A FISH AND WILDLIFE RESOURCE INVENTORY OF THE COOK INLET - KODIAK AREAS

VOLUME II - FISHERIES

A FISH AND WILDLIFE RESOURCE INVENTORY OF THE COOK INLET - KODIAK AREAS

1976

VOLUME 2 - FISHERIES

COMPILED BY THE ALASKA DEPARTMENT OF FISH AND GAME UNDER CONTRACT TO THE ALASKA COASTAL MANAGEMENT PROGRAM - DIVISION OF POLICY DEVELOPMENT AND PLANNING

VOLUME II STUDY TEAM

ROBERT F. MCLEAN KEVIN J. DELANEY

BEVERLY A. CROSS

CARTOGRAPHIC STAFF

SUSIE M. ELSNER PAMELA D. JOSEPH

VIRGINIA A. FOSTER MARY LU LARSON

KAREN RUSSELL

1976

THIS PROJECT WAS SUPPORTED, IN PART, BY THE FEDERAL COASTAL ZONE MANAGEMENT PROGRAM DEVELOPMENT FUNDS (P.L. 92-583, SECTION 306), GRANTED TO THE STATE OF ALASKA BY THE OFFICE OF COASTAL ZONE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE.

VOLUME II - FISHERIES

TABLE OF CONTENTS

VOLUME II - FISHERIES

TABLE OF TABLES

COOK INLET SALMON

COOK INLET KING CRAB

COOK INLET TANNER CRAB

COOK INLET DUNGENESS CRAB

COOK INLET SHRIMP

KODIAK SALMON

KODIAK GROUNDFISH

KODIAK KING CRAB

KODIAK TANNER CRAB

KODIAK DUNGENESS CRAB

KODIAK SHRIMP

KODIAK SCALLOP

KODIAK RAZOR CLAMS

KODIAK SUBSISTENCE FISHERIES

KODIAK SPORT FISHERIES

VOLUME II - FISHERIES

TABLE OF FIGURES

INTRODUCTION

This volume presents a compilation of existing commercial, sport, and subsistence fishery information for the Cook Inlet - Kodiak Island area. The report is divided into two primary sections: a written narrative and a portfolio of mapped data. The written narrative includes characterizations of each fishery and tabularization of statistical data. Historical catch, effort, economic value, and escapement statistics are included. The map section includes distribution mapping for all significant finfish and shellfish species. Major fishing areas are delineated for all commercial species. Critical salmon and shellfish spawning areas are indicated, by species, where known. Shellfish rearing areas, by species, have also been noted where known.

Included on the salmon distribution maps is additional information showing the location of ADF&G adult and juvenile salmon enumeration sites, sampling sites, state and private hatcheries, rehabilitation sites, test fishing areas, and index streams.

It is imperative that those who use this report recognize that fish populations are a dynamic, ever-changing resource. The information contained within this report is as up to date as possible, but changing land tenure, human use and development, and a multitude of natural factors require that data be continuously gathered and updated.

Most of the information in this report was obtained from Alaska Department of Fish and Game biologists, much of it unpublished before now. Additional contributions were made by other staff members and from members of other resource agencies. These contributions are greatfully acknowledged.

COOK INLET AREA SALMON FISHERIES

INTRODUCTION

The Cook Inlet area includes all waters draining into Cook Inlet and the Gulf of Alaska from Cape Fairfield in Blying Sound westward to Cape Douglas on the Alaska Peninsula (Figure 1). Cook Inlet is characterized by exceedingly strong tidal currents and, on occasion, by strong winds. The area is bordered on three sides by mountains: the Aleutian Range and Alaska Range on the northwest, the Talkeetna Mountains to the northeast and the Chugach and Kenai Mountains on the southeast. Glaciers are common throughout these mountain ranges and many of the stream's tributary to the Inlet carry heavy glacial sediment loads. The largest and most extensive watershed is the Susitna River and its tributaries. Other major drainage basins include the Kenai and Kasilof Rivers. Numerous smaller rivers and short, coastal streams also contribute significantly to the salmon production.

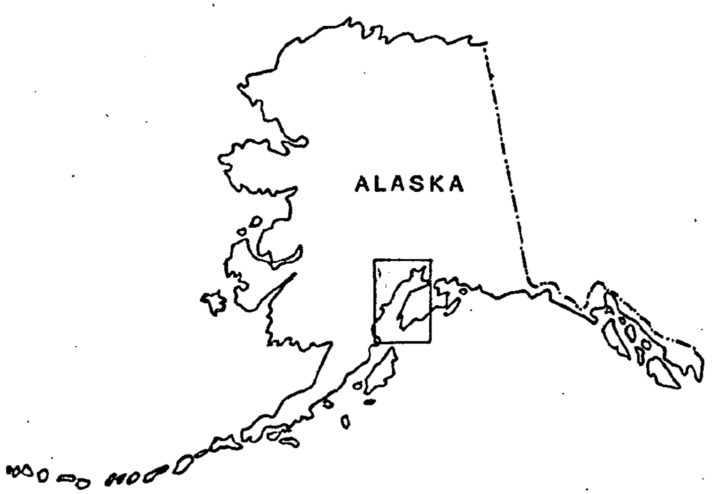
The Cook Inlet area includes six salmon management districts: two in Cook Inlet north of Anchor Point, the Northern and Central districts; one in Kachemak Bay near Homer, the Southern district; one on the west side of the lower inlet, the Kamishak district; one along the outer coast from Point Adam to Aialik Cape, the Outer district; and one south of Seward in the Resurrection Bay-Blying Sound area, the Eastern district (Figure 1).

COMMERCIAL FISHERIES

Description

All five species of Pacific salmon are commercially harvested in Cook Inlet. Commercial salmon fishing began in this area in 1882 although

ALASKA DEPT. OF FISH & GAME
DIVISION OF COMMERCIAL FISHERIES
COOK INLET-RESURRECTION BAY AREA
REGULATORY DISTRICT



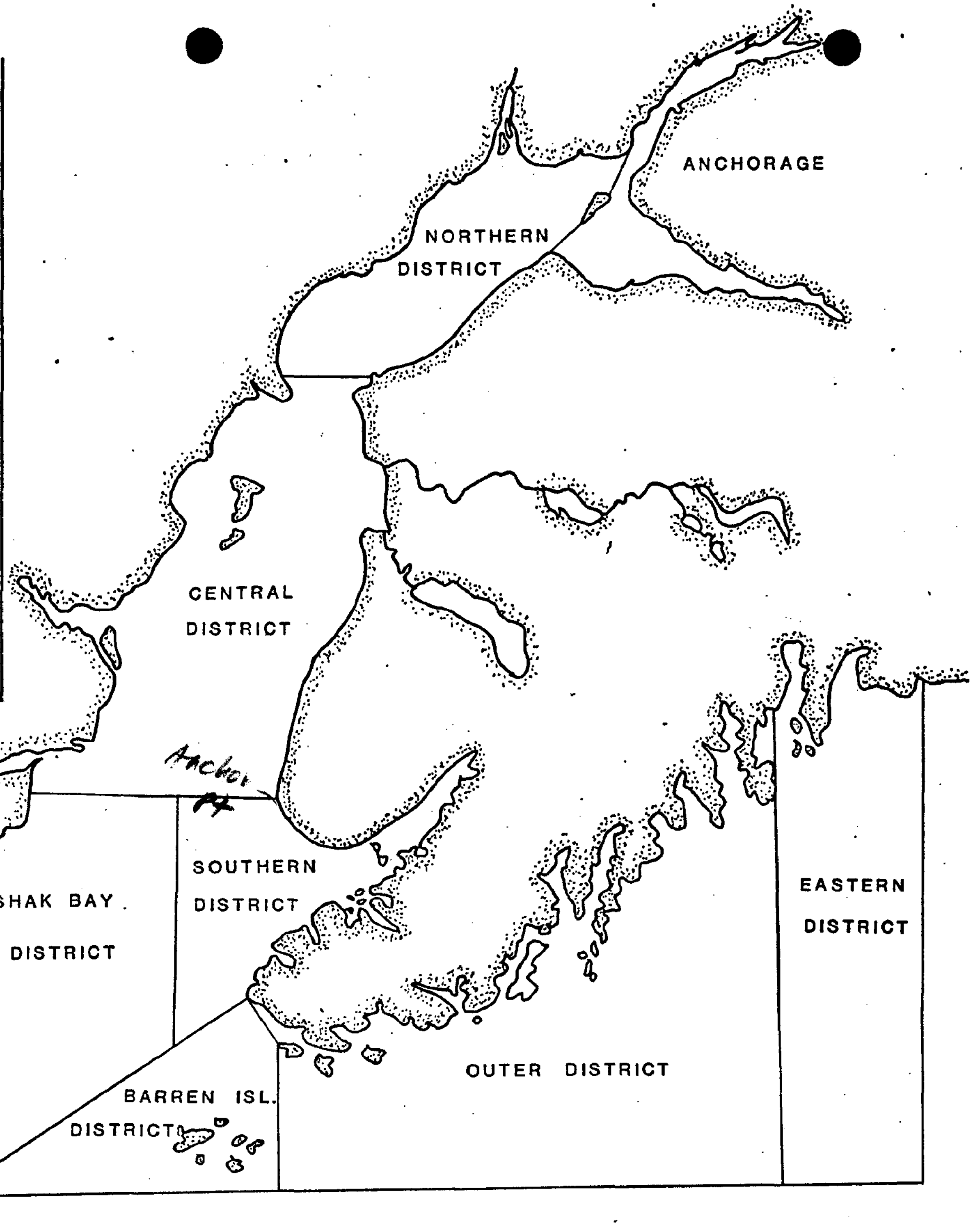


FIGURE 1.

no records of catch are available until 1893 (Table 1). Sockeye salmon have been the dominant species historically, however, in the last 20 years the pink salmon catch has been the greatest. Since 1954 pink salmon have comprised 43% of the total Cook Inlet commercial catch, followed by sockeye (29%), chum (21%), coho (6%) and king (1%). The average annual salmon harvest in Cook Inlet from 1960-1974 is approximately 3.4 million fish which represents 7% of the total statewide salmon harvest for the same period.

In the Cook Inlet area, pink salmon exhibit an even-odd year cycle with the greatest returns occurring during even years. Even year runs are also characterized by good returns of coho and chum salmon. Sockeye salmon is the dominate species during odd year runs. The majority of sockeye salmon harvested in Cook Inlet are produced in the Susitna, Kenai and Kasilof River systems. Historically, king salmon were an important commercial species, but due to their decline from earlier years, runs have been protected by late opening dates since 1964. Nearly all the king salmon commercially harvested in Cook Inlet are produced in systems north of Anchor Point, in the Northern and Central districts.

The Northern and Central districts in upper Cook Inlet are generally termed the gill net districts as gill nets are the only legal salmon gear. Furthermore, only set gill nets are allowed in the Northern district where mobile gear has not been used since 1953. In the Northern district primarily pink salmon are harvested, followed by sockeye, coho and chum salmon. Pink and sockeye salmon comprise the major portion of the Central district's catch and are taken in roughly equal proportions. Chum and coho salmon, in that order, represent a smaller percentage of the Central district's catch.

The Southern district primarily produces pink salmon followed by chum and sockeye salmon. Set gill nets, beach seines and hand purse seines are the only legal salmon gear in this district.

The Kamishak district is a difficult area to fish, and few fishermen are willing to venture into the area for salmon. Hand purse seines and beach seines are the only legal gear. Pink and chum salmon provide the bulk of the catch in roughly equal proportions.

In the Outer district only beach and hand purse seines are allowed as legal gear. The catch is composed primarily of pink salmon, followed by chum salmon. In some years there is a small sockeye fishery in the Nuka Bay area.

The Eastern district is the least important commercial salmon district in the Cook Inlet management area. There are fair pink salmon runs in some even years. The district has potential for sockeye production, however, the main producing system, Bear Lake, is presently being managed for coho salmon by the Sport Fish Division.

Timing

Timing of the commercial salmon fisheries in Cook Inlet varies by district and within districts by system. Fishing seasons in the Outer, Eastern, Kamishak and the seine gear season in the Southern district are opened and closed by emergency order. The Northern and Central districts fishing seasons and the set and drift gill net season in the Southern district are opened on fixed dates and closed by emergency order.

Although all five species of salmon may be found in the districts simultaneously, each species has a normal period of abundance. In the Northern and Central districts early king salmon runs can be expected in late May with the peak of the run in mid-June. Sockeye salmon bound for the Kasilof and Kenai Rivers in the Central district appear in early June and run until the third week of that month. A later run of sockeye, passing through the Central district up to the Northern district, begins shortly after June 25 and reaches a peak between July 12 and 17. The early run of pink salmon which is bound for systems in the Northern district peak around July 12-17, while the later run, which is bound primarily for the Central district peaks from July 26 through August 6. Chum salmon run timing in the Northern and Central districts varies greatly from year to year, however runs usually peak from July 18-24, which corresponds to the peak abundance of coho salmon.

In the Southern district sockeye salmon are the first species to appear in abundance with the run building during the first week of June and tapering off by mid-July. Pink salmon enter this district in late June or early July and usually peak by the last week of July or the first week of August. The chum salmon runs overlap the sockeye and pink runs and are caught incidentally by both fisheries. Coho runs begin building in the first week of August and usually taper off by mid- or late August.

There is a small sockeye fishery in the Outer district located around Nuka and Aialik Bays. The sockeye runs occur from late June until mid-July. Pinks and chums which are the most abundant species run from mid-July until mid-August.

Timing of the fisheries in the Kamishak district is more difficult to generalize. Basically, salmon move into the southern portion of the district first and progress up the coast northward. There is an early run of sockeye to Mikfik River which occurs from early June to mid-July. Chums and pinks enter the southern portion of the district in mid-July and progress up the coast. Pink and chum salmon are found in Bruin Bay from the first week of August until mid-August; while they are most numerous in Rocky and Ursus Bays from mid-August until late August. In Cottonwood and Iniskin Bays there is a late run of chum salmon from late August until early September.

Effort

The average number of licensed commercial fishermen in Cook Inlet from 1960-1974 is 2,635. Resident licenses represent 79% and nonresident licenses 21% of the 15-year average (Table 8). The amount of registered salmon gear has steadily increased since 1960 with the number of drift gill nets increasing markedly (Table 9). Set gill net effort has also risen, but less dramatically while seine effort has fluctuated but has not shown an upward trend. The gear type averages from 1960-1974 are: 539 drift gill nets, 672 set gill nets, 86 hand purse seines, 10 beach seines, and 17 troll licenses.

The proportion of catch has varied between gear types with drift and set net gear accounting for the majority of the salmon catch. Since 1960, drift gear has taken a slightly higher percentage of the catch than set net gear. Set net gear harvests a large portion of the king and coho catch, while both drift and set net gear account for the bulk of the sockeye salmon catch. Purse seine harvests the bulk of the pink salmon catch.

Economic Value

The 15-year (1960-1974) average annual value to the fishermen of the Cook Inlet salmon fisheries is approximately 3.8 million dollars (Table 10). During this period sockeye salmon accounted for 50% of the total salmon value to the fishermen, while pink and chum salmon represented 20% and 19% of the value, respectively. However, this average annual value is not truly representative of the fisheries economic value at today's prices. Figuring the 15-year average annual salmon harvest with 1974 prices paid to the fishermen, the average annual value since 1960 is approximately 13.4 million dollars.

ESCAPEMENT AND SPAWNING

Introduction

In the Cook Inlet area, salmon escapements are monitored by various methods, depending on the system and species involved. The following is a discussion of these methods by district.

Northern and Central Districts

In the Northern and Central districts escapement monitoring is conducted primarily on sockeye salmon. Although tower, weir and sonar sites operating in these districts monitor all species, emphasis is placed on enumerating sockeye salmon runs.

A counting tower is used to monitor escapement on the Talachulitna River, which is a major salmon producing system in the Susitna Basin. In past years runs of pink salmon have been estimated at one million and runs of sockeye have reached 50,000. Chum, coho, and king salmon also use this system extensively. In addition to this station, aerial and ground surveys are conducted on the key sockeye spawning systems along the Susitna River. A sampling station, located just below the confluence of the Susitna and Yentna Rivers has been operated since 1969. The site was established to provide an index of salmon run timing, species composition, and age-weight-length data.

The Kenai and Kasilof River systems are the major spawning systems in the Central district being utilized by all salmon species except chums. The main streams of both the Kenai and the Kasilof Rivers are turbid and prior to 1968, escapement into these systems was derived by surveying the clear water spawning areas. In 1968 sonar counters were installed in the main stems of both systems. The sonar counter not only provide more accurate escapement information but they are also located close enough to the fishery so that the information can be used for in-season management. Species composition of the sonar counts is apportioned by fishwheel catches. In addition to sonar counts on the main rivers, escapement surveys are conducted on clear water spawning streams of the Kenai and Kasilof systems. A weir has been operated on the Russian River, a major spawning system of the Kenai River, since 1969. Refer to Tables 11-13 for the estimated sockeye salmon escapement by system in the Cook Inlet area.

Escapement information prior to 1964 for king salmon is just about nonexistent. In 1964 a program was initiated to monitor escapements in key clear water spawning tributaries at the Kenai, Kasilof and Susitna River. It is not known how these counts compare to historical levels in these streams, or what proportion of the total escapement they represent, since major glacial rivers may produce significant numbers. Table 14 presents estimated king salmon escapement by system.

Coho escapement data is virtually non-existent in the Northern and Central districts except for a few systems monitored by the Sport Fish Division. Coho salmon are on the spawning grounds in strength in the fall during the rainy season when streams are swollen and silty, making accurate counts difficult.

There is no reliable information available on historical pink salmon escapement in the Northern and Central districts. In some clear water systems aerial surveys and ground counts are conducted, however this information is too fragmentary to be of value in assessing trends. Major pink salmon systems in these districts include: Deshka River, Talachulitna River, Lake Creek, Kenai River and Kasilof River.

There is very little information available regarding escapement of chum salmon in the Northern and Central districts. Chinitna Bay is the only area where chum escapement is monitored on a regular basis because the run is harvested relatively close to its spawning destination and must be managed closely. The timing of the majority of the chum salmon runs is too coincidental with sockeye salmon to allow separate management. The Susitna River is thought to account for approximately 80% of the chum salmon production in the Northern and Central districts.

Southern, Outer, Kamishak and Eastern Districts

Pink and chum salmon are the major species produced in the Southern, Outer and Kamishak districts. Aerial and ground surveys are conducted on the major spawning systems. There are nine pink salmon index streams in the Southern and Outer districts, these systems account for the majority of the production in the area. Table 15 presents the estimated pink salmon escapement for the index streams. The index streams are surveyed systematically by aerial and ground counts throughout the pink salmon run and total escapement estimates are derived. Forecast estimates of the number of pink salmon returning to the Southern and Outer districts have been calculated since 1966. Forecast predictions are based on the relationship between the density of pink salmon fry found in the gravel and subsequent return of adult salmon.

Salmon production in the Eastern district is limited. In recent years, the management of Resurrection Bay has been directed toward sport fish utilization of coho salmon. The majority of information available for Resurrection Bay salmon runs has been collected by the Sport Fish Division through their research and rehabilitation projects conducted on the Bear Lake system.

Habitat, Timing and Migration

Spawning and rearing habitat preferences for salmon in the Cook Inlet area are essentially the same as outlined in the generalized life histories (Appendix).

The majority of sockeye salmon in the area are produced in the Northern and Central districts. These stocks, for the most part, utilize the extensive lake systems of the Susitna, Kenai and Kasilof Rivers. Sockeye spawning has been observed in the mainstem as well as the tributaries and lake systems of these rivers. Several minor sockeye salmon runs, especially along the westside of the Inlet, spawn in systems without lakes and utilize sloughs and spring-fed areas for rearing. Sockeye salmon production for the entire Cook Inlet area does not exhibit a dominant cycle of abundance as demonstrated in the Bristol Bay area. Individual runs utilizing different systems do exhibit cycles, however because many systems contribute to the Cook Inlet sockeye production no dominant cycle is apparent for the entire area. The majority of sockeye salmon returning to the Cook Inlet area are five-year fish.

The Susitna, Kenai, and Kasilof Rivers are the major king salmon producers in the Cook Inlet area. King salmon enter the Inlet in two separate runs: the early run which is the major run is bound for the Susitna Basin; the late run is bound primarily for the Kenai and Kasilof Rivers.

Coho salmon in the Cook Inlet area are more evenly distributed than other species in both timing and area of occurrence. Coho runs are spread over a longer period of time and occur in the majority of anadromous streams. Coho salmon are predominately four-year fish and tend to run in greatest strength on even years.

Pink and chum salmon are produced in the majority of short, coastal streams in the Cook Inlet area. They spawn extensively in intertidal areas as well as upstream. Pink and chum salmon runs exhibit a dominant even-year cycle.

Timing of salmon spawning in the Cook Inlet area varies by species, system and season. Generalized timing information for salmon runs in the Cook Inlet area is presented in Tables 19-22.

Escapement Goals

Desired escapement goals have been developed for pink salmon returning to the Southern and Outer districts and are presented below. The stated levels are obviously of a very general nature and may be refined or modified as new information is gathered concerning spawning distribution, escapement to alevin production and odd and even-year run differences.

Southern District	
Humpy	22,500 - 30,000
Tutka	4,500 - 6,000
Seldovia	18,000 - 24,000
Pt. Graham	45,000 - 60,000
Sub-Total	90,000 -120,000
Outer District	
Windy Left	7,500 - 10,000
Windy Right	7,500 - 10,000
Rocky	37,500 - 50,000
Pt. Dick	22,500 - 30,000
Island	18,000 - 24,000
Sub-Total	93,000 -124,000
Total	183,000 -224,000

Desired escapement goals have also been formulated for the sockeye salmon runs on the Kenai and Kasilof Rivers. The present desired sockeye escapement ranges are 150,000-200,000 (mid-point 220,000) for the Kenai River and 80,000-150,000 (mid-point 110,000) for the Kasilof River. The desired escapement goals for the Russian River, which is the main spawning system in the Kenai River, are 8,500 sockeyes for the early run and 30,000 sockeye salmon for the late run.

No escapement goals have been formulated for the remaining salmon runs due to inadequate information concerning spawning magnitude and distribution. Escapement is regulated by monitoring commercial harvests and comparing them with the relationships between past harvests and escapement indices.

STATUS RELATED TO MAXIMUM SUSTAINED YIELD

Current stock assessment and escapement information is not adequate to estimate maximum sustained yields (MSY) for the Cook Inlet fisheries. However, average commercial harvest by species for the entire area will be presented below. Commercial harvests have been averaged for different periods, the high 30 consecutive years of the commercial fisheries, and the 1960-1974 average annual harvests. These average harvests point out possible MSY's for the various fisheries, if factors such as habitat degradation, gear selectivity, and environmental parameters have not changed significantly from past years.

King salmon harvests have declined drastically compared to historical catches. The average annual harvest for the high 30 consecutive years of the king salmon fishery is approxiamtely 84,000, while the 1960-1974 average annual king salmon harvest is only 13,000 fish.

The commercial sockeye fishery in Cook Inlet has also declined markedly from past years. It is believed that the advent of drift gill net gear into the Inlet in 1947 and subsequent catches through 1951 were a major factor to the following decline of sockeye stocks because the mobile gear exposed mixed stocks to longer periods of harvest. The high 30 consecutive years average annual harvest is approximately 1.6 million fish, while the 1960-1974 average annual harvest is 1.04 million fish.

Historically, the coho catch has fluctuated radically. It is not known if these fluctuations were the result of economic sanctions, fluctuations in the coho population or lack of effort. The average annual coho harvest for the high 30 consecutive years and the 1960-1974 average harvest is 230,000 fish annually.

Pink salmon in the Cook Inlet area have a distinct even-year cycle. In even years, pink salmon usually account for the largest portion of the total salmon catch. The average annual pink salmon harvest for the high 30 consecutive years is approximately 1.5 million pinks which is slightly greater than the 1960-1974 average annual harvest of 1.4 million fish.

About 85% of the chum salmon harvested in Cook Inlet are taken from the gill net districts above Anchor Point. Chum salmon were considered economically unimportant until recently and were only taken incidentally to other species. It wasn't until the advent of drift gill net gear in the Inlet that chum salmon took on any importance of their own. Today they are actively sought after as a supplement to the sockeye catch. The average annual chum harvest since 1960 is approximately 703,000 fish.

MANAGEMENT AND RESEARCH

The Cook Inlet area has a broad spectrum of management problems, especially in upper Cook Inlet, north of Anchor Point, which is characterized generally by turbid water and heavy tide flow. Information is needed on the number and origin of salmon by species entering the upper Inlet, migrational routes, milling areas, timing of runs, and escapement by species entering the major systems. Of prime concern is the area southeast of Kalgin Island where sockeye, coho, pink and chum salmon may mill in large numbers and could be overharvested by the drift gill net fishery. A major problem which complicates salmon management in upper Cook Inlet is the lack of data concerning stock separation of salmon runs returning to the Inlet. The development of accurate methods for defining individual stocks would contribute directly towards delineating stock segregation zones upon which district boundaries could be drawn. Additional escapement coverage is also necessary so that specific spawning areas can be delineated and numbers of spawning salmon by species enumerated for each system.

In the Southern and Outer districts, annual forecasts of returning pink salmon contribute significantly to fishery management. Increased accuracy in enumeration of pink salmon escapement and improvement in the formulation of optimum escapement for each system would assist management in balancing catch and escapement. Run timing of pink and chum salmon in the Southern, Outer, and Kamishak districts often overlap so closely that it is not possible to presently manage these runs separately.

Table 1 Commercial salmon catch, Cook Inlet area, by year, in numbers of fish, 1893-1974 1/.

Year	Total	King	Sockeye	Coho 2/	Pink	Chum
1893	234,000	30,000	170,000	34,000	--	--
1894	441,340	15,500	406,840	19,000	--	--
1895	349,476	25,199	324,277	--	--	--
1896	393,339	18,076	309,863	27,600	37,800	--
1897	396,883	14,083	354,800	28,000	--	--
1898	650,969	16,389	551,168	83,412	--	--
1899	630,521	17,102	558,529	54,890	--	--
1900	631,992	26,683	585,309	20,000	--	--
1901	531,283	34,319	482,406	8,967	5,591	--
1902	893,403	49,013	710,280	54,864	79,246	--
1903	689,180	66,023	564,189	58,968	--	--
1904	543,221	30,073	489,348	23,800	--	--
1905	113,215	17,668	95,547	--	--	--
1906	405,511	22,420	225,506	93,485	64,100	--
1907	707,260	62,944	460,620	177,276	6,420	--
1908	1,174,624	33,774	670,774	94,936	375,140	--
1909	734,276	59,624	582,562	88,350	3,740	--
1910	1,187,901	49,028	840,187	79,702	217,666	1,318
1911	1,464,322	55,845	1,249,154	87,909	70,665	749
1912	3,096,823	47,866	1,194,888	70,567	1,661,874	121,628
1913	1,536,071	63,652	1,369,196	81,484	10,926	10,813

continued

1) Source - INPFC, Historical Catch Statistics for Salmon of the North Pacific Ocean. 2nd Draft, July, 1974 and A.D.F.&G., Statewide Catch Statistics, Final IBM run.
2) For 1893-97, catch figures include a mixture of coho and pink salmon.

