon, and smelt - begin arriving at the start of spring ice breakup (5-20 June), disperse along the coastline in this brackish water band, and return by fall to their respective river drainages to spawn or overwinter.

According to Craig (1984 b), the summer coastal division of **anadromous** species depends upon three factors: "1) proximity of freshwater sources of **anadromous** fish stocks; 2) migration timing; and 3) daily responses to temperature and salinity fluctuations in the nearshore environment." Some

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anadromous species (e.g., whitefishes and least **ciscoes**) do **not** disperse far from their rivers of origin, whereas others (e.g., Arctic **ciscoes** and **at** least some Arctic char; Figure 4) disperse widely from their natal streams and are common along the entire **Beaufort** Sea coastline.

Marine species - Arctic cod, **sculpins**, and sailfishes - increase in abundance in nearshore waters as the summer progresses and salinities increase. They do not undertake the appreciable parallel migrations hugging the coastline as the **anadromous** species do. During a year-round study of coastal fishes in Alaskan Beaufort Sea waters, **Haldorson** and **Craig** (1984) found the summer nearshore fish community dominated by three **anadromous** species: Arctic cisco (*Coregonus autumnalis*), least cisco (*C. sardinella*), and Arctic char (*Salvelinus alpinus*); and two marine species: Arctic cod (*Boreogadus saida*), and fourhorn sculpin (*Myoxocephalus quadricornis*). In the winter months, however, rainbow smelt (*Osmerus mordua dentex*) dominated fish fauna in nearshore waters, accounting for 56% of the 2803 fish caught under the ice in gill and fyke nets. Next in order of abundance were fourhorn sculpin (37%) and Arctic cod (5%). The authors caution, however, that the low numbers of Arctic cod may reflect their relative invulnerability to gill nets rather than actual low densities. In the winter **pre-spawning** assemblages of rainbow smelt were found in Harrison Bay, near the mouth of the **Colville** River. Gill-net catch per unit effort (CPUE) peaked around February (22.2 fish-net-da-l), declined in March (16.1 fish net-da-l), and reached a low of 5.8 fish·net-da-l in May (**Haldorson** and **Craig** 1984).

Arctic cod predominated at most winter sampling stations, especially in marine waters. Only cod (N = 65) were caught at the 175-km offshore sampling site, and at **Narwhal Island** (N = 9). Cod were 78 of 97 fish (80% of catch) at the Boulder Patch in **Stefansson** Sound, 9 of 16 fish (56% of catch) at **Flaxman** Island, and 26 of 70 fish (37% of catch) at **Simpson** Lagoon. In contrast, there were no cod in the 150 fish taken in the brackish waters near **Colville** Delta and only a few (0.4% of 2612 fish) were captured at **Thetis** Island, in the nearshore waters near the **Colville** River (**Craig** 1981; **Craig et al.** 1982).

As opposed to the nearshore brackish waters with their characteristic lower salinities and higher water temperatures during the ice-free months, marine coastal waters are cold (-1 to 3°C) and saline (27-32ppt) and are identified by water mass characteristics rather than by distance from shore. These marine coastal waters **OCCUPY** the entire water column in more offshore areas and may extend into nearshore bays and lagoons as a subsurface wedge of water under a lens of brackish water. **Forty** fish species have been collected in offshore waters, although sampling effort has been low. A trawl survey of waters 40-400m deep near the southern edge of the ice pack resulted in low fish catches. An average of eighteen fish of four species were caught in the 35 five to ten-minute trawls. All-told, seventeen fish species were collected and three, Arctic cod, Canadian eelpout (*Lycodes polaris*), and twohorn sculpin (*Icelus bicornis*), accounted for 65% of the catch (**Frost** and **Lowry** 1983).

BEAU Finfish and Shellfish

As previously reported for the CHKS OCS Planning Area, the Arctic cod is considered a key species in the Arctic Ocean ecosystem because of its abundance, widespread distribution, and importance in the diets of marine mammals, birds, and other fishes (Quast 1974; Craig et al. 1982; Craig 1984b).

BEAU Finfish and Shellfish.

Table 1. Principal stocks of anadromous fishes in Beaufort Sea drainages. Minor and incidental catches have been excluded (from Craig 1984 b).

Drainage	Arctic char	Broad whitefish	Humpback whitefish	Least cisco	Arctic-Bering cisco	Chum salmon	Pink salmon	Rainbow smelt
U.S. - Canada Border								
Clarence	X							
Kongakut	X							
Egaksrak	X							
Aichilik	X							
Hulahula	X							
Canning	X							
Shaviovik	X							
Sagavanirktok	X	X						
Prudhoe Bay								
Colville Fish	X	X	X	X	X	X	X	X
Ikpikpuk		X	X	X	X		X	
Oumalik			X	X				
Jopagoruk		X	X	X				
Meade		X	X	X				
Irraru		X	X	X				

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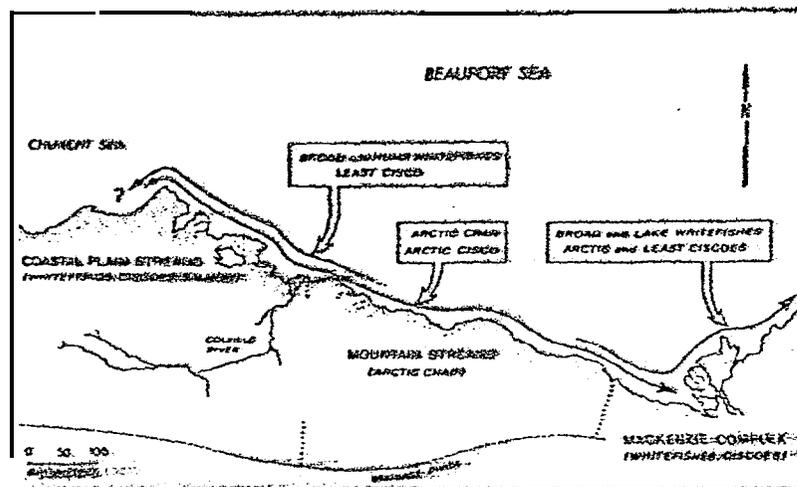


Figure 3. Sources of freshwater, and coastal dispersal patterns of anadromous fishes found along the Beaufort Sea coastline (from Craig 1984 b).

BEAU Finfish and Shellfish

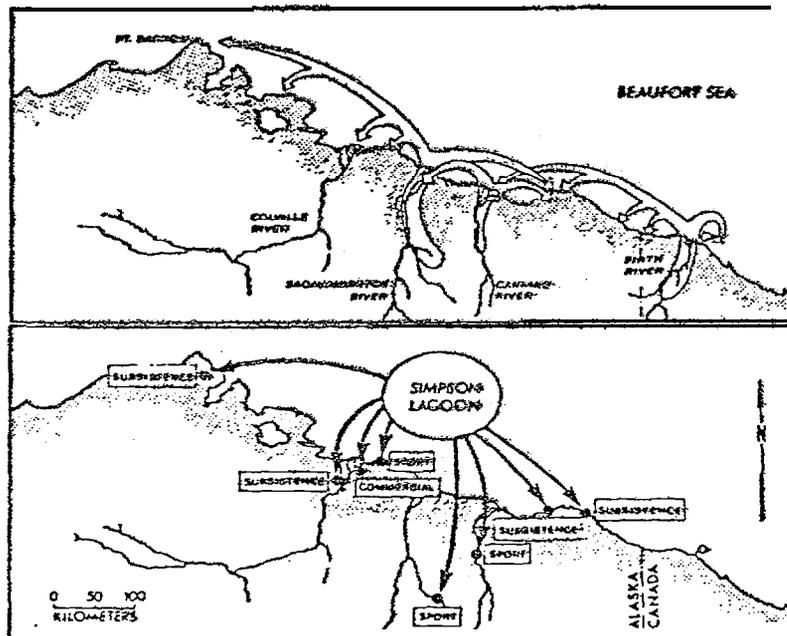


Figure 4. Summer dispersal patterns of Arctic char (top) and recapture location of char tagged in Simpson Lagoon (from Craig 1984 b).

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Annual management report, 1979. Norton Sound,
Port Clarence, Kotzebue.

AK Dept. Fish & Game, Div. Commercial Fisheries.
Anchorage, AK.

ALASKA : NORB

Finfish: Fisheries management; Commercial landings;
Subsistence landings; NE Bering Sea; Salmon.

Tables are provided of commercial and subsistence salmon harvests
by year and species in Norton Basin, 1961-1979, subsistence
harvests of inconnu, whitefish, and Arctic char, and commercial
harvests of inconnu and Arctic char.

ALTON, M. S.. 1981.

Gulf of Alaska bottomfish and shellfish resources.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-10. 51pp.

ALASKA : GOAK KODK SHUM

Finfish: Demersal fish; Density; CPUE;

Fisheries management; Gulf of Alaska; Commercial landings.

Shellfish: Annual catches; Commercial landings;

Life histories; Fisheries management; Gulf of Alaska.

A good review of U.S. and foreign fisheries in the Gulf of
Alaska. Life histories of pandalid shrimp, crabs, and
bottomfish are summarized and bathymetric distributions of
bottomfish and shellfish are examined.

ALTON, M. S. & R. B. Deriso. 1983.

Condition of the Gulf of Alaska pollock resource.

In: G. Stauffer (ed.).

Condition of Groundfish Resources of the Gulf of Alaska
Region as Assessed in 1983.

NOAA, NMFS, NWAFC.

NWAFC Processed Rept. 84-02. 19pp.

ALASKA : GOAK KODK SHUM

Finfish: Walleye pollock; Stock assessment;

Fisheries management; Trawl surveys; Gulf of Alaska.

Report assesses condition of Gulf of Alaska pollock resource.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ANDERSON, E. D.. 1983.

Status of the northwest Atlantic mackerel stock - 1983.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. No. 83-140. 44pp.

ATLANTIC: NATL
Finfish: Fish; Marine resources.

This report details fisheries information available on northwest Atlantic populations of Atlantic mackerel. It provides a detailed projection of short-term future stocks.

ANDERSON, E. D. (cd). 1984.

Status of the fishery resources off the Northeastern United States for 1983.

NOAA, NMFS, NEFC.

NOAA Tech. Mere. NMFS-F/NEC-29. 132pp.

ATLANTIC: NATL
Finfish: Stock assessment; Groundfish;
Pelagic fisheries; Commercial landings; Marine resources.

BAKKALA, R. G.. 1983.

Other flatfish.

pp.97 - 110 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL
Finfish: Flatfish; Stock assessment;
Commercial catches; Recruitment; Abundance, biomass.

Report summarizes commercial catches, relative abundance, biomass estimates, age composition, year-class strength, MSY, and EY for a complex of flatfish consisting primarily of flatfish sole, rock sole, and Alaska plaice, and small numbers of rex sole, Dover sole, starry flounder, longhead dab, and butter sole.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BAKKALA, R. G. . 1984a.

Other flat fish.

pp.77 - 89 In: R. G. Bakkala & L. L. Low (ed.).

Condition of groundfish resources of the Eastern Bering Sea and Aleutian Islands Region in 1983.

NOAA, NMFS. NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Fisheries management;

Trawl surveys; Biomass, MSY, EY; Commercial catches, cpue.

BAKKALA, R. G.. 1984b.

Pacific cod of the eastern Bering Sea.

pp.157 - 179 In:

Symposium on Determining Effective Effort and Calculating Yield in Groundfish Fisheries, and on Pacific Cod Biology and Population Dynamics.

International North Pacific Fish Commission. Bull.No. 42.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Pacific cod; Eastern Bering Sea;

Life history; Stock assessment; Commercial catches.

Excellent review of the life history, distribution, abundance, and commercial exploitation of Pacific cod in the eastern Bering Sea.

BAKKALA, R. G. & L.- L. Low (eds.). 1983.

Condition of groundfish resources of the eastern Bering Sea and Aleutian Islands region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42.187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: CPUE by species; Groundfish;

Biomass, MSY; Resource assessment; Eastern Bering Sea.

Report assesses condition of groundfish and squid stocks in the eastern Bering Sea and Aleutian Islands region through 1982. Assessments are based on species-by-species analysis of data collected from commercial fishery and research vessel surveys. Estimates of MSY and EY are calculated.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BAKKALA , R . G . & T. M. Sample. 1983.

Greenland turbot and arrowtooth flounder.

pp.81 - 95 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering
Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Greenland turbot; Arrowtooth flounder;

Stock assessment; Commercial catches; Eastern Bering Sea.

Report summarizes commercial catches, relative abundance, biomass estimates, age composition, and estimates MSY and EY for Greenland turbot and arrowtooth flounder stocks in the eastern Bering Sea and Aleutian Islands region.

BAKKALA, R. G. & J. J. Traynor. 1984.

Walleye pollock.

pp.1 - 20 In: R. G. Bakkala & L. -L. Low (cd.).

Condition of groundfish resources of the eastern Bering Sea
and Aleutian Islands Region in 1983.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Walleye pollock;

Fisheries management; Trawl surveys; Commercial catches, cpue.

Report assesses condition of walleye pollock in eastern Bering Sea and Aleutian Islands region through 1983. Biomass and EY estimates are given.

1131 E3LIECBGRAPIHI% - Finfish, Shellfish, & Ichthyoplankton

BAKKALA, R. G. & V. G. Wespestad. 1983a.

Walleye pollock.

pp.1 - 27 In: R. G. Bakkala & L.- L. Low (ed.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Walleye pollock; Biomass estimates;
Catch statistics.

Data about commercial catches, and age and size composition of walleye pollock in the eastern Bering Sea and Aleutian Islands region are reported. Estimates of relative abundance, biomass, MSY and EY are made using both cohort analysis and research vessel surveys.

BAKKALA, R. G. & V. G. Wespestad. 1983b.

Yellowfin sole.

pp.51 - 79 In: R. G. Bakkala & L. -L. Low (ed.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Yellowfin sole; Commercial catches;
Abundance projections; Stock assessment; Eastern Bering Sea.

Data from commercial catches are summarized, biomass from both research vessel surveys and cohort analysis is estimated, stock abundance for 1982-1989 is projected, and MSY and EY are estimated for yellowfin sole in the eastern Bering Sea and Aleutian Islands region.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BAKKALA, R. G. & V. G. Wespestad. 1984a.