Table 1 (continued) Commercial salmon catch, Cook Inlet area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1914	3,004,427	47,554	1,472,829	188,341	1,255,798	39,905
1915	2,113,646	83,793	1,860,684	122,028	19,308	27,833
1916	3,783,190	62,895	1,699,323	209,978	1,682,672	128,322
1917	1,918,936	65,499	1,659,907	60,776	54,286	78,468
1918	2,783,862	34,886	1,668,394	251,151	721,231	108,200
1919	1,238,130	23,801	943,694	172,855	43,447	54,333
1920	2,199,897	39,563	1,314,916	302,353	445,524	97,541
1921	1,065,216	13,946	983,625	20,519	4,717	42,409
1922	1,802,766	31,030	860,019	199,923	637,405	74,389
1923	1,334,929	29,911	1,099,465	142,926	39,146	23,481
1924	2,059,529	27,012	1,056,090	187,656	752,016	36,755
1925	1,786,932	51,033	1,510,861	198,146	11,828	15,064
1926	3,133,022	75,620	1,999,720	353,173	586,054	118,455
1927	2,245,464	87,404	1,459,068	387,746	251,866	59,380
1928	2,434,491	69,885	1,172,959	522,509	568,052	101,086
1929	1,813,867	67,694	1,049,851	184,858	376,863	134,601
1930	2,610,983	72,317	917,882	498,475	1,022,679	99,630
1931	1,720,071	51,402	805,526	328,294	472,221	62,628
1932	2,083,739	70,931	1,131,958	374,976	441,125	64,749
1933	1,758,820	59,281	1,336,135	187,972	118,187	57,245
1934	3,160,217	72,379	1,815,267	251,260	929,992	91,319
1935	2,193,264	75,075	1,355,787	170,438	430,540	161,424
1936	3,917,672	81,062	2,390,281	328,496	852,924	264,909
1937	2,519,426	85,982	1,581,183	215,700	487,692	148,869

continued

Table 1 (continued) Commercial salmon catch, Cook Inlet area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1938	3,736,781	57,663	2,425,253	213,804	848,733	191,328
1939	3,101,597	52,726	2,334,904	163,010	319,312	231,645
1940	5,075,130	63,016	1,648,952	478,096	2,604,235	280,831
1941	2,774,836	104,822	1,293,234	359,224	715,211	272,345
1942	3,646,684	95,180	1,540,185	644,823	965,507	400,989
1943	3,618,572	111,381	1,468,279	279,852	1,457,161	301,899
1944	4,356,044	85,210	1,939,932	256,621	1,815,441	258,840
1945	3,629,594	69,202	1,556,713	329,828	1,367,950	305,901
1946	3,842,422	64,281	1,474,473	581,374	1,338,731	383,563
1947	2,985,614	106,804	1,473,973	443,879	681,731	279,227
1948	4,648,842	105,996	2,035,306	408,079	1,660,147	439,314
1949	3,215,844	111,281	2,153,213	279,701	433,003	238,646
1950	4,752,353	162,942	2,642,374	351,366	1,132,164	463,507
1951	3,663,352	187,513	2,481,346	284,715	417,485	292,293
1952	4,546,084	74,500	1,510,214	233,771	2,277,019	450,580
1953	2,893,816	89,430	1,490,062	227,612	550,073	536,639
1954	4,884,392	65,325	1,246,672	336,685	2,460,051	775,659
1955	2,894,140	46,499	1,064,128	180,452	1,286,008	317,053
1956	4,241,503	65,310	1,295,095	207,534	1,803,295	870,269
1957	2,355,356	42,767	670,629	127,199	306,841	1,207,920
1958	3,955,743	22,847	496,842	241,561	2,598,314	596,179
1959	1,328,172	32,783	634,313	112,664	137,255	411,157
1960	4,089,063	27,539	948,040	314,153	2,023,252	776,079
1961	2,066,869	19,778	1,185,079	119,397	337,394	405,221
1962	7,661,051	20,270	1,172,859	358,051	4,690,030	1,149,841

continued

Table 1 (continued) Commercial salmon catch, Cook Inlet area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1963	1,939,198	17,632	958,101	203,876	234,052	525,537
1964	7,147,242	4,622	990,709	462,114	4,287,378	1,402,419
1965	2,074,666	9,751	1,426,352	154,481	139,561	344,521
1966	5,418,734	9,603	1,867,323	295,101	2,585,820	660,887
1967	2,387,595	8,035	1,409,106	180,455	407,717	382,282
1968	5,737,965	4,600	1,200,146	475,333	2,863,638	1,194,248
1969	1,496,011	12,462	815,050	101,575	235,866	331,058
1970	3,429,641	8,455	753,526	280,156	1,388,179	999,325
1971	1,687,698	19,838	658,537	105,197	428,495	475,631
1972	2,399,996	16,174	937,721	83,167	657,243	705,691
1973	2,227,767	5,339	699,234	106,521	633,587	783,086
1974	1,688,412	6,779	524,613	206,639	534,331	416,050

Table 2 . Commercial salmon catch, Cook Inlet area, Northern district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	8,218	148,247	144,377	442,185	117,739	860,766
1961	7,755	77,374	40,975	10,765	61,103	197,972
1962	9,785	133,545	172,883	280,433	144,033	740,679
1963	7,345	109,463	63,540	8,940	43,694	232,982
1964	168	160,264	167,928	586,386	126,958	1,041,704
1965	300	31,575	21,902	4,914	16,906	75,597
1966	1,422	131,105	80,568	372,667	35,637	621,399
1967	184	118,065	43,854	8,460	38,384	208,947
1968	471	140,575	156,648	534,839	58,454	890,987
1969	2,904	38,065	20,425	7,620	11,836	80,850
1970	1,460	66,419	82,529	173,694	22,493	346,595

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches may not agree with total Cook Inlet salmon catch reported by INPFC.

Table 2 (continued). Commercial salmon catch, Cook Inlet area, Northern district, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total
1971	9,598	40,533	22,094	8,423	16,603	97,251
1972	4,912	85,737	19,346	90,830	19,780	220,605
1973	170	45,614	23,951	137,250	30,851	237,836
1974	169	41,563	47,038	42,876	36,490	168,136

Table 3 . Commercial salmon catch, Cook Inlet area, Central district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	19,294	775,067	167,084	969,420	536,183	2,467,048
1961	11,982	1,084,929	76,803	23,252	288,525	1,485,491
1962	10,425	1,013,993	177,036	2,422,505	826,549	4,450,508
1963	10,191	833,470	133,600	21,496	343,333	1,342,090
1964	4,363	809,723	284,726	2,646,041	952,126	4,696,979
1965	9,441	1,380,775	131,717	19,049	299,538	1,840,520
1966	8,118	1,720,885	209,122	1,633,224	496,979	4,068,328
1967	7,675	1,261,997	133,875	23,769	258,453	1,685,769
1968	4,065	964,329	313,802	1,743,358	1,060,660	4,086,214
1969	9,494	654,189	80,527	25,802	258,019	1,028,031
1970	6,887	664,795	192,644	640,201	752,674	2,257,201

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches may not agree with total Cook Inlet salmon catch reported by INPFC.

Table 3 (continued) Commercial salmon catch, Cook Inlet area, Central district, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total
1971	10,167	595,770	78,542	27,201	310,426	1,022,106
1972	11,174	794,087	61,587	537,750	610,368	2,014,966
1973	5,024	624,411	80,469	188,934	636,722	1,535,560
1974	6,427	455,622	153,087	440,854	360,350	1,416,340

Table 4. Commercial salmon catch, Cook Inlet area, Southern district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	12	12,239	1,237	209,989	3,158	226,635
1961	39	10,104	1,149	191,867	2,916	206,075
1962	58	16,573	2,095	565,161	9,078	592,965
1963	88	13,142	4,020	99,820	7,523	124,593
1964	84	17,283	8,905	266,412	11,527	304,211
1965	10	11,185	733	90,260	2,458	104,646
1966	60	12,176	4,529	164,403	14,570	195,738
1967	173	26,349	2,379	92,793	8,107	129,801
1968	61	18,716	4,660	154,033	4,403	181,873
1969	59	12,578	485	70,753	2,600	86,475
1970	90	12,120	3,544	208,066	7,873	231,693

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches, may not agree with total Cook Inlet salmon catch reported by INPFC.

Table 4 (continued) Commercial salmon catch, Cook Inlet area, Southern district, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total
1971	41	18,403	3,151	50,059	2,857	74,511
1972	69	31,345	1,283	9,126	4,931	46,759
1973	139	24,072	1,241	97,574	3,588	126,614
1974	182	27,029	3,054	48,875	2,725	81,865

Table 5 . Commercial salmon catch, Cook Inlet area, Kamishak district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	11	768	28	11,563	44,328	56,698
1961		1	14	6,019	12,465	18,499
1962		38	100	6,519	43,404	50,061
1963	2	49	97	82,314	13,892	96,354
1964	5	1,979	115	20,719	42,280	65,098
1965		808	122	3,452	3,175	7,557
1966		21	158	2,918	5,874	8,971
1967	1	182	74	17,340	24,221	41,818
1968		492	101	198,253	49,461	248,307
1969	2	10,723	121	80,157	53,193	144,196
1970		2,846	218	22,500	95,841	121,405

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches may not agree with total Cook Inlet salmon catch reported by INPFC.

Table 5 (continued). Commercial salmon catch, Cook Inlet area, Kamishak district, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total
1971		3	121	32,094	26,327	58,545
1972		47	31	342	26,374	26,794
1973		1	28	12,568	35,584	48,181
1974			2,915	48	4,554	7,517

Table 6 . Commercial salmon catch, Cook Inlet area, Outer district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	4	11,614	574	381,375	73,866	467,433
1961	2	12,671	456	105,491	40,212	158,832
1962	2	8,710	1,894	1,685,310	126,767	1,822,683
1963	6	1,976	369	21,471	117,095	140,917
1964	2	1,370	431	767,473	269,514	1,038,790
1965		2,009	7	21,886	22,444	46,346
1966 3)	1	2,710	357	398,751	87,620	489,439
1967	2	2,165	70	262,258	52,842	317,337
1968	1	1,550	106	191,691	20,398	213,746
1969		92	11	51,533	5,400	57,036
1970	5	4,177	243	302,759	118,749	425,933

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches, may not agree with total Cook Inlet salmon catch reported by INPFC.

3) Source - ADF&G, 1966 Cook Inlet Annual Management Report, Final IBM run not available.

Table 6 (continued). Commercial salmon catch, Cook Inlet area, Outer district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1971	11	1,630	174	310,710	118,995	431,520
1972	7	26,423	17	1,005	43,490	70,942
1973	1	5,063	31	197,259	76,341	278,695
1974	1	399	28	1,678	11,931	14,037

Table 7 (continued).. Commercial salmon catch, Cook Inlet area, Eastern district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1967		348	203	3,097	275	3,923
1968 [3]	2	74,484	5	41,464	872	116,827
1969 [3]	3	99,403	6	1	10	99,423
1970	11	1,755	691	40,226	633	43,316
1971	21	2,198	1,115	1	423	3,758
1972	12	82	903	18,190	743	19,930
1973 [4]	5		801	2		808
1974 [4]			517			517

Table 7 Commercial salmon catch, Cook Inlet area, Eastern district, by species, in numbers of fish, 1960-1974. 1) 2)

Year	King	Sockeye	Coho	Pink	Chum	Total
1960		105	853	8,720	467	10,145
1961			Fishery Closed			
1962			4,043	102	10	4,155
1963		1	2,250	11		2,262
1964		22	672	813	12	1,519
1965			Fishery Closed			
1966			Fishery Closed			

continued

1) Source - ADF&G, Cook Inlet Catch Statistics, Final IBM run.

2) Totals of district catches may not agree with total Cook Inlet salmon catch reported by INPFC.

3) These abnormally high catches of sockeye salmon were a result of good returns from the 1964 brood year. In 1963 Bear Lake was rehabilitated and in 1964 survival conditions were close to ideal for the progeny.

4) Commercial salmon season not opened in the Eastern district; however, fish caught in the Annual Seward Derby then sold by the Derby are recorded as commercially caught salmon.

Table 8 Summary of commercial and vessel license registration, Cook Inlet area, 1968-1974 1/.

	Commercial Licenses			Vessel Licenses 2/		
Year	Resident	Non-resident	Total	Resident	Non-resident	Total
1968	1,675	615	2,290	954	230	1,184
1969	1,750	597	2,347	986	236	1,222
1970	2,164	667	2,831	1,038	264	1,302
1971	2,090	484	2,574	1,122	223	1,345
1972	2,111	483	2,594	1,089	183	1,272
1973	2,379	481	2,860	1,188	181	1,369
1974	2,470	483	2,953	1,325	191	1,516

1) Source - A.D.F.&G., Cook Inlet Annual Management Reports. Data unavailable prior to 1968.
2) Includes dorries.

Table 9 Summary of salmon gear registrations, Cook Inlet area, 1960-1974 1/.

Gear	Residency	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Drift	Resident	221	279	260	333	323	329	328	350	407	479	537	519	419	516	458
gill	Non-res.	67	93	112	139	145	145	176	186	204	208	220	191	152	146	150
net	Total	288	372	372	472	468	474	504	536	611	687	757	710	571	662	608
Set	Resident	511	564	589	626	596	556	580	554	638	686	707	693	672	732	764
gill	Non-res.	59	22	28	34	35	34	48	50	43	42	65	38	35	43	39
net	Total	570	586	617	660	631	590	628	604	681	728	772	731	707	775	803
Hand	Resident	86	85	84	102	102	66	72	53	85	72	86	80	71	78	103
purse	Non-res.	9	4	7	10	6	6	5	5	6	3	3	1	1	1	1
seine	Total	95	89	91	112	108	72	77	58	91	75	89	81	72	79	104
Troll	Resident	0	8	9	12	3	6	8	11	10	21	23	40	17	30	41
	Non-res.	0	0	0	1	0	2	4	2	1	2	2	1	1	1	3
	Total	0	8	9	13	3	8	12	13	11	23	25	41	18	31	44
Beach	Resident	NA	3	5	5	5	NA	NA	NA	4	19	18	17	13	12	11
Seine	Non-res.	NA	-	-	-	2	NA	NA	NA	-	-	-	-	-	-	-
	Total	NA	3	5	5	7	NA	NA	NA	4	19	18	17	13	12	11
Com-bined	Resident	818	939	947	1,078	1,029	957	988	968	1,144	1,277	1,371	1,349	1,192	1,368	1,377
Gear	Non-res.	135	119	147	184	188	187	233	243	254	255	290	231	189	191	193
Total	Total	953	1,058	1,094	1,282	1,217	1,144	1,221	1,211	1,398	1,532	1,661	1,580	1,381	1,559	1,570

1) Source - A.D.F.&G., Cook Inlet Annual Management Reports.

Table 10 Approximate value to fishermen of commercial salmon, Cook Inlet area, 1960-1974 1/ 2/.

Year	King	Sockeye	Coho	Pink	Chum	Total
1960	140,000	1,370,000	310,000	950,000	470,000	3,240,000
1961	100,000	1,720,000	120,000	160,000	240,000	2,340,000
1962	100,000	1,720,000	350,000	2,330,000	690,000	5,190,000
1963	90,000	1,410,000	200,000	100,000	320,000	2,120,000
1964	20,000	1,460,000	460,000	1,500,000	840,000	4,280,000
1965	50,000	2,120,000	110,000	410,000	250,000	2,940,000
1966	50,000	2,750,000	300,000	1,060,000	420,000	4,580,000
1967	50,000	2,180,000	190,000	170,000	260,000	2,850,000
1968	30,000	1,910,000	520,000	1,520,000	900,000	4,880,000
1969	70,000	1,450,000	110,000	160,000	250,000	2,040,000
1970	50,000	1,170,000	360,000	660,000	960,000	3,200,000
1971	190,000	1,140,000	150,000	270,000	460,000	2,210,000
1972	180,000	2,110,000	230,000	500,000	1,360,000	4,380,000
1973	100,000	2,700,000	260,000	640,000	1,700,000	5,400,000
1974	198,801	3,270,175	953,308	1,054,769	1,660,289	7,137,342

1) Source - A.D.F.&G., Cook Inlet Stock Status Report (unpublished).
2) Values were calculated from fish tickets. An average weighted price per pound was derived from the actual catch in pounds by species by processor and the price per pound paid by each processor. All values have been rounded off.

Table 11 Sockeye salmon escapements, Kenai and Kasilof Rivers, Cook Inlet area, 1968-1974 1/ 2/.

Year	Kenai River	Kasilof River
1968	113,409	92,708
1969	53,625	45,588
1970	66,418	37,240
1971 3/	170,000	90,000
1972	269,679	111,944
1973	368,369	40,189
1974	200,000	42,000

1) Source - A.D.F.&G., Cook Inlet Annual Management Reports.
2) Based on sonar enumeration begun in 1968. Escapement data unavailable prior to 1968 due to water turbidity.
3) Estimates, sonar counters malfunctioned during 1971.

Table 12 . Sockeye salmon escapements, Russian River, Cook Inlet area, 1960-1974 1/.

Year	Escapement Early Run 2/	Escapement Late Run 3/	Total
1960 4/	9,120	34,850	43,970
1961	7,790	18,680	26,470
1962	33,300	22,370	55,670
1963	14,380	51,120	65,500
1964	12,700	46,930	59,630
1965	21,510	21,820	43,330
1966	16,660	34,430	51,090
1967	13,710	49,480	63,190
1968	9,200	48,880	58,080
1969 5/	5,000 6/	28,920	33,920
1970	5,450	28,200	33,650
1971	2,650	54,430	57,080
1972	9,270	79,000	88,270
1973	13,120	24,970	38,090
1974	13,150	24,650	37,800

1) Source - A.D.F.&G., Div. Sport Fish, Annual Report for Russian River Red Salmon Study, Study AFS-44-1.
2) Early run, through 7/15.
3) Late run, after 7/15.
4) Tower counts, 1960-1968.
5) Weir counts, 1969-1974.
6) Escapement determined by foot survey of upper Russian Creek.

Table 13 Sockeye salmon escapements, Fish Creek, Cook Inlet area, 1960-1974 1/.

Year	Weir Counts
1960	80,000
1961	40,000
1962	60,000
1963	105,000
1964	65,000
1965	16,544
1966	41,312
1967	22,624
1968	20,000
1969	6,233
1970	19,881
1971	31,470
1972	6,981
1973	2,500
1974	2,609

1) Source - A.D.F.&G., Cook Inlet Stock Status Report and Cook Inlet Annual Management Reports.

Table 14 Estimated king salmon escapements, Cook Inlet area, Northern District, 1964-1974 1/ 2/.

Stream	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973 6/	1974 6/
Deshka	2,422	2,749	933	1,535	3,318	4,836	4,441	161 5/	1,780	NA	NA
Alexander	205	416	248	388	563	663	491	3/	202	NA	NA
Lake Creek	305	172	147	723	653	770	189	119	920	NA	NA
Chunilna	319	8	300	3/	1,000	375	58	5	91	245	236
Ship Creek	94	207	50	200	500	710	1,746	221	121	444	202
Campbell Creek	116	119	15	300	125	4/	63	102	37	NA	NA
Willow Creek	51	35	103	24	125	290	640	165	370	1,074	402
Little Willow Creek	7	3	38	6	12	150	45	3/	99	233	109
Montana Creek	75	57	100	2	5	150 6/	260	24	211	527	280

1) Source - A.D.F.&G., Cook Inlet Stock Status Report (unpublished).
2) Counts includes available data from ground and aerial surveys.
3) No count made due to poor water conditions.
4) No count available.
5) Count made on East Fork Deshka.
6) Source - Kubik, Stan. 1975. Federal Aid in Fish Restoration Report. Volume 16, Job No. 6-I-D.

Table 15 Estimated pink salmon escapements, Cook Inlet area, Southern and Outer Districts, in thousands of fish, 1962-1974 1/ 2/.

Stream	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Humpy	56.0	34.7	18.5	28.0	30.0	25.0	24.7	5.4	55.2	45.0	13.8	36.9	17.4
Tutka	30.0	10.0	20.0	20.0	12.0	7.0	7.9	6.5	6.5	16.7	1.5	6.5	2.6
Seldovia	50.0	15.0	60.0	30.0	86.0	55.0	53.2	60.0	23.0	31.1	5.8	14.5	13.7
Port Graham	50.0	2.0	16.0	1.5	24.0	2.0	24.4	4.0	16.6	13.2	2.4	7.0	2.8
Windy Left	12.5	4.5	7.7	10.0	7.0	6.0	6.9	23.0	13.0	35.4	.4	12.9	.1
Windy Right	12.5	4.9	6.2	2.0	7.0	6.0	2.8	3.2	2.1	13.0	.1	4.6	.1
Rocky	200.5	12.0	80.0	.3	44.0	1.0	43.1	1.0	32.0	1.6	8.1	2.0	1.5
Port Dick 3/	40.0	16.0	31.5	50.0	35.0	20.0	29.0	12.0	34.5	97.8	10.0	26.4	1.5
Island	15.0	3.6	30.0	.5	7.0	.5	4.3	.1	5.5	.1	1.7	.5	.5

1) Source - A.D.F.&G., Cook Inlet Annual Reports.
2) The total escapement estimates were determined by graphing the available daily counts of pink salmon in the streams by magnitude and day and calculating the area under the graph. This figure is then divided by the estimated time the pink salmon are present in the stream, which averages 2.5 weeks.
3) A weir has been located on Port Dick Creek from 1971-1974. Total escapement estimates are calculated from ground and aerial surveys of fish spawning below the weir, plus weir counts of fish upstream.

Table 16 Estimated sockeye salmon escapement, Cook Inlet area, Kamishak district, by system, in numbers of fish, 1960-1974. 1)

Year	Amakedori	Chenik	Mikfik
1960	1,500	1,000	
1961	2,500	100	3,000
1962	3,000	1,000	3,000
1963	8,000		
1964			
1965			
1966	3,500		
1967			
1968			
1969			
1970			1,000
1971	1,200		5,000
1972	1,000	300	15,000
1973	2,500	500	3,000
1974	1,500	15	1,500

1) Source - A.D.F.&G., personal communication with Cook Inlet area biologists, estimates derived from recorded stream surveys and represent peak live counts. Those years with no estimates recorded, surveys were incomplete, thus no estimates could be derived.

Table 17 Estimated pink salmon eacapement, Cook Inlet area, Kamishak district, by system, in numbers of fish, 1960-1974. 1)

Year	Iniskin Bay	North Head	Cottonwood Bay	Ursus Cove	Browns Peak	Rocky Cove
1960				800		1,500
1961						
1962			1,000	1,500	25,000	5,000
1963	1,000		1,500	6,000	10,000	2,000
1964					20,000	
1965		500				
1966	25,000 2/	4,500	11,500 2/	11,000	11,000	20,000
1967						
1968						
1969	17,500 2/		1,000		2,000	
1970		7,500		25,000		
1971	3,000	5,000		6,500	8,000	43,000
1972	1,000	800			1,200	2,000
1973	1,000	530			3,200	5,000
1974			1,000	100	100	50

continued

1) Source - A.D.F.&G., personal communication with Cook Inlet area biologists, estimates derived from recorded stream surveys and represent peak live counts. Those years where no estimates are recorded, surveys were incomplete, thus no estimates could be derived.

2) Species of counts questionable, normally this system produces mostly chum salmon.

3) Count represents pink and chum salmon.

4) Estimate derived from count recorded as pink and chum salmon, 100,000 fish apportioned as pink salmon.

Table 17 (continued) Estimated pink salmon escapement, Cook Inlet area, Kamishak district, by system, in numbers of fish, 1960-1974.

Year	Bruin Bay	Amakedori	Little Kamishak	Strike	Big Kamishak
1960	18,000	60,000			
1961					
1962	300,000	80,000		100,000 [3/]	100,000 [4/]
1963	25,000		20,000	4,000	100,000 [4/]
1964					75,000
1965					
1966	20,000	8,000	28,000	30,000	13,000
1967					
1968					
1969				500	
1970	40,000	13,000			
1971	22,000				
1972	2,500	200			
1973	2,000	3,000	13,000		15,000
1974	600	1,000			1,000

Table 18 Estimated chum salmon escapement, Cook Inlet area, Kamishak district, by system, in numbers of fish, 1960-1974. 1)

Year	Iniskin Bay	North Head	Cottonwood Bay	Ursus Cove	Browns Peak	Rocky Cove
1960	9,000		20,000	1,000		
1961						
1962	40,000		20,000	600		
1963	11,000		3,000	1,000		
1964	11,000					
1965		500				2,000
1966						
1967						
1968	5,000					
1969						
1970						
1971	13,000		9,000			
1972	10,000	900	4,000	1,600	1,000	2,000
1973	12,000		4,000	3,000	500	1,000
1974	7,000		2,500	3,500	700	1,000

continued

1) Source - A.D.F.&G., personal communication with Cook Inlet area biologists, estimates derived from recorded stream surveys and represent peak live counts.

2) Count represents pink and chum salmon.

3) Estimate derived from count recorded as pink and chum salmon, 30,000 fish apportioned as chum salmon.

Table 18 (continued) Estimated chum salmon escapement, Cook Inlet area, Kamishak district, by system, in numbers of fish, 1960-1974.

Year	Bruin Bay	Amakedori	McNeil	Little Kamishak	Strike	Big Kamishak
1960	600		7,000			
1961	2,000		35,000			3/
1962	13,000		36,000		100,000 2/	30,000 3/
1963	5,000		100,000	3,000	1,000	30,000
1964			90,000			25,000
1965						
1966					500	5,000
1967						
1968						
1969						
1970						
1971	1,000					
1972	1,000					
1973	8,000	150	10,000	1,000		4,000
1974	3,000	100	1,500	500	100	7,000

Table 19 . General salmon timing information, Cook Inlet area, Northern district. 1)

Species	
King Salmon	
Adults	
Enter Freshwater	May 15-July 15
Actual Spawning	June 20-Aug. 15
Juveniles Present Freshwater	April 15-July 15
Sockeye Salmon	
Adults	
Enter Freshwater	May 20-Aug. 15
Actual Spawning	Aug. 1-Nov. 15
Juveniles Present Freshwater	April 15-Aug. 1
Coho Salmon	
Adults	
Enter Freshwater	July 10-Nov. 1
Actual Spawning	Aug. 1-Feb. 1
Juveniles Present Freshwater	April 15-July 15
Pink Salmon	
Adults	
Enter Freshwater	June 21-Aug. 15
Actual Spawning	July 10-Sept. 1
Juveniles Present Freshwater	April 15-June 7
Chum Salmon	
Adults	
Enter Freshwater	July 1-Sept. 1
Actual Spawning	Aug. 1-Oct. 1
Juveniles Present Freshwater	April 15-July 7

1) Source - A.D.F.&.G., Cook Inlet area staff, personal communications, 1976.

Table 20. General salmon timing information, Cook Inlet area, Central district. 1)

Species	
King Salmon	
Adults	
Enter Freshwater	May 15-Sept. 10
Actual Spawning	July 20-Sept. 10
Juveniles Present Freshwater	Out by mid July
Eggs and Alevins Present	July 30-July 15
Sockeye Salmon	
Adults	
Enter Freshwater	May 20-Aug. 15
Actual Spawning	July 15-Nov. 10
Juveniles Present Freshwater	Out by July 1
Eggs and Alevins Present	July 15-July 1
Coho Salmon	
Adults	
Enter Freshwater	July 25-Nov. 10
Actual Spawning	Sept. 10-Feb. 1
Juveniles Present Freshwater	Out by mid July
Eggs and Alevins Present	Sept. 15-July 15
Pink Salmon	
Adults - Odd Year	
Enter Freshwater	July 14-Sept. 14
Actual Spawning	August 1 - Sept. 30
Adults - Even Year	
Enter Freshwater	July 20-Sept. 30
Actual Spawning	Aug. 1-Sept. 30
Juveniles Present Freshwater	Out by mid April
Eggs and Alevins Present	Aug. 1-April 15
Chum Salmon	
Adults	
Enter Freshwater	July 15-Sept. 15
Actual Spawning	Aug. 15-Nov. 15
Juveniles Present Freshwater	No data
Eggs and Alevins Present	No data

1) Source - A.D.F.&.G, Cook Inlet area staff, personal communications, 1976.

Table 21 . General salmon timing information, Cook Inlet area, Southern district. 1)

Species	
King Salmon	No data specific to this area. King runs minor. See generalized timing for other districts of Cook Inlet.
Sockeye Salmon	No data specific to this area. Sockeye runs minor. See generalized timing for other districts of Cook Inlet.
Coho Salmon	
Adults	
Enter Freshwater	Mid August-October
Actual Spawning	Sept. 1-Nov. 30
Juveniles Present Freshwater	Out by mid July
Pink Salmon	
Adults	
Enter Freshwater	July 15-Aug. 30
Actual Spawning	July 25-Sept. 10
Juveniles Present Freshwater	Out by mid May
Chum Salmon	
Adults	
Enter Freshwater	July 10-Aug. 15
Actual Spawning	July 20-Sept. 1
Juveniles Present Freshwater	Out by April 10

1) Source - A.D.F.&G., Cook Inlet area staff, personal communications, 1976.