Pacific cod.

pp.21 - 36 In: R. G. Bakkala & L. -L. Low (ed.).

Condition of groundfish resources of the eastern Bering Sea and Aleutian Islands Region in 1983.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; groundfish;

Pacific cod; fisheries management; trawl surveys.

Report assesses condition of Pacific cod in eastern Bering Sea and Aleutian Islands region through 1983. Projected biomass and acceptable biological catch given through 1986.

BAKKALA, R. G. & V. G. Wespestad. 1984b.

Yellowfin sole.

pp.37 - 60 In: R. G. Bakkala & L. -L. Low (ed.).

Condition of groundfish resources of the eastern Bering Sea and Aleutian Islands Region in 1984.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; yellowfin sole;

fisheries management; trawl surveys; biomass, MSY, EY.

Report assesses condition of yellowfin sole in eastern Bering Sea through 1983. Abundance projections given through 1989.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BAKKALA , R . G . , V. G. Wespestad,
& H. H. Zenger, Jr. 1983.

Pacific cod.

pp.29 - 50 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering
Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Pacific cod; Stock assessment;

Commercial catches; Abundance projection; Eastern Bering Sea.

Report summarizes commercial catches, assesses relative abundance,
estimates biomass, analyzes age and size composition, and projects
abundance of Pacific cod in the eastern Bering Sea and Aleutian
Islands region. Estimates of MSY and EY of the stock are also
made.

BARANS, C. A. 1982.

Methods for assessing reef fish stocks.

pp.105 - 123 In: G. R. Huntsman, W. R. Nicholson,
& W. W. Fox, Jr. (eds.).

The Biological Basis for Reef Fishery Management.

NOAA, NMFS, SEFC.

NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL

Finfish: Reef fish communities; Sampling problems;

Stock assessment; Abundance estimates.

Paper discusses several factors to be considered prior to
selection of an assessment technique and points out advantages
and disadvantages of several methods of obtaining estimates of
reef fish abundance.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BERRIEN, P. L.. 1978.

Eggs and larvae of 'Scomber scombrus' and 'Scomber japonicus' in continental shelf waters between Massachusetts and Florida.
Fish. Bull., U. S. 76 :p.95 - 116.

ATLANTIC: MATL
Ichthyoplankton: Abundance; Distribution;
 'Scomber scombrus'; 'Scomber japonicus' .

Collections of eggs and larvae of 'Scomber scombrus' and 'S. japonicus' taken during R.V. Dolphin cruises are summarized. 'S. scombrus' eggs were collected on the shoreward half of the continental shelf waters north of Cape Hatteras during spring and summer and 'S. japonicus' eggs were collected in the seaward half of shelf waters south of Cape Hatteras during the winter and spring.

BLACKBURN, J. E., K. Anderson,
c. I. Hamilton, & S. J. Starr. 1983.
Pelagic and demersal fish assessment in the lower Cook Inlet estuary system. Final report.
pp.107 - 382 In: NOAA, National Ocean Service (cd.).
Environmental Assessment of the Alaskan Continental Shelf.
Final reports of principal investigators. Vol.17.
Biological Studies. Prepared for MMS. Washington, D.C.

ALASKA : CKIN
Finfish: Groundfish; Nearshore communities;
 Growth; Food habits; Abundance & distribution.
Shellfish: Commercial harvest; Oil spills;
 Nearshore community; Food habits.

Report summarizes distributions, relative abundance, seasonal movements and food habits of the nearshore community of fishes and commercial invertebrates in lower Cook Inlet. Report reviews available information on the fisheries of Cook Inlet and Shelikof Strait and describes the potential for impact of oil related activities on marine resources of the area.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BLANKENBECKLER, D. & R. Larson. 1982.

Pacific herring spawning ground research in southeast Alaska, 1978, 1979 and 1980.
AK Dept. Fish & Game. Anchorage, AK.
Rept. No. 69. 51pp.

ALASKA : GOAK
Finfish: Herring; Spawning.

BLUNT, C. E., JR.. 1980.

Atlas of California coastal marine resources.
CA Dept. Fish & Game, CA Resources Agency.
134pp.

PACIFIC: NCAL
Finfish: Marine resources.

Geological survey maps depicting useful information about kelp, vertebrate, and invertebrate locations are presented. Maps show locations of refuges, estuaries, wilderness areas, ASBS's, etc. Nearshore and intertidal rocky, boulder, & sandy beaches are indicated.

BUREAU OF LAND MANAGEMENT. 1977.

Proposed OCS Sale 48ES, Southern California Offshore Area. Visual No.5: Sport Fishing.
Visual No.6: Commercial Fisheries.

PACIFIC: SCAL
Finfish: Maps; Commercial landings;
Pelagic fishes; Tuna; Abundance categories.

Map plots average commercial fisheries catch for period 1971-1975 in three categories of abundance, each referenced to standard blocks of 2304 ha. Annual catches are based on CA Dept. Fish Game statistics.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

BURNETT, J. & S. H. Clark. 1983.

Status of witch flounder in the Gulf of Maine- 1983.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. No. 83-36. 31pp.

ATLANTIC: NATL

Finfish: Witch flounder; Marine Resources.

This report provides catch and stock assessment for witch flounder populations in the Gulf of Maine. This is a valuable report because witch flounder was not specifically managed before 1977 and since then has been unregulated (and therefore only partially monitored).

BURNS, J. J., L. Javela,

W. Drury, & L. Thorsteinson. 1982.

II. Interdisciplinary Session B and C: Impacts of potential OCS development on the eastern and western Norton Sound regions.

pp.8 - 40 In: S. T. Zimmerman (ed.).

The Norton Sound Environment and Possible Consequences of Oil and Gas Development. Proceedings of a synthesis meeting, Anchorage, AK, October 28-30, 1980.

NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA : NORB

Finfish: Fishery resources; Physical habitat;

Oil pollution assessment NE Bering Sea; Distribution; Abundance.

Benthos: Physical habitat; Oil pollution assessment;

NE Bering Sea.

Report summarizes major oceanographic and transport - related events in Norton Sound, discusses distribution of benthos, shellfish, demersal and pelagic fishes, salmon, birds, and marine mammals, assesses effects of oil spills on shoreline areas, and the biota, and considers four specific oil spill scenarios.

BI0E1410 GRAPHY - Finfish, Shellfish, & Ichthyoplankton

CHESTER, A. J., G. R. Huntsman,
P. A. Tester, & C. S. Manooch, III.. 1984.
South Atlantic Bight reef fish communities as
represented in hook-and-line catches.
Mar. Sci. 34 :p.267 - 279.

ATLANTIC: SATL
GULF OF MEXICO
Finfish: Reef fish communities; Catch;
Species distribution; Headboat fishery.

Analysis of catch records from the recreational headboat fishery and research cruises revealed five reef communities off the coasts of North and South Carolina. A complex, inner shelf community dominated by black sea bass and porgies occurred in waters less than 30 meters throughout the study area. A deep shelf-break community consisting of groupers and blueline tilefish was found at depths greater than 100 meters. Three communities were defined in the mid shelf (30 - 100 meters) regions.

CHITTENDEN, M. E., JR. & J. D. Mc Eachran. 1976.
Composition, ecology, and dynamics of demersal fish
communities on the northwestern Gulf of Mexico continental
shelf, with a similar synopsis for the entire Gulf.
Texas A&M Univ. Sea Grant College. College Station, TX.
TAMU-SG-76-208 . 104pp.

GULF OF MEXICO: EGUL
Finfish: Demersal fish communities Population dynamics;
Faunal assemblages.
Shellfish: White shrimp grounds; Brown shrimp grounds;
Faunal assemblages.

Overall and seasonal compositions of demersal fish communities associated with white shrimp grounds and brown shrimp grounds on the continental shelf of the northwestern Gulf of Mexico are described for fifteen species each of which made up more than three percent of the catch on a given shrimp ground.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

CLARK, S. H. & B. E. Brown. 1977.

Changes in biomass of finfishes and squids from the Gulf of Maine to Cape Hatteras, 1963-74, as determined from research vessel survey data.

Fish. Bull. 75 :p.1 - 22.

ATLANTIC: NATL MATL

Ichthyoplankton: Spawning stock estimates; Cod;

Haddock; Commercial landings; Bottom trawl surveys.

Trends in finfish and squid biomass from 1963 - 1974 for ICNAF Subarea 5 and Statistical Area 6 are reviewed. Landings for major commercial groundfish species and pelagic species are examined. Analyses for four strata sets (southern New England, Middle Atlantic, Georges Bank, and Gulf of Maine) include adjusted and unadjusted biomass estimates, stock size estimates, and maximum sustainable yields.

CLARK, S. H., L. O' Brian,
& R. K. Mayo. 1981.

Yellowtail flounder stock status - 1981.

NOAA, NMFS, Woods Hole, MA. Lab. Ref. Dec. No.81-10.

47pp. (not seen by investigator.)

ATLANTIC: NATL

Finfish: Stock assessment; Catch data;

'Limanda ferriginea'.

Ichthyoplankton: Yellowtail flounder; Commercial landings;

Spawning; Stock assessment.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

COLGATE, W. A. & D. M. Hicks. 1983.

Investigations of life history and fishery for
Tanner crab ('Chionoecetes bairdi') in the Westward
Region, Alaska, 1982.
AK Dept. Fish & Game.
Technical Data Rept. No. 96. 115pp.

ALASKA : KODK SHUM
Shellfish: Tanner crab; Stock assessment;
 Commercial fishery; Catch, CPUE; Black Mat Syndrome.

Surveys to assess Tanner crab populations *were* conducted in the
North Mainland fishing of the Kodiak Management District and in the
Chignik Management District. Report analyzes stock size, *age*
composition and commercial fishing effort.

COLIN, P. L.. 1982.

Aspects of the spawning of western Atlantic reef
fishes.
pp.69 - 78 In: G. R. Huntsman, W. R. Nicholson,
& W. W. Fox, Jr. (eds.).
The Biological Basis for Reef Fish Management.
Proceedings of a workshop held Oct 7-10, 1980, St. Thomas,
Virgin Islands.
NOAA, NMFS. NMFS-SEFC-80 .

ATLANTIC: SATL
Finfish: Reef fishes; Spawning;
 Behav: or; Study techniques; Spawning hab: tat.

COLTON, J. B., JR., W. G. Smith,
A. W. Kendall, Jr., P. L. Berrien, & M. P. Fahay. 1979.
Principal spawning areas and times of marine fishes,
Cape Sable to Cape Hatteras.
Fish. Bull., U. S. 76 :p.911 - 915.

ATLANTIC: NATL MATL
Ichthyoplankton: Spawning; Yellowtail flounder;
 Stock estimates.

This paper looks at principle spawning areas and times for 35
species of marine species from 14 families. Area surveyed was from
Cape Sable, Nova Scotia to Cape Hatteras including the Middle
Atlantic Bight and Gulf of Maine.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

CONTINENTAL SHELF ASSOCIATES, INC. 1983.

Jupiter, FL. .
North Carolina fisheries and environmental data
search and synthesis study. Prepared for MMS, New York
OCS Office. Final report, 21 June 1983.
Rept. No. 14-12-001-29189. 18pp.

ATLANTIC: SATL
Finfish: Recreational fisheries; North Carolina.
Shellfish

CRAIG, P. C.. 1981.

Fisheries. Chapt.1.4 In: S. R. Johnson (cd.).
Ecological Characterization of the Sale 71 Environment.
pp.31 - 38 In: D. W. Norton & W. M. Sackinger (cd.).
Beaufort Sea (Sale 71) Synthesis Report. Proc. synthesis
meeting, Chena Hot Springs, AK, April 21-23, 1981.
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA : BEAU
Finfish: Colville River estuary; Relative abundance; CPUE;
Offshore fishes; Nearshore fishes; Distribution.

The limited data on distribution and relative abundance of fishes
in the Colville River Delta-Harrison Bay Region, Simpson Lagoon,
and nearshore areas, and in the offshore waters of the western
Beaufort Sea are summarized.

CRAIG, P. C.. 1984a.

Fish Resources. Chapt. 6.
pp.117 - 131 In: J. C. Truett (cd.).
The Barrow Arch Environment and Possible Consequences of
Offshore Oil and Gas Development. PROC. synthesis meeting
Girdwood, Ak, 30 Oct - 1 Nov 1983.
NOAA/MMS, OCSEAP. Juneau, AK.

ALASKA : CHKS
Finfish: Nearshore fishes; Subsistence fisheries;
Physical oceanography; Offshore fishes; Distribution; Abundance.

Available data on fish fauna of northeastern Chukchi Sea are
summarized in relation to the three major aquatic environments
and discusses the subsistence fisheries of the region.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

CRAIG, P. C.. 1984b.

Fish use of coastal waters of the Alaskan
Beaufort Sea: A review.
Trans. Am. Fish. Soc. 113 :p.265 - 282.

ALASKA : BEAU
Finfish: Anadromous fish; Beaufort Sea;
 Seasonal distribution; Trophic relations; Harvests.

Article reviews available information on the Beaufort Sea fish
fauna, discusses utilization of freshwater and brackish nearshore
habitats and describes seasonal distributions and movements.
Commercial and subsistence harvests are briefly discussed
as are habitat alterations associated with oil drilling
activities. An excellent review.

CRAIG, P. C., W. B. Griffiths,
L. Haldorson, & H. Mc Elderry. 1982.
Ecological studies of arctic cod ('Boreogadus
saida') in Beaufort Sea coastal waters, Alaska.
Can. J. Fish. Aquat. Sci. 39 :p.395 - 406.

ALASKA : BEAU
Finfish: Colville River estuary; Distribution; Abundance;
 Feeding ecology; Life history strategy; Arctic cod.

Life history, ecology, feeding habits, spawning, distribution
and relative abundance of Arctic cod in the coastal waters of
the Beaufort Sea are examined. This is an excellent paper on
a key species in the Arctic food chain.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

CURL, H. E. & C. .4. Manen. 1982.
Shellfish resources. Chapt.7.
pp. 141 - 159 In: M. J. Hameedi (cd.).
The St. George Basin Environment and Possible Consequences
of Planned Offshore Oil and Gas Development. Proceedings
of a synthesis meeting, Anchorage, AK. April 28-30, 1981.
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA : SGBA
Shellfish: Distribution; Abundance;
 Life Histories; Commercial fisheries; Petroleum pollution.