Table 22. General salmon timing information, Cook Inlet area, Kamishak district. 1)

Species	
King Salmon	No data specific to this area-see generalized timing for other districts of Cook Inlet.
Sockeye Salmon	
Adults	
Enter Freshwater	June 10-Aug. 15
Actual Spawning	July 15-Aug. 30
Juveniles Present Freshwater	Out by July 15
Coho Salmon	
Adults	
Enter Freshwater	Mid August-October
Actual Spawning	Sept. 1-Nov. 30
Juveniles Present Freshwater	Out by mid July
Pink Salmon	
Adults	
Enter Freshwater	July 20-Sept. 1
Actual Spawning	August 1-Sept. 30
Juveniles Present Freshwater	April 1-May 30
Chum Salmon	
Adults	
Enter Freshwater	Aug. 1-Sept. 15
Actual Spawning	Aug. 15-Sept. 30
Juveniles Present Freshwater	April 1-May 30

1) Source - A.D.F.&G., Cook Inelt area staff, personal communciations, 1976.

COOK INLET AREA HERRING FISHERIES

COMMERCIAL FISHERIES

Commercial herring fishing started in the Cook Inlet area in 1914 as a gill net fishery in the Halibut Cove area of Kachemak Bay. All herring were supplied to a local saltery. The minimum sized allowed for salting was 10.5 inches. The industry expanded rapidly and by 1925 there were a total of eight salteries in Cook Inlet. Gill netting remained the chief method of harvesting herring until 1923 when purse seining was introduced.

In 1927 catches began to decline as the larger size herring became harder to find. By 1931 stocks were apparently depleted and it became uneconomical to fish the area. During the three highest years of production in Kachemak Bay, 1924-1926, the annual harvest averaged 8,000 tons of herring. The average annual herring catch throughout the span of the active fishery, 1914-1928, was 2,850 tons (Table 23).

The next major herring fishery to occur in the Cook Inlet area was a purse seine operation for reduction purposes in the Resurrection Bay-Day Harbor area. The fishery was active from 1939 through 1959. The annual harvest during the three highest years of production, 1944-1946, averaged around 16,500 tons while the average for all years of operation was 3,500 tons of herring (Table 24).

The present herring fishery in the Cook Inlet area began in 1969. It was initiated primarily to supply herring roe to the Japanese market. The herring fishery occurs immediately prior to spawning when the roe is at its highest development. The roe fishery usually occurs from May through mid-June.

The herring catch peaked in 1970 when 4,800 tons were taken from the Southern and Eastern districts. In 1972, the herring harvest declined drastically and only 96 tons were landed. This large reduction in catch appears to be due to a combination of late, cold springs, plus the possibility that the Eastern and Southern districts may have been overfished in 1970 and stocks were reduced. Market problems also played a role in keeping the 1972 catch low. Herring catches have steadily increased since 1972 and the 1975 Cook Inlet herring harvest totaled 4,149 tons. Table 25 outlines the Cook Inlet area herring harvest by district from 1969-1975.

Until recently, herring fishing effort in Cook Inlet has been concentrated in Resurrection Bay in the Eastern district and Kachemak Bay in the Southern district. Since 1972, fishing effort has shifted to other areas, including the Kamishak, Outer, and Central districts. The shift in fishing effort resulted from a decline in herring catches in Resurrection and Kachemak Bays, and the increased prices paid to the fishermen which allowed fishermen to locate good concentrations of herring in other areas.

Hand purse seining is the primary means of harvesting herring in Cook Inlet. In addition, set nets are used in the Central district. Table 26 outlines the number of purse seine vessels and set nets participating in the Cook Inlet herring fishery by district and year from 1969-1975. Many purse seine vessels fish several districts during a season, consequently the total number of different purse seines fishing for herring in Cook Inlet will not agree with the sum of the districts' totals. The total number of purse seine vessels fishing for herring in Cook Inlet increased from 11 boats in 1969 to 23 boats in 1971. In 1972 effort decreased markedly and only 6 vessels fished the entire area.

As fishing expanded into other areas in 1973, effort increased. In 1975 a total of 44 purse seine vessels and 1 set net participated in the Cook Inlet commercial herring fishery. As reflected by the catch, the bulk of the fishing effort took place in the Kamishak district where 39 purse seine vessels fished.

The economic value to the fishermen of the Cook Inlet herring fishery has fluctuated markedly during the past six years as the result of different catch levels and increased prices. Table 27 lists the value of the herring fishery to the fishermen by year. The average annual value from 1969-1974 is approximately $170,000. However, this average value is not truly representative of the fishery's value at today's prices. In 1973, the price paid to the fishermen increased from 2 to 8 cents per pound. In 1974 the average price was 9 cents per pound. Using the average annual herring harvest (1969-1974) with the 1974 prices the average annual value to the fishermen is approximately $346,000.

DISTRIBUTION AND LIFE HISTORY

Very little is known about the offshore marine life or the migratory habits of herring in the Cook Inlet area. It is not presently known whether Cook Inlet herring are a distinct population separate from other Alaskan herring. The degree of separation or intermingling of stocks within the area is also not known.

Aerial surveys are conducted each year by A.D.F.&.G. to locate concentrations of feeding and spawning herring. Herring are sporadically distributed throughout the Cook Inlet area, with the greatent concentrations occurring in the Kamishak, Southern, Outer and Eastern districts.

Herring are found throughout the Kamishak district. Spawning has been observed in Oil Bay, Dry Bay, Ursus Cove, Bruin Bay, off Augustine Island, and along reefs located in the southern portion of Kamishak Bay. It appears that herring also spawn in deep water areas along the southern portion of Kamishak Bay. Herring spawn has been repeatedly found on tanner crab pots fished in the area. However, the extent of deep water spawning is not known.

In the Southern district herring schools have been noted in several bays and spawning has been observed in Mallard Bay, Bear Cove and along the Homer Spit.

Herring spawning occurs intermittently throughout the Outer district. Concentrations have been observed in Aialik, Harris, Two Arm, Nuka, Tonsina, West Arm of Port Dick and Rocky Bays.

In the Eastern district heavy concentrations of spawning herring occur in the Seward small boat harbor, Thumbs Cove, and off Fourth of July Creek in Resurrection Bay. Spawning also occurs in Safety Cove and Killer Bay in Day Harbor. Refer to the Cook Inlet maps included in the map portion of this report for specific areas of herring spawning and feeding.

Herring spawning in the Cook Inlet area generally occurs from May through mid-June, however the peak of spawning varies from year to year and between geographical areas. Water temperatures appear to be one of the main factors influencing the time of spawning. It has been noted (pers. comm., Dave Daisy, A.D.F.&.G., 1976) that in the Cook Inlet area, herring spawning is not necessarily triggered by specific water temperatures. Instead, herring appear to spawn at a range of temperatures, averaging 38°-40° F., and are influenced by the length of time these temperatures are maintained. Spawning may occur at lower temperatures, such as 38°F., if they are maintained for an extended period, and conversely warmer temperatures, such as 40°F., appear to trigger spawning more rapidly.

MANAGEMENT AND RESEARCH

The basic herring management philosophy in the Cook Inlet area is to keep fishing effort off stocks that appear to be low in numbers. This will probably result in little or no herring fishing in the Eastern, Outer and possibly the Southern districts in the near future. Because of the good quality and plentiful numbers of herring in the Kamishak district, it appears as though the bulk of the commercial catch will continue to come from this area.

There is no closed season for herring fishing in Cook Inlet. However, present regulations state that from March 1 through June 30 the commercial herring season is closed shall be 4,000 tons of herring are taken. The present quota may be modified in the future as additional stock assessment information is collected.

Samples are taken annually from each district's commercial herring harvest to determine weight, length, and sex data. Contribution by age class is determined for each fishing district. Data has been collected from the Eastern district since 1970 and from the Outer, Southern, Kamishak and Central districts since 1973.

Table 23 Commercial herring catch, Cook Inlet area, Kachemak Bay, in tons of fish, 1914-1928. 1) 2)

Year	Catch in tons
1914	150
1915	15
1916	50
1917	950
1918	2,000
1919	2,650
1920	950
1921	2,600
1922	500
1923	3,800
1924	7,050
1925	9,600
1926	7,150
1927	3,600
1928	2,150

1) Source - A.D.F.&G., Reports to the Board of Fish and Game, Cook Inlet Herring Report, December, 1975.

2) The first herring fishery in the Cook Inlet area began in 1914 as a gill net fishery in Kachemak Bay and was active until 1928.

Table 24 Commercial herring catch, Cook Inlet area, Day Harbor-Resurrection Bay, in tons of fish, 1939-1959. 1) 2)

Year	Catch in tons
1939	100
1940	
1941	1,600
1942	200
1943	2,600
1944	15,450
1945	14,600
1946	18,750
1947	600
1948	6,100
1949	
1950	3,850
1951	2,150
1952	400
1953	150
1954	200
1955	7,450
1956	1,650
1957	2,250
1958	
1959	50

1) Source - A.D.F.&G., Reports to the Board of Fish and Game, Cook Inlet Herring Report, December 1975.

2) A purse seine herring fishery operated in the Resurrection Bay-Day Harbor area from 1939-1959.

Table 25 Commercial herring catch, Cook Inlet, by district, in tons of fish, 1969-1975. 1) 2)

Year	Central	Southern	Kamishak	Outer	Eastern	Total
1969		551.5		38.0	757.9	1,347.4
1970		2,708.7			2,100.2	4,808.9
1971		12.5			974.0	986.5
1972		1.0			95.0	96.0
1973	14.0	203.8	243.1	300.5	830.8	1,592.2
1974	36.6	110.2	2,108.0	390.1	47.4	2,692.3
1975	6.0	24.0	4,119.0			4,149.0

1) Source - A.D.F.&.G., Reports to the Board of Fish and Game, Cook Inlet Herring Report, December 1975.

2) The present herring fishery for sac roe in the Cook Inlet area began in 1969.

Table 26 Number of vessels participating in the herring fishery, Cook Inlet area, by district, by year, 1969-1975. 1) 2).

Year	Central 3)	Southern	Kamishak	Outer	Eastern	Total 4)
1969		5		1	7	11
1970		11			11	18
1971		3			20	23
1972		1			5	6
1973	6	12	9	7	22	30(6 set net)
1974	12	7	26	22	10	42(12 set net)
1975	1	5	39			44(1 set net)

1) Source - A.D.F.&G., Reports to the Board of Fish and Game, Cook Inlet Herring Report, December 1975.

2) Numbers represent purse seine vessels, unless noted otherwise.

3) Numbers represent set nets.

4) Purse seine vessels may fish several districts during a season, consequently the total numbers of different vessels fishing the entire Cook Inlet area will not agree with the sum of the districts totals.

Table 27 Value of the commercial herring fishery to the fishermen, Cook Inlet area, in dollars, 1969-1974. 1)

Year	Value in dollars
1969	53,899
1970	192,359
1971	39,461
1972	3,842
1973	238,822
1974	484,614

1) Values were computed from catch totals from the Cook Inlet Herring Report to the Board which were multiplied by the price per pound paid to the fishermen.

COOK INLET AREA HALIBUT FISHERIES

COMMERCIAL FISHERIES

The halibut fishery is regulated by the International Pacific Halibut Commission (IPHC). Each halibut management area overlaps and includes several state management areas. Catch records from discrete state management areas (Cook Inlet, Kodiak, etc.) are not available. IPHC statistical area 3A overlaps and includes the Cook Inlet area. Historical catch statistics for this area, since 1960, are presented in Table 87. Since much of the Cook Inlet catch is landed by fishermen outside of the Cook Inlet area, no estimates of economic value to the fishermen are available.

DISTRIBUTION

Halibut are caught in every district of Cook Inlet south of Anchor Point, including the Outer and Eastern districts. A minor number of halibut have also been reported as far north as the forelands, although no commercial catches have been made above Kalgin Island.

Halibut are seasonally distributed in Cook Inlet and are generally present from May through August. Based on exploratory cruises by the National Marine Fisheries Service, the highest concentration of halibut appears to be in Kachemak Bay.

LIFE HISTORY

Life history information specific to the Cook Inlet area is not available. A generalized life history may be found in the Appendix.

ABUNDANCE

Estimates of abundance are only available for IPHC Area 3A. No estimates are available for the Cook Inlet area alone.

MANAGEMENT AND RESEARCH

As mentioned earlier, the halibut fishery is managed jointly by Canada and the United States under the auspices of the International Pacific Halibut Commission. The fishing season presently extends from May 1 till September 6, unless closed earlier by emergency order. The quota for IPHC Area 3A in 1975 was 12 million pounds.

IPHC undertakes annual trawl surveys in the Gulf of Alaska to assess stock size and recruitment. Halibut catch quotas are developed using this data. Presently, few surveys are conducted in lower Cook Inlet.

COOK INLET AREA GROUNDFISH FISHERIES

COMMERCIAL FISHERIES

Various groundfish species comprise a small but important part of Cook Inlet commercial fishing activity. Although the present commercial fishery is minor, the resource potential of these species is large and will become more important as markets develop and demand increases. The primary producing areas at present are the Eastern and Outer districts and adjacent Gulf of Alaska waters.

In 1974, over 100,000 pounds of various groundfish species were recorded as being landed. Catch statistics, by species, for the years 1970 to 1974, are presented in Table 28 . Most of this catch is presently utilized as bait.

No estimates of economic value to the fishermen are available for recent years. However, the 1971 groundfish catch was valued at nearly 15 thousand dollars to the fishermen.

DISTRIBUTION

Groundfish species are distributed in all districts of Cook Inlet south of Anchor Point, including the Outer and Eastern districts. Small numbers are also found seasonally in the Central district south of Kaligan Island. Specific distribution, by species, is not presently known. Refer to the generalized distributions outlined in the Kodiak Area Groundfish section and in the generalized life histories found in the Appendix.

LIFE HISTORY

Life history information specific to the Cook Inlet area is not presently documented. Refer to the generalized life histories outlined in the Kodiak Area Groundfish section and in the generalized life histories found in the Appendix.

ABUNDANCE

No assessments of groundfish abundance for the Cook Inlet area have been made.

MANAGEMENT AND RESEARCH

There is currently no closed season on the Cook Inlet groundfish fishery. Groundfish may be taken by trawl and longlines in all districts and by pots in all districts except parts of Kachemak and Resurrection Bays.

There is presently no research activity on the groundfish resources, outside of exploratory trawl surveys conducted periodically by the National Marine Fishery Service.

Table 28 Commercial miscellaneous fish catch, Cook Inlet area, by species, in pounds of fish, 1970-1974. 1)

Year	True Cod	Flounder	Ling Cod	Rockfish/Red Snapper	Dolly Varden	Sablefish
1970	36,034					10,338
1971	58,630	1,697	3,557	4,650	688	
1972	397	1,210	112	132	797	14,749
1973	48,733		705	10,502		
1974	7,188	2,091	87,902	2,651	363	277

1) Source - A.D.F.&.G., Catch Statistics, Cook Inlet area, final IBM run.

COOK INLET KING CRAB FISHERIES

COMMERCIAL FISHERIES

The king crab fishery began in Cook Inlet on a commercial basis in 1951 and developed through 1959. By 1960, 60 boats were engaged in the king crab fishery. Effort dropped off after the 1964 earthquake to a low of 23 boats in 1965, but gradually increased to a high of 76 boats in 1974 (Table 32). In the earlier years of the fishery, pots, trawls, and tangle-nets were used but have since been replaced by regulation with pots. Since 1960 the fishery has remained relatively stable, although the peak harvests prior to the 1964 earthquake were offset by a low level of effort and a resulting low harvest in the years immediately following the earthquake. The average harvest for the years 1960 to 1974 is 4.6 million pounds (Table 29).

Prior to 1961, nearly all of the Cook Inlet king crab catch came from Kachemak Bay in the Southern district. Since then, effort has shifted heavily to Kamishak Bay, which now rivals the Southern district as the major king crab producer. Smaller fisheries also occur in the Barren Islands, Outer, and occasionally Eastern districts. The king crab fishery is a high value fishery with a 15 year average value (1960-1974) to the fishermen of slightly over 1 million dollars. The value of the 1974 catch to the fishermen was 2.2 million dollars (Table 33).

DISTRIBUTION

King crab are distributed in all districts of Cook Inlet south of Anchor Point. Stocks are also present in the Outer district and to a lesser extent in the Eastern district. King crabs are distributed to depths of 200 fathoms, although the commercial fishery is generally confined to depths less than 100 fathoms. The favored bottom habitat appears to be mud or sand. Based on exploratory fishing cruise data by the National Marine Fishery Service, king crab appear to be most abundant in the deepwater region midway between Augustine Island and the Barren Islands.

Juveniles are more frequently encountered in nearshore, shallow waters. However, at this point, little is known of juvenile king crab distribution at greater depths. Juvenile king crab off Kodiak Island have been documented to depths of 58 fathoms.

LIFE HISTORY

King crab life history information is described in the generalized life history found in the Appendix. For information specific to Kachemak Bay, reference should also be make to the Alaska Department of Fish and Game, Habitat Protection Section's recent publication, "Kachemak Bay - A Status Report." The following discussion summarizes some of the highlights of Cook Inlet king crab life history.

Figure 2 depicts the general larval biology and timing of Kachemak Bay king crab. Larvae are present in the plankton from mid-February to late June. The larvae remain planktonic for approximately 30 to 40 days. The first demersal-benthic settling generally occurs from mid-April to late August, but is heaviest during July-August. Kachemak Bay king crab begin spawning in February with a peak in April. Kamishak Bay king crab may be slightly later.

Cook Inlet king crab undergo a seasonal migration consisting of an inshore movement in spring and summer and an offshore movement to deeper waters in fall and winter. In Kachemak Bay, the inshore spawning migration begins in late December and extends through May. Peak movement is in early March. Females may be slightly later. The average depth at

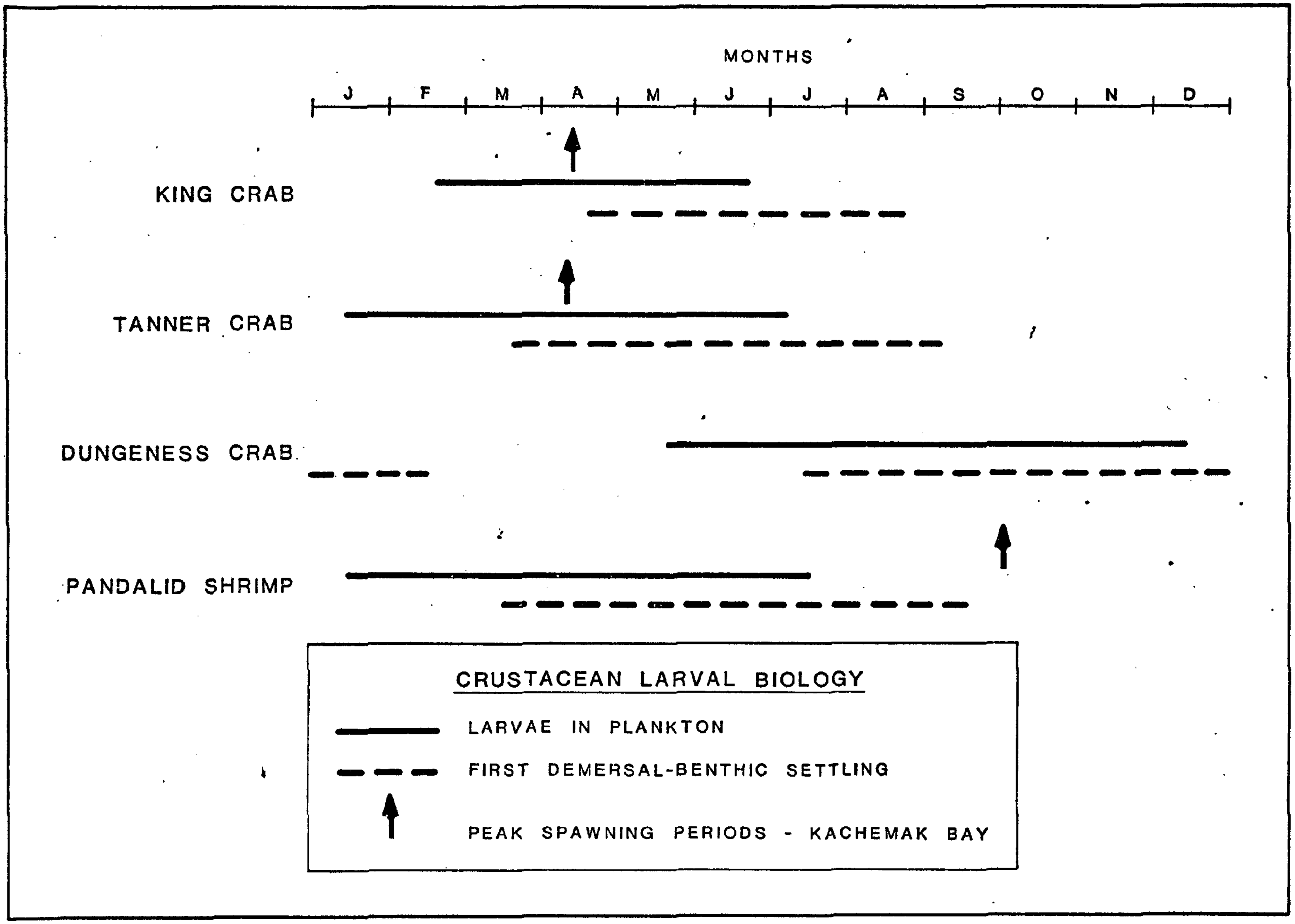


FIGURE 2. PLANKTONIC OCCURENCE OF CRUSTACEAN LARVAE, COOK INLET AREA, KACHEMAK BAY.

the end of this migration is 20 fathoms. Molting and spawning occur at this time. The offshore movement, sometimes termed the feeding migration, begins in September and extends through November. This movement is a slow, foraging one, rather than a direct movement to deeper water.

ABUNDANCE

Total population estimates for Cook Inlet king crab are not presently available. However, a population index program for Kachemak and Kamishak Bays indicates that the populations are fairly strong. A strong year class is expected to enter the commercial fishery in 1979.

MANAGEMENT AND RESEARCH

The commercial king crab season currently extends from August 1 to March 15 for all districts in Cook Inlet, unless closed by emergency order. The guideline harvest level for the Cook Inlet area is 5 million pounds, with a breakdown by district as follows:

Southern district	
Aug. 1-Dec. 31	1.0 million pounds
Jan. 1-Mar. 15	.5 million pounds
TOTAL	2.5 million pounds
Kamishak district	3.0 million pounds
Outer and Eastern districts	.5 million pounds
COOK INLET TOTAL	5.0 million pounds

Research activities consist primarily of tagging and a population index program for both Kachemak and Kamishak Bays. The tagging program is designed to provide distribution, timing, migration, growth, and fishing mortality information. The index program is based on a catch/pot relationship and is designed to provide relative index of abundance, a measure of year class strength, and a measure of female ovigerity. During the summer of 1976, experimental use of an underwater still camera censusing technique will begin in Kachemak Bay. If successful, this technique will provide population estimates.

Table 29. Commercial king crab catch, Cook Inlet area, in pounds 1960-1974. 1)

Year	Catch
1960	4,287,970
1961	4,324,118
1962	6,851,621
1963	8,386,983
1964	6,905,094
1965	2,814,465
1966	3,897,589
1967	3,117,430
1968	4,008,488
1969	2,855,534
1970	3,888,331
1971	4,157,633
1972	4,607,876
1973	4,384,651
1974	4,601,793

1) Source - A.D.F.&.G., Cook Inlet Catch Statistics, Final IBM run.

Table 30 . Commercial king crab catch, Cook Inlet area, by district, in pounds, 1960-1974. 1)

Year	Southern	Kamishak	Barren Islands	Outer	Eastern	Total
1960	4,239,775			48,195		4,287,970
1961	3,032,416	1,215,766		75,936 2/		4,324,118
1962	1,968,980	4,305,444		577,197 2/		6,851,621
1963	2,490,529	5,720,920		175,534		8,386,983
1964	2,032,920	4,852,176		19,998		6,905,094
1965	1,879,953	934,512				2,814,465
1966	1,910,364	1,949,569	16,395	21,261		3,897,589
1967	1,279,708	1,552,552		268,719	16,451	3,117,430
1968	996,520	2,815,731	154,975	41,262 2/		4,008,488
1969	1,302,554	1,349,222	83,080	120,678		2,855,534
1970	1,501,288	1,899,224	447,134	40,685		3,888,331
1971	1,251,142	2,302,583	586,374	17,534		4,157,633
1972	1,900,006	2,445,805	260,101	1,966 2/		4,607,876
1973	2,114,841	1,918,932	347,140	3,738		4,384,651
1974	1,565,493	2,720,702	309,886	3,910	1,802	4,601,793

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.
2) Includes Eastern district catches.

Table 31 . Commercial king crab catch, Cook Inlet area, by month, in pounds, 1960-1974. 1)

Month	1960	1961	1962	1963	1964	1965	1966
January	342,981	238,064	185,601	207,605	171,043	149,128	51,935
February	997,617	545,372	432,172	935,606	278,521	52,243	279,538
March	475,197	279,203	696,827	626,082	649,497	626,306	334,914
April	425,820	274,641	1,004,055	451,993	773,607	372,276	548,010
May	648,515	608,417	579,656	866,363	228,770	220,572	502,257
June	298,768	1,133,679	1,363,082	1,852,829	985,278	253,135	646,018
July	545,863	794,449	919,365	1,854,746	2,256,991	508,967	652,339
August	440,635	285,848	1,022,945	779,245	982,117	526,153	514,224
September	35,049	74,878	170,901	562,805	316,037	77,943	226,607
October	18,644	37,380	182,187	129,075	184,262	694	14,746
November	2,481	20,037	51,965	31,756	22,318	9,137	55,978
December	56,400	32,150	242,865	88,878	56,653	17,911	71,023
TOTAL	4,287,970	4,324,118	6,851,621	8,386,983	6,905,094	2,814,465	3,897,589

continued

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

Table 31 . (continued) Commercial king crab catch, Cook Inlet area, by month, in pounds, 1960-1974. 1)

Month	1967	1968	1969	1970	1971	1972	1973	1974
January	20,456	38,095	88,025	168,305	158,725	359,169	127,602	155,387
February	142,780	369,255	160,177	452,071	149,864	365,750	315,871	163,925
March	324,234	935,011			88,933	388,167	216,430	143,710
April	508,271	364,262						25,815
May	72,713	z 563						
June						5,682		
July	922,390							
August	788,405	1,163,756	1,171,892	1,586,575	1,583,654	1,350,600	2,251,849	2,975,034
September	247,824	642,104	1,042,398	756,080	1,078,204	981,939	571,509	932,087
October	69,179	325,920	292,852	478,644	369,318	224,161	284,968	51,653
November	11,788	109,899	8,045	328,209	579,556	385,751	432,590	51,707
December	9,390	59,623	92,145	118,447	149,379	546,657	183,832	102,475
TOTAL	3,117,430	4,008,488	2,855,534	3,888,331	4,157,633	4,607,876	4,384,651	4,601,793

Table 32 . Number of vessels actively fishing in the shellfish fisheries, Cook Inlet area, by type of fishery, 1960-1974. 1)

Year	King Crab	Tanner Crab	Dungeness Crab	Trawl Shrimp	Pot Shrimp
1960	60	2)	3)	3)	3)
1961	71	2)	3)	3)	3)
1962	70	1	3)	3)	3)
1963	50	2)	3)	3)	3)
1964	46	2)	3)	3)	3)
1965	23	2)	3)	3)	3)
1966	33	2)	3)	3)	3)
1967	34	2)	3)	3)	3)
1968	44	25	3)	3)	3)
1969	29	24	3)	2	3)
1970	41	25	9	3	8

continued

1) Source - A.D.F.&.G., Cook Inlet Annual Management Reports.
2) No fishery.
3) Not available.

Table 32 (continued). Number of vessels actively fishing in the shellfish fisheries, Cook Inlet area, by type of fishery, 1960-1974.

Year	King Crab	Tanner Crab	Dungeness Crab	Trawl Shrimp	Pot Shrimp
1971	54	40	21	4	11
1972	48	43	23	9	17
1973	63	80	51	10	41
1974	76	83	37	10	46

Table 33 . Value of commercial shellfish catch to the fishermen, Cook Inlet area, by species, in dollars, 1960-1974. 1)

Year	King Crab	Tanner Crab	Dungeness Crab	Shrimp	Razor Clam	Total
1960	422,000			35,000		457,000
1961	419,000			52,000		471,000
1962	685,000			27,000		712,000
1963	838,000			95,000		933,000
1964	677,000			30,000		707,000
1965	278,000			4,000		282,000
1966	390,000			15,000		405,000
1967	322,000			37,000		359,000
1968	1,000,000	16,000		1,000		1,017,000
1969	700,000	148,000		83,000		931,000
1970	1,000,000	136,000	29,200	258,000		1,423,200
1971	1,164,000	169,000	17,500	286,000	3,300	1,639,800

continued

1) Source - A.D.F.&G., Cook Inlet Stock Status Report, unpublished

2) Preliminary, estimated value.

Table 33 . (continued) Value of commercial shellfish catch to the fishermen, Cook Inlet area, by species, in dollars, 1960-1974. 1)

Year	King Crab	Tanner Crab	Dungeness Crab	Shrimp	Razor Clam	Total
1972	1,540,000	728,000	15,200	320,000	5,300	2,608,500
1973	3,700,000	1,447,351	186,029 2/	479,000	13,766 2/	5,826,146
1974	2,162,843	1,532,179	396,684	1,437,230		5,528,936

COOK INLET TANNER CRAB FISHERIES

COMMERCIAL FISHERIES

The commercial tanner crab fishery started on a sustained basis in Cook Inlet in 1968 after a brief attempt in 1962. In 1968, 25 boats landed approximately 151,000 pounds. Catches rose rapidly and in 1972 exceeded 4.8 million pounds. A record harvest of 8.5 million pounds was landed in 1973. In 1974, the harvest dropped slightly but remained high at 7.7 million pounds (Table 34). The rapid expansion in this fishery resulted from improved market conditions and a growing interest on the part of king crab fishermen to diversify. The number of boats engaged in the fishery increased from 25 in 1968 to 80 in 1973 (Table 32).

The value of the tanner crab catch to the fishermen has risen rapidly as the fishery has expanded. In 1968 the catch was worth $16,000 to the fishermen, while in 1974 the value had risen to $1,532,179 (Table 33).

DISTRIBUTION

Tanner crab, Chionoecetes bairdi, are distributed in all districts of Cook Inlet south of Anchor Point. Stocks are also present in the Eastern and Outer districts. C. bairdi is found from the littoral zone to depths of 300 fathoms. Based on exploratory fishing cruise data by the National Marine Fishery Service, tanner crab appear to be most abundant in the deep water region midway between Augustine Island and the Barren Islands.

Juveniles are frequently encountered in the nearshore, shallow waters. Concentrations of mature male and female tanner crab appear to school separately from each other except when mating.

LIFE HISTORY

Tanner crab life history information is described in the generalized life history found in the Appendix. For information specific to Kachemak Bay, reference should also be made to the Alaska Department of Fish and Game, Habitat Protection Section's recent publication "Kachemak Bay-A Status Report." The following discussion summarizes some of the highlights of Cook Inlet tanner crab life history.

Migratory information for Cook Inlet tanner crab populations is largely unavailable. Tanner crab appear to migrate seasonally, moving into deeper water in the fall and winter and into shallower water, for molt and spawning, with the onset of spring and summer.

Within Kachemak Bay, tanner crab larvae are most abundant from late May through mid June, with the band of greatest abundance extending due east to Homer Spit from a point due south of Anchor Point. Inner Kachemak Bay does not appear to be a major nursery area. Currently little is known of larval distribution in the remainder of Cook Inlet.

Figure 2 depicts the general larval biology and timing of Kachemak Bay tanner crab. Larvae are present in the plankton from mid-January to mid-July. The larvae remain planktonic for approximately 60 days. The first dermersal benthic settling generally occurs from mid-March to mid-September. Spawning appears to begin in January, peaking in mid-April in Kachemak Bay and approximately mid-May in Kamishak Bay.

ABUNDANCE

Total population estimates for Cook Inlet tanner crab are not presently available. However, as an indicator of population trends, the 1975 index for Kachemak Bay derived through a catch per unit effort (CPUE) sampling program, was higher than the 1974 estimate, which was the lowest since the inception of the fishery.

MANAGEMENT AND RESEARCH

The commercial tanner crab season currently runs from December 1 to April 30 in the Southern, Outer, and Eastern districts. The Kamishak district season runs from December 1 to May 31. Guideline harvest levels for tanner crab are as follows:

Southern district	3 million pounds
Kamishak and Barren Islands districts	4.5 million pounds
Outer and Eastern districts	3.5 million pounds
TOTAL	11.0 million pounds

Research activities consist primarily of tagging, trawl surveys, SCUBA surveys, and an index program. The tagging program is designed to provide distribution, timing, migration, and fishing mortality information. Trawl surveys were first tried in Kachemak Bay and have now been extended to Kamishak Bay. These surveys are designed to provide a sample of the entire population, whereas sampling of the commercial catch is biased toward commercial sized crab. SCUBA surveys are conducted to provide information on molt timing, breeding timing, and on growth per molt. The index program is conducted in both Kachemak and Kamishak Bays and is based on a catch/pot relationship. It is designed to provide a relative index of abundance, a measure of size class strength, and a measure of female ovigerity.

During the summer of 1976, experimental use of an underwater still camera censusing technique will begin in Kachemak Bay. If successful, this technique will provide population estimates.

Table 34. Commercial tanner crab catch, Cook Inlet area, in pounds, 1962-1974. 1) 2)

Year	Catch
1962	3,404
1968	150,949
1969	1,455,269
1970	1,328,694
1971	2,116,849
1972	4,807,843
1973	8,513,829
1974	7,660,895

1) Source - A.D.F.&G, Cook Inlet Catch Statistics, Final IBM Run.

2) No commercial catch reported prior to 1962 or between 1963-1967.

Table 35 . Commercial tanner crab catch, Cook Inlet area, by district, in pounds, 1962-1974. 1) 2)

Year	Southern	Kamishak	Barren Islands	Outer	Eastern	Total
1962	3,404					3,404
1968	146,491	2,969		1,489		150,949
1969	1,436,680	14,987	2,786	816		1,455,269
1970	1,152,609	68,167	1,985	1,824	104,109	1,328,694
1971	1,186,488	804,572	4,626	1,258	119,905	2,116,849
1972	2,942,082	1,158,468	676	174,531	532,086	4,807,843
1973	3,763,060	3,451,574	35,664	578,290	685,241	8,513,829
1974	1,129,099	3,863,059	776,054	1,285,013	606,008	7,660,895

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

2) No commercial catch reported prior to 1962 or between 1963-1967.

Table 36 . Commercial tanner crab catch, Cook Inlet area, by month, in pounds, 1962-1974. 1) 2)

Month	1962	1968	1969	1970	1971	1972	1973	1974
January			38,993	61,394	29,561	169,088	236,609	372,253
February		6,284	128,610	161,180	113,116	163,554	881,302	596,653
March		8,647	298,678	289,044	228,196	1,053,548	1,536,267	1,327,762
April		35,565	474,234	414,261	365,900	732,614	1,774,137	3,757,034
May	3,404	80,375	161,753	363,055	406,973	1,019,085	1,554,901	1,508,687
June		5,420	288,752	21,824	431,472	911,797	1,284,060	69,229
July			41,950		271,949	172,460	48,527	
August		608				1,688		
September		490			728	3,226	60	
October		1,570	10,516	1,304	930	25,852		
November		1,514		835	75,027	258,585	861,777	
December		10,476	11,783	15,797	192,997	296,346	336,189	29,277
TOTAL	3,404	150,949	1,455,269	1,328,694	2,116,849	4,807,843	8,513,829	7,660,895

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

2) No commercial fish catch reported prior to 1962 or between 1963-1967.

COOK INLET DUNGENESS CRAB FISHERIES

COMMERCIAL FISHERIES

The dungeness crab commercial fishery started on a sustained basis in Cook Inlet in 1961 after some sporadic attempts in the 1950's. Ten boats fished out of Seldovia and Homer in 1961 and landed approximately 194 thousand pounds. Catches rose rapidly and in 1963 peaked at 1.7 million pounds. Following the loss of processing facilities from the 1964 earthquake and a generally declining market, catches fell off drastically in the mid 1960's. In recent years, the catch has continued to fluctuate sporadically and is largely attributable to West Coast market conditions which dictate the demand for Alaskan dungeness crab. Good dungeness crab landings in Washington, Oregon and California make it economically infeasible for Alaska caught dungeness to compete for the major markets of the West Coast. The 1974 catch, which was a good year for the Alaska dungeness fishery, was approximately 721,000 pounds (Table 37).

The average value of the 1970-1974 catch to the fishermen is $129,000. The 1974 catch was worth $397,000 to the fishermen (Table 33).

DISTRIBUTION

Cook Inlet dungeness crab are distributed in the shallow nearshore waters of the Inlet south of Anchor Point and in the Outer and Eastern districts. Although dungeness crab are known to be distributed in Kamishak district, their extent and range here is presently unknown. Dungeness crab inhabit bays, estuaries, and open ocean near the coast from the intertidal zone to depths of 50 fathoms. Favored substrate is a sand or sand-mixed bottom, although dungeness may be found on almost any bottom substrate. Juveniles are commonly associated with stands of eelgrass or masses of detached algae.

A major concentration of large ocean dungeness crab exists off the Bluff Point area at the entrance to Kachemak Bay. The larger size and better quality of this stock of crab makes them competitive with the West Coast dungeness crab fishery.

LIFE HISTORY

Dungeness crab life history information is described in the generalized life history found in the Appendix. The following discussion pertains only to specifics of Kachemak Bay dungeness crab.

Migration of dungeness crab within Kachemak Bay appears to be somewhat limited. Based on summer tagging operations, dungeness crab released just northeast of Homer Spit moved up the bay while crab released southwest of the spit (Barabara Point, Seldovia Bay) moved in a southwesterly direction. The majority of the returns were located at release points indicating no movement. This data, however, is limited and not conclusive. There also appears to be a seasonal movement of the Bluff Point stock, with crab moving from south to north into the shallow waters off Bluff Point in spring and summer for molting and mating; then south into deeper waters in fall and winter.

Isolated bay stocks of dungeness crab appear to be relatively stationary, apparently not migrating out of the bays. Most of these bays, in cross sectional profile, contain both a shallow shelf along the shoreline and a deep basin. The entire seasonal migration appears to occur within the bays, between the deep and shallow areas. In shallow bays, without deep basins for overwintering, it has been documented that some dungeness crab burrow into the bottom mud and overwinter in that fashion.

Figure 2 depicts the general larval biology and timing of Kachemak Bay dungeness crab. Larvae are present in the plankton from mid-May to mid-December. The larvae remain planktonic for approximately 60 days. The first demersal-benthic settling generally occurs from mid-July to mid-February. Spawning timing for Kachemak Bay dungeness crab is not presently known, however, based on the observation of soft-shelled crabs, spawning appears to occur from May to October.

ABUNDANCE

Total population estimates for Cook Inlet dungeness crab are not presently available. However, a research program, utilizing an underwater still camera censusing technique, is proposed for the Bluff Point area in 1976 and may provide total population estimates for that area.

As an indicator of population trends, the 1975 catch per unit effort (CPUE) was approximately half of the 1974 peak year CPUE.

MANAGEMENT AND RESEARCH

There is currently no closed season on the commercial harvest of dungeness crab for most of the Cook Inlet area. However, from May 1 through August 31, dungeness crab may not be taken in Kachemak Bay northeast of a line extending from Coal Point to the northeast tip of Glacier Spit. There is presently no guideline harvest level for the dungeness fishery.

Research activities primarily consist of a tagging program which is designed to provide distribution, migration, timing and fishing mortality information. In addition, an underwater still camera censusing technique is experimentally being used in the Bluff Point area during the summer of 1976. If successful, this technique will provide total population estimates.

Table 37 . Commercial dungeness crab catch, Cook Inlet area, in pounds, 1961-1974. 1)

Year	Catch
1961	193,683
1962	530,770
1963	1,677,204
1964	423,041
1965	74,211
1966	129,560
1967	7,168
1968	487,859
1969	49,894
1970	209,819
1971	97,161
1972	38,930
1973	310,048
1974	721,243

Table 38 . Commercial dungeness crab catch, Cook Inlet area, by district, in pounds, 1961-1974. 1)

Year	Southern	Kamishak	Barren Island	Outer	Total
1961	193,683				193,683
1962	530,770				530,770
1963	1,665,599			11,605	1,677,204
1964	417,005			6,036	423,041
1965	74,211				74,211
1966	12,523	117,037			129,560
1967	7,168				7,168
1968	484,452			3,407	487,859
1969	49,894				49,894
1970	209,819				209,819
1971	97,161				97,161
1972	38,930				38,930
1973	308,777	57	260	954	310,048
1974	718,729	60		2,454	721,243

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

Table 39 . Commercial dungeness crab catch, Cook Inlet area, by month, in pounds, 1961-1974. 1)

Month	1961	1962	1963	1964	1965	1966	1967
January	699		3,379	1,492			
February		10,090	609	170			
March			37,240	1,984			
April	290		37,810	3,004			
May	664	1,963	231,725	17,672	466	2,836	1,776
June	442	11,502	262,645	66,979	11,029	7,651	1,776
July		30,167	296,061	62,587	13,389		
August		67,811	247,915	77,623	7,607	48,345	
September		165,407	271,376	120,929	27,192	69,875	90
October	54,965	188,317	258,822	64,346	9,318		3,831
November	136,623	21,868	24,665	6,255	4,008	853	
December		6,645	4,957		1,202		
TOTAL	193,683	530,770	1,677,204	423,041	74,211	129,560	7,168

continued

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

Table 39 (continued). Commercial dungeness crab catch, Cook Inlet area, by month, in pounds, 1961-1974.

Month	1968	1969	1970	1971	1972	1973	1974
January		488			60	3,727	4,609
February		25			1,620	703	975
March		335	115		36	158	3,227
April		1,346				4,032	468
May	137	1,833		1,745		11,429	5,674
June		3,987	7,889	11,271	1,715	13,696	16,185
July	84,480	13,898	15,009	21,818	5,336	7,861	114,779
August	182,393	14,876	37,597	17,049	3,568	8,224	217,570
September	123,510	13,106	95,571	20,287	5,085	36,069	201,958
October	66,841		52,265	15,951	4,517	147,502	98,803
November	30,482		1,373	7,221	7,031	68,243	52,803
December	16			1,819	9,962	8,404	4,192
TOTAL	487,859	49,894	209,819	97,161	38,930	310,048	721,243

COOK INLET SHRIMP FISHERIES

COMMERCIAL FISHERIES

The shrimp fisheries in the Cook Inlet area are based on several species of pandalid shrimp. The trawl fishery, exploiting primarily pink and humpy shrimp, began in 1958 and has grown rapidly. The 1963 harvest of 1.9 million pounds represented the peak of the fishery prior to the 1964 earthquake, when processing facilities in Seldovia and Seward were destroyed. Five years elapsed before significant effort in this fishery resumed in 1969. Catches averaged 5.2 million pounds between 1970 and 1974 (Table 41). Nearly all trawl catches are made in Kachemak Bay, although in recent years a minor trawl fishery has developed in the Outer district. During recent years trawl effort has been basically limited to three boats fishing the entire season, although more vessels fish part of the season.

A small shrimp pot fishery, harvesting primarily coonstripe and some sidestripe shrimp, has existed since early statehood but did not start up on a significant basis until 1971 when approximately 56 thousand pounds were landed. This fishery has expanded and in 1974 landed a record catch of approximately 677 thousand pounds (Table 43). Nearly all pot catches are made in Kachemak Bay in the Southern district, although in recent years a minor pot fishery has developed in the Outer district. The number of vessels participating in the fishery has increased from 11 in 1971 to 46 in 1974 (Table 32).

The value of all shrimp fisheries to the fishermen has risen rapidly as the fisheries have expanded. The value of the 1974 catch to the fishermen was in excess of 1.4 million dollars (Table 33).

DISTRIBUTION

Pandalid shrimp are distributed in all districts of Cook Inlet south of Anchor Point. Stocks are also present in the Eastern and Outer districts. Major concentrations are present in Kachemak Bay and in the deep waters off of Cape Douglas. Habitat and depth preferences for each of the commercially sought pandalid shrimp species is presented in the generalized life history found in the Appendix.

Within Kachemak Bay there are over 75 square miles of habitat with commercial quantities of pandalid shrimp. Shrimp are distributed throughout the area but are found in quantity in waters deeper than 10 fathoms. A migrational movement within Kachemak Bay occurs, with shrimp moving into a deep water hole, 80 fathoms deep, off Yukon Island in February and March. They remain here until March and April, while the females drop their eggs, and then disperse throughout the bay.

LIFE HISTORY

Life history information for all of the commercially exploited pandalid shrimp species in Cook Inlet is described in the generalized life history found in the Appendix. For information specific to Kachemak Bay, reference should also be made to the Alaska Department of Fish and Game, Habitat Protection Section's recent publication, "Kachemak Bay-A Status Report." The following discussion summarizes some of the specifics of Kachemak Bay shrimp life history.

Figure 2 depicts the general larval biology and timing of Kachemak Bay shrimp. Larvae are present in the plankton from mid January to mid July. The larvae remain planktonic for approximately 60 days. The first demersal benthic settling generally occurs from mid March to mid September. Spawning occurs from late September through mid October.

Egg bearing females begin dropping their eggs in late March and April.

ABUNDANCE

The present trawl fishery is utilizing a healthy shrimp stock. Biological data indicates the population should maintain at least the present harvest level. Since 1969, a log book program has been maintained on the Kachemak Bay shrimp trawl fishery. Data from this program during recent years has shown a general increase in the catch per unit effort (CPUE), indicating a healthy stock.

Comparative CPUE data for the Kachemak Bay shrimp pot fishery is not available. However, recent investigations indicate the population is healthy and should be able to maintain the current harvest guideline of 600,000 pounds.

Population estimates for Kachemak Bay shrimp, primarily pink and humpy, for 1971 to 1975 are presented in Table 45 .

MANAGEMENT AND RESEARCH

The commercial shrimp trawl fishery runs from June 1 through March 31, unless closed earlier by emergency order. There is no closed season for the shrimp pot fishery. Guideline harvest levels have been established only for Kachemak Bay inside a line from Point Pogibshi to Anchor Point. For the pot fishery, the harvest guidelines are 100,000 pounds between June 1 and September 30 and 50,000 pounds between October 1 and May 31. The harvest guidelines for the trawl fishery are 2,500,000 pounds between June 1 and October 31 and 2,500,000 pounds between November 1 and March 31.

Commercial catch sampling is conducted in all districts where landings are made. Catch sampling is designed to provide species composition, age, and fecundity information. Other research activities are limited to Kachemak Bay and include a population index program for trawl caught shrimp. The index program provides population estimates, species abundance, and age class abundance of trawl caught shrimp.

Table 40. Commercial shrimp catch, Cook Inlet area, in pounds, 1962-1974. 1)

Year	Catch 2)
1962	403,108
1963	1,897,624
1964	601,411
1965	61,708
1966	309,676
1967	741,438
1968	26,448
1969	1,849,710
1970	5,817,633
1971	5,451,340
1972	5,548,567
1973	4,876,804
1974	5,748,919

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

2) Includes pot and trawl shrimp catches.

Table 41 . Commercial trawl shrimp catch, Cook Inlet area, by district, in pounds, 1962-1974. 1)

Year	Southern	Kamishak	Outer	Eastern	Total
1962	344,251		57,760	720	402,731
1963	1,896,097			1,483	1,897,580
1964	566,917	32,748			599,665
1965	61,004				61,004
1966	285,976				285,976
1967	732,888				732,888
1968	25,237				25,237
1969	1,849,579				1,849,579
1970	5,808,160				5,808,160
1971	5,382,426		13,024		5,395,450
1972	5,284,557		75,654	16,970	5,377,181
1973	4,385,375		164,429		4,549,804
1974	4,692,000	25,846	264,976	80,892	5,063,714

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

Table 42 . Commercial trawl shrimp catch, Cook Inlet area, by month, in pounds, 1962-1974. 1)

Month	1962	1963	1964	1965	1966	1967
January		220,815			17,830	118,890
February					9,611	200,193
March		112,781			4,427	53,555
April		207,073	64,735			107,160
May	27,910	499,529	295,974			
June	90,870	294,521	136,959			33,885
July	49,256	417,907				208,985
August	47,055	144,954	101,997			
September	16,917			3,811		10,220
October				6,419	32,553	
November				35,893	119,145	
December	170,723			14,881	102,410	
TOTAL	402,731	1,897,580	599,665	61,004	285,976	732,888

continued

1) Source - A.D.F.&G., Cook Inlet catch Statistics, Final IBM Run.

Table 42 (continued) Commercial trawl shrimp catch, Cook Inlet area, by months, in pounds, 1962-1974.

Month	1968	1969	1970	1971	1972	1973	1974
January		1,130	215,036	102,836	405,730	450,873	1,209,366
February		3,272	448,856	446,136	641,653	443,266	156,524
March		1,870	494,894	979,136	170,868	102,614	328,332
April		11,927	550,731	466,265	77,133	49,625	
May	11,335	4,661	338,599	160,617	77,318		
June	1,310	103,895	665,715	434,045	539,482	615,078	437,331
July		158,178	852,132	484,362	544,454	1,086,344	613,168
August		252,434	766,600	590,902	569,364	727,595	478,953
September		345,296	603,117	624,807	471,921	73,137	790,173
October	10,478	432,848	324,360	488,492	651,547		193,139
November	1,970	219,791	386,352	457,822	618,781	431,023	431,827
December	144	314,277	161,768	160,030	608,930	570,249	424,901
TOTAL	25,237	1,849,579	5,808,160	5,395,450	5,377,181	4,549,804	5,063,714

Table 43 . Commercial pot shrimp catch, Cook Inlet area, by district, in pounds, 1962-1974. 1)

Year	Southern	Outer	Eastern	Total
1962	377			377
1963	44			44
1964	1,746			1,746
1965	704			704
1966	23,700			23,700
1967	8,550			8,550
1968	793		418	1,211
1969	131			131
1970	7,108		2,365	9,473
1971	55,665	225		55,890
1972	165,941	5,297	148	171,386
1973	324,111	2,889		327,000
1974	676,978	8,227		685,205

1) Source - A.D.F.&.G., Cook Inlet Catch Statistics, Final IBM Run.

Table 44 . Commercial pot shrimp catch, Cook Inlet area, by month, in pounds, 1962-1974. 1)

Month	1962	1963	1964	1965	1966	1967	1968	1969
January								
February								
March								
April					72			
May					167			
June					424		418	131
July						8,550		
August			276					
September			1,046				216	
October	169	44	424	699			244	
November				5	11,757		189	
December	208				11,280		144	
TOTAL	377	44	1,746	704	23,700	8,550	1,211	131

continued

1) Source - A.D.F.&G., Cook Inlet Catch Statistics, Final IBM Run.

Table 44 (continued) Commercial pot shrimp catch, Cook Inlet area, by month, in pounds, 1962-1974. 1)

Month	1970	1971	1972	1973	1974
January	120		1,494	13,883	61,213
February	860		1,463	35,585	48,290
March	1,024		14,879	18,964	203,161
April	361	960	7,879	32,780	259,209
May	540	3,680	7,994	22,818	29,992
June	401	2,872	23,211	20,239	17,813
July	1,706	260	24,191	11,946	17,217
August	1,115	4,945	11,752	20,036	8,955
September	384	759	16,241	11,417	5,210
October	2,471	13,476	3,242	34,088	8,067
November	491	26,720	29,288	66,864	10,898
December		2,218	29,752	38,380	15,180
TOTAL	9,473	55,890	171,386	327,000	685,205

Table 45 . Shrimp population estimates, Cook Inlet area, Kachemak Bay, calculated from trawl surveys, in pounds, 1971-1975. 1)

Year	Mean Catch	Pop. Est.	Range-Mill. of lbs.		% Error
1971 2)	118.34	3,370,411.1	2.639	4.102	21.7%
1972 2)	271.17	7,723,260.6	4.982	10.465	35.5%
1973 2)	602.29	17,153,972.1	12.334	21.974	28.1%
1974 2)	435.9	12,414,976.9	9.485	15.345	23.6%
1975 3)	1,149.5	16,369,598.4	12.032	20.708	26.5%

1) Source - A.D.F.&G., File Data, Homer.

2) 66" Nordby net 75 mi^2, 50% net efficiency, 32' width.

3) 61' High opening net 75 mi^2, 100% net efficiency, 32' width.

COOK INLET SCALLOP FISHERIES

COMMERCIAL FISHERIES

There is no commercial scallop fishery in the Cook Inlet area at the present. Commercial fishing for scallops is not allowed in most of the area, including Kachemak and Kamishak Bays and the inshore waters of the Outer district. The only historical fishery was in 1969, when 240 pounds were harvested in the Kamishak district.

DISTRIBUTION

Weathervane sea scallops, the desired commercial scallop species in the Gulf of Alaska, occur throughout the Cook Inlet area south of Anchor Point and in the Outer district. Exploratory surveys in Cook Inlet indicate that the greatest abundance is in the Kamishak district between Augustine Island and the Barren Islands. Weathervane sea scallops are most abundant in depths of thirty to seventy fathoms. Gravel and sand, with some mud, is typical of commercially exploited Alaska scallop beds.

Little is known of the distribution and abundance of scallops in more rocky areas, due to the difficulty of trawling in such areas.

LIFE HISTORY

Life history information specific to the Cook Inlet area is not available. However, studies conducted in the Yakutat and Kodiak areas indicate that weathervane sea scallops spawn only once annually, with spawning occurring during June and early July. Scallops do not move to special areas for breeding. Most weathervane sea scallops attain sexual maturity at age three, with all mature by age four.

Additional life history information is detailed in the generalized life history found in the Appendix.

ABUNDANCE

Present data suggests that Cook Inlet weathervane sea scallops are not abundant and may not be available in commercial quantities. A scallop fishery, if proposed, would probably support only a few vessels.

MANAGEMENT AND RESEARCH

Present management restricts the commercial harvest of scallops in Cook Inlet north of a line from Cape Douglas to Point Adams. In addition, fishing is restricted in the inshore waters of the Outer district. These closures are designed to prevent possible conflicts with the crab fisheries.

Research priorities include: 1) further identification of commercial scallop beds within the Cook Inlet area, 2) estimates of abundance, 3) determination of sustainable harvest levels if commercial quantities of scallops are available, and 4) investigation of potential scallop gear conflicts with the crab fisheries.

COOK INLET RAZOR CLAM FISHERIES

COMMERCIAL FISHERIES

Commercial exploitation of razor clams within the Cook Inlet area has been sporadic since early in this century. A peak was reached in 1922 when slightly over 1 million pounds were canned, largely from 1.5 square miles of beach on the western side of the Inlet between Chisik Island and Harriet Point. Sporadic catches continued through 1962, with a harvest of approximately 171 thousand pounds that year. In 1963, the Alaska Department of Health and Welfare declared all beaches in Alaska suspect of containing poisonous shellfish, and commercial utilization of clams, mussels, and similar shellfish species was strictly forbidden unless the harvest areas were approved and certified by that department. During the following seven years all clam growing areas in Alaska remained technically closed and unapproved for commercial utilization due to insufficient funds, equipment, personnel, and testing facilities essential for the establishment of a proper shellfish sanitation program. In 1970 the Polly Creek area was again certified for commercial utilization. Currently, a small commercial operator has harvested razor clams in the Polly Creek vicinity since 1971. The reported harvest for 1971 was 15,151 pounds. No catch was reported in 1974. The value of the 1972 harvest to the fishermen was $3,300. The 1973 harvest was valued at $5,300 to the fishermen (Table 33).

There is presently no closed season on the commercial harvest of razor clams. However, almost all of the annual harvest is normally made from May through July, prior to July-August spawning. Polly Creek on the westside of Cook Inlet is the only legal beach. Although both mechanical and hydraulic harvest equipment is allowed, most clams are taken by hand operated shovels.

DISTRIBUTION

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

Razor clams are found intertidally to several fathoms in depth on sandy, surfswept beaches that are low in gravel and clay. They require exposure to the open ocean, and are not found in water of low salinity or high temperature.

LIFE HISTORY

Razor clam life history information is described in the generalized life history found in the Appendix. Cook Inlet razor clams, however, differ from this generalized outline in at least two respects. First, spawning appears to occur from mid-July through mid-September, rather than July-August. Secondly, Cook Inlet razor clams appear to grow much faster than those of Prince William Sound or Kodiak. Cook Inlet razor clams reach sexual maturity in their third year, as opposed to five and six years for Kodiak and Prince William Sound clams, respectively.

ABUNDANCE

No estimates of total population are available for the Polly Creek commercial razor clam beds. However, based on subjective observations, the razor clam resource could probably sustain a much higher level of exploitation.