Report summarizes available information on distribution and
life histories of commercially valuable shellfish in St. George
Basin and attempts to assess their vulnerability to oil spills.

DAMES & MOORE . Anchorage, Ak. 1983.
A preliminary assessment of composition and food
webs for demersal fish assemblages in several shallow
subtidal habitats in Lower Cook Inlet, Alaska.
pp.383 - 450 In: NOAA, National Ocean Service. (cd.).
Environmental Assessment of the Alaskan Continental Shelf.
Final Reports of the Principal Investigators. Vol.17
Biological studies. Prepared for MMS. Washington, D.C.

ALASKA : SGBA
Finfish: Feeding ecology; Demersal fish assemblages;
 Food webs; Subtidal habitats; Cook Inlet.

Report estimates relative abundance of dominant species of fish
assemblages that inhabit nearshore waters of Lower Cook Inlet.
Data on temporal variations, seasonal differences, trophic
interactions, food habits, and spawning or reproductive
behavior of conspicuous fish species are included.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

DARCY, G. H. & E. J. Gutherz. 1984.

Abundance and density of demersal fishes on the west Florida shelf, January, 1978.

Bull. Mar. Sci. 34 :p.81 - 105.

GULF OF MEXICO: EGUL

Finfish: Distribution; Density;

CPUE; Standing stock estimates Demersal fish.

A 12.2 meter semi-balloon shrimp trawl was towed at 338 stations.

Total catch and fish caught per 20'x 20' grid zones are reported.

DARNELL, R. M., R. E. Defenbaugh,

& D. Moore. 1983.

Northwestern Gulf Shelf Bio-Atlas. A study of the distribution of demersal fishes and penaeid shrimp of soft bottoms of the continental shelf from the Rio Grande to the Mississippi River Delta.

MMS, Gulf of Mexico OCS. Open File Rept. 82-04. 438pp.

GULF OF MEXICO: CGUL

Finfish: Demersal fish.

Shellfish: Penaeid shrimp.

DEUEL, D. G. 1973.

1970 Saltwater angling survey.

NOAA, NMFS. Washington, D.C.

Current Fisheries Statistics NO.6200. 54pp.

ATLANTIC: NATL

Finfish: Fishing Surveys; Recreational Fisheries;

Catch Effort.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

DUNN, J. R., A. W. Kendall, Jr. ,

& R. D. Bates. 1984.

Distribution and abundance patterns of eggs and larvae of walleye pollock, 'Theragra chalcogramma' in the western Gulf of Alaska.

NOAA, NMFS, NWAFC.

NWAFC Processed Report 84-10. 66pp.

ALASKA : KODK

Ichthyoplankton: Distribution; Abundance.

EBER, L. E. & N. Wiley. 1982.

Revised update and retrieval system for the CALCOFI Oceanographic Data File.

NOAA, NMFS.

NOAA Tech. Mere. NOAA-TM-NMFS-SWFC-24. 69pp.

PACIFIC: SCAL CCAL NCAL

Finfish: CALCOFI Data Base.

FAHAY, M. P. 1974.

Occurrence of silver hake, 'Merluccius bilinearis', eggs and larvae along the Middle Atlantic Continental Shelf during 1966.

Fish. Bull., U. S. 72 :p.813 - 834.

ATLANTIC: NATL MATL

Finfish: Distribution; Abundance;

'Merluccius bilinearis'

Ichthyoplankton: R.V. Dolphin cruises; Silver hake;

Early life history; Distribution.

Collections made during R.V. Dolphin cruises throughout 1966 were examined for silver hake eggs and larvae. The seasonal and spatial distribution and range of eggs and larvae is reported and location of spawning area is suggested. Evidence is presented that there is size-related diel vertical migration by postlarvae.

FEDER, H. M. & S. C. Jewett. 1979.

Environmental assessment of the Alaskan continental shelf. vol. 4. Biological studies: Distribution and abundance of some epibenthic invertebrates of the Northeastern Gulf of Alaska with notes on the feeding biology of selected species.

Prepared for NOAA, OCSEAP. Boulder, CO.

Univ. AK Inst. Mar Science. Fairbanks, AK. 811pp.

ALASKA : GOAK

Shellfish: Invertebrates; Trawl survey;
Distribution; Abundance.

FOGARTY, M. J. & S. H. Clark. 1983.

Status of Atlantic herring resources in the Gulf of Maine region - 1983.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. #83-46. 33pp.

ATLANTIC: NATL

Ichthyoplankton: Fish; Marine resources;
Atlantic herring.

This report provides data and projections on Atlantic herring fisheries. Despite the title, it addresses assessments based on a Cape Hatteras to Nova Scotia area.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

FORRESTER, C. R., R. G. Bakkala,
K. Okada, & J. E. Smith. 1983.
Groundfish, shrimp, and herring fisheries in the
Bering Sea and northeast Pacific - historical catch
statistics, 1971-1976.
International North Pacific Fisheries Commission.
Bull. No. 41. 100pp.

ALASKA : NABA SGBA NAVB SMHL
Finfish: Groundfish; Herring;
 Catch statistics; Bering Sea, NE Pacific; Catch effort.
Shellfish: Shrimp; Catch statistics;
 Catch effort; Bering Sea, NE Pacific.

Commercial catch statistics for groundfish, shrimp, and herring
fisheries in the Bering Sea and northeast Pacific for the
years 1971-1976 are reported by major species and country.
Tables of fishing effort, gear, catch, and country for
principal groundfish species are presented for each area.

FROST, K. J. & L. F. Lowry. 1983.
Demersal fishes and invertebrates trawled in the
northeastern Chukchi and western Beaufort Seas, 1976-77.
NOAA, NMFS. Seattle, WA.
NOAA Tech. Rept. NMFS-SSRF-764. 22pp.

ALASKA : BEAU CHKS
Finfish: Demersal fishes; Trawl survey;
 Abundance; Life histories; Distribution.
Benthos: Epifauna.

Data on size, reproductive condition, and food habits are presented
for several species of finfish and shellfish.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

GROSSLEIN, M. D. & T. R. Azarovitz. 1982.

Fish Distribution.

NY Sea Grant Institute, MESA NY Bight Project, Albany
MESA NY Bight Atlas Monograph 15. 182pp.

ATLANTIC: NATL MATL

Finfish: Bottom trawl surveys; Sampling problems;
Commercial landings; Shellfish abundance.

Distribution and seasonal movements, population size, fisheries, reproduction, growth, life span, feeding interrelationships, and sensitivity to pollutants and natural environmental factors is summarized for 43 important species of Middle Atlantic Bight finfish and shellfish. Annual composite distribution, occurrence and spawning data for each of 18 species of fish larvae is presented. Summaries of seasonal occurrence of 27 species of fish larvae is also included.

GUTHERZ, E. J.. 1982.

Reef fish assessment - snapper/grouper stocks in the western North Atlantic south of Cape Hatteras, NC. pp.124 - 141 In: G. R. Huntsman, W. R. Nicholson, & W. W. Fox, Jr. (eds.).
The Biological Basis for Reef Fishery Management.
NOAA, NMFS, SEFC.
NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL

Finfish: Reef fish communities; Gear comparisons;
Snapper-grouper stocks; Finfish surveys; Habitat evaluation.

HALDORSON, L. & P. Craig. 1984.

Life history and ecology of a Pacific-Arctic population of rainbow smelt in coastal waters of the Beaufort Sea.
Trans. Am. Fish. Soc. 113. :p.33 - 38.

ALASKA : BEAU

Finfish: Rainbow smelt; Seasonal distribution;
Life history; Age; Growth; Beaufort Sea.

Paper examines life history, ecology, seasonal distributions, food habits, and spawning of rainbow smelt collected from coastal waters of the Alaskan Beaufort Sea.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

HAYNES, E.. 1983.

Distribution and abundance of larvae of king crab
'Paralithodes comtschatica' and pandalid shrimp in the
Kachemak Bay area, Alaska, 1972 and 1976.

NOAA, NMFS.

Rept. No. NMFS SSRF-765. 64pp.

ALASKA : CKIN

Shellfish: Decapods.

HERRICK, S. F., JR.. 1981.

Status report: Eastern tropical Pacific
yellowfin tuna.

pp.143 - 162 In: NMFS (cd.).

Status Reports on World Tuna and Billfish Stocks.

NOAA, NMFS, SWFC.

NOAA Tech. Mere. NMFS-SWFC-15. 302pp.

PACIFIC: SCAL

Finfish: Yellowfin tuna; Eastern tropical Pacific;
Production models; Fishery management; Stock assessment.

Report evaluates status of eastern Pacific yellowfin tuna using
general production models and age-structured models.

HETTLER, A. J. & A. J. Chester. 1982.

The relationship of winter temperature and spring
landings of pink shrimp, 'Penaeus duorarum', in
North Carolina.

Fish. Bull. 80 :p.761 - 768.

ATLANTIC: SATL

Shellfish: Winter temperature; Shrimp landings;
North Carolina; Pink shrimp.

The effect of winter temperatures on the amount of pink shrimp
landings the following spring is established in this study.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

HILDEBRAND, H. H.. 1955.

A study of the fauna of the pink shrimp ('*Penaeus duororum*' Burkenroad) grounds in the western Gulf of Mexico.

Publ. Inst. Mar. Sci. Univ. Tx 4 :p.170 - 232.

GULF OF MEXICO: EGUL

Finfish: Pink shrimp grounds; Fish communities;
Gulf of Mexico.

HOUDE, E. D.. 1977a.

Abundance and potential yield of the round herring, '*Etrumeusteres*', and aspects of its early life history in the eastern Gulf of Mexico.

Fish. Bull. 75 :p.61 - 89.

GULF OF MEXICO: EGUL

Finfish: Ichthyoplankton; Biomass;
Potential Yield.

HOUDE, E. D.. 1977b.

Abundance and potential yield of the Atlantic thread herring, '*Opisthonemus oglinum*' and aspects of its early life history in the eastern Gulf of Mexico.

Fish. Bull. 75 :p.493 - 512.

GULF OF MEXICO: EGUL

Finfish: Ichthyoplankton; Biomass;
Potential Yield.

HOUDE, E. D.. 1977c.

Abundance and potential yield of the scaled sardine, '*Harregula jaguana*' and aspects of its early life history in the eastern Gulf of Mexico.

Fish. Bull. 75 :p.613 - 628.

GULF OF MEXICO

Finfish: Ichthyoplankton; Biomass;
Potential Yield.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

HOUDE, E. D.. 1982.

Kinds, distributions and abundances of sea bass larvae (Pisces: Serranidae) from the eastern Gulf of Mexico.

Bull. Mar. Sci. 32 :p.511 - 522.

GULF OF MEXICO: EGUL

Finfish: Ichthyoplankton; Abundance; Distribution.

HOUDE, E. D. & S. A. Berkeley. 1982.

Gulf of Mexico "Coastal Herrings" summary document prepared for Southeast Fisheries Center Stock Assessment Workshop, Miami, FL, 3-7 Aug 1982.

UMCEES Ref. No. 82-102 CBL. 17pp.

GULF OF MEXICO: EGUL

Finfish: Ichthyoplankton; Biomass; Potential Yield.

HOUDE, E. D. & N. Chitty. 1976.

Seasonal abundance and distribution of zooplankton, fish eggs, and fish larvae in the eastern Gulf of Mexico, 1972 - 1974.

NOAA, NMFS. Seattle, WA.

NOAA Tech. Rept. NMFS SSRF-701. 18pp.

GULF OF MEXICO: EGUL

Finfish: Zooplankton; Ichthyoplankton; Abundance; Distribution.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

HOUDE, E. D., S. A. Berkeley,

J. J. Klinovsky, & C. E. Dowd. 1976.

Ichthyoplankton survey data report. Summary of egg and larvae data used to determine abundance of clupeid fishes in the eastern Gulf of Mexico.

Univ. of Miami Sea Grant. Tech. Bull. No. 32. 193pp.

GULF OF MEXICO: EGUL

Finfish: Zooplankton; Ichthyoplankton surveys;

Clupeid fishes; Abundance & distribution Standing stocks.

Bulletin summarizes catches of fish eggs and larvae from seven cruises during 1971-74 to the eastern Gulf of Mexico. Tabular data on clupeid eggs and larval densities, zooplankton volumes, surface temperatures and salinities and station positions are included. Spawning areas are delineated and briefly discussed. Report summarizes standing stock estimates of clupeids in the eastern Gulf and techniques used to obtain them.

HUNTSMAN, G. R. & C. S. Manooch, III. 1978.

Coastal pelagic and reef fishes in the South Atlantic Bight.

pp.97 - 106 In: H. Clepper (ed.).

Marine Recreational Fisheries. 3.

Sport Fishing Institute. Washington, D.C.

ATLANTIC: SATL

Finfish: Coastal pelagic fishes; Offshore reef community;

Recreational fishing; So. Atlantic Bight; Resource management.

Chapter briefly describes the recreational fisheries for coastal pelagic fishes and offshore reef fishes in the South Atlantic Bight. The authors describe physical environment in which these fisheries occur, the pertinent aspects of the biology of the fish species and communities supporting recreational fisheries, and most importantly suggest the constraints that the environment and the biological characteristics of the target species place on use of these fisheries. This is an excellent review.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

HUNTSMAN, G. R., C. S. Manooch, II I.,

& C. B. Grimes. 1983.

Yield per recruit models of some reef fishes

in the South Atlantic Bight.

Fish. Bull. 81 :p.679 - 695.

ATLANTIC: SATL

Finfish: Reef fishes; YPR models;

South Atlantic Bight; Fishery management; Fishing mortality.

Yield per recruit models for red porgy, vermilion snapper, white grunt, red snapper, black sea bass, gag, scamp, snowy grouper, and speckled hind are devised in this paper. These models are used in an examination of the management of reef fishes in the South Atlantic Bight. A preliminary estimate of maximum sustainable yield is calculated from annual total recreational and commercial catches.

IKEDA, I.. 1979.

Rockfish biomass in the eastern Bering Sea slope and Aleutian area.

Far Seas Fish. Res. Lab., Jap. Fish. Agency, Shimizu, Japan
12pp. (not seen by author).

ALASKA : NABA SGBA NAVB SMHL

Finfish: Biomass estimates; Rockfish;

Aleutian area; Trawl survey; Eastern Bering Sea.

IPHC. 1978.

Annual Report, 1978.

International Pacific Halibut Commission. Seattle, WA.

ALASKA : GOAK KODK SHUM

Finfish: Halibut; Commercial landings;

Stock assessment; Fisheries regulations; Catch, CPUE.

Report summarizes regulations for the Pacific halibut fishery in 1978, assesses stock condition, and summarizes commercial landings by port and country, and catch, CPUE, and effort by statistical area, region, regulatory area and country.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

IPHC. 1979.

Annual Report, 1979.

International Pacific Halibut Commission. Seattle, WA.

ALASKA : GOAK KODK SHUM

Finfish: Halibut; Commercial landings;

Stock assessment; Fisheries regulations; Catch, CPUE.

Regulations for the Pacific halibut fishery in 1979 are summarized, stock condition is assessed, and commercial landings by port and country, catch, CPUE, and effort by statistical area, region, regulatory area and country are summarized.

IPHC. 1980.

Annual Report, 1980.

International Pacific Halibut Commission. Seattle, WA.

ALASKA : GOAK KODK SHUM

Finfish: Halibut; Commercial landings;

Stock assessment; Fisheries regulations; Catch; CPUE.

Report summarizes regulations for Pacific halibut fishery in 1980, assesses stock condition, and summarizes commercial landings by port and country, and catch, CPUE and effort by statistical area, region, regulatory area and country.

ITO , D. H.. 1982.

A cohort analysis of Pacific ocean perch stocks from the Gulf of Alaska and Bering Sea regions.

NOAA, NMFS, NWAFC.

NWAFC Processed Rept. 82-15. 157pp.

ALASKA : GOAK KODK SHUM NABA

SGBA NAVB SMHL

Finfish: Pacific ocean perch; Stock assessment;

Cohort analysis; Recruitment.

Comprehensive paper reviews and summarizes pertinent background information on the biology and fishery of Pacific ocean perch in the Gulf of Alaska and eastern Bering Sea. Cohort analysis is applied to catch at age data from Gulf of Alaska and Bering Sea stocks to obtain absolute abundance estimates.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ITO, D. H.. 1983a.

Pacific ocean perch.

pp. 127 - 150 In: R. S. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Pacific ocean perch; Commercial catches;

Stock assessment; Aleutian stock; Eastern Bering Sea stock.

Report analyzes relative abundance and commercial catches, and estimates biomass, MSY, and EY for the eastern Bering Sea slope stock and the Aleutians region stock of Pacific ocean perch.

ITO, D. H.. 1983b.

Other rockfish.

pp. 151 - 162 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42.

ALASKA : NABA SGBA NAVB SMHL

Finfish: 'Sebastes', 'Sebastolobus' Rockfish;

Commercial catches; Stock assessment; Eastern Bering Sea.

Commercial catches are analyzed and biomass, MSY, and EY are estimated for all species of 'Sebastes' and 'Sebastolobus' other than Pacific ocean perch, 'Sebastes alutus' from the eastern Bering Sea and Aleutian Islands region.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ITO, D. H.. 1984a.

Pacific ocean perch.

pp. 109 - 142 In: R. G. Bakkala & L. -L. Low (ed.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1983.

NOAA Tech. Mere. NMFS F / NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Pacific ocean perch;

fisheries management; trawl surveys; commercial catches, cpue.

Report assesses condition of Pacific ocean perch in eastern Bering Sea and Aleutian Region through 1983. Pacific ocean perch catches from Japanese vessels are analyzed from 1968-1982. Population abundance, biomass estimates, MSY and EY are given for eastern Bering Sea and Aleutian regions.

ITO, D. H.. 1984b.

Other rockfish.

pp. 143 - 155 In: R. G. Bakkala & L. -L. Low (ed.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1983.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-52. 204pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; 'Sebastes';

'Sebastes'; Fisheries management; Commercial catches.

Report assesses condition of rockfish species except Pacific ocean perch in eastern Bering Sea and Aleutian region through 1982. Analysis of commercial catches in both foreign and joint venture fisheries from 1977-1982 given. Biomass estimates, MSY and EY for both eastern Bering Sea and Aleutian regions.

R11E31L10 GRAPHY - Finfish, Shellfish, & Ichthyoplankton

JUDY, M. H. & R. M. Lewis. 1983.

Distribution of eggs and larvae of Atlantic menhaden '*Brevoortia tyrannus*', along the Atlantic coast of the United States.

NOAA, NMFS.

NOAA Tech. Rept. NMFS-SSRF-774. 23pp.

ATLANTIC: MATL

Ichthyoplankton: MARMAP; Atlantic menhaden;
Early life history.

Collections were made monthly from Cape Canaveral, FL to Martha's Vineyard, MA. for Atlantic menhaden eggs and larvae. Seasonal distribution and abundance & distribution along the coast and in the water column were determined and compared with the seasonal distribution of adults.

KENDALL, A. W., JR. 1972.

Description of black sea bass, '*Centropristis striata*' (Linnaeus), larvae and their occurrences north of Cape Lookout, North Carolina, in 1966.

Fish. Bull. 70 :p.1243 - 1260.

ATLANTIC: MATL

Ichthyoplankton: Larval Description; Distribution;
Black sea bass; Early life history; R.V. Dolphin cruises.

Black sea bass ('*Centropristis striata*') larvae collected on R.V. Dolphin cruises are described. Vertical distribution and temperature and salinity of surface waters where black sea bass occur were reported.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

KENDALL, A. W., JR. & J. W. Re'intjes. 1975.

Geographic and hydrographic distribution of Atlantic menhaden eggs and larvae along the middle Atlantic coast from R. V. Dolphin cruises, 1965-66.
Fish. Bull. u. s. 73 :p.317 - 335.

ATLANTIC: MATL

Ichthyoplankton: Distribution; Menhaden Larvae;
Early life history; R.V. Dolphin cruises.

Seasonal spawning and larval distribution of Atlantic menhaden are reported. Total larval catches (densities and abundances) by station are summarized for collections made during R.V. Dolphin cruises. Data includes monthly occurrences, temperature and salinity ranges, and depth and diel distributions. Part of the observed annual variation in year classes was attributed to cold-related mortality of larvae entering MATL estuaries in late fall.

KENDALL, A. W., JR. & L. A. Walford. 1979.

Sources and distribution of bluefish 'Pomatomus saltatrix', larvae and juveniles off the east coast of the United States.
Fish. Bull. 77 :p.213 - 227.

ATLANTIC: MATL

Ichthyoplankton: Spawning; Larval Distribution;
Bluefish; Surveys; Early life history.

Spawning, seasonal migrations and early life history information is presented for bluefish ('Pomatomus saltatrix'). The spatial and temporal distributions of two main spawning concentrations (possibly two different populations) are reported. Movement of juveniles from the two main spawning groups is tracked shoreward, seaward and along the continental shelf and in to the estuaries of the Middle Atlantic Bight. A small resident population of the South Atlantic Bight is also suggested.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

KIM, S. & A. W. Kendall, Jr. . 1983.

The number and distribution of walleye pollock
eggs and larvae in southeastern Bering Sea.

NOAA, NMFS, NWAFC.

Rept. No. 83-22. 35pp.

ALASKA : SGBA

Ichthyoplankton

LANGE, A. M. T.. 1983a.

Status of the long-finned squid, 'Loligo pealei',
stocks off the northeastern USA.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. 83-38. 27pp.

ATLANTIC: NATL

Finfish: Fish; Shellfish;

Marine Resources; Squid.

This report updates fishery characteristics of long-finned squid
populations in middle Atlantic and New England waters. It
provides brief but valuable discussions of management and biology.

LANGE, A. M. T.. 1983b.

Status of the short-finned squid ('Illex
illecebrosus') off the northeastern USA.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. 83-30. 14pp.

ATLANTIC: NATL

Finfish: Fish; Shellfish;

Marine resources; Squid.

This report updates fishery characteristics of short-finned
squid stocks of western Atlantic waters. Valuable for brief
discussions of biomass, biology, and management.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

LEAK, J. C.. 1981.

Distribution and abundance of carangid fish larvae
in the eastern Gulf of Mexico, 1971 - 1974.
Biol. Oceanog. 1 :p.1 - 27.

GULF OF MEXICO: EGUL

Finfish: Ichthyoplankton; Early Life History;
Larval Standing Stocks; Spawning.

Standing stock of larvae and adults and potential sustainable yield
are reported for several species of carangid fish from the eastern
Gulf of Mexico.

MACINTOSH, R. A.. 1980.

The snail resources of the eastern Bering Sea
and its fishery.
Mar. Fish. Rev. May, 1980 :p.15 - 20.

ALASKA : NORB

Shellfish: Distribution; Catch Rates;
Commercial harvests; 'Neptunea heros'; Eastern Bering Sea.

Distribution and catch of various snail species which are
commercially harvested by the Japanese snail fishery in the
eastern Bering Sea are reviewed.

MANOOCH, C. S. III., L. E. Abbas,

& J. L. Ross. 1981.

A biological and economic analysis of the North
Carolina charter boat fishery.
Mar. Fish. Rev. 43 :p.1 - 11.

ATLANTIC: SATL

Finfish: Charter boat fishery; Catch & cpue;
Economic analysis; Bottom fishing; Trolling.

North Carolina's 135 charter boats were surveyed during the
1978 fishing season to obtain information on catch, effort and
profitability of the fishery. Species catch and CPUE data
are presented by month, geographical area, type of fishing
trip, and are compared with results obtained in a similar
study in 1977. Economic and related descriptive data are
presented by number of trips and district. This is a thorough
though dated regional study.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

MARKLE, D. G.. 1975.

Young witch flounder on the slope off Virginia.
J. Fish. Res. Bd. Canada 32 :p.1447 - 1450.

ATLANTIC: NATL
Finfish: Witch flounder; Spawning.

MAYO, R. K., U. B. Dozier,
& S. H. Clark. 1983.

An assessment of the redfish, 'Sebastes fasciatus'
stock in the Gulf of Maine - Georges Bank region.
NOAA, NMFS, NEFC. Woods Hole, MA.
Woods Hole Lab. Ref. Dec. No. 83-22. 39pp.

ATLANTIC: NATL
Finfish: Redfish; Marine resources.

This report updates fishery statistics for northwest Atlantic
stocks of redfish. It provides valuable population and harvest
projections.

MC BRIDE, M. M. & S. H. Clark. 1983.

Assessment status of yellowtail flounder ('Limanda
ferruginea') stocks off the northeast United States, 1983.
NOAA, NMFS, NEFC. Woods Hole, MA.
Woods Hole Lab. Ref. Dec. No. 83-32. 50pp.

ATLANTIC: NATL
Finfish: Fish; Marine resources;
Yellowtail flounder.

This report assesses yellowtail flounder stocks from New England
to the middle Atlantic. It lacks a detailed projection of
future fishery characteristics.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

MC FARLAND, W. N.. 1982.

Recruitment patterns in tropical reef fishes.
pp.83 - 91 In: G. R. Huntsman, W. R. Nicholson,
& W. W. Fox, Jr. (eds.).
The Biological Basis for Reef Fish Management.
Proceedings of a workshop held Oct 7-10, 1980, St. Thomas,
Virgin Islands.
NOAA, NMFS, SEFC.
NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL

Finfish: Reef fishes; Recruitment;
Larval dispersion; Reproduction; Spawning patterns.

Paper reviews reproductive and recruitment processes in reef fishes.

MC KENNEY, T. W. 1983.

Distribution and abundance of 'Merluccius albidus'
larvae in shelf waters off the northeastern
United States, 1977-1981.
ICES, Demersal Fish Committee.
ICES C. M. 1983/G:48. 15pp.

ATLANTIC: NATL

Ichthyoplankton: Distribution; Abundance;
MARMAP ; 'Merluccius albidus'; Spawning.

Density (number per 10 square meters] and abundance estimates for offshore hake larvae in 4 subareas of western North Atlantic, from Cape Hatteras, North Carolina, to Gulf of Maine, 1977-81 are reported.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

MENZEL, D. W. & F. F. Wright. 1982.

Interdisciplinary Session A: Impacts of potential
OCS development on the Yukon Delta Region.
pp.1 - 7 In: S. T. Zimmerman (ed.).
The Norton Sound Environment and Possible Consequences of
Oil and Gas Development. Proceedings of a synthesis
meeting, Anchorage, Ak, Oct. 28-30, 1980.
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA : NORB
Finfish: Yukon Delta; Coastal habitat;
Natural resources; Oil spill pollution; Physical transport.
Benthos

The Yukon Delta and its natural resources are briefly described
and unique factors which may influence the movement of spilled
oil in the Bering Sea and Norton Sound near the Yukon Delta are
discussed.

MINERALS MANAGEMENT SERVICE. 1983c.

Final environmental impact statement for OCS
sale No. 73. Proposed 1983 outer continental shelf
oil and gas lease sale offshore central California.
MMS, Pacific OCS Office. Los Angeles, CA. 2 Vols.+ Graphics.

PACIFIC: SCAL
Finfish: Anadromous fish streams; Commercial fisheries.

Biological (eg. harbor seal pupping sites), chemical, and
physical factors that influence the marine community near Santa
Barbara Channel, north to Morro Bay are detailed.

MINERALS MANAGEMENT SERVICE. 1984c.

Proposed Southern California Lease Offering
(Feb, 1984). Commercial Fisheries. Graphic No.6.

PACIFIC: SCAL CCAL
Finfish: Maps; Commercial landings;
Average catches; Abundance categories; Fisheries production.
Coastal Habitats

Commercial fisheries landings averaged for the years 1970-
1974 are summarized in eight abundance categories referenced
to 278 km squared blocks.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

MOORE, D., H. A. Brusher,
& L. Trent. 1970.

Relative abundance, seasonal distribution, and
species composition of demersal fishes off Louisiana and
Texas, 1962-1964.

Contrib. Mar. Sci. 15 :p.45 - 70.

GULF OF MEXICO: CGUL WGUL

ATLANTIC: SATL

Finfish: Trawl surveys; Species composition.