MANAGEMENT AND RESEARCH

There are presently no seasons or harvest limits imposed upon the razor clam commercial fishery. No regulation is required due to low levels of effort and a healthy razor clam resource. If market conditions improve and effort increases, direct management may be necessary.

COOK INLET HARDSHELL CLAM FISHERIES

A one family operated cannery at Kasitna Bay, near McDonald spit in the Southern district, has been canning butter clams under "grandfather's" rights and has a history of Alaska Department of Health and Social Services monitored production. Annual production records are not currently available.

Hardshell clams are distributed throughout Cook Inlet from the Kenai River south. Specific distributions vary by species. Generalized life history and distribution information for butter clams and cockles is presented in the Appendix.

COOK INLET AREA SUBSISTENCE FISHERIES

DESCRIPTION

All five species of Pacific salmon are utilized in the Cook Inlet area for subsistence purposes. Since statehood, all subsistence salmon fishing has been in conformance with commercial regulations and, therefore, the areas open and methods used have been identical to those in the commercial fishery. Reported subsistence catches in this area for the years 1962-1974 are given in Table 46. King crab, tanner crab, dungeness crab, shrimp, smelt, herring, bottom fish, and clams are also utilized. However, records are not available on the degree of utilization.

ECONOMIC CONDITIONS IN THE AREA

No figures are available on the average income of those applying for subsistence permits in the Cook Inlet area. It is the personal opinion of the area management biologist that less than 5 or 10% of the subsistence fishing in the area is carried out by persons in such financial positions that they actually have a legitimate need of the resource harvested in order to subsist. The type of subsistence fishing found in the Cook Inlet area could more appropriately be classified as recreational or supplemental fishing. Many people regard it as a form of sport fishing in which they not only derive recreational benefits but at the same time supplement their food stocks.

METHODS OF FISHING

A variety of subsistence fishing methods are used in the Cook Inlet area, as it is a multi-species utilization area. Currently set nets, seines and drift nets are used for harvesting salmon with set nets accounting for about 95% of the effort. Prior to statehood, much of the subsistence fishing took place in salmon spawning streams with gear ranging from hook and line to gill nets. Snagging was one of the more popular methods.

Both gill nets and dip nets have been used in the Cook Inlet area for taking smelt, however, in 1972 dip nets became illegal gear for taking smelt in the waters of the Kenai Peninsula. A limited amount of hook and line snagging for smelt also exists.

The gear most commonly utilized for freshwater species is small mesh gill nets and seines. In the past, fishwheels and dip nets have also been used in freshwater.

PROBLEMS

As in other areas of the state, the subsistence fishing in Cook Inlet is more recognized as a recreational fishery than as a subsistence fishery. However, it is the personal opinion of the area biologist that a need exists for subsistence fishing in Cook Inlet and that it should continue, perhaps with some modifications. The 5 or 10% of the people who actually have a legitimate need to subsistence fish should not be denied this right just because the fishery has become recreationally oriented.

A subsistence permit or licensing system has been proposed to eliminate some of those who are participating more for recreation than need. It has been estimated that this type of measure would probably reduce subsistence fishing by 75% in the Cook Inlet area and subsistence fishing would again conform with the true meaning of subsistence.

Table 46 Subsistence salmon catch, Cook Inlet area, by year, in numbers of fish, 1962-1974 1/2/.

Year	Permits Issued	Permits Returned	King	Sockeye	Coho	Pink	Chum	Total
1962 3/	192	179	45	770	3,574	417	391	5,197
1963	229	216	29	859	2,510	447	424	4,269
1964	191	183	--	393	2,463	368	207	3,431
1965	190	162	--	484	2,109	49	285	2,927
1966	330	301	8	1,656	3,533	598	356	6,151
1967	375	333	4	863	3,105	73	213	4,258
1968	386	332	10	1,009	4,201	1,170	236	6,626
1969	447	395	--	1,518	2,011	68	94	3,691
1970	449	407	3	1,218	3,371	438	152	5,182
1971	168	133	2	23	1,697	44	7	1,773
1972	170	136	1	29	1,030	75	84	1,219
1973	266	221	--	53	1,636	96	77	1,862
1974	256	199	1	30	667	60	79	837

1) Source - A.D.F.&G., Cook Inlet Management Area Subsistence Fishery Report, Report to the Board of Fish and Game, April, 1973 and Annual Management Reports.
2) These represent actual figures and have not been extrapolated to reflect a "real" subsistence catch value.
3) Subsistence catch and effort data not available prior to 1962.

COOK INLET AREA SPORT FISHERIES

INTRODUCTION

Description of the Region

The Cook Inlet area covers all freshwater drainages and marine waters within Cook Inlet from Point Adam and Cape Douglas north to the Susitna River drainage below Devil's Canyon (Figure 3). The area is distinguished by mountainous bays in its exposed south, while most of north Cook Inlet is comprised of swampy forelands and floodplains. Lowland lakes and ponds are numerous. Streams are generally low gradient and less than 50 miles long. The coastline is fairly regular but is cut by several large bays or arms. These are Kachemak Bay, Turnagain and Knik Arms, and Kamishak Bay. The climate is maritime, with mild winters and summers. Precipitation is light, averaging 20-25 inches annually.

Distribution of Fish Species

Cook Inlet area's sport fish distribution and relative abundance are listed in Table 47. The area has the most varied representation of sport fish species in Alaska. Known distribution is marked on the maps.

SPORT FISH LIFE HISTORY AND HABITAT

Life history information specific to sport fish is limited, however, the information in the Appendix is generally applicable. Documented habitat and life history information specific to the region is discussed below by species.

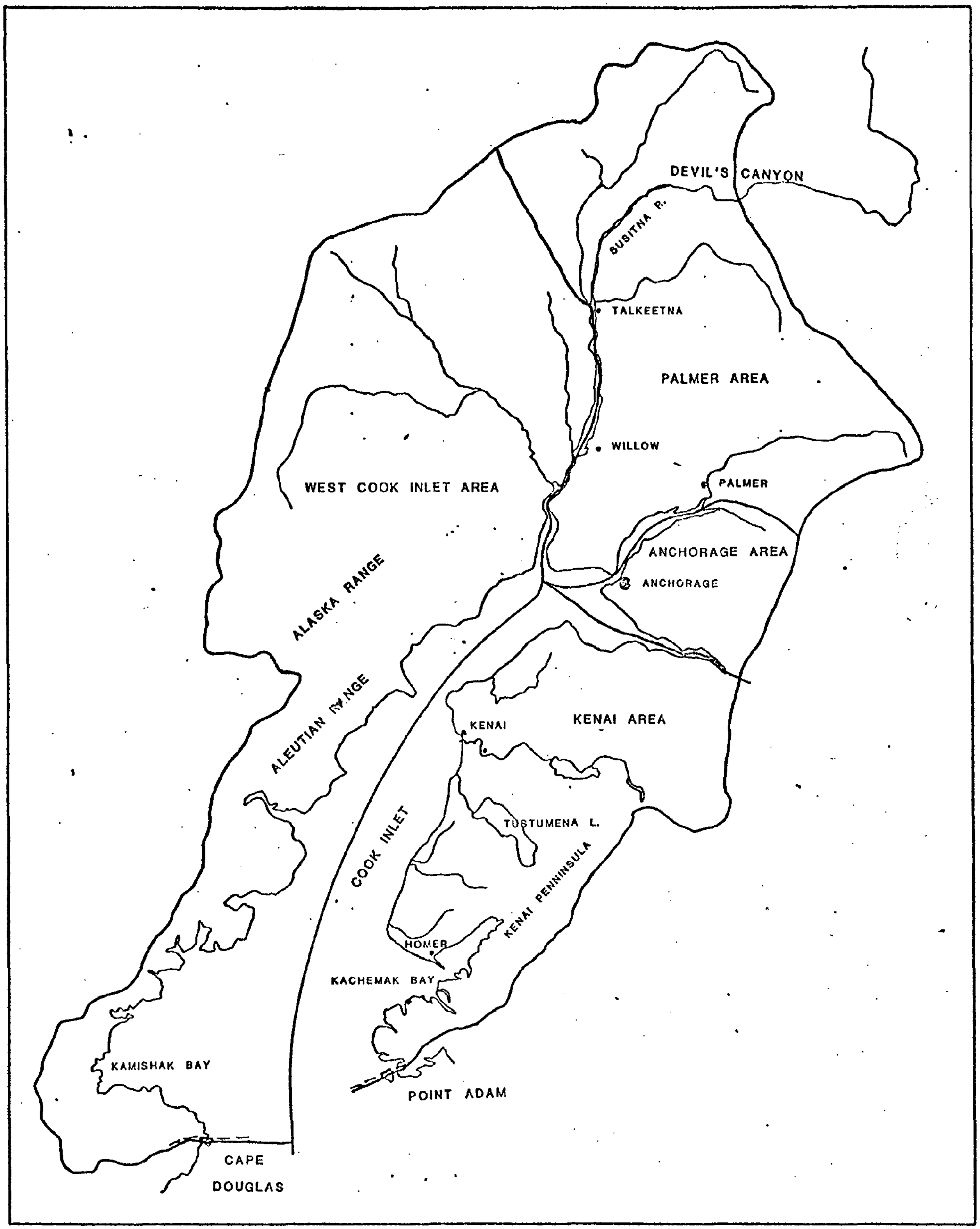


FIGURE 3. COOK INLET REGION WITH KENAI, ANCHORAGE, PALMER, AND WEST COOK INLET SPORT FISHING AREA

Dolly Varden

Dolly Varden (Salvelinus malma) distribution is uneven over Cook Inlet with anadromous populations found on the Kenai Peninsula and in some west side streams. The upper Kenai River and lower Susitna River drainages contain stunted resident Dolly Varden. These fish have earned the nickname "goldenfins" because of their unique coloring. Resident fish are found in all Susitna River tributaries below Montana Creek, and a number of streams above, but no anadromous populations are found anywhere in upper Cook Inlet.

The timing of migratory movements for Kenai Peninsula anadromous Dolly Varden has been studied at Anchor River. Large, mature fish enter Anchor River beginning in early July, followed by progressively smaller mature, then immature fish. The early arriving mature and immature fish move into the upper stream sections from late July into September. Very small fish are just entering the river in September. Spawning occurs in September. Beginning in late September, the mature Dolly Varden are believed to migrate downstream, eventually entering Cook Inlet. Whether the fish complete the migration to sea in the fall or overwinter in the lower river is unknown.

Arctic Char

Resident Arctic char (Salvelinus alpinus) are in a number of deeper lakes in the Swanson River drainage of the Kenai Peninsula and in Big Lake near Wasilla. They are essentially lake dwellers and have not been reported in surrounding streams. Char vertical distribution in lakes appears to be temperature dependent. Char are found in midwater and bottom depths, perferring temperatures lower than 55°F.

Rainbow Trout

Observations at Fire Lake near Anchorage and on the Swanson River and Moose Creek (Kenai Peninsula) indicate that Cook Inlet rainbow (Salmo gairdneri) spawn in May. The fish utilize lake, inlet or outlet streams for spawning.

Steelhead Trout

Steelhead (Salmo gairdneri) are found in several lower Kenai Peninsula streams. These are fall run fish whose immigration begins in late July and continues through October. The run usually peaks in September. Steelhead overwinter in the streams and spawn in March and April. Post spawning outmigration takes place in May and June. Repeat spawners are rare. Juveniles rear 2-3 years in freshwater, migrate out as smolts in June and July and stay 1-4 years in saltwater before returning to spawn. Age 3.2 and 3.3 fish are dominent.

Grayling

Grayling (Thymallus arcticus) life history studies at Cresent Lake (upper Kenai River drainage) indicated that spawning occurs between April and June. Entry onto the spawning grounds may begin in late March. Adults spawn in the outlet stream for a short distance immediately below the lake in depths of 1/2 to 2 1/2 feet with water temperatures of 38°-42°F. Spawning terminates with ice breakup on the lake. Adults, after completion of spawning, return to the lake to reside the rest of the year.

Juvenile grayling move into Cresent Creek with the adults, but are mostly segregated from them. The juveniles remained in the outlet to rear and feed throughout the summer before returning to the lake in the fall.

Fish distribution and migration studies on the Susitna River indicate that grayling overwinter in the mainstem slough areas when the waters are relatively clear. Grayling move into clear tributaries in the spring and summer months to feed or spawn, returning to the mainstem again in the fall.

Whitefish

Several whitefish species occur in Cook Inlet area. Round whitefish (Prosopium williamsori) and the common whitefish (Coregonus clupeioformes) are found in the Susitna, Kenai and Kasilof River drainages while the Arctic cisco (Coregonus autumnalis) inhabit the Matanuska and Knik Rivers. The mainstem Susitna provides the primary overwintering area for Susitna fish as well as summer habitat. Whitefish also reside in tributary streams in the summer. An upstream migration occurs in the fall. Whitefish are believed to overwinter in Skilak and Kenai Lakes on the Kenai system and in Tustemena Lake on the Kasilof system.

Burbot

Burbot (Lota lota) are found in the mainstem lower Susitna River all year and in some of the larger lakes such as Nancy and Redshirt Lakes near Wasilla.

Razor Clams

Life history information for Cook Inlet razor clams (Siliqua patula) stocks is present in the Appendix. Data to date indicate razor clams enter the fishery at about four years of age. Age structure analysis of the population shows clams in their 10+ year also are harvested. A total of at least five age classes contribute to the fishery. Failure of a year class would not have a serious effect on the fishery.

PRODUCTIVITY AND PRODUCTION

Productivity

Information on lake productivity is available for many lakes in the Anchorage-Palmer area and for a few on the Kenai Peninsula and west Cook Inlet. Some of the most eutrophic lakes in Alaska are found near Palmer in the Matanuska-Knik River delta area and are associated with the richest farmland. Nutrient levels are very high compared with other lakes in the state. Farm practices have contributed some by increased use of fertilizers. As a result, fish production is excellent and angler use is high.

In many small land-locked lakes, winter fish kill may result from oxygen depletion due to decomposition. Biological oxygen demand is heaviest in the richer lakes. Fish stocking programs are necessary to perpetuate these fisheries.

Productivity decreases for lakes away from the Palmer area as lake fertility drops. Productivity levels drop with increase in elevation because of colder waters and shorter growing seasons. Susitna River delta lakes are quite unproductive compared to lakes closer to Palmer, but are more productive than those further upstream. On the Kenai Peninsula, the most productive lakes lie north of the Kenai River on the lowlands.

Production

Estimates of fish production in the Cook Inlet area are limited to population estimates in several grayling lakes and relative measures of fish production in stocked lakes. In 1972 the Cresent Lake adult grayling spawning population was estimated to be 1,756 fish, with a range of

1,547 to 2,031 fish. In 1974 the Cresent Lake adult grayling spawning population was estimated to be 1,756 fish, with a range of 1,547 to 2,031 fish. In 1974 the Bench Lake adult grayling spawning population was estimated to be 1,931 fish.

Many lakes in the Palmer, Anchorage and Kenai-Soldotna areas have been stocked with rainbow and coho to benefit intensive sport fisheries. The lakes are checked frequently to assess growth and survival. The most productive lakes are the Kepler-Bradley Lake system, Knik, Finger, and Seymour lakes near Palmer. These lakes have produced the most fish poundage per surface acre and receive some of the highest angler use in the area.

SPORT FISHERIES

Cook Inlet area receives the heaviest sport fishing pressure in the state. Effort is concentrated on freshwater stream and lake systems, with only a few saltwater boat or beach fisheries of any consequence. In freshwater, king, coho, sockeye, and pink salmon draw the most interest when and where they are available, but rainbow, grayling and Dolly Varden also are widely sought. Lake trout, chum salmon, burbot, whitefish and smelt are also taken in small numbers. In saltwater, halibut, salmon, and Dolly Varden attract primary interest but flounders, cod and greenling are also taken. A substantial beach fishery for razor clams exists in the eastern Cook Inlet.

The sport fishing seasons extend year round. In the spring, king salmon and razor clams receive the bulk of sport effort. Salmon, trout and grayling are fished throughout the summer and early fall. After freeze-up in October, many lakes in the Palmer, Anchorage and Kenai areas support light to intensive ice fisheries for rainbow and land-locked coho salmon.

King salmon catch and effort information has been collected on a continuous basis since 1960. Comprehensive data has also been collected for specific sockeye systems and stocked lakes. Creel surveys have been conducted at many locations, but generally give only a very minimal estimate of catch and effort. In 1974 an estimated total effort of 419,500 angler days for the Kenai Peninsual and 221,500 angler days for upper Cook Inlet.

The Cook Inlet king salmon fishery will be described separately. Other fisheries will be described by geographical area and system. Cook Inlet sport fisheries occur in four main areas; Kenai Peninsula, Anchorage, Palmer and west Cook Inlet. Significant saltwater sport fisheries occur in Kachemak Bay and on the clam beaches of eastern Cook Inlet.

King Salmon Fisheries

Cook Inlet king salmon sport fisheries are divided into lower and upper Cook Inlet. In lower Cook Inlet, kings are taken in the Kenai, Ninilchik and Anchor Rivers, and Deep Creek. A saltwater troll fishery occurs off the Deep Creek-Anchor River area. In upper Cook Inlet, the fishery has been closed since 1973. The majority of fish were previously taken from the Deshka River (Kroto Creek) and Alexander Creek, tributaries to the lower Susitna River. Chunilna and Little Susitna Rivers, Lake Creek, and Willow Creek (all tributaries to the Susitna) and Ship Creek (Anchorage) provide the remainder of the catch.

Management of king salmon sport fisheries has varied greatly since statehood. Prior to 1964, most streams were open to king salmon fishing from May through July on a continuous basis. Declining runs forced the closure of all king salmon fisheries in Cook Inlet in 1964 and 1965. Sport fisheries were reopened on a quota basis for selected streams in 1966. A harvest of 250 fish was allowed for upper Cook Inlet and 500 fish for the Kenai streams. The fisheries were opened only on two or three weekends in late May or June and anglers were required to carry special harvest punch cards. The quotas were removed in 1971, but the other restrictions remained in force. The upper Cook Inlet area was closed again in 1973. The Kenai fisheries have remained open and they appear to be in good shape. Total Cook Inlet catches have averaged 1,767 fish for all streams since 1966 and the saltwater catch has averaged 1,186 fish since 1970 (Table 48). The Kenai River fishery has become the heaviest producer in the last few years since anglers discovered the proper fishing technique (boats instead of shore angling). Catches from the Kenai River were negligible in the late 1960's but increased to 4,910 fish in 1974 (Table 49). Lower Kenai Peninsula streams average several hundred kings apiece. The Deshka River produced the largest catches (around 350 fish) for upper Cook Inlet before the fishery closure (Table 50).

The Kenai River king salmon fishery receives the greatest amount of fishing pressure, averaging about 24,000 angler days a season (Table 51). The three lower Kenai Peninsula streams receive about 7,500 angler days apiece, and the saltwater fishery receives about 6,000-8,000 angler days. In 1970 and 1971, the Ship Creek (in Anchorage), king salmon fishery was also opened several weekends in June. An estimated 5,000 fishermen caught about 50 kings the first season, and 1,000 caught 14 king slamon the following year. The fishery has been closed since then.

Kenai Fisheries

The Kenai Peninsula sport fisheries are the most heavily utilized sport fisheries in the Cook Inlet area and anywhere else in the State of Alaska. Both freshwater and saltwater fisheries draw anglers to this area. Extremely popular systems include Kachemak Bay, Anchor River, Deep Creek, Ninilchik River, Kenai River, Russian River and the Swanson-Moose River canoe system.

Saltwater

Kachemak Bay is a major saltwater sport fishery in the area and one of the largest recreational fisheries in the state. Most effort is directed toward pink and coho salmon, Dolly Varden, halibut, flounder and cod. Within the bay, the Homer Spit shore fishery has the highest use. In 1973 over 25,000 angler trips were make on the Spit between June and September (Table 52). Cod and flatfish are the primary target species. Effort is also directed toward Dolly Varden in June, pink salmon in July and coho salmon in August and September.

A privately owned boat fishery is developing within Kachemak Bay. Fishing is concentrated north of Homer Spit and across the bay around Tutka Lagoon. Halibut and pink salmon comprise the bulk of the boat catches. A significant charter boat fishery has also developed. No estimates of total effort are available for either of these fisheries. Available Kachemak Bay sport finfish catch and effort data are present in Table 52.

The east side Kenai Peninsula razor clam sport fishery has become the largest saltwater sport fishery in the Cook Inlet area. Razor clams are found along eastside Kenai Peninsula beaches from the Kasilof River south to Anchor Point. The highest population densities are found along the seven miles of beach at Clam Gulch. Catch, effort and total estimated harvest data has been collected for the Clam Gulch beach from 1965-1975 (Table 53). Management personnel pay close attention to both the clams per digger per trip and the average size of clams in the catch. Analysis of the catch data reveals an increase in CPUE since 1970. Size frequency data collected since 1966 shows an increase in average length from 4 1/2 to 5 inches. These two factors suggest the stocks are mountaining at a high level.

Harvest and effort has continued to increase in 1976. If digger effort continues at the present ratio, it is estimated that harvest for all eastside beaches will exceed one million razor clams. Effort is expected to approximate 32,000 man days. Table 54 shows estimated effort and harvest for all eastside Kenai Peninsula beaches.

Freshwater

Important freshwater fisheries other than king salmon include Dolly Varden, sockeye salmon, pink salmon, coho salmon, grayling, rainbow and steelhead trout. Catch-effort data is limited and sporatic for these species but timing is fairly well documented. Dolly Varden and rainbow trout fisheries peak in June, sockeye salmon in July, pink salmon in July and August. Both the coho and steelhead fisheries take place in the autumn, peaking in September and October respectively.

The Russian River, a tributary of the Kenai River, receives a large amount of sport fishing effort concentrated upon its sockeye salmon runs. This fishery is closely monitered to allow proper escapement. Emergency order closures are enacted when conditions warrant. Comprehensive data including catch, effort and timing have been collected for this system (Table 55).

Russian River red salmon stocks are comprised of two distinct runs which extend from June through August. The early run typically lasts from June 15 to the first week of July, the late run from July 15 to August 15. To allow for maximum resource utilization, Russian River sockeye anglers are restricted to single hooked, artificial flies. Dolly Varden, rainbow trout, cohos, pinks, whitefish and grayling are also caught in the Russian River (Table 56).

The Kenai, Anchor, and Ninilchik Rivers and Deep Creek all provide pink salmon, coho, Dolly Varden or steelhead trout fisheries into October. Combined with the Russian River these systems receive the bulk of angler effort.

Aside from the major river systesm, numerous lakes and streams along the Sterling and Seward Highways provide good fishing for rainbow, Dolly Varden and grayling (Table 58).

Anchorage Area

The most significant freshwater fisheries in the Anchorage area are the Ship Creek salmon fishery, stocked lakes and the Twenty Mile River eulachon fishery (Table 59). Available creel census data is presented in Tables 60 and 60A. Ship Creek supports a coho salmon fishery during years with good runs. This fishery takes place after the king salmon have reached the spawning grounds. Table 61 lists Anchorage area stocked lakes. Since 1972 angler usage of these stocked lakes has increased but current estimates are not available.

The Twenty Mile River provides a popular eulachon dipnet fishery in May and June. Catches vary greatly between years (Table 60A). The Placer River also supports a eulachon fishery but production in recent years has declined.

Palmer Area

The most popular fisheries in the Palmer area are the Willow-Talkeetna highway salmon fisheries, the Knik-Palmer road salmon fisheries, and the managed lakes. Significant fishing areas are listed in Table 62.

The primary salmon streams on the Willow-Talkeetna section are Willow, Little Willow, Sheep, Sunshine, Kashwitna, Goose and Montana Creeks. They all receive heavy use (July-September), primarily for coho and pink salmon, but also for chum salmon in good run years. Rainbow trout and grayling are fished heavily in May and June before the salmon arrive. The stream mouths are utilized most heavily.

No total catch estimates are available for any of these systems. Spot creel survey checks were made during the 1960's, but the information is of minimal value. Estimates of total effort in 1970 and 1972 indicated that about 21,000 anglers utilized the Willow-Talkeetna area streams during the mid-July to mid-August period (Table 63). Anglers were primarily after coho and pink salmon. Willow Creek received the greatest amount of effort, between 8,500 and 9,500 anglers.

On the Knik-Palmer Road, Wasilla Creek (Rabbit-Slough), Cottonwood Creek, and Fish Creek are heavily fished for salmon, primarily coho, sockeye, and pink salmon. The sockeye fishery occurs earliest, from mid-June to early July. The coho and pink fisheries extend from mid-July through August. The fisheries are restricted to weekends only, single hooks and the lower stream sections. No total catch or effort information is available. The runs have apparently declined in size over the last six or seven years, and effort has declined because of this and stringent angling restrictions.

The numerous lakes between Palmer and Talkeetna are utilized extensively by anglers seeking rainbows, Dolly Varden, Arctic char, grayling, coho salmon, and burbot. About 25 lakes are consistently stocked with rainbows, coho salmon, and grayling (Table 64). Between 400,000 and 700,000 fish are stocked annually. The lakes provide year-round fisheries, with heaviest effort in May and June before the salmon runs in nearby streams. The effort may pick up again in the fall and a fairly intensive ice fishery develops on many lakes in the early and late winter months. Some lakes are managed primarily as winter fisheries and are planted with land locked coho salmon, which bite well in winter months.

Catch and effort information is limited to some partial creel censuses, which do not give total estimates. the Kepler-Bradley Lake complex (Table 64) has the most intensive use in the area. Other high use stocked areas include Finger and Seymour Lakes. High use nonstocked lakes include Big Lake, the Wasilla-Cottonwood Lake group, Redshirt, and Nancy Lakes.

The biggest winter fisheries are on Finger, Echo, Lucille, and Victor lakes. Estimated total angler effort and coho salmon catch information for several lakes is available for 1968-1969 (Table 65). Finger Lake yielded over 4,800 fish for 1,450 angler trips. Winter burbot fishing is also gaining in popularity. Redshirt Lake near Willow has the best fishery, but Nancy and Cow Lakes are also fished.

West Cook Inlet

Popular sport fisheries on the west side of Cook Inlet are the Deshka River (Kroto and Moose Creeks), Alexander Creek, Lake Creek, Talchulitna River, Peters Creek, and the Chuitna River (Table 67). The Deshka is the highest use system in the area, with most effort directed to salmon, primarily coho and pink, although good rainbow and grayling fishing is available. The Talchulitna River is the top rainbow fishery in the area and receives heavy effort from fishermen who fly in and float the river. Most systems in this area are accessible only by airplane or riverboat. Float trips are a popular means of fishing.

No estimates are available for total catch and effort for systems in the area. Effort is moderate, estimated at just over 1,000 angler days of use a year. Most fishing effort is concentrated on systems in the lower Susitna and its tributaries. Very little fishing is done below the Chuitna River.

ECONOMIC VALUES

Information on economic value for Cook Inlet area sport fisheries is limited to economic surveys of the three lower Kenai Peninsula king salmon fisheries, the Russian River sockeye fishery, and the Willow-Talkeetna area salmon fishery. Economic value was measured only in terms of expenditures for goods and services incurred in the fishing trips.

Average expenditures per angler were highest for the lower Kenai Peninsula king salmon fisheries and lowest for the Willow area fisheries. The bulk of the fishermen in each fishery originate in the Anchorage area, so travel expenses are an important factor in determining fishing trip costs. An average of $8.12 was spent per angler day ($22.74 per angler trip) in the Kenai king fishery in 1971 (Table 66), while the average cost per angler day for the Willow salmon fisheries was $3.20 in 1970 and $5.47 in 1972 ($6.30 and $12.06, respectively, per angler trip). The Russian River sockeye fishery costs fell between the other two fisheries. Total estimated expenditures were $100,000 for the Kenai king fishery (1971), $105,000 for the Russian River sockeye fishery (1971), and averaged $195,000 for the Willow salmon fisheries (1970,1972).

MANAGEMENT AND RESEARCH

Sport fish management and research activities in Cook Inlet area include catalog and inventory, creel census, habitat protection, public access acquisition, life history studies, and enhancement work. Catalog and inventory, creel census, enhancement, and access acquisition work have been primary activities.

For catalog and inventory work, most of the streams around the highways as well as the readily accessible lakes around Palmer, Anchorage and the northern Kenai Peninsuala have been surveyed for fish distribution and abundance. The popular fly-in systems on the west side of Cook Inlet have also been surveyed.