Demersal fishes were collected monthly with a shrimp trawl at
33 to 60 stations in 7-110 meters between the Mississippi River
Delta and the US-Mexico border from 1962-1964. Tabular results
of catches per hour of demersal fishes by year, station, depth,
transect, and month. Relative abundance mapped by season.
Data base presented so thorough in coverage that it formed
basis of Northwestern Gulf Shelf Bio-Atlas (Darnell et al. 1983).

MORSE, W. 1982.

Spawning stock biomass estimates of sand lance,
'Ammodytes' sp. , off northeastern United States, determined
from MARMAP plankton surveys, 1974-1980.

International Council Exploration Sea.

ICES C. M. 1982/G:59. 11pp.

ATLANTIC: MATL

Ichthyoplankton: Density; Mortality;

MARMAP; Sand lance larvae; Abundance.

Spawning stock estimates of sand lance from Georges Bank to Cape
Hatteras 1974-1980 are calculated based on egg survival rates.
Mean larval catch and larval mortality for 1974-1980 are reported.
Estimated larval mortality rates are related to length of larvae.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

MUSIC, J. L., JR. . 1979.

Assessment of Georgia's shrimp and crab resources.
GA Dept. of Natural Resources. Brunswick, GA.
Contrib. Series No. 30. 75pp.

ATLANTIC: SATL

Shellfish: Life histories; Spawning;
Resource assessment; Penaeid shrimp; Blue crabs.

This report summarizes seasonal abundance, geographical distribution, spawning activity, and other life history information for the commercially important shrimp species (especially white shrimp) and blue crabs.

MUSIC, J. L., JR. & J. M. Pafford. 1984.

Population dynamics and life history aspects of major marine sportfishes in Georgia's coastal waters.
GA Dept. Natural Resources. Brunswick, GA.
Contrib. Series No. 38, March, 1984. 382pp.

ATLANTIC: SATL

Finfish: Population dynamics; Life history;
Spawning; Sportfishes; Sciaenids.

Report is a comprehensive review of life history and ecology including seasonal movements and migration patterns, age distribution, growth rates, food preferences, feeding habits, spawning times and locations, fecundity, etc. of eleven species of Georgia's inshore marine recreational sportfishes: spotted seatrout, weakfish, red drum, black drum, southern flounder, summer flounder, sheepshead, Atlantic croaker, spot, southern kingfish, and gulf kingfish.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NARITA, R. E.. 1983.

Sablefish.

pp. 111 - 125 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1982.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Sablefish; Commercial catches;

Stock assessment; Eastern Bering Sea; Trawl surveys.

Commercial catches, estimates of abundance from research trawl surveys, and estimates of MSY and EY for sablefish in the eastern Bering Sea and Aleutian Islands region are summarized.

NARITA, R. E.. 1984.

Sablefish.

pp. 91 - 107 In: R. G. Bakkala & L. -L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Islands Region in 1983.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Sablefish;

Fisheries management; Trawl surveys; Commercial catches, CPUE.

Report assesses condition of sablefish in eastern Bering Sea and Aleutian region through 1983. Sablefish catches of foreign fisheries were analyzed for 1964-1982. Population abundance, biomass estimates, MSY, and EY given for eastern Bering Sea and Aleutian regions.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NATIONAL MARINE FISHERIES SERVICE. 1981a.

Preliminary fishery statistics of the United States 1980.

NOAA, National Fisheries Statistics Program.
Washington, D.C.

ATLANTIC: MATL SATL

Finfish: Commercial catches; Economic value;
Catches by states.

Shellfish: Commercial catches; Economic value;
Catches by states.

NATIONAL MARINE FISHERIES SERVICE. 1981b.

Status reports on world tuna and billfish stocks.

NOAA, NMFS.

NOAA Tech. Mere. NOAA-TM-NMFS-SWFC-15. 302pp.

PACIFIC: SCAL

Finfish: Tuna stocks; Billfish stocks;

Fisheries management; Commercial fisheries; Stock assessment.

Report summarizes results of the NMFS, Southwest Fisheries Center's Second Workshop on Tuna and Billfish Research, Dec 15-17, 1980, San Clemente, CA. Included are sixteen status reports on 25 different species or stocks of Atlantic, Pacific, and Indian Ocean tuna and billfish which include most of the world's tuna stocks of direct and indirect interest or importance to U.S. commercial and recreational fisheries, the canning industry and consumers. Publication will probably be updated in 1985 or 1986.

NATIONAL MARINE FISHERIES SERVICE. 1982.

Preliminary fishery statistics of the United States 1981.

NOAA, National Fisheries Statistics Program.
Washington, D.C.

ATLANTIC: MATL SATL

Finfish: Commercial catches; Economic value;
Catches by state.

Shellfish: Commercial catches; Economic value;
Catches by state.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NATIONAL MARINE FISHERIES SERVICE. 1983a.

Preliminary fishery statistics of the United States 1982.

NOAA, National Fisheries Statistics Program.
Washington, D.C.

ATLANTIC: MATL SATL

GULF OF MEXICO: WGUL

PACIFIC: ORWA

Finfish: Commercial catches; Economic value;
Catches by states.

Shellfish: Commercial catches; Economic value;
Catches by states.

NATIONAL MARINE FISHERIES SERVICE. 1983b.

Status of the fishery resources off the northeastern United States for 1982.

NOAA, NMFS, NEFC, Resource Assessment Division.

NOAA Tech. Mere. NMFS-F/NEC-22. 128pp.

ATLANTIC: NATL MATL

Finfish: Stock assessment; Abundance;
Catch; Fisheries management; Shellfish.

Benthos

The general status of major finfish and shellfish resources off northeast coast of the U.S. from Cape Hatteras to Nova Scotia through 1982 are summarized. Stock assessment, commercial and recreational catch data, and management information is provided for 24 fish species or species groups and 8 shellfish species.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NATIONAL MARINE FISHERIES SERVICE. 1984a.

Marine recreational fishery statistics survey,
Atlantic and Gulf Coasts, 1979 (revised) - 1980.
NOAA, NMFS, Nat'l Fishery Statistics Prog. Washington, D.C.
Fishery Statistics No. 8322.

ATLANTIC: NATL MATL SATL
GULF OF MEXICO: CGUL
Finfish: Recreational fisheries; Statistical surveys;
Total catch; CPUE; Fishing method.

Recreational fisheries statistics (estimated total catch and estimated weights) are tabulated by species for each subregion, North Atlantic, Middle Atlantic, South Atlantic, and Gulf of Mexico. Estimated numbers of fish caught by species or species group are presented for each state. For each region estimated number of fish caught by species are presented by mode of fishing and area of fishing.

NATIONAL MARINE FISHERIES SERVICE. 1984b.

Preliminary fishery statistics of the United States 1983.
NOAA, National Fisheries Statistics Program.
Washington, D.C.

ATLANTIC: NATL MATL SATL
GULF OF MEXICO: CGUL WGUL
PACIFIC: ORWA
Finfish: Commercial catches; Economic value;
Catches by states.
Shellfish: Commercial catches; Economic value;
Catches by states.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NATIONAL MARINE FISHERIES SERVICE. 1984c.

Fishery statistics of the United States, 1977.

NOAA, NMFS, Nat'l Fishery Statistics Prog. Washington, D.C.
Statistical Digest No. 71. 407pp.

PACIFIC: ORWA

Finfish: Commercial statistics; Market value;
Fishing gear; Fishing vessels; Catch by species.

Shellfish: Commercial catch data; Market value;
Fishing gear; Fishing vessels; Catch by species.

Tabular summaries of commercial catches of finfish and shellfish are presented by species, by regions (Atlantic, Gulf of Mexico, and Pacific) and by individual states for 1977. Numbers of fishing vessels and fishermen and economic value of catches (dockside value by species) and processed products are also presented.

NATIONAL MARINE FISHERIES SERVICE. 1985a.

Marine recreational fishery statistics survey,
Atlantic and Gulf Coasts, 1981-1982.

NOAA, NMFS, National Fishery Statistics Program. 215pp.
Current Fishery Statistics No. 8324.

ATLANTIC: NATL MATL SATL

GULF OF MEXICO: CGUL

Finfish: Recreational catches; Biomass;
Fishery surveys; Catch and effort; Modes of fishing.

NATIONAL MARINE FISHERIES SERVICE. 1985b.

Preliminary fishery statistics of the United
States 1984.

NOAA, National Fishery Statistics Program.
Washington, D.C.

ATLANTIC: NATL MATL SATL

GULF OF MEXICO: CGUL WGUL

PACIFIC: ORWA

Finfish: Commercial catches; Economic value;
Catches by states.

Shellfish

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION. 1982a.
NOAA comments on the draft environmental impact
statement for Mid-Atlantic OCS lease sale no. 76.
NOAA, Strategic Assessment Branch, Envir. Assess. Division

ATLANTIC: MATL
Finfish: Marine resources; Finfish resource analysis;
ORCA data base.
Shellfish: Resource analysis.

Comments contained within this report are divided into two sections. The first section is an analysis of tract deletion alternatives and the second section comments on marine mammals, fisheries, and natural hazards information presented in the draft environmental impact statement.

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION. 1983c.
Gray's Reef National Marine Sanctuary
Management Plan.
NOAA, Office of Ocean & Coastal Resources Management.
Washington, D.C. 107PP.

ATLANTIC: SATL
Finfish: National sanctuary; Live bottom reef;
Management plan; Resource studies; Recreational programs.

This management plan focuses on the special resource features of Gray's Reef National Marine Sanctuary, a large expanse of live bottom reef located 17.5 nautical miles east of Sapelo Island, GA.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

NORTON, D. W. & W. M. Sackinger (eds.). 1981.

Beaufort Sea (sale 71) synthesis report. Proceedings of a synthesis meeting, Chena Hot Springs, Alaska, April 21-23, 1981.

NOAA/BLM, OCSEAP. Juneau, AK.
178pp.

ALASKA : CHKS BEAU
Finfish: Natural resources; Habitat evaluation;
 Pollution impacts; Offshore drilling; Physical oceanography.
Benthos: Natural resources; Habitat evaluation.

Section 1 of this synthesis report summarizes available data on the flora and fauna of the Sale 71 environment, discusses winds, tides, and storm surges in the region, and discusses the physical characteristics of the area. Section 2 considers interdisciplinary process analyses, impact prediction, and issue decisions.

OGDEN, J. C.. 1982.

Fisheries management and the structure of coral reef fish communities.
pp.147 - 159 In: G. R. Huntsman, W. R. Nicholson,
& W. W. Fox, Jr. (eds.).

The Biological Basis for Reef Fish Management.
Proceedings of a workshop held Ott 7-10, 1980, St. Thomas,
Virgin Islands.
NOAA, NMFS, SEFC.
NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL
Finfish: Reef fish communities; Fisheries management;
 Trophic relationships; Disturbance response; Recruitment.

Paper reviews the status of knowledge (or lack of it) of community structure of coral reef fishes and its relevance to fisheries management problems. Excellent review of complexities of coral reef fish communities.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

OVERHOLTZ, W. J., S. H. Clark,
& D. Y. White. 1983.

A review of the status of the Georges Bank and
Gulf of Maine haddock stocks for 1983.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. No. 83-23. 31pp.

ATLANTIC: NATL

Finfish: Haddock; Marine Resources.

This report is an up-to-date stock assessment of New England
haddock populations. Particularly valuable for its long and
short term outlook predictions.

OWEN, D. L. & J. E. Blackburn. 1983.

Bottomfish catch and trawl data from an otter trawl
survey in N. Shelikof Strait, Chignik area and Chiniak
Gully, Alaska, July and August 1981.

AK Dept. Fish & Game.

Tech. Data Rept. No. 82. 68pp.

ALASKA : KODK SHUM

Finfish: Trawl survey; Stock assessment;
Bottomfishes; Catch, CPUE; Distribution.

Shellfish: Tanner crab; Stock assessment;
Distribution; Catch, CPUE.

Report assesses abundance, distribution, and size-age-sex
composition of bottomfish stocks in northern Shelikof Strait,
Chignik and in Chiniak Gully. Distribution and CPUE for major
taxa are tabulated and presented in figures.

OWEN, D. L. & J. E. Blackburn. 1984.

Tanner crab and bottom trawl survey of Northern
Shelikof Strait, Uyak and Uganik Bays, and the Chignik area,
July and August 1982.

AK Dept. Fish & Game. Tech. Data Rept. No. 113. 42pp.

ALASKA : SHUM

Finfish: Trawl survey; Groundfish assessment;

Pacific cod; Shelikof Strait; Distribution & abundance.

Report assesses, abundance, distribution, and size-age-sex
composition of bottomfish stocks in Northern Shelikof Strait,
Uyak and Uganik Bays, and the Chignik area.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

PACIFIC MARINE FISHERIES COMM. . 1984.

36th Annual Report of the Pacific Marine Fisheries
Commission for the year 1983.

PACIFIC

Finfish: Commercial fisheries; Landings by species;
Fishing gears; Recreational fisheries; Fisheries management.
Shellfish: Landings by species; Fishing gear;
Fisheries management; Commercial fisheries.

Report gives tabular landings of commercial and recreational catches (where applicable) by species and by state for the Pacific Coast. Market conditions and numbers of fishermen and types of gear employed are also discussed.

PARKER, R. O., JR., D. R. Colby,
& T. D. Willis. 1983.

Estimated amount of reef habitat on a portion of the
U.S. south Atlantic and Gulf of Mexico continental shelf.
Bull. Mar. Sci. 33 :p.935 - 940.

ATLANTIC: SATL

GULF OF MEXICO: EGUL

Finfish: Reef fish communities; Bottom surveys;
Mapping; South Atlantic shelf; Gulf of Mexico shelf.
Benthos: Reefs; Bottom surveys;
South Atlantic shelf; Gulf of Mexico shelf; Mapping.

The amount of reef habitats (rock, coral, and sponge) on the continental shelf of the South Atlantic and Gulf coasts was estimated from observations made with submersible television. Percentage of all reef habitat and reef habitat greater than one meter are given for the following strata: Cape Hatteras - Cape Fear, Cape Fear - Cape Canerval, Key West - Pensacola, Pensacola - Pass Cavallo, and Pass Cavallo - Rio Grande.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

PARKS, N. B. & H. Zenger. 1979.

Trawl survey of demersal fish and shellfish resources in Prince William Sound, Alaska: Spring, 1978. NOAA, NMFS, NWAFC. NWAFC Processed Rept. 79-2. 49pp.

ALASKA : GOAK
Finfish: Demersal fish; Resource assessment; Prince William Sound; CPUE; Biomass; Distribution; Abundance.
Shellfish: Resource assessment; Distribution; Abundance; Biomass.

Report assesses distribution, abundance, and biological condition of demersal fish and shellfish resources within Prince William Sound based on a trawl survey during April-May, 1978. Feasibility and impact of a trawl fishery in the Sound are evaluated.

PEREYRA, W. T., J. E. Reeves,
& R. G. Bakkala. 1976.

Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975. NOAA, NMFS, NWAFC. Seattle, WA. NWAFC Processed Rept. 619pp.

ALASKA : NABA SGBA NAVB SMHL
Finfish: Demersal fish; Trawl survey; Biomass estimates; CPUE; Size & age composition.
Shellfish: Biomass estimates; Trawl survey; Commercial catches; CPUE.

Results of baseline trawl survey in eastern Bering Sea in 1975 serve as a reference for the triennial trawl surveys in that area. Commercial catches, size and age composition, and estimates of relative abundance and biomass by species are reported.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

PEREZ-FARFANTE, I.. 1978.

Shrimps and pawns. Unpaginated

In: W. Fischer (cd.).

FAO Species Identification Sheets for Fishery Purposes.

Western Central Atlantic Fishery Area 31, Vol.6.

FAO, Rome. (not seen by author).

GULF OF MEXICO: EGUL

Finfish: Benthos.

POWLES, H. & C. A. Barans. 1980.

Groundfish monitoring in sponge-coral areas off the
southeastern United States.

Mar. Fish. Rev., May 1980 :p.21 - 35.

ATLANTIC: SATL

Finfish: Reef fish; Biomass.

QUAST, J. C.. 1974.

Density distribution of juvenile Arctic cod in the
eastern Chukchi Sea in the fall of 1970.

Fish. Bull. 72 :p.1094 - 1105.

ALASKA : CHKS

Finfish: Arctic cod; Density distribution;

Estimated biomass; Depth-density relation; Chukchi Sea.

Vertical and horizontal distribution of juvenile Arctic cod
in the eastern Chukchi Sea are examined. Biomass is also
estimated.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

REPS. OF OIL/FISHERIES GRP OF AK. 1983.

A manual for geophysical operations in fishing areas of Alaska.

Sohio Alaska Petroleum Co. Anchorage, AK.

ALASKA : CKIN NABA SGBA NAVB
 NORB

Finfish: Commercial fisheries; Fishing methods;
 Geophysical operations; Fishing areas, seasons.

Shellfish: Commercial fisheries; Fishing techniques;
 Fishing areas, seasons.

Manual prepared for companies operating seismic survey vessels and for the fishing industry in order to avoid potential operating conflicts. Fishing seasons, areas, gear and vessels utilized are summarized by species for Cook Inlet/Kodiak Island, St George Basin/North Aleutian Shelf, Norton sound and Navarin Basin.

RICHARDS, S. W. & A. W. Kendall, Jr.. 1973.

Distribution of sand lance, 'Ammodytes' species, larvae on the continental shelf from Cape Cod to Cape Hatteras from R.V. Dolphin surveys in 1966.
Fish. Bull., U. S. 71 :p.371 - 386.

ATLANTIC: MATL
Ichthyoplankton: Distribution; Abundance;
 R.V. Dolphin cruise; Early life history.

The abundance and distribution of sand lance larvae ('Ammodytes' sp.) collected during the R.V. Dolphin cruises are reported. Spatial and temporal distributions, as well as diurnal migratory patterns are described. Spawning is reported to occur from late November to late March both offshore and inshore.

BIBLIO 431%A1P'IHI% - Finfish, Shellfish, & Ichthyoplankton

RICHARDS, W. J. . 1982.

Planktonic processes affecting establishment and maintenance of reef fish stocks.

pp.92 - 100 In: G. R. Huntsman, W. R. Nicholson, , & W. W. Fox, Jr. (eds.).

The Biological Basis for Reef Fish Management.

Proceedings of a workshop held Ott 7-10, 1980, St. Thomas, Virgin Islands.

NOAA, NMFS, SEFC.

NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL

Finfish: Reef fishes; Stocks;

Biological factors; Physical factors; Proposed research.

Paper provides background material and outlines types of experiments needed to solve problem of how reef fishes which have pelagic early life stages are recruited and maintained in the midst of strong oceanic currents.

RICHARDSON, S. L.. 1973.

Abundance and distribution of larval fishes in waters off Oregon, May-October 1969, with special emphasis on the northern anchovy, 'Engraulis mordax'.
Fish. Bull. 71 :p.697 - 711.

PACIFIC: ORWA

Ichthyoplankton: Abundance; Distribution; Seasonal occurrence;

Gear comparison; Northern anchovy; Oregon.

Paper discusses species composition, abundance, frequency of occurrence and dominance of larval fishes off the Oregon coast. Catches by three types of gear - bongos, meter net, Isaacs-Kidd midwater trawl are compared as are shallow tows and deep tows from the same stations.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

RICHARDSON, S. L. & W. G. Pearcy. 1977.

Coastal and oceanic fish larvae in an area of upwelling off Yaquina Bay, Oregon.
Fish. Bull. 75 :p.125 - 145.

PACIFIC: ORWA

Ichthyoplankton: Coastal assemblages; Offshore assemblages;
Distribution; Abundance; Circulation patterns.

Coastal and offshore assemblages of larval fish are described from a one and a half year ichthyoplankton survey off the mid-Oregon coast. Distribution patterns, seasonality, species composition, dominance and relative abundance of larval fishes are discussed.

RICHARDSON, S. L., J. L. Laroche,
& M. D. Richardson. 1980.

Larval fish assemblages and associations in the northeast Pacific Ocean along the Oregon Coast, winter-spring 1972-1975.
Est. Cstl. Mar. Sci. 11 :p.671 - 699.

PACIFIC: ORWA

Ichthyoplankton: Fish larvae; Associations;
Coastal waters; NE Pacific Ocean; Oregon coast.

Patterns of larval fish distributions found along the Oregon coast between the Columbia River and Cape Blanco during the winter-spring months of 1972 to 1975 are described. Coastal transitional, and offshore fish assemblages are considered.

RIGBY, P. W.. 1984.

Alaska domestic groundfish fishery for the years 1970 through 1980 with a review of two historic fisheries- Pacific cod ('Gadus macrocephalus') and sablefish ('Anoplopoma fimbria').

AK Dept. Fish & Game. Anchorage, AK.
Tech. Data Rept. No. 108. 446pp.

ALASKA : GOAK KODK SHUM
Finfish: Sablefish; Pacific cod;
Domestic fisheries; Historic review; Groundfish.

Report briefly reviews domestic groundfish fisheries of Alaska and provided detailed catch statistics for years 1970-1980. The more historically significant fisheries for Pacific cod and sablefish are discussed in more detail and catch data for earliest years of these fisheries are provided. The report is the most detailed tabulation of Alaska's domestic groundfish fisheries available.

RINALDO, R. G.. 1981.

Status report: Eastern tropical Pacific skipjack tuna.
pp.163 - 181 In: NMFS (cd.).
Status Reports on World Tuna and Billfish Stocks.
NOAA, NMFS, SWFC.
NOAA Tech. Mere. NOAA-TM-NMFS-SWFC- 15. 302pp.

PACIFIC: SCAL
Finfish: Skipjack tuna; Eastern tropical Pacific;
Stock assessment; Fishery management; Commercial fisheries.

Paper analyzes stock structure of skipjack tuna in the eastern tropical Pacific.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ROGERS, B. J., M. E. Wangerin,

& D. E. Rogers. 1983a.

Seasonal composition and food web relationships of marine organisms in the nearshore zone of Kodiak Island - including ichthyoplankton, zooplankton and fish. A report on the fish component of the study.

pp.541 - 658 In: NOAA, National Ocean Service (cd.).

Environmental Assessment of the Alaskan Continental Shelf.

Final reports of principal investigators. vol. 17.

Biological Studies. Prepared for MMS. Washington, D.C.

ALASKA : KODK

Finfish: Feeding Ecology; Catch, CPUE;

Food webs; Kodiak Archipelago; Nearshore fish community.

Feeding habits of forty species of nearshore fishes from the Kodiak Archipelago are described. Food webs were constructed for those species of fish that contributed over five percent (weight) to the mean CPUE.

ROGERS, B. J., M. E. Wangerin,

K. J. Garrison, & D. E. Rogers. 1983b.

Epipelagic meroplankton, juvenile fish and forage fish: Distribution and relative abundance in coastal waters near Yakutat.

pp.1 - 106 In: NOAA, National Ocean Service (cd.).

Environmental Assessment of the Alaskan Continental Shelf.

Final Reports of Principal Investigators. Vol.17.

Biological Studies. Prepared for MMS. Washington, D.C.

ALASKA : GOAK

Finfish: Forage fish; Life History;

Demersal fish; Pacific salmon; Commercial catches; CPUE.

Shellfish: Life history; Distribution; Abundance;

Commercial fisheries; Gulf of Alaska; Meroplankton.

Report summarizes life histories, distribution, abundances, and reviews history of the commercial fisheries (when applicable) of forage fishes, Pacific salmon, demersal fishes, starry flounder, Pacific halibut, and shellfish in the northeast Gulf of Alaska.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

RONHOLT, L. L.. 1983a.

Atka mackerel.

In: G. Stauffer (cd.).

Condition of Groundfish Resources of the Gulf of Alaska
Region as assessed in 1983.

NOAA , NMFS, NWAFC.

NWAFC Processed Rept. 84-02. 24pp.

ALASKA : GOAK KODK SHUM

Finfish: Atka mackerel; Commercial landings;

Size composition; Stock assessment; Gulf of Alaska.

Report summarizes commercial landings (foreign) of Atka
mackerel in the Gulf of Alaska and discusses limited data
available on stock condition.

RONHOLT, L. L.. 1983b.

Atka mackerel.

pp.163 - 177 In: R. G. Bakkala & L.- L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering
Sea and Aleutian Islands Region in 1982.

NOAA, NMFS.

NOAA Tech. Mere. NMFS F/NWC-42. 187pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Atka mackerel; Abundance.

RONHOLT, L. L.. 1984.

Atka mackerel.

pp.157 - 169 In: R. G. Bakkala & L. -L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea
and Aleutian Islands Region in 1983.

NOAA Tech. Mere. NMFS F / NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Atka mackerel;

Fisheries management; Commercial catches; Biomass estimates.

Report assesses condition of Atka mackerel in Aleutian Islands
region through 1983. Abundance, commercial landings , age
distribution, MSY and EY are given.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

RONHOLT, L. L., H. H. Shippen,
& E. S. Brown. 1978.

Demersal fish and shellfish resources of the Gulf
of Alaska from Cape Spencer to Unimak Pass, 1948-1976,
a historical review.

pp.1 - 955 In: NOAA (cd.).

Environmental Assessment of the Alaskan Continental Shelf
Final reports of principal investigators. Vol.2.
Biological Studies.

ALASKA : GOAK

Finfish: Demersal fish; Trawl surveys;
CPUE; Standing stocks; Resource management.

ROSE, C. S.. 1983.

Flatfish.

In: G. Stauffer (cd.).

Condition of Groundfish Resources of the Gulf of Alaska
Region as assessed in 1983.

NOAA, NMFS, NWAFC.

NWAFC Processed Rept. 84-02. 11pp.

ALASKA : GOAK KODK SHUM

Finfish: Flounder; soles; Commercial landings;
Stock assessment; Fisheries management; Gulf of Alaska.

Condition of stocks of flatfishes (major species include
arrowtooth flounder, flathead sole, rock sole, rex sole, and
Dover sole) is assessed. Commercial landings are summarized
by region and country.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ROSENTHAL, R. J.. 1983.

Shallow water fish assemblages in the Northeastern Gulf of Alaska: Habitat evaluation, species composition, abundance, spatial distribution, and trophic interaction. pp.451 - 540 In: NOAA, National Ocean Service (cd.). Environmental Assessment of the Alaskan Continental Shelf. Final reports of principal investigators. Vol.17. Biological studies. Prepared for MMS. Washington, D.C.

ALASKA : GOAK

Finfish: Nearshore fishes; Abundance; distribution; Habitat evaluation; Feeding ecology; Gulf of Alaska.

Report provides a detailed description and ecological analysis of nearshore fishes and their characteristic habitats in the northeastern Gulf of Alaska. Included are data on fish abundance, density, biomass, and patterns of habitat utilization. Important food web links and dietary trends among conspicuous species are also identified.

SAMPLE, T. M.. 1984.

Groundfish surveys conducted by the Northwest and Alaska Fisheries Center in 1983. NOAA, NMFS, NWAF. Processed Rept. No. 84-08. 30pp.

ALASKA : NABA SGBA NAVB SMHL
PACIFIC

Finfish: Demersal fish; Trawl surveys; Ichthyoplankton; Survey design, gear; Biomass.
Shellfish: Survey design, gear; Biomass; Relative abundance.

The Northwest and Alaska Fisheries Center conducted twelve resource assessment surveys during 1983 in order to assess the current biological condition of important crab and groundfish species for management purposes and to conduct specific scientific studies. Descriptions of each survey including purpose, area, vessels used, timing, and sampling information are summarized by geographical area for the Bering Sea, Aleutian Islands region, Gulf of Alaska, and the west coast of Canada and the United States. Results and findings from each survey are briefly summarized.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SAMPLE, T. M. & R. G. Bakkala. 1984.

Greenland turbot and arrowtooth flounder.

pp.61 - 89 In: R. G. Bakkala & L. -L. Low (cd.).

Condition of Groundfish Resources of the Eastern Bering Sea and Aleutian Island Region in 1983.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-53. 189pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Stock assessment; Greenland turbot;

Arrowtooth flounder; Trawl surveys; biomass, MSY, EY.

Report assesses condition of Greenland turbot and arrowtooth in eastern Bering Sea and Aleutian Islands region through 1983.