Creel census work has concentrated on collecting information on the king salmon fisheries and the Russian River sockeye system. As time permits, data is collected on Anchorage area lakes and in upper Cook Inlet.

Lake fish stocking has been greatly emphasized, particularly in heavy use recreaction areas. Self sustaining fish populations have been established in many lakes, but most are stocked with hatchery reared, catchable-size fish for "put and take" fisheries. In these lakes, total harvest of the stock is desirable. Overharvest is not a problem and these lakes can sustain much heavier pressure than they presently receive.

Often fishing has improved, or a successful sport fishery has been created where none existed before, through stocking and/or lake rehabilitation. Much of the stocking work now is focused upon improving growth and survival by determining proper stocking rates and improving strains of fish by hybridization.

Acquiring public access to streams and lakes has been very important in the area. Recreational fishing demand is already heavy on Cook Inlet area sport fisheries, and private land development is rapidly restricting access to existing and potential sport fishing areas. In some locations in the Palmer and Anchorage area, the situation has become acute. Future expansion of the sport fisheries could be severely hampered, with increased access restrictions.

Habitat protection also has been important. Urban development has severely damaged or destroyed fish habitat in several streams by stream diversion, channeling, dredging, filling, and blocking. These activities affect fish populations by removing or damaging spawning and rearing habitat or by blocking migration. Instances of this are most common in the Anchorage area. Dumping toxic pollutants has also killed fish in several urban or suburban area streams. Private recreational developments around Anchorage and the Matanuska Valley have also caused problems with improper domestic effluent disposal. Phosphate levels and organic material increases in nearby lakes have caused destructive drops in oxygen levels for overwintering fish populations.

Life history work has included a study on Cresent and Bench Lake grayling populations, and a long-term study of the Russian River sockeye runs. The Russian River study is conducted from a seasonal station and weir site on the river. In addition, escapement counts for coho and king salmon have been gathered for important tributaries on the Susitna drainage and for lower Kenai Peninsula king salmon systems.

Table 47 . Distribution and abundance of sport fish species in the Cook Inlet region.

Species	Forms: Resident	Anadromous	Abundance	Remarks
Dolly Varden Char	X	X	Moderate	Not found in all anadromous streams, particularly on west side. Resident forms found in headwater tributaries, lakes.
Arctic Char	X		Low	Found in several lakes and streams on upper Kenai Penin. May be Dolly Varden.
Rainbow Trout	X		High	Found in clearwater streams and lakes throughout area. Highest concentration on Kenai Penin. Planted extensively around Palmer, Anchorage, and Kenai areas.
Steelhead Trout		X	Low	Found in Anchor, Ninilchik, Kasilof Rivers, Deep Cr. on lower Kenai Penin.
Lake Trout	X		Low	Found in a few deep lakes on Kenai Penin., west Cook Inlet, and near Cantwell.
Kokanee	X		Low	Found in a few lakes on Kenai Penin., lower end of Susitna, Matanuska Rivers.
Land-locked Silver Salmon	X		Low	Planted in some lakes near Palmer, Anchorage, Kenai for winter ice fisheries.
Grayling	X		Moderate	Planted stocks in Kenai River headwaters, natural stocks in Susitna tributaries.
Whitefish	X		Low	Found in Kenai, Kasilof, Matanuska, Susitna & Beluga River drainages.
Smelt		X	Low	Eulachon in Kenai, 20-Mile Rivers, Placer Creek, Matanuska and Susitna Rivers. May be locally abundant.

continued

Table 47 (continued). Distribution and abundance of sport fish species in the Cook Inlet region.

	Forms			
Species	Resident	Anadromous	Abundance	Remarks
Northern Pike	X		Low	Found in Susitna River drainage in a few lakes.
Burbot	X		Low	Found in Susitna River drainage.
Sturgeon		X	Negligible	Green sturgeon reported rarely in Susitna River.

Table 48 . Cook Inlet sport caught king salmon catches based on punchcard returns, 1966-1975 1/.

Year	Upper Cook Inlet	Kenai Peninsula	Stream Total	Kenai Saltwater	Inlet Total
1966	263	563	826		
1967	315	544	859		
1968	398	614	1,012		
1969	339	273	612		
1970	871	742	1,613		
1971	479	782	1,261		
1972	461	801	1,262	2,250	3,512
1973	--	770	770	1,010	1,780
1974	--	5,996	5,996	600	6,596
1975	--	3,455	3,455	885	4,340
Mean	447	1,454	1,767	1,186	4,057

1) Source: Alaska Dept. of Fish and Game, 1967-1975. Fed. Aid to Fish Restoration, Ann. Progress Reports. Vol.7-16.

Table 49 . Lower Cook Inlet king salmon catch, 1960-1975[1/] .

Year	Anchor R.	Deep Cr.	Ninilchik R.	Kenai R.	Deep Cr. Saltwater	Total
1960	1,150					
1961	1,012					
1962	502					
1963	1,158					
1964		FISHERY CLOSED				
1965		FISHERY CLOSED				
1966	286	48	218	11		563
1967	236	183	118	7		544
1968	247	157	206	4		614
1969	84	40	131	18		273
1970	170	60	275	237		742
1971	58	42	137	545		782
1972	167	137	156	341	2,250	3,051
1973	330	142	298	N/A	1,010	1,780
1974	443	290	353	4,910	600	6,596
1975	210	100	540	2,605	885	4,340
Mean	220	110	240	964	1,186	1,919

1) Source: Alaska Dept. of Fish and Game, 1961-1975. Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol.2-16.

Table 50. King salmon catches in upper Cook Inlet systems, 1961-1975 1/.

Year 2/	Deshka River	Alexander Creek	Chunilna Creek	Little Susitna River	Willow Creek	Lake Creek	Ship Creek	Total
1961	91	15			9	21	--	136
1962	142	33			3	44	--	222
1963	758	47		1	23	51	--	880
1964			FISHERY CLOSED					
1965			FISHERY CLOSED					
1966	205	28	4	--	--	26	--	263
1967	234	20	1	--	--	60	--	315
1968	324	71	--	--	--	3	--	398
1969	310	21	--	--	--	8	--	339
1970	579	286	5	--	--	1	--	871
1971	434	15	14	7	0	2	7	479
1972	275	79	43	23	16	14	11	461
1973			FISHERY CLOSED					
1974			FISHERY CLOSED					
1975			FISHERY CLOSED					

1) Source: Alaska Dept. of Fish and Game, 1962-1975. Fed. Aid to Fish Restoration, Ann. Prog. Reports. Vol.3-16.

2) 1961-1963 catches reported in creel census - not total estimates. 1966-1972 catches according to punch card returns.

Table 51. Lower Cook Inlet king salmon fishery effort (angler-trips)[1/].

Year	Anchor R.	Deep Cr.	Ninilchik	Sub Total	Kenai	Deep Cr. Saltwater	Total
1960	5,300						
1961	6,165						
1962	2,325						
1963	5,747						
1964			FISHERY CLOSED				
1965			FISHERY CLOSED				
1966							
1967							
1968							
1969							
1970							
1971				15,900			
1972				13,520		3,610	
1973	7,010	8,150	8,940	24,100		8,040	
1974	6,850	8,460	5,690	21,000	23,610	5,090	
1975				19,600	23,820	8,050	

1) Source: Alaska Dept. of Fish and Game, 1961-1975. Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol. 2-16.

Table 52 . Kachemak Bay sport finfish catch and effort [1/].

Year	Angler-Trips	KS	SS	PS	CS	DV	Hal.	Fld.	Cod	RKF	Others	Totals	Survey Data	Survey Period	Type of Fishery	Remarks
1966	714		43	102		391	242	70	45			893	Censused	6/24-9/5	shore,boat,pier	partial census
1972	890	2	3	93	1	28	220	36	6	36	56	481	Censused	7/3-8/7	mainly boat	partial census
1973	25,257		676	4,000		952	20,314		22,623		124	48,689	Expanded	6/1-9/2	Homer spit, shore	includes Mud Bay SS fishery
	663		78	59		49	46	43	7			282	Censused	7/8-9/2	private boats	
	846	212 Salmon					715				357	1,284	Censused	6/1-9/2	charter boats	data from log book

1) Source: Alaska Dept. of Fish and Game. 1967,1973,1974. Anadromous fish studies: southwestern Kenai Peninsula and Kachemak Bay. Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol.7,14,15.

Table 53. Razor clam creel census information collected at Clam Gulch, 1965-1975. 1)

Year	No. Diggers Interviewed	Total Clams Enumerated	Clams/Digger	Estimated Harvest
1965	unknown	unknown	35.2	32,500*
1966	91	3,790	41,6	39,000*
1967	987	32,455	32.9	45,800*
1968	997	27,334	27.4	84,700*
1969	2,998	93,836	31.3	279,480
1970	2,964	87,650	29.6	226,150
1971	1,465	43,201	29.5	126,260
1972	3,624	109,528	30.2	259,560
1973	4,054	145,489	35.9	392,140
1974	4,733	163,906	34.6	596,110
1975	4,056	154,527	38.1	607,850

* Clam harvest figures for 1965-1968 are minimum estimates.

1) Source - David Nelson, A.D.F.&.G., Sport Fish biologist, Soldotna.

Table 54. Estimated recreational razor clam harvest and effort on all east side Kenai Peninsual Beaches, 1969-1975. 1)

Year	Total Estimated Effort (Man-Days)	Estimated Razor Clam Harvest
1969	12,200	375,800
1970	11,100	306,450
1971	6,800	187,760
1972	15,400	437,530
1973	23,770	682,600
1974	27,410	872,450
1975	24,260	896,080

1) Source - David Nelson, A.D.F.&.G., Sport Fish biologist, Soldotna.

Table 55 . Sockeye salmon harvest, effort and success rates on Russian River, 1962-1974 1/.

Year	Harvest Early Run	Harvest Late Run	Harvest Total	Effort Angler-trips	Catch/ Hour	Census Period
1962	3,410	1,290	4,700	6,600	0.220	6/15-8/12
1963	3,670	1,390	5,060	7,880	0.190	6/8-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/20-8/16
1965	10,030	2,160	12,190	9,730	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,270	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/7-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-7/27*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/20**
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,590	0.102	6/9-8/19***
1974	6,440	8,500	14,940	21,120	0.131	6/8-7/30****
1962-1973 Avg.	6,332	5,298	11,630	14,924	0.185	

* Census active from June 11 through July 3 and from July 24 through July 27.
** Census active from June 17 through July 7 and from July 31 through August 20.
*** Census active from June 9 through July 4 and from July 15 through August 19.
**** Census active from June 8 through June 30 and from July 6 through July 31.

1) Source: Nelson, David c. 1975. Russian River red salmon study. Alaska Dept. of Fish and Game. Fed. Aid to Fish. Restoration, Ann. Report of Progress, Project F-9-7. 16:41pp.

Table 56. Russian River miscellaneous sport catch censused during the sockeye sport fishery, 1968-1974 1/.

Year	SS	PS	RB	DV	WF	GR
1968	40	55	450	800	6	3
1969	55	2	140	634	10	2
1970	2		37	175	12	2
1971	42		72	284	8	4
1972	385	42	382	589	14	
1973						
1974	1		171	1,446	57	
Mean	88	33	209	414	18	3

1) Sources: Engel, L.J., 1967-1972. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol.10-13.

Nelson, D.C., 1973-1975. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol.14-16.

Table 57. Anchor River sport fish catch and effort 1/.

Year	Angler-Trips	Coho Salmon	Pink Salmon	Dolly Varden	Steelhead	Census Period
1968 2/	3,045	1,150	350	4,352	102	7/6-10/19
1969						
1970 3/	2,050	166		36	5	8/20-9/13

1) Sources: McHenry, E.T., 1969. Anadromous fish studies - southwestern Kenai Peninsula and Kachemak Bay areas. Alaska Dept. of Fish and Game. Fed. Aid to Fish Restoration, Ann. Progress Report. Project F-9-1, 10:151-178.

Nelson, D.C., 1972. Anadromous fish studies - southwestern Kenai Peninsula and Kachemak Bay. Alaska Dept. of Fish and Game. Fed. Aid to Fish Restoration, Ann. Progress Report. Project F-9-4, 13:13-30.

2) Expanded estimates.

3) Angler-trips expanded, catch reported as censused.

Table 58 . Kenai Peninsula sport fishing areas [1/] .

System	Location [2/]	Species Present [3/]	Remarks
Homer Spit	Homer	SS,PS,DV,H, bottomfish	Heavy summer use.
Mud Bay	Homer	SS	Moderate use fall fishery.
Anchor R.	STH	KS,SS,PS,DV,SH,RT	Heavy summer, fall use. Species sought.
Stariski Cr.	STH	KS,SS,PS,DV,SH	Moderate summer, fall fisheries.
Deep Cr.	STH	KS,SS,PS,DV,SH	Heavy summer, fall use. RS snag fishery off mouth in July.
Ninilchik R.	STH	KS,SS,PS,DV,SH,RT	Heavy summer, fall use.
Crooked Cr.	STH	KS,SS,RS,DV,RT,WF	Light summer, fall fishery.
Johnson L.	STH	RT	Year-round fishery. Stocked.
Tustemena L.	STH	SS,RS,DV,LT,WF	Light fishery spring for LT, fall for SS, dangerous boat conditions.
Centennial L.	STH	SS	Light year-round fishery, stocked
Mackay Lakes	STH	SS,RT	Moderate year-round fishery, stocked.
Kenai R.	Soldotna	KS,SS,RS,CS,PS,DV, RT,GR,WF,EU	Intense KS summer, SS fall fisheries. DV,RT caught incidental. EU netted by Kenai in May.
Sport L.	Soldotna	RT	Stocked.
Beaver Cr.	Kenai	SS,RT,DV	Summer, fall fishery.
Cabin L.	N.Kenai Rd.	RT	Stocked.
Bishop Cr.	N.Kenai Rd.	SS,RT	Summer, fall fishery.
Stormy L.	N.Kenai Rd.	AC,RT	Year-round fishery.

continued

1) Source: Alaska Dept. of Fish and Game, 1975. Alaska sport fishing guide. Sport Fish Division, Juneau, Ak. 96 p.

2) STH = Sterling Highway.
SWH = Seward Highway.

3) Underlined species are most heavily sought.

Table 58 (continued). Kenai Peninsula sport fishing areas.

System	Location	Species Present	Remarks
Longmare L.	Soldotna	RT	Year-round fishery, stocked.
Scout L.	STH	SS	Year-round fishery, stocked.
Sunken Is. Lake	Swanson R.Rd.	SS	Year-round fishery, stocked.
Forest Lakes	Swanson R.Rd.	RT	Summer, fall fishery, stocked.
Dolly Varden Lake	Swanson R.Rd.	RT,AC	Year-round fishery.
Rainbow Trout Lake	Swanson R.Rd.	RT,AC	Year-round fishery, stocked.
Swanson R.	Swanson R.Rd.	SS,RS,DV,RT	Summer, fall fishery, moderate use.
Swan Lakes	Swanson R.Rd.	RT,AC	Summer, fall fishery, moderate use, canoe-portage system.
Swanson Lakes	Swanson R.Rd.	SS,RT,AC	Summer, fall fishery, moderate use. Canoe-portage system.
Moose R.	Naptowne	KS,SS,RS,DV,RT	Summer, fall fishery, moderate use.
E.Fork Moose R.	STH	RT	Summer, fall fishery, moderate use.
Watson L.	STH	RT	Summer, fall fishery.
Kelly, Peterson Lakes	STH	RT	Summer, fall fishery.
Upper Jean L.	STH	SS	Year-round fishery, moderate use.
Jean L.	STH	RT,DV	Year-round fishery, moderate to heavy use.
Skilak L.	Skilak Lp.Rd.	KS,SS,RS,PS,DV, RT,LT,WF	Summer, fall fishery.
Ohmer Lakes	Skilak Lp.Rd.	RT,DV	Summer, fall fishery, moderate use.
Rock L.	Skilak Lp.Rd.	SS	Summer, fall fishery.

continued

Table 58 (continued). Kenai Peninsula sport fishing areas.

System	Location	Species Present	Remarks
Hidden L.	Skilak Lp.Rd.	DV,RT,LT,Kok	Year-round fishery, moderate to heavy use. Excellent winter, LT,Kok fishery, spring LT fishery.
South Fuller L.	STH	GR	Spring, summer, fall fishery, trail access.
Russian R.	Cooper Landing	KS,SS,RS,PS,DV RT,GR,WF	Summer, fall fishery - very intense use. Top Kenai fishery. Mainly RS.
Russian Lakes	Cooper Landing	RT,DV	Summer, fall fisheries. Trail access.
Swan L.	STH	RS,DV,RT,LT	Summer fishery, trail access.
Juneau L.	STH	RT,LT,WF	Summer fishery. trail access, light hiker use.
Trout L.	STH	RT,WF	Summer fishery, trail access.
Quartz Cr.	STH	SS,RS,DV,RT,GR,WF	Summer, fall fishery.
Cresent Cr.	STH	GR	Summer, fall fishery, moderate use.
Cresent	STH	GR	Summer, fall fishery, moderate use. Large fish-unique stock for Kenai Penin. Trail access.
Jerome L.	SWH	RT,DV	Year-round fishery, stocked.
Trail L.,R.	SWH	DV,RT,LT,WF	Summer, fall fishery.
Granite Cr.	SWH	GR	Summer, fall fishery.
Ptarmigan Cr.	SWH	RT,DV	Summer, fall fishery. Stunted DV called "golden-fins."
Kenai L.	SWH	SS,RS,DV,LT,GR,WF	Summer, fall fishery. Light effort.
Grayling, Meridian L	SWH	GR	Year-round fishery, light use. Trail access.
Paradise Lakes	SWH	GR,RT	Summer fishery, light use. Fly-in access.

continued

Table 58 (continued). Kenai Peninsula sport fishing areas.

System	Location	Species Present	Remarks
Summit Lakes	SWH	DV	Year-round fishery.
Bench L.	SWH	GR	Summer, fall fishery. Trail access.
Resurrection Cr.	Hope	PS,DV	Summer fishery, light use.
Granite Cr.	SWH	DV	Summer fishery.
Ingram Cr.	SWH	PS,DV	Summer fishery.

Table 59 . Anchorage area sport fishing locations (also see Table 61 stocked lakes) 1/.

System	Location	Species Present	Remarks
Placer Cr.	SWH	PS,DV,EU	May dipnet fishery, light to heavy use.
Portage Cr.	SWH	SS,DV	Summer, fall fishery, very light use.
20-Mile R.	SWH	SS,EU	May dipnet fishery, moderate to heavy use.
Bird Cr.	SWH	SS,PS,DV	Summer fishery, light to moderate use.
Campbell Cr.	Anchorage	KS,SS,PS,RS,DV,RT	Summer fishery. Light to moderate use, mainly children. Closed to salmon fishing.
Ship Cr.	Anchorage	KS,SS,PS,DV,RT	Summer, fall fishery. Light to heavy use, depending on SS run.
Eagle R.	GH	PS,DV	Summer fishery, light use.
Knik R.	GH	EU	May dipnet fishery.

1) Sources: Alaska Dept. of Fish and Game, 1975. Alaska sport fishing guide. Sport Fish Division, Juneau, Ak. 96p.

Pers. comm., 1976. Stanley Kubik, Alaska Dept. of Fish and Game, Anchorage, Ak.

Table 60. Sport catch and effort on Jewell, DeLong and Campbell Pt. Lakes, Anchorage area, from June 7 to September 3, 1972 1/.

Lake	Species 2/	Angler-Hours	Catch	Catch Per Hour
Campbell Pt.	RT	6,363	3,308	0.52
Delong	RT	4,788	2,011	0.42
Jewell	RT	17,925	7,170	0.40

1) Source: Trent, T.W., 1973. Catalog and Inventory of the Lower Susitna River and central Cook Inlet. A.D.F.&G., Fed. Aid to Fish Restoration, Ann. Progress Report, F- ,14:53-73.

2) RT - Rainbow Trout.

Table 60A Twenty-Mile River eulachon catch and effort, 1972-1974 1/.

Year	Census Period	Angler-Hours	Catch	Catch Per Hour
1972	5/25-6/4	1,759	15,870	9.02
1973	5/16-6/12	3,514	72,950	20.76
1974	5/16-6/12	2,100	630	0.3

1) Source: Alaska Dept. of Fish and Game, 1973-1975. Inventory and cataloging of sport fish and sport fish waters of the lower Susitna and central Cook Inlet drainages. Alaska Dept. of Fish and Game Fed. Aid to Fish. Restoration, Ann. Progress Reports. Vol. 14-16.

Table 61. Intensive use stocked lakes in the Anchorage area [1/].

Lake	Location	Species	Stocking Rate (1975)	Remarks
Beach	Anchorage	RT	4,000	
Campbell Pt.	Anchorage	RT	5,000	
Delong	Anchorage	RT	5,100	
Jewell	Anchorage	RT	14,600	Heaviest civilian use fishery.
Sand	Anchorage	RT	5,300	
Fish	Elmendorf AFB	RT	2,300	
Hilberg	Elmendorf AFB	RT	8,100	
Old Cooling Pond	Elmendorf AFB	RT	300	Used for kids derby.
Triangle	Elmendorf AFB	RT	3,500	
Clunie	Ft. Richardson	RT	10,000	
Derby Pond	Ft. Richardson	RT	600	Used for kids derby.
Gwen	Ft. Richardson	RT	4,000	
Otter	Ft. Richardson	RT	10,500	
Thompson	Ft. Richardson	RT	5,000	
Lower Fire	Peters Creek	RT	6,300	
Mirror	Eklutna	GR	20,000	

1) Source: Kubik, S.W., 1976. Catalog and inventory of sport fish and sport fish waters in the upper Susitna River and central Cook Inlet drainages. Fed. Aid to Fish Restoration, Ann. Prog. Report. Study G-1 (in press), vol.17.

Table 62 . Palmer area main sport fishing locations (also see stocked lakes, Table 64) 1/.

System	Location	Species Present	Remarks
Moose Cr.	GH	DV,RT	Summer, fall fishery, light use.
17-Mile L.	Sutton	GR	Year-round fishery, excellent summer fishery.
Chickaloon R.	GH	SS,DV,RT,GR	Summer, fall fishery, light use.
Caribou Cr.	GH	RT,GR	Summer, fall fishery, light use.
Wasila Cr.	Palmer	SS,PS,DV,RT	Summer, fall fishery. Very heavy SS fishery limited weekend openings. Light trout fishery.
Cottonwood Cr.	Wasila	SS,RS,PS,DV,RT	Summer, fall fishery, very heavy SS fishery, limited weekend openings, light trout fishery.
Wasila L.	Wasila	RT	Year-round fishery, moderate use.
Fish Cr.	Knik	SS,RT,DV,RT	Summer, fall fishery, very heavy SS fishery, limited weekend openings, light trout fishery.
Big L.	Big L.Rd.	SS,RS,DV,AC, RT,BB	Year-round fishery, top non-stocked lake fishery in area. Best DV,AC,BB fishery in winter, best SS,RT in summer.
Horseshoe L.	Big L.Rd.	SS,RT	Summer, fall fishery.
Barbara L.	Big L.Rd.	SS,RS,RT,BB	Year-round fishery. Excellent BB fishery in winter.
Little Susitna R.	AFH	KS,SS,PS,CS,DV RT,GR,WF	Summer, fall fishery. Lower creek below bridge heavy salmon fishery. Good float trip. Upper creek have stunted DV, light fishery.
Nancy L.	AFH	SS,RS,DV,RT,WF,BB	Year-round fishery. Heavy use DV,RT summer, winter BB fishery good.

continued

1) Source: Alaska Dept. of Fish and Game, 1975. Alaska sport fishing guide. Sport Fish Division, Juneau, Ak. 96p.

2) GH = Glenn Highway; AFH = Anchorage-Fairbanks Highway

3) Underlined species are most heavily sought.

Table 62 (continued) Palmer area main sport fishing locations (also see stocked lakes, Table 64).

System	Location	Species Present	Remarks
Red Shirt L.	Nancy L.Rd.	SS,RS,DV,RT,WF,BB	Year-round fishery, moderate use. DV,RT summer, winter BB fishery good.
Lower Willow Cr.	AFH	KS,SS,PS,CS,DV, RT,WF,GR,BB	Summer, fall fishery. Very heavy summer salmon fishery. Moderate DV,RT,GR fishery early summer. Light BB fishery, winter.
Upper Willow Cr.	Fishhook Rd.	DV	Summer, fall fishery. Stunted DV. Light fishery.
Deception Cr.	Fishhook Rd.	SS,PS,CS,DV,RT,WF	July-Aug. fishery, moderate-heavy for salmon. Light for trout
Little Willow Cr.	AFH	KS,SS,PS,DV,RT,WF, GR	Summer, fall fishery. Heavy salmon fishery, light for RT,GR.
Kashwitna Cr.	AFH	SS,DV,RT,GR,WF	Summer, fall fishery. Poor salmon fishery. Moderate fishery.
Caswell Cr.	AFH	SS,PS,CS,DV,RT,GR	Summer, fall fishery. Moderate-heavy salmon fishery.
Sheep Cr.	AFH	KS,SS,PS,CS,DV,RT GR,WF	Summer, fall fishery. Very heavy salmon fishery, light RT,GR fishery.
Goose Cr.	AFH	SS,PS,CS,RT,GR,WF	Heavy use summer, fall fishery.
Montana Cr.	AFH	KS,SS,PS,CS,DV,RT GR,WF	Very heavy summer salmon fishery, fall RT, GR fishery.
Birch Cr.	AFH	SS,RS,RT,GR,WF	Poor salmon fishery, summer, fall RT,CR fishery.
Chulina Cr.	Talkeetna Rd.	KS,SS,PS,CS,DV,RT, GR,WF	Spring, summer GR fishery. Moderate use. Riverboat, airplane access.
Prairie Cr.	Talkeetna Rd.	RT,GR	Summer, fall fishery. Excellent RT fishery. Moderate fly-in fishery.
Troublesome Cr.	AFH	SS,PS,CS,RT,GR,WF	Summer, fall fishery salmon, RT, GR light to moderate use.
Byers L.	AFH	LT,GR,BB	Year-round fishery. Light BB BB effort in winter, moderate LT, GR spring, fall effort.

continued

Table 62 (continued) Palmer area main sport fishing locations (also see stocked lakes, Table 64).

System	Location	Species Present	Remarks
Spink L.	near Byers L.	RT	Summer, fall fly-in fishery. Very light to light use. Excellent fishery.
Lucy L.	Eldridge Gl.	LT,GR	Summer fly-in fishery. Very light to light use.
Coal Cr.	Lucy L.	SS,PS,CS,RT,GR,WF	Summer fishery. Riverboat, fly-in use.
Indian R.	Chulitna	SS,PS,RT,GR	Summer fishery. Railroad access. Light fishery.
Portage Cr.	Susitna R. below Devil's Canyon	KS,SS,RT,GR	Summer, fall fishery. Excellent potential, very light use. Riverboat or fly-in access.

Table 63 . Total angler effort estimated for selected Susitna River tributaries in 1970 and 1972 1/.

Stream	Anglers 1970 2/	1972 3/
Willow Creek	8,612	9,533
Montana Creek	6,179	5,636
Sheep Creek	2,083	2,629
Sunshine Creek	1,482	1,241
Little Willow Creek	1,090	847
Caswell Creek	1,120	613
Kashwitna River	477	308
Iron Creek	270	--
Goose Creek	169	225
Birch Creek	--	121
Total	21,482	21,153

1) Sources: Kubik, S.W., 1973. Anadromous fish population studies: Matanuska Valley and east side tributaries of the Susitna River and tributaries of the Chulitna River, Alaska Dept. of Fish and Game, Fed. Aid to Fish Restoration, Ann. Progress Report. Project F-9-5, Study G-IV, 14:45-59.

Watsjold, D.A., 1971. Creel census studies of the sport fish and sport fish waters of the Cook Inlet drainage, Alaska Dept. of Fish and Game, Fed. Aid to Fish Restoration, Ann. Progress Report. Project F-9-3, Study G-IV, 12:19-29.

2) Period of coverage: 7/22-8/26.

3) Period of coverage: 7/20-8/28.