Population abundance, biomass estimates, MSY and EY are given.

SC MARINE RESOURCES RESEARCH INST, GA Dept. Natural Resources, & Duke Univ. Marine Laboratory. 1981a.

Final report. South Atlantic OCS area: Living marine resources study. Vol.1. An investigation of live bottom habitats south of Cape Fear, NC. Prepared for BLM,

Washington, D. C. Contract No. AA 551-CT9-27.

SC Wildlife & Marine Resources Dept. Charleston, SC.

GA Dept. Natural Resources. Brunswick, GA. 297pp.

ATLANTIC: SATL

Finfish: Live bottom communities; Biomass, abundance;

Numerical analysis; Demersal fish; Environmental impacts.

Benthos: Species assemblages; Live bottom communities;

Epibenthos; Numerical analysis; Environmental impacts.

This report characterizes benthic and nektonic communities associated with representative live bottom habitats on the continental shelf south of Cape Fear, NC and evaluates factors which might influence these communities, particularly the potential for impact by offshore oil and gas activities.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SC MARINE RESOURCES RESEARCH INST, GA Dept. Natural Resources,
& Duke Univ. Marine Laboratory. 1981b.

Final report. South Atlantic OCS area: Living
marine resources study. vol. 3. Appendices.

Prepared for BLM. Washington, D.C. Contract No.
AA 551-CT9-27.

SC Wildlife & Marine Resources Dept. Charleston, SC.
GA Dept. Natural Resources. Brunswick, GA. 180pp

ATLANTIC: SATL

Benthos: Epibenthos; Live bottom communities;
Community structure; Species lists; Abundance, distribution.

Finfish: Live bottom communities; Demersal fishes;
Abundance, biomass; Community structure; Species lists.

This volume contains appendices and bibliography for volumes
1 and 2.

SHERMAN, K., C. Jones,

L. Sullivan, W. Smith, P. Berrien, & L. Ejsymont. 1981.

Congruent shifts in sand eel abundance in western
and eastern North Atlantic ecosystems.

Nature 291 :p.486 - 489.

ATLANTIC: MATL

Finfish: Abundance Shifts; 'Ammodytes';
Distribution; Abundance.

Ichthyoplankton: 'Ammodytes'; Larvae distribution;
Abundance; Abundance shifts.

The importance of sand eels 'Ammodytes' in marine food webs is
examined in a comparison of fisheries in the North Sea and on
the northwest Atlantic continental shelf. In both cases, sand
eels have increased as herring and mackerel stocks have become
depleted. These observations are used to illustrate the importance
of changes in trophic levels to the structure of marine ecosystems.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SHIPPEN, H. & G. Stauffer. 1983.

Pacific ocean perch.

In: G. Stauffer (ed.).

Condition of the Groundfish Resources of the Gulf of Alaska Region as Assessed in 1983.

NOAA, NMFS, NWAFC. Seattle, WA.

NWAFC Processed Rept. 84-02. 33pp.

ALASKA : GOAK KODK SHUM

Finfish: Pacific ocean perch; Stock assessment;

Fisheries management; Commercial landings; Gulf of Alaska.

Stock conditions and commercial landings for Gulf of Alaska stocks of Pacific ocean perch are assessed. Pacific ocean perch encompasses five 'Sebastes' species: Pacific ocean perch, northern rockfish, roughey rockfish, shortraker rockfish, and sharpchin rockfish as found in the current Gulf of Alaska Groundfish Management Plan.

SILVERMAN, M. J.. 1982.

The distribution and abundance of silver hake,

'Merluccius bilinearis' larvae off Northeastern United States, 1977-1980.

ICES, Demersal Fish Committee, Ref. Biol. Oceanogr. Comm.

ICES C. M. 1982/G:58.

ATLANTIC: NATL

Ichthyoplankton: Silver hake; Abundance & distribution;

Spawning; 'Merluccius bilinearis' .

Density and abundance estimates for silver hake larvae in four subareas of the western North Atlantic from Cape Hatteras to the Gulf of Maine are reported. The period during which spawning occurs, starting in early May in southern New England and as it spreads south, east, and then north is documented. The pattern of dispersion of larvae throughout the area was discerned during the study.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SILVERMAN, M. J.. 1983.

Distribution, abundance and production estimates of yellowtail flounder, 'Limanda ferruginea', larvae off northeastern United States, 1977-1981.

ICES, Demersal Fish Committee.

ICES C.M. 1983/G:47. 15pp.

ATLANTIC: NATL MATL

Ichthyoplankton: MARMAP; Abundance & distribution;
'Limanda ferruginea'; Georges Bank; Spawning.

Abundance of yellowtail flounder in four subareas (Gulf of Maine, Georges Bank, southern New England, and mid-Atlantic) is estimated from collections made from 1977 - 1981. The timing and major areas of spawning are determined. An increase in larval production estimates occurred during the five years covered by this report.

SINDERMANN, C. J. 1979.

Status of northwest Atlantic herring stocks of concern to the United States.

NOAA, NMFS, NEFC. Sandy Hook Lab. Highlands, NJ.
Tech. Series Rept. No. 23. 449pp.

ATLANTIC: NATL

Ichthyoplankton: Stock Assessment; Management;
Atlantic herring; Recruitment; Commercial catch.

This report is a comprehensive review of Atlantic herring stock assessments. Critical problem areas, hypotheses to be tested, and research needs are identified to analyze the decline in Atlantic herring stocks.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SMITH, C. L.. 1982.

Patterns of reproduction in coral reef fishes.
pp.49 - 66 In: G. R. Huntsman, W. R. Nicholson,
& W. W. Fox, Jr. (eds.).
The Biological Basis for Reef Fish Management.
Proceedings of a workshop held Oct 7-10,1980, St.
Thomas, Virgin Islands.
NOAA, NMFS, SEFC.
NOAA Tech. Mere. NMFS-SEFC-80.

ATLANTIC: SATL
Finfish: Reef fishes; Reproduction;
Life history; Spawning; Population dynamics.

Paper reviews the diverse reproductive strategies of coral reef fishes. This is an excellent review.

SMITH, G. B.. 1976.

Ecology and distribution of eastern Gulf of Mexico reef fishes.
FL Dept. of Natural Resources. St. Petersburg, FL.
FL Marine Research Publ. No. 19. 78pp.

GULF OF MEXICO: EGUL
Finfish: Distribution; Visual Census;
Reef fishes; Ecology; Eastern Gulf of Mexico.
Benthos

Comprehensive survey of fishes inhabiting patch reefs off Sarasota, FL is summarized. Data on fish species composition and relative abundance, intra-reef species distributional patterns, inter-reef and bathymetric species distribution, relation of physiochemical and biological parameters to species distribution, seasonality, ecology and behavior, and zoogeographic relationships of the mideastern Gulf reef fish fauna are presented.

BIBLIOGRAPHY - Fin fish, shellfish, & Ichthyoplankton

SMITH, G. B., H. M. Austin,

S. A. Bortone, R. W. Hastings, & L. H. Ogren. 1975.
Fishes of the Florida middle ground with comments on
ecology and zoogeography.
FL Dept. of Natural Resources. St. Petersburg, FL.
FL Marine Research Publ. No. 9. 14pp.

GULF OF MEXICO: EGUL

Finfish: Reef fishes; Distribution;

Annotated checklist; FL Middle Ground; Zoogeography.

Benthos: FL Middle Ground.

Annotated checklist of fishes known to inhabit the Florida Middle
Sound with ecological and distributional comments when appropriate
is provided.

SMITH, W. G. 1973.

The distribution of summer flounder, 'Paralichthys
dentatus', eggs and larvae on the continental shelf between
Cape Cod and Cape Lookout, 1965-66.
Fish. Bull. U. S. 71 :p.527 - 548.

ATLANTIC: MATL

Ichthyoplankton: Abundance & distribution; R.V. Dolphin;

Early life history; 'Paralichthys dentatus'; Spawning.

Three spawning populations of summer flounder 'Paralichthys
dentatus' were identified from R.V. Dolphin collections. Abundance
and distribution of eggs and larvae are reported and important
spawning grounds, temperature range and time period in which
spawning occurs were determined.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SMITH, W. G.. 1983.

Temporal and spatial shifts in spawning of selected fish and invertebrate species in the Georges Bank region. NOAA, NMFS, NEFC, Sandy Hook Lab. Highlands, NJ.

ATLANTIC: NATL MATL

Finfish: Shellfish; Spawning.

Ichthyoplankton: Spawning times; Atlantic herring.

Spawning seasons are given for 37 species of fish and elasmobranchs, lobsters, 2 species of crabs, scallops, and squid in five subareas on the continental shelf of the northeastern U.S. Species are arranged in six groups; boreal (shallow), boreal (deep), warm water, eurythermal, stenothermal, and "other", corresponding to faunal groupings and related to general depth and/or temperature preferences (tolerances).

SMITH, W. G., A. Wells,
& D. G. Mc Millan. 1979b.

The distribution and abundance of ichthyoplankton in the Middle Atlantic Bight as determined from coastal surveys and site-specific studies, 1965-1976. Prepared for BLM under interagency agreement AA550-IA7-35. NMFS NEFC, Sandy Hook Lab. Highlands, NJ.
SHL - 79-02. 263pp.

ATLANTIC: NATL MATL

Finfish: Distribution; Abundance;
Zooplankton; Spawning.

Ichthyoplankton: Atlantic cod; Haddock;
R.V. Dolphin cruises.

Densities of fish eggs and larvae are summarized by species collected during R.V. Dolphin cruises (1965 - 1966), New York Bight Survey (1974-76), and semi-annual MARMAP surveys of the Middle Atlantic Bight (Fall, 1976 to Spring, 1976).

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SMITH, W. G., D. G. Mc Millan,

& A. Wells. 1980a.

The distribution and abundance of Atlantic herring larvae in the Gulf of Maine region as determined from MARMAP surveys, 1977-80.

Annual Meeting of North Atlantic Fisheries Organization Scientific Council Sept. 1980.

NAFO SCR Doc. 89/Ix/146. Serial No. N220.

ATLANTIC: NATL

Ichthyoplankton: Distribution; Abundance;

'Clupea harengus'; MARMAP; 'Atlantic herring'.

Population estimates are given for Atlantic herring larvae collected by MARMAP surveys of the Gulf of Maine and Georges Bank from 1977 to 1980. Continued low numbers of herring larvae and a shift in the center of distribution from the eastern part of Georges Bank to Nantucket Shoals and along the western parts of The Gulf of Maine and Georges Banks are reported.

SMITH, W. G., D. G. Mc Millan,

C. Obenchain, P. Rosenberg, A. Wells, M. Silverman,

E. Baranowski, & M. Adams. 1980b.

Spawning cycle of marine fishes off northeastern United States, based on broad scale surveys of eggs and larvae, 1977-79.

ICES, Biological Oceanographic Committee.

C.M. 1980/L:66.

ATLANTIC: NATL

Ichthyoplankton: Distribution & Abundance; Seasonal spawning cycles;

Atlantic herring; Annual spawning cycles; MARMAP.

Densities (number per 10 square meters) and abundance estimates for fish eggs and larvae collected in four subareas of western north Atlantic from Cape Hatteras to Gulf of Maine during hi-monthly cruises from 1977 to 1979 are calculated.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SMITH, W. G., P. Berrien,
D. G. McMillan, & A. Wells. 1981a.
The distribution, abundance and production of
Atlantic cod and haddock larvae off northeastern United
States in 1978-79 and 1979-80.
ICES Demersal Fish Committee.
ICES C. M. 1981/G:52.16pp.

ATLANTIC: NATL
Finfish: Distribution; Abundance;
Spawning; Larval production.
Ichthyoplankton: Atlantic cod.

Density, abundance estimates, and distribution of cod and haddock larvae are reported for four subareas of the continental shelf from Cape Hatteras to Gulf of Maine. Period of peak spawning by Atlantic cod and onset of haddock spawning was associated with environmental conditions.

SMITH, W. G., J. G. Mc Millan,
& A. Wells. 1981b.
The distribution and abundance of Atlantic herring larvae in the Gulf of Maine region as determined from MARMAP surveys during autumn and winter, 1980-81.
North Atlantic Fishery Organization.
NAFO SCR Dec. 81/IX/115, Serial No. N421. 7pp.

ATLANTIC: NATL
Ichthyoplankton: Distribution; Abundance;
Spawning; Atlantic herring.

Density and abundance are estimated for Atlantic herring larvae in Gulf of Maine, on Georges Bank, and off southern New England, 1977 to 1981. Continued low production of larvae is reported.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SOUTH ATLANTIC & GULF OF MEXICO

FISHERY MANAGEMENT COUNCILS. Charleston, SC & Tampa, FL. 1981.
Profile of the calico scallop fishery in the south
Atlantic and Gulf of Mexico.
105pp.

ATLANTIC
GULF OF MEXICO
Shellfish

Profile traces the calico scallop fishery from its beginning
in the 1950's to the present and is distributed as a background
paper on the status of the calico scallop fishery and resource.

SOUTH ATLANTIC & GULF OF MEXICO

FISHERY MANAGEMENT COUNCILS. Charleston, SC & Tampa, FL. 1983.
Fishery management plan, final environmental impact
statement, regulatory impact review and final regulations
for coastal migratory pelagic resources (mackerels) in the
Gulf of Mexico and South Atlantic Region.

ATLANTIC: SATL
Finfish: Fishery management plan; Environmental impacts;
Pelagic resources; Mackerels; Regulations.

Regulations are proposed for king mackerel, Spanish mackerel,
and cobia. Species in the fishery but not in the management
unit (no regulations proposed) include cero mackerel, little
tunny, dolphin, and bluefish (Gulf of Mexico only).

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

SOUTH ATLANTIC FISHERY MANAGEMENT

COUNCIL. Charleston, SC. 1983a.

Fishery management plan, regulatory impact review, and final environmental impact statement for the snapper-grouper fishery of the South Atlantic Region.

ATLANTIC: SATL

Finfish: Snappers; Fishery management plan; Groupers; Regulatory review; Reef fish.

This document presents a combined fishery management plan for the snapper-grouper fishery of the South Atlantic region, regulatory impact review of the economic consequences of the proposed management measures, and final environmental impact statement describing the possible effects on the environment of implementing the plan.

SOUTH ATLANTIC FISHERY MANAGEMENT

COUNCIL. Charleston, SC. 1983b.

Source document for the snapper-grouper fishery of the south Atlantic Region.

292pp.

ATLANTIC: SATL

Finfish: Commercial statistics; Population dynamics; Reef fish; Life history; Stock assessment.

This source document is the background material for the Snapper-Grouper Fishery Management Plan of the South Atlantic Region containing detailed supportive documentation on which the management regime for the snapper-grouper fishery is based.

SPRINGER, S. & H. R. Bullis. 1954.

Exploratory shrimp fishing in the Gulf of Mexico, summary report for 1952 -54.

Comm. Fish. Rev. 16 :p.1 - 16.

GULF OF MEXICO: EGUL

Finfish

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

STARCK, W. A., II. 1968.

A list of fishes at Alligator Reef, Florida, with comments on the nature of the Florida reef fish fauna. Undersea Biol. 1 :p.4 - 40.

GULF OF MEXICO: EGUL

Finfish: Reef fishes; Florida Keys;
Annotated checklist; Zoogeography.

STAUFFER, G. (cd.). 1983a.

Condition of groundfish resources of the Gulf of Alaska region as assessed in 1983. Submitted to International North Pacific Fisheries Commission. NOAA, NMFS, NWAFC. Seattle, WA.
NWAFC Processed Report 84-02.

ALASKA : GOAK KODK SHUM

Finfish: Demersal fishes; Stock assessment;
Commercial landings; Fisheries management; Gulf of Alaska.

Report assesses stock conditions and summarizes commercial landings for Gulf of Alaska stocks of pollock, sablefish, Pacific cod, Atka mackerel, Pacific ocean perch, and flatfish.

STAUFFER, G.. 1983b.

Sablefish.

In: G. Stauffer (cd.).

Condition of Groundfish Resources of the Gulf of Alaska Region as Assessed in 1983.
NOAA/NMFS NWAFC. Seattle, WA.
NWAFC Processed Report 84-02. 36pp.

ALASKA : GOAK KODK SHUM

Finfish: Sablefish; Stock assessment; CPUE;
Fisheries management; Commercial landings; Size distribution.

Commercial landings of sablefish by country are reviewed. Report also assesses stock condition and discusses management of the sablefish resource.

1E%IEIE%LIECBG?IRAIT?'H% - Finfish, Shellfish, & Ichthyoplankton

STRUHSAKER, P.. 1969.

Demersal fish resources: Composition, distribution,
and commercial potential of the continental shelf stocks off
southeastern United States.

Fish. Ind. Res. 4 :p.261 - 300.

ATLANTIC: SATL

GULF OF MEXICO: EGUL

Finfish: Trawl surveys; Demersal fish resources;
Bottom habitat types; Species association; Commercial catches.

A five year study of demersal fish resources of the southeastern
continental shelf showed that the region can be divided into
five general habitat types, each harboring a distinctive
association of demersal fishes. Paper lists demersal fishes
taken during exploratory trawling along with notations on
their occurrences in trawl catches and habitat occupation.
Comprehensive early study often cited in current literature.

TAMM, G. R.. 1980.

Fish. Chapt. 8.

pp.150 - 185 In: Science Applications, Inc. Boulder, CO. (cd.).

Environmental Assessment of the Alaskan Continental
Shelf. Northeast Gulf of Alaska Interim Synthesis

Report prepared under the guidance of OCSEAP.

NOAA, Office of Marine Pollution Assessment. Juneau, AK.

ALASKA : GOAK

Finfish

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

THORSTEINSON, F. V. & L. K. Thorsteinson. 1982.

Finfish Resources. Chapt. 6.

pp.111 - 139 In: M. J. Hameedi (cd.).

The St. George Basin Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Proceedings of a synthesis meeting. Anchorage, AK, April 28-30, 1981.

NOAA/MMS, OCSEAP. Juneau, AK. 162pp.

ALASKA : NABA SGBA NAVB SMHL
 KODK

Finfish: Groundfish stocks; Resource assessment;
 Oil spills; Abundance & distribution Toxicity studies.
Ichthyoplankton

Available data on abundance and distribution, life histories, and estimated biomass of major commercial fish species in the St. George Basin are summarized. Lethal and sublethal effects of petroleum hydrocarbons on finfish resources are also discussed.

THORSTEINSON, F. V., T. M. Sample,

& L. K. Thorsteinson. 1984.

Fishery resources. Chapt.6.

pp.63 - 76 In: L. E. Jarvela (cd.).

The Navarin Basin Environment and Possible Consequences of Planned Offshore Oil and Gas Development.

NOAA/MMS, OCSEAP.

ALASKA : NAVB

Finfish: Shellfish; Harvest statistics.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

UMEDA, Y. & R. Bakkala. 1983.

Data report: 1980 demersal trawl survey of the eastern Bering Sea continental shelf.

NOAA, NMFS, NWAFC.

NOAA Tech. Mere. NMFS F/NWC-49. 175pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: RACE survey; Abundance & distribution;
Demersal fish; CPUE; Resource assessment.

Shellfish: Abundance & distribution; CPUE;
Resource assessment; Trawl surveys.

Report describes methods used in trawl survey. Abundance and distribution of major groups of groundfish, principal individual species of groundfish, and invertebrates are reported.

WALDRON, K. D. & B. M. Vinter. 1978.

Ichthyoplankton of the eastern Bering Sea.

NOAA, NMFS, NWAFC. Processed Rept., April 1978. 88pp.

ALASKA : SGBA

Ichthyoplankton: Density; Distribution;
Pollock; Size distribution.

Report analyzes abundance, density, and distribution of fish eggs and larvae collected with bongo and neuston nets in the eastern Bering Sea from mid-April to mid-May, 1977. Distribution and relative abundance of pollock eggs and larvae are shown for 1976 and 1977 as well as length frequencies of collected pollock larvae. Distributions and relative abundances of other species are also illustrated.

WARING, G. T. & E. D. Anderson. 1984.

Status of the northwestern Atlantic butterfish stock - 1983.

NOAA, NMFS, NEFC. Woods Hole, MA.

Woods Hole Lab. Ref. Dec. 83-41. 38pp.

ATLANTIC: NATL

Finfish: Atlantic butterfish; Marine resources.

This report assesses fishery characteristics and short-term future catch of butterfish in the northwest Atlantic.

BIBLIOGRAPHY - Fin fish, Shellfish, & Ichthyoplankton

WEBER, E.. 1981.

Status report: North Pacific albacore.
pp.228 - 245 In: NMFS (cd.).
Status reports on world tuna and billfish stocks.
NOAA, NMFS, SWFC .
NOAA Tech. Mere. NOAA-TM-NMFS-SWFC-15. 302pp.

PACIFIC: SCAL

Finfish: Albacore tuna; North Pacific;
Stock assessment; Fisheries management; Commerical fisheries.

Report summarizes status of North Pacific albacore stock which is harvested primarily by the Japanese surface and longline and North American surface fleets.

WENNER, C. A., C. A. Barans,

B. W. Stender & F. H. Berry. 1979a.
Results of MARMAP otter trawl investigations in the South Atlantic Bight. I. Fall 1973.
SC Wildlife & Marine Resources Dept. Charleston, SC.
Tech. Rept. No. 33. 79pp.

ATLANTIC: SATL

Finfish: Distribution; Diversity;
MARMAP ; Sand bottom communities.

Numbers and biomass of individual species of fish by depth zones and stations are reported.

WENNER, C. A., C. A. Barans,

B. W. Stender, & F. H. Berry. 1979b.
Results of MARMAP otter trawl investigations in the South Atlantic Bight. II. Spring, 1974.
SC Wildlife & Marine Resources Dept. Charleston, SC.
Tech. Rept. No. 40. 78pp.

ATLANTIC: SATL

Finfish: Biomass; Diversity;
MARMAP; Pelagic fishes; Demersal fishes.

Biomass of pelagic fish, elasmobranchs, squid and demersal bony fish are reported for individual species and by depth zone. This is an excellent seasonal study.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

WENNER, C. A., C. A. Barans,
B. W. Stender, & F. H. Berry. 1979c.
Results of MARMAP otter trawl investigations in the
South Atlantic Bight. III. Summer, 1974.
SC Wildlife & Marine Resources Dept. Charleston, SC.
Tech. Rept. No. 41. 62pp.

ATLANTIC: SATL
Finfish: Biomass; Diversity;
MARMAP; Pelagic fishes; Demersal fishes.

Biomass of pelagic fish, elasmobranchs, squid, and demersal
fish for individual species is reported by station and depth
zone. This is an excellent seasonal study.

WENNER, C. A., C. A. Barans,
B. W. Stender, & F. H. Berry. 1979d.
Results of MARMAP otter trawl investigations in the
south Atlantic Bight. IV. Winter - Early Spring, 1975.
SC Wildlife & Marine Resources Dept. Charleston, SC.
Tech. Report No. 44. 59pp.

ATLANTIC: SATL
Finfish: Biomass; Diversity;
MARMAP; Pelagic fishes; Demersal fishes.

Biomass of pelagic fish, elasmobranchs, squid and demersal fish
are reported for individual species by station and depth zones.
This is an excellent study.

WENNER, C.A., C. A. Barans,
B. W. Stender, & F. H. Berry. 1980.
Results of MARMAP otter trawl investigations in the
South Atlantic Bight. Summer 1975.
SC Wildlife & Marine Resources Dept. Charleston, SC.
Tech. Report No. 45. 57pp.

ATLANTIC: SATL
Finfish: Biomass; Diversity;
MARMAP; Demersal fishes; Pelagic fishes.

Biomass of pelagic fish, elasmobranchs, squid and demersal bony
fish are reported by station. This is an excellent seasonal
study of individual species by depth zone.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

WESPESTAD, V. G., R. Bakkala,

& J. June. 1982.

Current abundance of Pacific cod ('Gadus macrocephalus'), in the eastern Bering Sea and expected in abundance 1982-86.

NOAA, NMFS.

NOAA Tech. Mere. NMFS F/NWC-25. 26pp.

ALASKA : NABA SGBA NAVB SMHL

Finfish: Pacific cod; Abundance & distribution;

Eastern Bering Sea; Projected abundance; Recruitment.

Report summarizes projections of abundance of the Pacific cod population in the eastern Bering Sea through 1986 using a numeric population simulator.

WOLOTIRA, R. J., T. M. Sample,

& M. Morin, Jr.. 1977.

Demersal fish and shellfish resources of Norton Sound, the southeastern Chukchi Sea, and adjacent waters in the baseline year, 1976.

NOAA, NMFS, NWAFC. Seattle, WA-

Processed Rept. Ott, 1977. 292pp.

ALASKA : NORB HBAS

Finfish: Commercial harvests; Trawl survey;

Standing stocks; Biomass; Distribution.

Shellfish: Distribution; Abundance;

Standing stocks; Biomass.

Report summarizes results of 1976 baseline survey of fish and shellfish of Norton Sound, the northern Bering Sea, and southwestern Chukchi Sea. Extensive data on distribution, relative abundance, standing stocks, and life histories of principal species of demersal fishes, king and Tanner crabs, and snails are included. Report also briefly reviews commercial and subsistence fisheries of area.

IE311E31L IOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

WOLOTIRA, R. J., JR., J. E. Munk,
& J. H. Bowerman, Jr. . 1984.
Seasonal distribution and abundance of decapod
larvae for the Kodiak Island Region.
NOAA, NMFS, NWAFC. Seattle, WA.
NWAFC Processed Rept. 84-01. 167pp.

ALASKA : KODK
Shellfish

WOODWARD-CLYDE CONSULTANTS. 1982a.
Central and northern California coastal marine
habitats: Oil residence and biological sensitivity
indices. Final Report. Prepared for MMS, Pacific OCS.
Los Angeles, CA.
POCS Technical Paper No. 83-5. 226pp.

PACIFIC: SCAL CCAL NCAL
Finfish
Benthos

Differences between oil residence and biological sensitivity are
analyzed. The coastal mainland is divided into outer coastal zone,
inner coastal zone, and inlet zone, and shore-zone components
(e.g. sand, rock, boulder veneer) are discussed for each zone.

WOODWARD-CLYDE CONSULTANTS. 1982b.
Central and northern California coastal marine
habitats: Oil residence and biological sensitivity
indices. Executive Summary. Prepared for MMS,
Pacific OCS. Los Angeles, CA.
POCS Technical Paper No. 83-6. 34pp.

PACIFIC: SCAL CCAL NCAL
Benthos
Finfish

Besides summarizing the main points of the full study, the
executive summary provides a glossary of substrata (e.g. boulder
veneer, sand, and rock) and a key to symbols used on accompanying
maps which were generated during the study.

BIBLIOGRAPHY - Finfish, Shellfish, & Ichthyoplankton

ZENGER, H. H., JR. . 1983.

Pacific cod.

In: G. Stauffer (ed.).

Condition of Groundfish Resources of the Gulf of Alaska
Region as Assessed in 1983.

NOAA, NMFS, NWAFC.

NWAFC Processed Rept. 84-02. 19pp.

ALASKA : GOAK KODK SHUM

Finfish: Pacific cod; Commercial landings;

Stock assessment; Fisheries management; Gulf of Alaska.

Paper summarizes commercial catches of Pacific cod by U.S.,
foreign, and joint venture fisheries and assesses condition of
Gulf of Alaska stocks.

ZIMMERMAN, S. T. (ed.). 1982.

The Norton Sound environment and possible conse-
quences of planned offshore oil and gas development.

Proceedings of a synthesis meeting, Anchorage, AK.

October 28-30, 1980.

NOAA/BLM OCSEAP. Juneau, AK. 55pp.

ALASKA : NORB SMHL

Coastal Habitats: Mammals; Shellfish;

Benthos; Birds.

Finfish: Bottomfish Resources; Ocean circulation;

Oil spill impacts; NE Bering Sea.

The emphasis of this report is on impacts, however much useful
information on fish, bird, and mammal distributions and coastal
habitats is included. Some of material descriptive of coastal
habitats is not to be found elsewhere.

ZIPPIN, J. P.. 1983.

Draft environmental impact statement, Gorda Ridge
area offshore Oregon and Northern California.

MMs.

PACIFIC

Finfish