Table 64. Managed lakes stocked on a regular basis in Matanuska - Susitna valley, Palmer area.[1/]

Lake	Location INS	RNG	SEC	Species	Stocking Rates (1,000's)	Remarks
Florence	19N	5W	23	RT	21.0	
Knik	16N	3W	9	RT	20.0-37.5	Very productive, popular fishery.
Rocky	17N	3W	16,21	RT	12.0-33.0	Low productivity.
Loon	18N	3W	36	SS	16.2 center	Low productivity.
Prator	18N	3W	25	SS	15.1 center	Low productivity
Seymour	18N	2W	32	RT	257.6 center	Very productive, heavy use.
Lucille	17N	1W	8,9	SS	55.5	Good winter fishery.
Meirs	17N	1E	18	GR	5.0-10.2	Fair productivity, light-moderate use.
Kepler-Bradley Complex						Very productive lakes, year round fishing.
Matanuska	17N	1E	23	RT	21.2-92.0	Excellent fishery.
Kepler	17N	1E	24	RT	10.0-102.5	Excellent for small fish.
Bradley	17N	1E	24	RT	10.0-102.5	Good fishery for small fish.
Echo	17N	1E	24	SS	6.9-9.2	Fair to good, winter fishery largest.
Harriet	17N	1E	25	GR	5.0-16.4	Good fishery, summer-fall.
Victor	17N	1E	14	SS	2.7-10.4	Fair to good, mainly winter fishery.
Canoe	17N	1E	13	RT	%.7-8.5	Poor due to winter die-off.
Irene	17N	1E	13	RT	5.6-8.4	Fair fishery.

(continued)

Table 64. (continued).

Lake	Location INS	RNG	SEC	Species	Stocking Rates (1,000's)	Remarks
Long (A)	17N	1E	14,13	RT	52.8	Good fishery.
Gooding	18N	1E	22,23	GR	10.0	
Finger	18N	1E	33,84	SS	108.6	Most population winter fishery,very productive.
Reed	18N	1E	8	RT	3.4-4.5	Fair productivity
Wishbone	19N	1E	24	RT	7.5-33.5	
Lower Bonnie	20N	6E	19,20	GR,RT	12.2 RT	Moderate-heavy use all year.
Ravine	20N	6E	19	RT	8.7	
Long (B)	20N	7E	20,21	GR	40.0	Moderate use, year round fishery.
Weiner	20N	7E	22	RT	10.0	Heavy use, fair productivity

1/ Source: Alaska Dept. of Fish and Game 1961-1975. Catalog and Inventory of sport fish and sport fish waters in Upper Cook Inlet. Fed. Aid to Fish. Restoration, Ann. Prog. Reports, Study G-I.

Table 65 . Winter fishery estimated effort and coho catch from three Palmer lakes (11/24/68 - 3/31/69) 1/.

Lake	Angler-trips	Catch	Catch/Hour
Finger	1,447	4,810	1.02
Matanuska	158	302	0.78
Reed	210	384	1.10

1) Source: Redick, R.R. 1969. Inventory and cataloging of the sport fish and sport fish waters in the Cook Inlet drainage. Fed. Aid to Fish Restoration, Ann. Progress Report, Project F-9-1, 10:243.

Table 66 . Estimated angler expenditures on goods and services for four Cook Inlet region sport fisheries 1/.

Fishery	Year	Period	Avg./Cost Angler-Day	Avg./Cost Angler-Trip	Avg./Cost Fish	Total Expenditur
Lower Kenai king streams	1971	5/26-6/12	$8.12	$22.74	$461.00	$100,050
Russian R. sockeye	1971	6/1-8/31	6.18	16.76	7.84	105,500
Willow area salmon fisheries	1970	7/20-8/28	3.20	6.30		135,259
Willow area salmon fisheries	1972	7/22-8/26	5.97	12.06		255,092

1) Sources: Engle, L.J. and D.C. Nelson, 1972. An economic survey of the king salmon sport fishery on three lower Kenai Peninsula streams and the Russian River red salmon fishery, 1971. Unpub. Report, Alaska Dept. of Fish and Game on file in Anchorage office: 26pp.
Watsjold, 1971. Creel census of sport fish and sport fish waters of the Cook Inlet drainage. Alaska Dept. of Fish and Game, Fed. Aid to Fish. Restoration, Ann. Progress Report. Project. F-9-3, study G-IV, 12:19-29.
Kubik, S.W., 1973. Anadromous fish population studies: Matanuska Valley and east side tributaries of the Susitna River and tributaries of the Chulitna River. Alaska Dept. of Fish and Game, Fed. Aid to Fish. Restoration, Ann. Progess Report, Project F-9-5, Study G-II, 14:45-59.

Table 67. West Cook Inlet sport fishing areas.[1]

System	Location TWS	RNG	SEC	Species Present[2]	Remarks
Deshka R. (Kroto-Moose Cr.)	Petersville Rd.			KS,SS,PS,CS,DV, RT,GR	Summer-fall fishery, top salmon fishery in area also receives heavy pressure for RT,GR. popular float. Road access.
Peters Cr.	Petersville Rd.			SS,PS,DV,RT,GR	Summer, fall fishery. Moderate to heavy use. Road access.
Chelatna L.	27N	12W	1,2	LT,GR,WF	Summer fishery. Light to moderate use,fly-in lake.
Hewitt L.	22N	12W	11,12	RT,WF	Summer fishery, moderate use, fly-in lake, good RT fishery.
Whiskey L.	22N	13W	13,24	RT,WF,BB	Summer fishery, moderate use, fly-in lake, good RT fishery.
Fish Cr.	21N	9W	8	SS,RS,PS,RT	Summer fishery, light to moderate use.
Lake Cr.	21N	9W	15	KS,SS,PS,CS,RT,	Summer, fall fishery. Very heavy use. Fly-in, riverboat access.
Canyon Cr.	21N	12W	19	SS,PS,CS,DV,RT,GR	Summer fishery. Light to moderate use.Fly-in access.
Talchulitna R.	21N	12W	35	KS,SS,RS,PS,CS DV,RT,GR	Summer,fall fishery. Top RT producer in region. Heavy use for RT. popular float trip, fly-in access.
Judd L.	17N	13W	13	SS,RS,DV,RT, GR,WF,BB	Summer, fall fishery, DU main species, light to moderate use. Fly-in access.
Alexander Cr.	15N	7W	6	DS,SS,RS,PS, CS,DV,RT,GR	Summer, fall fishery, very heavy use. Popular float. Fly-in riverboat access.
Lewis R.	13N	9W	12	SS,PS,CS,DV,RT	Summer fishery, light use, fly-in or boat access.
Theodore R.	13N	9W	11	SS,PS,CS,DV,RT	Summer fishery, light use, fly-in or boat access.

(continued)

Table 67. West Cook Inlet sport fishing areas.[1/] (continued)

System	Location TWS	RNG	SEC	Species Present[2/]	Remarks
Felts L.	14N	11W	31,32	DV,RT	Summer fishery, light use, fly-in access.
Coal Cr.	15N	13W	12	SS,RS,DV,RT,GR	Summer fishery, light to moderate use.
Chuitna	12N	11W	30	SS,PS,CS,DV,RT	Summer fishery, heavy use for SS, PS, good DU, RT fishery.

1/ Source: Alaska Dept. Fish and Game. 1975. Alaska sport fishing guide. Sport Fish Division. Juneau, AK. 26 p. pers. Comm. 1976. Stanley Kubik, Alaska Department of Fish and Game. Anchorage, AK.

2/ Underlined species are most heavily sought.

KODIAK AREA SALMON FISHERIES

INTRODUCTION

The Kodiak management area includes all waters from the southern entrance of Imuya Bay near Kilokak Rocks to Cape Douglas, including Kodiak, Afognak, Trinity and adjacent islands (Figure 4). The Kodiak Island group is formed by the Kodiak Mountains which are a structural, southwest continuation of the Kenai-Chugach Mountains. The area is characterized by rugged mountains and an extremely irregular coastline with many fiords and islands. Streams are short and swift, lakes are small, and small ponds are widely scattered over the glacially sculptured topography. The Karluk and Red Rivers, each about 25 miles long, drain much of southwestern Kodiak Island. The Karluk River, including Karluk Lake, and Dog Salmon River, including Frazer Lake, are among the most important river systems.

The Kodiak area is divided into nine salmon management districts which are: the Alitak, Red River, Sturgeon River, Karluk, Uyak Bay, Uganik Bay, Afognak, General and Mainland districts (Figure 4).

COMMERCIAL FISHERIES

Description

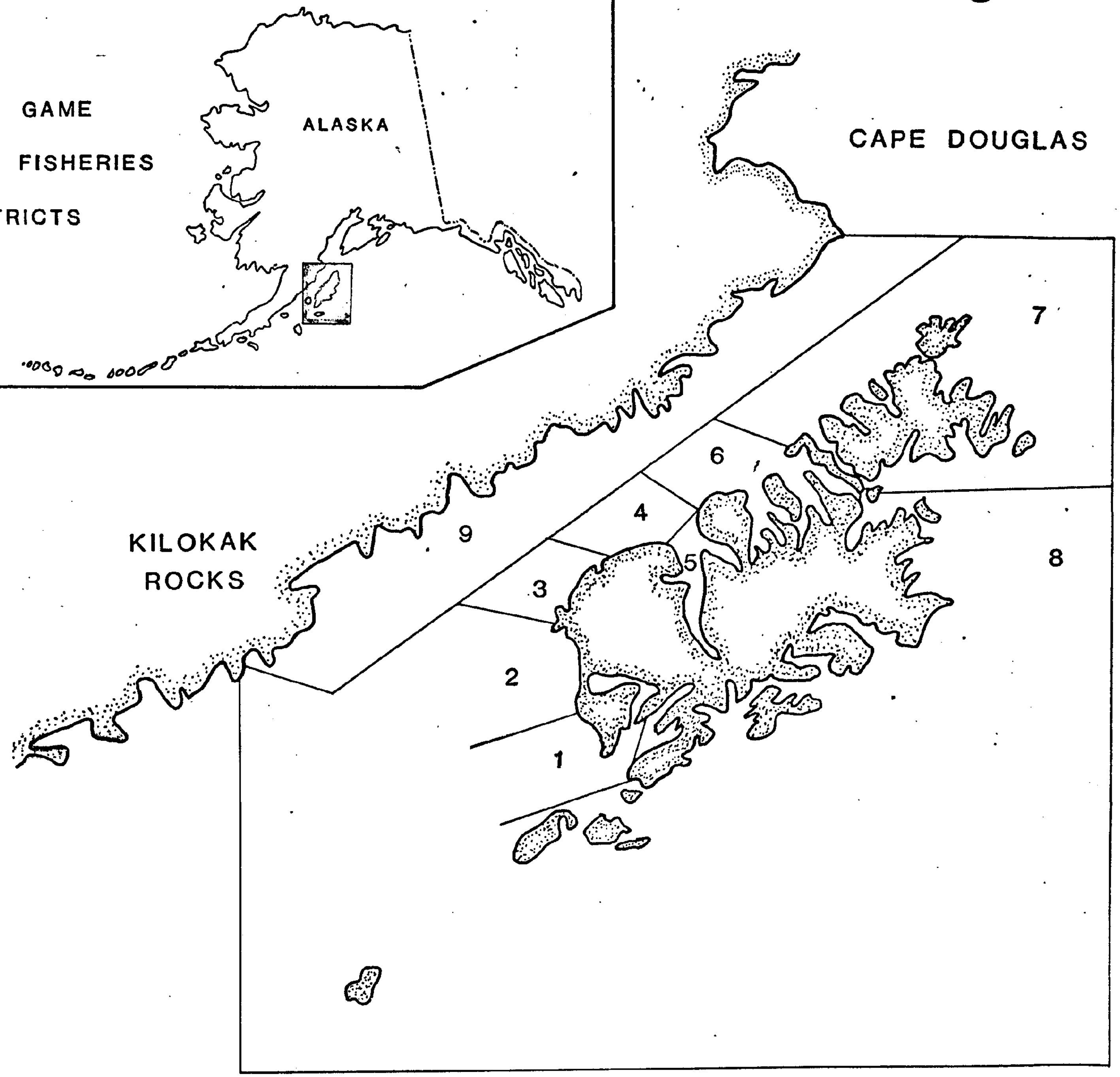
Commercial salmon fishing in the Kodiak area dates back to the late 1800's although catch figures are only available since 1893 (Table 68). The first cannery was built in 1882 at Karluk and shortly thereafter the salmon fishery extended to the Red River district and Moser-Olga Bays in the Alitak district. Sockeye salmon were the principle species harvested for the first 30 years. Few king, coho and pink salmon were taken prior to 1912. When sockeye salmon catches began to decline as stocks

FIGURE 4.

ALASKA DEPT. OF FISH & GAME

DIVISION OF COMMERCIAL FISHERIES

KODIAK REGULATORY DISTRICTS



REGULATORY DISTRICTS

1. ALITAK
2. RED RIVER
3. STURGEON RIVER
4 KARLUK
5. UYAK BAY
6. UGANIK BAY
7. AFOGNAK
8. GENERAL
9. MAINLAND

were depleted, effort was shifted to other species. Since 1924, pink salmon have dominated the commercial salmon catch. In recent years chum salmon have been second followed by sockeye salmon.

There are more than 30 sockeye salmon systems in the Kodiak area, but only three of these, the Karluk, Red River and Upper Station systems, are today considered to be of major economic importance. Sockeye salmon were introduced into the Frazer Lake system in 1951 and presently the run is building at a rapid rate. The Akalura Lake system was historically an important sockeye producer but stocks declined drastically in the mid-1900's. The 1974 sockeye escapement, however, was over 35,000 fish and is the largest since 1948.

There are approximately 240 streams in the Kodiak area that produce pink salmon. However, 60% to 85% of the total pink salmon escapement is usually contained in 31 of the major river systems. The major pink salmon producers are listed in Table 83 which gives the pink salmon escapements for the index streams in Kodiak.

In recent years, chum salmon have become an important commercial species in the Kodiak area. Chum salmon are taken incidental to the pink and sockeye fisheries, but during late summer, chums are the main species harvested, particularly on the north mainland and on the eastside of Kodiak Island.

Coho salmon catches are incidental to other species. Catches have fluctuated with the level of effort for other species, especially effort directed at fall runs of sockeye and chum salmon. Many Kodiak streams have runs of cohos, but the bulk of the fish arrive fairly late and little directed effort exists. Coho salmon stocks are considered to be in good condition and generally under-utilized.

Very few king salmon are harvested in the Kodiak area and those caught are all incidental to other fisheries. The Karluk and Red Rivers have the only natural king salmon runs. Kings have been recently introduced into the Dog Salmon River-Frazer Lake complex and appear to be established.

The average annual salmon harvest in the Kodiak area from 1960-1974 is approximately 7.9 million fish which represents 17% of the total statewide salmon harvest for the same period. Since 1960, pink salmon have comprised 84% of the total Kodiak area commercial salmon catch, followed by chum (9%) and sockeye (6%).

There are approximately 10 large processors in or near the city of Kodiak. In addition, there are processors located at Uganik Bay, Uyak Bay, Alitak, Port Williams, Port Wakefield, Larsen Bay, Port Bailey and Moser Bay. Most salmon are canned, however, some are frozen, smoke-cured or sold fresh.

Timing

Sockeye salmon are the first species available to the commercial fishery. When available in sufficient numbers, a fishery in June occurs in the Red River district. Sockeye salmon bound for the Chignik River system are harvested in June from the capes near the southern boundary of the Mainland district along the Alaska Peninsula. Sockeye salmon remain in the fishery throughout the summer and are taken incidental to the pink salmon fishery. Sockeye salmon continue to enter some systems as late as October, particularly in the Karluk River and in the Upper Station system.

Pink salmon are usually available to the fishery in early July. These early runs are generally harvested from the Capes and consist primarily of migrating fish bound for the bays of adjacent districts. As the season progresses, bay fisheries develop. The pink salmon fishery normally peaks from the last week of July through the first week of August, although variations from this pattern occur.

Chum and coho salmon are primarily harvested by purse seines after the pink fishery, or taken incidentally during the pink fishery. The few king salmon harvested are taken primarily from the westside pink salmon fisheries.

Effort

Salmon may be taken by purse seines, hand purse seines and beach seines in all districts of the Kodiak area except Olga and Moser Bays, where only set gill nets are permitted. Set gill nets are permitted in those bays and a few other locations on the westside of the island. The distinction between purse seines and hand purse seines is not clear, sometimes only a few rings are used on a modified purse seine. The fishing regulations and licenses make no distinction between the two. Purse seines account for the majority of the salmon catch in the Kodiak area and have averaged 232 licensed nets annually since statehood (1960-1974). Beach seines have averaged 27 licensed nets annually for the same period, while set nets have averaged 181 licensed nets.

Economic Values

The 15-year (1960-1974) average annual value to the fishermen of the Kodiak salmon fisheries is approximately 4.6 million dollars (Table 79). However, this average annual value is not truly representative of the fisheries economic value at today's prices. Figuring the 15-year average annual salmon harvest at 1974 prices, the average annual value to the fishermen is approximately 14 million dollars.

ESCAPEMENT AND SPAWNING

Introduction

The Department operates counting weirs on the major sockeye salmon systems in the Kodiak area. The Commercial Fisheries Division operates weirs at Karluk, Red River and Upper Station while weirs at Frazer Lake and Akalura Lake are run by the Division of Fisheries Rehabilitation and Enhancement (FRED). Sockeye escapement counts on these systems represent total numbers of spawning sockeye salmon. Escapements of king salmon into the three Kodiak systems, Karluk, Red River and Frazer Lake, are monitored by aerial surveys and weir counts. Coho salmon escapements are not closely monitored due to their late appearance, and the difficulty in surveying these systems. Escapement counts of pink and chum salmon are made by aerial and grpimd surveys. These counts represent indices of spawner magnitude and are not total escapement numbers.

Very few king salmon are produced in the Kodiak area. The Karluk and Red River have the only natural king salmon runs with recent five-year average escapements of 2,500 and 1,300, respectively. Kings have been recently introduced into the Dog Salmon River-Frazer Lake complex and appear to be established. Table 80 presents estimated king salmon escapment for the Karluk and Red Rivers.

Many Kodiak streams have runs of coho salmon, but due to the lateness of the runs escapement figures are incomplete. Coho salmon stocks are considered to be in good condition and generally under-utilized. Estimated coho escapements on a few selected streams are presented in Table 81 .

Very little escapement information for chum salmon in the Kodiak area is available. Many of the early and mid-season runs of chum salmon are difficult to manage because pink and sockeye fisheries are also harvesting chums. The fisheries on the early run of chum at Sturgeon River and the late runs on the north mainland and the eastside of the Island are managed with the aid of aerial surveys. Chum salmon utilize many of the same streams as pink salmon for spawning.

Sockeye salmon stocks in the Kodiak area have declined drastically from earlier years. The present strategy used in managing the sockeye salmon fishery is to try to gradually build the escapement levels in the major systems such as Karluk, Red River and Upper Station. Some supplemental production from spawning channels, incubation devices and hatcheries, including adult transplants, will be required to bring all former Kodiak producers of sockeye salmon back up to earlier production levels. Table 82 presents the estimated sockeye salmon escapement for the major systems in the Kodiak area.

Pink salmon pre-emergent fry data has been collected from the Kodiak area since 1963. The data is used to estimate pink salmon returns with varying degrees of success. The method does not take ocean mortality into account, but forecasts based on fry abundance do help identify strong and weak portions of the expected returns. Table 83 presents the peak escapement counts of pink salmon for the Kodiak area since 1960. From 1934 to 1959 the odd-year cycle dominated the fishery. In 1960 the even-year cycle began to improve and the odd-year cycle declined slowly. Presently the majority of pink salmon runs in the Kodiak area are characterized by an even-year cycle of abundance. The 1971 and 1972 low pink salmon returns are believed to have resulted from the extreme streambed scouring and high stream temperatures in the late summer and early fall of 1969 and the severe winter of 1970-1971 and low estuarine temperatures.

Habitat, Migration and Timing

Salmon spawning and rearing habitat in the Kodiak area is essentially the same as outlined in the generalized life histories (Appendix). Several minor sockeye salmon runs are produced in systems without lakes and rear in side sloughs, spring-fed areas, or deep holes. Many coho salmon runs are also found rearing in the same habitat. In the Kodiak area, pink salmon exhibit a dominant even-year cycle. As mentioned earlier, 60% to 85% of the total pink salmon escapement is usually contained in 31 of the major systems which comprise the Kodiak area's index streams. These major streams are cyclic with large runs occurring during even years. Odd-year production is greatly reduced. A major portion of the pink salmon stocks in the Kodiak area, and to a lesser extent chum salmon stocks, utilize intertidal areas for spawning.

Timing of salmon spawning in the Kodiak area differs by species, systems, and season. Generalized timing information is presented by species for the entire Kodiak area in Table 84.

Escapement Goals

Optimum escapement figures are not defined for each pink salmon system, but desired escapement levels for many major producers have been determined. Properly distributed, the desired pink salmon escapement goal for the entire Kodiak area is 2.5-3 million fish during even years and 0.8-1.3 million fish during odd years.

Desired escapement goals for sockeye salmon are not as clearly defined. Escapement goals have been forumlated for sockeye salmon runs on the Karluk, Upper Station, Red and Frazer Rivers. However, these escapement goals are based on the available spawning ground, rearing potential and historic production. Presently sockeye production is at a very low level. Although these runs are increasing, the following escapement goals may be revised according to future responses of the runs. Desired sockeye escapement goals for future production are: 800,000-1,000,000 for the Karluk River, 180,000 for Upper Station, 200,000 for Red River, and 385,000 for the Frazer River.

Escapement goals for king, coho and chum salmon have not been defined. These fisheries are managed by comparison of past catch and escapement information.

STATUS RELATED TO MAXIMUM SUSTAINED YIELD

Current stock assessment and escapement information is not adequate to estimate maximum sustained yields (MSY) for the Kodiak area's fisheries. However, average commercial harvests by species for the entire area is presented below. Comparisons of catches from past years indicate possible estimates for maximum sustained yields of the Kodiak fisheries. Very few king salmon are harvested in the Kodiak area and those caught are taken incidentally to other fisheries. No estimates of MSY have been formulated.

There are no estimates of MSY for sockeye stocks in the Kodiak area. The average annual sockeye harvest since 1934 is approximately 905,000, compared to the last 10-year average annual harvest of 484,000 fish. A better indication of sockeye salmon potential might be the comparison of the 12-year average catch from 1934 to 1945 of 1,826,000 fish with the average catch since 1945 of 549,000 fish. Comparison of catches from past years indicate that present production in all systems is far below the MSY.

Coho salmon stocks in the Kodiak area are considered to be in good condition and generally under-utilized. It is suspected that coho runs could sustain catches from 100,000-200,000 fish annually.

The pink salmon fishery in the Kodiak area is very cyclic. Pink salmon harvests since 1934 have varied from a low of 188,000 in 1967 to a high of 14,114,000 fish in 1962. The average annual harvest from 1934-1974 of 7,081,000 fish is probably close to an estimated MSY for pink salmon in the Kodiak area.

Chum salmon have become an important commercial species in the Kodiak area. The average annual chum salmon harvest from 1935-1974 of 660,000 fish probably comes fairly close to the MSY level.

MANAGEMENT AND RESEARCH

Management problems in the Kodiak area center around segregation of stocks in the fishery and the depressed state of the sockeye salmon runs.

Some form of nonregulatory rehabilitation will be required to rebuild the Karluk sockeye salmon run to former levels. Frazer Lake was originally opened to sockeye runs through use of a fishway in 1963 and a subsequent program of fry and adult stocking was undertaken to establish a sockeye run. This system is now building on its own and annual escapements are increasing. It is desirable to afford this stock continued protection through at least one more cycle until it has increased to the spawning and rearing capacity of the system.

Statewide programs to develop new methods of stock identification will have particular application to the problems of rebuilding and maintaining Kodiak sockeye salmon stocks. These techniques will also allow more precise management of individual pink and chum salmon stocks. Optimum escapement estimates for major pink and chum systems will be improved through analysis of new and existing data, expanded escapement coverage, and work within the systems on spawning capacity and measures of annual variability in survival conditions. Pink salmon run strength assessment will be improved through the application of marine survival estimation techniques to upgrade pre-season forecasts. This, coupled with stock identification, would give the manager the tools to increase or decrease fishing pressure by stock in response to annual fluctuations in stock abundance and spawning requirements.

Table 68 Commercial salmon catch, Kodiak area, by year, in numbers of fish, 1893-1974 1/.

Year	Total	King	Sockeye	Coho 2/	Pink	Chum
1893	3,244,609	--	3,244,609	--	--	--
1894	3,830,336	--	3,830,336	--	--	--
1895	2,255,287	--	2,246,966	8,321	--	--
1896	3,328,846	--	3,328,846	--	--	--
1897	2,787,015	--	2,785,515	1,500	--	--
1898	2,052,269	--	2,033,094	19,175	--	--
1899	1,968,350	1,104	1,934,771	32,475	--	--
1900	3,487,557	4,838	3,450,480	32,239	--	--
1901	4,831,012	3,838	4,826,159	--	2,015	--
1902	3,906,005	2,932	3,868,101	34,972	--	--
1903	1,956,891	1,187	1,826,163	119,541	10,000	--
1904	2,986,624	3,190	2,875,118	103,136	5,180	--
1905	2,231,776	2,496	2,142,367	86,913	--	--
1906	4,007,840	3,640	3,980,462	23,738	--	--
1907	4,274,528	4,105	4,232,454	38,059	--	--
1908	2,851,039	3,208	2,487,848	73,789	286,374	--
1909	2,124,232	3,907	1,915,230	51,500	153,595	--
1910	2,215,988	1,598	1,954,717	44,291	215,382	--
1911	2,944,551	689	2,685,949	21,870	229,551	6,492
1912	2,836,403	686	2,246,467	17,491	547,171	24,588
1913	2,285,740	1,082	1,663,163	27,634	590,039	3,822
1914	3,028,341	1,329	1,255,444	32,063	1,726,411	13,094
1915	1,989,588	939	1,664,426	51,819	252,073	20,331

continued

1) Source - INPFC, Historical Catch Statistics for Salmon of the North Pacific Ocean. 2nd Draft, July, 1974 and A.D.F.&G., Statewide Catch Statistics, Final IBM run.

2) For 1893-97, catch figures include a mixture of coho and pink salmon.

Table 68 (continued) Commercial salmon catch, Kodiak area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1916	6,634,628	1,038	3,373,055	49,683	3,181,890	28,962
1917	3,919,152	1,457	3,645,914	30,485	225,335	15,961
1918	4,523,680	2,021	1,894,466	78,169	2,467,325	81,699
1919	2,067,982	1,831	1,619,101	104,233	282,715	60,102
1920	4,080,839	1,637	1,957,636	88,970	1,977,421	55,175
1921	2,966,813	660	2,857,922	45,764	67,688	24,779
1922	4,208,013	703	1,097,359	119,724	2,766,257	223,970
1923	2,136,749	1,915	1,090,117	77,554	928,510	38,653
1924	7,082,187	1,002	1,407,525	120,686	5,435,091	117,883
1925	4,674,095	1,911	1,693,057	92,960	2,673,675	212,492
1926	8,121,837	596	3,015,366	174,475	4,606,694	324,706
1927	7,026,369	4,358	1,155,202	151,548	5,297,305	417,956
1928	4,146,987	2,546	1,592,003	290,645	1,535,313	726,480
1929	8,025,616	3,200	712,126	144,226	6,108,402	1,057,662
1930	2,770,609	4,991	466,409	288,800	1,651,398	419,011
1931	8,378,333	1,541	1,183,074	170,075	6,839,906	183,737
1932	6,069,473	1,873	1,058,446	52,192	4,719,939	237,023
1933	8,631,536	1,140	1,428,373	91,428	6,573,660	536,935
1934	10,223,073	1,300	1,828,953	89,588	7,641,891	661,341
1935	12,854,126	1,393	1,613,519	76,849	10,780,612	381,753
1936	8,819,590	2,548	2,657,195	183,903	5,647,726	328,218
1937	19,180,851	1,257	1,881,304	164,902	16,787,150	346,238
1938	11,160,234	1,232	1,965,943	154,959	8,397,981	640,119
1939	14,283,799	2,272	1,786,445	112,171	11,741,218	641,693
1940	12,138,646	1,233	1,318,233	148,016	9,997,899	673,265

continued

Table 68 (continued) Commercial salmon catch, Kodiak area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1941	9,978,339	2,571	1,730,201	199,515	7,601,531	444,521
1942	8,047,173	1,329	1,281,529	106,865	6,092,526	564,924
1943	14,985,164	1,133	1,990,557	59,661	12,479,608	454,205
1944	7,332,275	668	1,817,875	51,675	4,955,354	506,703
1945	11,707,109	2,021	2,041,090	60,122	9,044,544	559,332
1946	10,739,774	129	838,863	56,425	9,545,871	298,486
1947	10,220,907	99	993,394	76,230	8,856,666	294,518
1948	7,593,512	1,401	1,260,465	32,364	5,968,487	330,795
1949	6,574,251	851	892,336	53,737	4,927,779	699,548
1950	6,953,475	2,127	920,885	40,653	5,304,701	685,109
1951	3,102,503	2,402	467,875	48,792	2,100,377	483,057
1952	6,476,278	1,081	603,677	51,567	4,576,726	1,243,227
1953	6,084,041	2,991	317,150	41,681	5,174,645	547,574
1954	10,082,593	942	325,157	66,430	8,439,231	1,250,833
1955	11,478,081	2,428	164,482	34,582	10,794,164	482,425
1956	4,349,104	1,123	271,249	52,844	3,318,841	705,047
1957	6,195,232	1,030	234,253	34,995	4,716,482	1,208,472
1958	5,280,147	1,942	288,014	20,555	4,038,938	930,698
1959	3,047,278	1,837	330,087	14,512	1,967,058	733,784
1960	8,456,274	1,238	362,525	54,308	6,737,817	1,300,386
1961	4,882,380	864	407,979	28,579	3,926,023	518,935
1962	15,748,920	1,095	784,664	54,583	14,113,851	794,727
1963	6,249,556	286	407,040	57,011	5,480,158	305,061
1964	13,713,833	1,306	498,488	35,535	12,044,341	1,134,163
1965	3,691,866	786	346,237	26,672	2,886,831	431,340

continued

Table 68 (continued) Commercial salmon catch, Kodiak area, by year, in numbers of fish, 1893-1974.

Year	Total	King	Sockeye	Coho	Pink	Chum
1966	12,218,293	599	631,646	67,700	10,755,582	762,766
1967	735,357	1,753	308,756	10,354	187,813	226,681
1968	10,337,508	1,936	760,393	56,629	8,768,122	750,428
1969	13,678,465	2,469	591,481	48,759	12,500,823	534,933
1970	13,941,130	1,089	917,047	66,424	12,036,598	919,972
1971	6,378,179	920	478,479	22,844	4,334,492	1,541,444
1972	3,883,197	1,300	222,800	16,588	2,478,737	1,163,772
1973	1,001,343	800	167,341	3,573	511,708	317,921
1974	3,329,475	545	418,761	13,631	2,647,244	249,294

Table 69 Commercial salmon catch, Kodiak area, Afognak sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	73	22,146	21,683	699,866	16,581	760,349
1961	78	56,959	13,372	163,386	5,893	239,688
1962	180	38,322	26,664	1,190,890	41,840	1,297,896
1963	48	20,841	11,778	283,656	9,984	326,307
1964	92	13,584	5,012	694,459	26,979	740,126
1965	1	1,252	3,985	31,009	1,845	38,092
1966	146	24,257	14,561	2,132,838	29,064	2,200,866
1967	111	8,309	2	1,328	2,017	11,767
1968	727	23,640	14,659	983,170	44,612	1,066,808
1969	636	32,381	1,004	32,724	3,594	70,339
1970	163	28,318	8,891	855,986	29,481	922,839

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 69 (continued) Commercial salmon catch, Kodiak area, Afognak sub area, by species, in numbers of fish, 1960-1974. 1).

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971		7	74	1,029	388	1,498
1972	439	14,979	2,866	311,100	25,277	354,661
1973	23	5,428	892	53,414	6,423	66,180
1974	30	7,619	6,016	71,367	3,857	88,889

Table 70 . Commercial salmon catch, Kodiak area, Chiniak and South Marmot Bay sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	31	5,365	7,691	468,258	70,910	552,255
1961	72	4,854	2,099 *	293,700	32,861	333,586
1962	80	15,702	12,515	1,243,596	81,327	1,353,220
1963	29	7,857	6,144	551,184	48,811	614,025
1964	71	10,340	6,880	1,105,879	143,808	1,266,978
1965	13	1,313	684	75,274	75,418	152,702
1966	67	17,596	6,362	1,573,000	132,456	1,729,481
1967	51	3,996	1,212	30,165	20,183	55,607
1968	250	18,915	5,833	648,370	78,706	752,083
1969	915	22,659	843	1,532,652	112,740	1,677,397
1970	187	23,035	10,477	1,582,520	115,112	1,731,331

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 70 (continued). Commercial salmon catch, Kodiak area, Chiniak and South Marmot Bay sub area, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total[2)]
1971	181	4,312	4,001	552,370	161,006	721,870
1972	82	6,926	1,934	252,899	65,918	327,759
1973	39	3,120	51	39,630	6,985	49,825
1974	154	1,249	1,309	18,386	23,129	344,227

Table 71 Commercial salmon catch, Kodiak area, Eastside sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	96	3,209	5,939	795,257	125,268	929,769
1961	77	15,788	5,984	896,216	160,946	1,079,011
1962	41	24,902	5,760	2,772,831	149,720	2,953,254
1963	75	47,181	10,059	2,203,836	117,238	2,378,389
1964	359	13,718	9,150	1,685,480	205,880	1,914,587
1965	50	7,179	5,702	880,119	140,336	1,033,386
1966	29	2,356	5,459	1,334,291	99,928	1,442,063
1967			686	41,842	20,657	63,185
1968	105	3,417	3,475	2,266,237	167,916	2,441,150
1969	184	14,799	12,844	6,224,847	243,636	6,496,310
1970	98	14,710	6,423	5,136,400	281,063	5,438,725

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 71 (continued) Commercial salmon catch, Kodiak area, Eastside sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971	495	28,926	8,237	1,556,439	680,296	2,274,393
1972	221	14,873	4,415	1,173,185	600,602	1,793,296
1973	704	3,212	977	93,395	143,611	241,899
1974	102	4,744	1,754	962,097	107,454	1,076,151

Table 72 Commercial salmon catch, Kodiak area, Alitak sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	29	67,527	2,156	1,561,476	102,415	1,733,603
1961	23	145,827	1,590,427	60,653	1,471	1,798,401
1962	5	124,497	1,793	1,886,832	54,124	2,067,251
1963	30	54,999	1,203	1,526,720	42,896	1,625,848
1964	29	50,185	736	1,419,475	37,051	1,507,476
1965	16	68,809	693	1,135,841	20,804	1,226,263
1966	2	70,526	585	429,204	33,201	533,518
1967	8	14,693	57	85,042	16,397	116,197
1968	16	40,662	3,701	1,046,221	29,450	1,120,050
1969	27	98,699	7,240	3,770,604	45,134	3,921,804
1970	8	81,544	4,540	949,871	93,320	1,129,283

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 72 (continued) Commercial salmon catch, Kodiak area, Alitak sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971	33	124,480	2,261	1,066,180	191,437	1,384,391
1972	15	22,134	1,290	188,829	95,181	307,449
1973	4	10,338	125	49,932	24,408	84,807
1974	19	67,743	1,284	355,154	23,938	448,138

Table 73 Commercial salmon catch, Kodiak area, Red River sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	13	12,043	528	577,793	10,463	600,840
1961	105	53,071	8,877	1,765	25	63,843
1962	270	188,659	735	2,833,912	11,335	3,034,911
1963		23,459	856	7,462	280	32,057
1964	169	58,379	2,171	2,399,854	17,521	2,478,094
1965	107	26,567	312	2,221	482	29,689
1966	146	155,751	2,794	307,556	2,678	468,925
1967	716	94,528	95	2,487	4,775	102,601
1968	541	286,407	11,021	1,203,093	10,331	1,511,393
1969	50	69,780	1	6,669	348	76,848
1970	45	40,816	2,468	834,771	3,748	881,848

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 73 (continued) Commercial salmon catch, Kodiak area, Red River sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971	Closed - No fishery					
1972	197	63,333	118	119,780	4,437	187,865
1973	79	44,109	2	3,688	439	48,317
1974	24	53,718	107	215,790	2,115	271,754

Table 74 Commercial salmon catch, Kodiak area, Uyak and Uganik Bay sub area, by species, in numbers of fish 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	482	88,433	4,882	3,187,758	10,463	3,688,832
1961	126	80,259	3,196	930,119	193,665	1,207,365
1962	137	223,493	5,064	1,728,335	191,043	2,148,072
1963	43	104,926	260,901	663,658	385,282	1,414,810
1964	228	143,711	4,797	2,657,403	266,632	3,072,771
1965	108	105,489	5,372	682,774	147,699	941,442
1966	101	179,147	31,170	4,207,851	323,339	4,741,608
1967	60	46,969	1,155	22,431	16,992	87,607
1968	170	134,434	4,993	1,951,276	178,785	2,269,658
1969	270	153,820	3,865	646,566	33,880	838,401
1970	238	98,290	7,783	1,985,355	118,276	2,209,942

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals to not match with INPFC totals due to errors in IBM runs.

Table 74 (continued) Commercial salmon catch, Kodiak area, Uyak and Uganik Bay sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971	87	54,888	4,603	777,008	133,983	970,583
1972	342	42,691	3,934	376,106	177,914	600,987
1973	53	24,862	1,217	253,704	46,236	326,072
1974	165	45,473	1,713	566,231	30,103	643,685

Table 75 Commercial salmon catch, Kodiak area, Mainland sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1960	57	4,483	2,272	347,925	407,277	892,375
1961	1	2,580	34,102	61,464	344	98,491
1962	8	4,020	445	1,187,829	259,828	1,452,130
1963		150	1,624	4,706	8,428	14,908
1964	10	24,435	937	604,879	203,203	833,464
1965	8	16,561	513	64,827	83,836	165,745
1966	10	23,945	945	301,418	133,449	459,767
1967	232	29,321	563	940	114,892	145,948
1968	24	179,052	4,115	377,956	237,811	798,953
1969	142	103,133	1,014	65,562	94,349	264,200
1970	32	545,472	1,764	283,630	271,272	1,102,170

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 75 (continued) Commercial salmon catch, Kodiak area, Mainland sub area, by species, in numbers of fish, 1960-1974. 1)

Year	King	Sockeye	Coho	Pink	Chum	Total 2)
1971	110	251,572	2,477	379,657	373,979	1,007,795
1972	3	49,096	1,935	45,162	192,990	289,186
1973	84	72,845	315	24,356	90,651	188,251
1974	40	156,879	820	23,762	56,719	238,220

Table 76 Commercial salmon catch, Kodiak area, Karluk sub area, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total[2)]
1960	452	157,580	8,308	788,970	29,293	984,608
1961	380	48,433	6,404	2,044	2,081	59,342
1962	282	171,869	1,816	1,155,797	6,415	1,336,179
1963	51	147,627	20,402	13,979	528	182,587
1964	433	163,585	4,884	1,293,076	31,129	1,493,107
1965	473	119,048	9,435	16,307	2,953	148,216
1966	100	155,678	1,469	464,292	8,654	630,193
1967	577	111,406	6,591	6,854	30,788	156,216
1968	103	73,866	8,832	291,799	2,817	377,417
1969	226	95,988	14,372	16,510	1,187	128,283
1970	318	84,872	24,080	417,053	7,034	553,357

continued

1) Source - ADF&G, Kodiak Area Annual Management Reports.

2) Totals do not match with INPFC totals due to errors in IBM runs.

Table 76 (continued) Commercial salmon catch, Kodiak area, Karluk sub area, by species, in numbers of fish, 1960-1974.

Year	King	Sockeye	Coho	Pink	Chum	Total[2)]
1971		14,010	1,191	311	138	15,650
1972	1	7,572	154	18,741	2,207	28,675
1973	2	3,903		573	57	4,535
1974	8	77,811	326	133,300	564	212,009

Table 77 Summary of salmon gear registration, Kodiak area, 1960-1974 1/.

Year	Purse Seine			Beach Seine			Set Net			Grand Total
	Resident	Non-Res.	Total	Resident	Non-Res.	Total	Resident	Non-Res.	Total	
1960	228	97	325	20	2	22	99	50	149	496
1961	248	111	359	14	1	15	126	36	162	536
1962	223	103	326	7	0	7	118	36	154	487
1963	180	95	275	9	3	12	109	42	151	438
1964	198	98	296	9	3	12	112	44	156	464
1965	208	84	292	20	3	23	133	46	179	494
1966	203	93	296	23	5	28	142	50	192	516
1967	189	66	255	20	3	23	125	35	160	438
1968	241	89	330	22	3	25	150	35	185	540
1969	219	88	307	22	4	26	153	44	197	530
1970	253	109	362	34	3	37	166	60	226	625
1971	265	98	363	32	5	37	138	48	186	586
1972	272	113	385	46	4	50	168	51	219	654
1973	272	101	373	48	6	54	164	55	219	646
1974	NA	NA	303	NA	NA	32	NA	NA	170	505

1) Source - A.D.F.&G., Kodiak Annual Management Reports and unpublished file data, Limited Entry Commission.

Table 78 Summary of vessel license registration, Kodiak area, 1960-1974 1/.

	Vessel Licenses		
Year	Resident	Non-resident	Total
1960	404	216	620
1961	441	341	782
1962	565	257	822
1963	360	196	556
1964	524	195	719
1965	518	198	716
1966	600	240	840
1967	581	182	763
1968	626	182	808
1969	654	183	837
1970	475	174	649
1971	1,024	343	1,367
1972	464	166	630
1973	465	146	611
1974	451	124	575

1) Source - A.D.F.&G., Kodiak Annual Management Reports and unpublished file data, Limited Entry Commission.

Table 79 Value of commercial salmon catch to the fishermen, Kodiak area, in dollars, 1960-1974 1/.

			Value to the Fishermen 2/			
Year	King	Sockeye	Coho	Pink	Chum	Total
1960	3,251	342,273	45,539	2,807,615	595,041	3,793,719
1961	2,359	385,541	24,006	1,727,459	295,793	2,435,158
1962	3,011	761,124	6,976	6,422,704	476,830	7,670,645
1963	798	394,829	49,030	2,411,270	183,037	3,038,964
1964	3,644	483,533	30,560	4,215,519	680,498	5,413,754
1965	2,193	363,549	22,938	1,096,996	258,804	1,744,480
1966	2,139	894,416	77,765	5,343,158	583,325	6,900,803
1967	6,813	418,672	13,510	92,635	174,643	706,273
1968	5,728	1,076,712	67,103	3,786,074	645,365	5,580,982
1969	6,527	780,754	50,025	6,150,403	333,794	7,321,503
1970	2,982	1,677,213	125,982	5,371,343	697,690	7,865,210
1971	2,626	829,206	27,975	2,612,180	1,500,962	4,972,949
1972	3,669	427,220	25,444	1,710,154	1,742,452	3,908,939
1973	5,326	610,231	5,055	591,078	882,046	2,093,736
1974	3,794	1,151,702	29,249	3,007,827	615,748	4,808,320

1) Source - A.D.F.&G., Kodiak Annual Management Reports.

2) Based on the average weight/fish times the average price/lb.

Table 80 . Estimated king salmon escapement, Kodiak area, Karluk and Red Rivers, by year, in numbers of fish, 1965-1974 1/.

Year	Karluk River 2/	Red River 3/
1965	978	
1966	8,000	
1967	1,500	
1968	700	
1969	1,750	
1970		
1971	4,500	
1972	3,000	851
1973	3,000-4,000	1,261
1974	1,000	1,644

1) Source - A.D.F.&G., 1966-1975. Inventory and cataloging of sport fish and sport fish waters. Federal Aid in Fish Restoration, Annual Progesss Reports, Vol.7-16.

2) Karluk River king salmon escapement estimates are approximations based on post-spawning surveys, harvest trends and personal observations of the fisheries by area biologists.

3) Red River king salmon escapement estimates represent weir counts.

Table 81 Estimated coho salmon escapement, Kodiak Island area, by year, in numbers of fish, 1966-1974. 1/ 2/.

	1966	1967	1968	1969	1970	1971	1972	1973	1974
American River	350	300	700		450	250	140	50	300
Buskin Lake	250	2,200	2,100	850	1,200	1,000	675	1,250	500
Kalsin River				150	150	25	50	73	75
Lake Rose Tead	1,600	2,600	3,500	2,000	1,000	1,050	2,800	2,350	
Miam Lake	350	800	300	500	3,000	700	460		1,500
Olds River	250		750	275	275	275	50	252	50
Pillar Creek				50	35	25	4		
Roslyn River	80	60	250	300				30	100
Solonie Creek	250	600	700	450	500	100	37	75	300
Saltery Creek			1,000			400	240		600

1) Source - A. D. F. & G., 1966-1975. Inventory and cataloging of sport fish and sport fish waters. Federal Aid in Fish Restoration, Annual Progress Reports, Vol. 7-16.

2) Escapement estimates are approximates based on post-spawning surveys, harvests trends, and personal observations of the fisheries.

Table 82 Estimated sockeye salmon escapement, Kodiak area, by year, in numbers of fish, 1960-1974 1/ 2/.

Year	Red River	Karluk River	Upper Station Lake	Frazer Lake	Akalura Lake 4/
1960	34,546	348,693	45,193	440	
1961	205,493	295,801	73,884	273	
1962	278,954	561,740	39,531	1,290	
1963	63,563	397,020	30,270	2,357	
1964	36,342	484,075	37,249	8,166	
1965	72,356	347,486	22,603	5,074	
1966	66,057	455,112	44,931	11,728	
1967	227,089	372,464	88,980	14,500	
1968	212,794	344,940	40,531	16,708	442 5/
1969	71,097	318,860	95,000 3/	13,976	360 5/
1970	28,395	313,552	53,001 3/	24,081	3,563
1971	109,199	142,265	104,809	55,366	3,618
1972	113,733	210,087	96,577	65,777	8,491
1973	119,993	237,464	87,633	56,255	5,769
1974	181,630	333,086	286,665	82,609	35,908

1) Source - A.D.F.&G., Kodiak Stock Status Report (unpublished) and Annual Management Reports.
2) Data obtained from weir counts.
3) Weir count plus estimated escapement before and after weir operated during weir washouts.
4) Akalura weir not operated between 1958-1968.
5) Weir removed before September-October portion of run.

Table 83. Estimated pink salmon escapement for index streams Kodiak area, by year, in numbers of fish, 1960-1974[1].

Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Portage Lake	28,000	5,000	27,300		37,000	10,000	20,000	3,000	6,000	25,000	15,000	25,000	12,000	11,000	6,000
Paramanoff	18,000	13,000	20,000	23,000	18,000	2,200[2]	17,000	200	27,000	2,900	15,000	1,300	15,600	3,000	7,000
Malina	34,000		60,000		35,000	200[2]	19,000		13,000	1,000	31,000	100	2,030	3,800	8,300
Afognak	14,000	3,000	75,000	2,000	45,000	900	26,000	1,000	10,000	12,000	25,000	3,400	29,000	9,500	15,250
Marka		20,000	65,000	12,000	22,000	5,500	35,000	2,500	15,000	12,000	120,000	12,500	31,000		38,000
Danger	17,000	8,000	50,000	300	11,000	5,000	25,000	5,000	15,000	7,600	45,000	5,800	20,600	3,000	14,000
Bauman's			17,000	800	8,000	1,800	9,000	4,200	6,000	7,000	7,000	6,000	1,300	3,000	4,000
Terror	32,000	22,000	45,000	79,000	40,000	17,280	85,000	35,000	45,000	55,000	40,000	40,000	25,000	14,000	39,000
Uganik	91,000	24,000	100,000	29,000	75,000	12,000	80,000	40,000	21,000	60,000	80,000	37,000	60,000	50,000	95,000
Little	31,000		45,000		50,000		65,000		45,000		75,000		14,000	2,000	16,000
Zachar	40,000	10,000	25,000	31,000	24,000	12,600	16,000	2,700	15,000	17,000	30,000	14,000	45,000	9,000	92,000
Brown's	62,000	2,000	96,000		65,000	300[2]	24,000	300	35,000	2,600	37,000	400	8,000	500	8,000
Uyak	36,000	15,000	65,000	30,000	100,000	60,000	40,000	75,000	35,000	95,000	69,000	65,000	34,000	50,000	12,500
Karluk	336,000		350,000	20,000	525,000		225,000		140,000		210,000		36,000	57	212,000
Sturgeon	52,000		35,800		140,000		90,000		30,000		48,000	4,000	13,000		13,000
Red River	205,000		100,000		425,000		175,000		300,000		800,000		100,344	1,500	612,712

continued

1) Source - A.D.F.&G., Kodiak Area Office files, summarized from annual aerial surveys and represent peak live counts of spawning pink salmon.

2) FRI aerial peak counts.

Table 83 (continued). Estimated pink salmon escapement for index streams, Kodiak area, by year, in numbers of fish, 1960-1974.

Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Dog Salmon	173,000	47,000	83,000	100,000	50,000	36,000	21,000	11,000	12,000	45,000	25,000	63,000	38,000	22,000	27,000
Narrows	18,000		18,000	4,500	4,200	2,500	600	3,500	2,800	6,000	3,000	5,000		1,000	2,600
Deadman	38,000	3,000	25,000	35,000	18,000	30,000	12,000	70,000	20,000	65,000	65,000	100,000	44,000	40,000	43,000
Humpy	85,000	89,000	300,000	160,000	80,000	175,000	36,000	60,000	120,000	55,000	110,000	122,000	45,000	45,000	72,000
Seven Rivers	135,000	20,000	128,000	72,000	10,000	104,270	40,000	47,000	100,000	33,000	100,000	54,000	12,000	20,000	15,500
Kaiugnak		10,000	34,000	24,500	10,000	8,500	10,000	8,000	10,000	4,000	29,000	3,000	17,000	1,000	2,000
Barling	28,000	28,000	40,000	9,600	60,000	7,454	20,000 2/	12,000	28,000	20,000	48,000	23,000	13,000	23,000	32,000
Kiliuda	11,000	10,000	18,700	12,000	17,000	2,200	9,000	1,700	5,000	2,000	8,000	2,500	15,000	1,500	14,500
Saltery	22,000	75,000	70,000	68,000	28,000	20,000	17,000	36,000	5,000	50,000	15,000	57,000	19,000	25,000	22,000
Miam			37,000				22,000		42,000		57,000	3,000	20,000	1,000	55,000
Hurst										20,000	16,000	3,000	27,000	8,000	
Sid Olds			70,000	3,000	30,000	6,000	35,000	19,000	55,000	36,000	63,000	40,000	17,000	12,000	36,000
American			21,000	24,000	25,000	9,000	24,000	14,000	25,000	70,000	84,000	18,900	48,000	10,500	17,000
Buskin	19,000	7,200	109,000	7,250	93,000	25,500	20,000	28,000	42,000	66,500	44,250	7,900	26,350	10,000	45,815
Sharatin	10,200	12,000	15,000		11,000	3,200	13,000	11,000	11,000	9,000	10,000	6,400	28,000	3,000	17,000

Table 84 . General salmon run timing information, Kodiak area[1/] .

Species	Present Bays and Estuaries	Present Freshwater	Peak of Spawning
King Salmon	Mar. 15-July 1	June 15-Sept. 1	Aug. 10-Sept. 1
Sockeye Salmon	May 1-Sept. 15	May 15-Nov. 15	Aug. 1-Oct. 1
Coho Salmon	July 1-Oct. 1	Aug. 15-Dec. 15	Oct. 15-Nov. 15
Pink Salmon	June 1-Sept. 1	June 15-Oct. 1	Aug. 1-Sept. 15
Chum Salmon	June 15-Sept. 1	Aug. 15-Oct. 1	Aug. 15-Oct. 1

1) Source - A.D.F.&G., Kodiak area staff, personal communication, 1976.

KODIAK AREA HERRING FISHERIES

COMMERCIAL FISHERIES

The first recorded commercial harvest of herring occurred in the Kodiak area during the 1912 season. A sustained annual herring harvest commenced in 1916 and developed to a large scale fishery by the early 1930's which continued through the 1950's. During the early years of the fishery, small herring operations were prevalent for salting and halibut bait. As the fishery expanded, large herring reduction plants developed. During the height of the fishery (1930's, 1040's), herring were utilized for meal, oil, pickling, dry salted and halibut bait. Market conditions for meal and oil became nonprofitable and no herring were processed between 1960 and 1963.

The average commercial herring harvest in the Kodiak area from 1916 to 1933 was 1,860 tons annually while the average annual harvest from 1934-1950 was 40,000 tons. The peak harvest occurred in 1934 when 120,797 tons of herring were harvested (Table 85).

During the years of intensive herring fishery, 1934-1950, large seine vessels were utilized along with limited use of gillnets and herring pounds. Herring fishing effort was spread throughout the entire Kodiak area. As the herring fishery declined in the late 1950's, many of the large seine vessels were converted to crab boats as the king crab fishery developed.

The Kodiak herring fishery remained idle from 1960-1963. The advent of the Japanese market for herring sac roe, combined with the meal by-product, sparked new interest and a limited fishery began in 1964. Presently the herring fishery in Kodiak is directed at sac roe, with one plant processing the carcasses for meal and oil and others for crab and halibut bait. The average annual herring harvest from 1964-1974 is 1,034 tons with a peak harvest in 1966 of 2,769 tons (Table 85).

Herring harvest for sac roe depends on the availability of herring in pre-spawn condition for roe removal. During the past five years herring have not been available in sufficient numbers in pre-spawn condition, so only a limited amount of the herring harvest has been processed for sac roe. The herring sac roe fishery normally occurs from May through early June prior to the spawning period. From July through August herring are taken for bait and reduction purposes. The Zachar Bay reduction plant in Kodiak has been processing a lesser amount of herring for meal over the past few years. At present, the meal operation seems to be a break-even business.

Since 1964, herring fishing effort has been concentrated on the west side of Kodiak Island, primarily in Zachar and Uyak Bays. Refer to Table 86 for the breakdown by geographical area of the Kodiak commercial herring harvest from 1964-1974. Herring recently harvested in the Kodiak area have mostly been taken by small salmon seine vessels. The use of pounds to trap and hold herring until the roe has been removed has also been utilized by small independent operators. Comparative effort data by year for the Kodiak herring fishery is incomplete. However, the number of purse seine vessels participating in the herring fishery was 5 in 1967, 21 vessels in 1969 and 11 vessels in 1973.

The annual value to the fishermen of the Kodiak herring fishery has fluctuated markedly since the inception of the sac roe fishery in 1964. Fluctuations in the value resulted from: different catch levels, market conditions which influence prices paid to the fishermen, and the quality of the herring for sac roe. The 1974 Kodiak herring harvest was worth approximately $169,600 to the fishermen.

DISTRIBUTION AND LIFE HISTORY

The offshore marine existence and the migratory habits of herring in the Kodiak area have not been documented, consequently this portion of herring life history is poorly understood. Currently, research conducted on herring in the area is carried out during the summer months when herring are distributed inshore. The degree of separation or intermingling of herring stocks within the area is not known.

Aerial surveys are conducted annually to establish areas of spawning and spawning intensity. Surveys have had limited success since herring spawning in the Kodiak area occurs over a very wide period of time as well as physical area, thus making it difficult to cover the right area at the right time. Herring spawning behavior in the Kodiak area has been erratic for the past five years. Large concentrations of prespawn herring have been unavailable to the sac roe fishery, however, high numbers of herring have been observed throughout the Kodiak area after the spawning period. Areas of herring spawning as well as timing of spawning has varied greatly during recent years.

The Kodiak herring map included in the map portion of this report outlines areas in which herring spawning and feeding have been observed. In the Kodiak area, herring do not always utilize the same spawning areas each year. Also, the amount of deep water spawning occurring in the area is not known. Therefore, it should be noted that the spawning areas outlined on the map are not all inclusive and that these spawning areas may not be consistent from year to year.

Large concentrations of spawning herring have been observed on the westside of Kodiak Island throughout Uyak, Uganik, and Viekoda Bays. Spawning herring have also been observed on the eastside in Port Hobrom and on the mainland in Kukak Bay.

Herring spawning in the Kodiak area generally occurs from May through mid-June, however, the peak of spawning varies greatly from year to year and between geographical areas. Water temperatures appear to play an important role in the timing of herring spawning. Generally water temperatures of 39°-40°F. are considered minimum. However, temperature requirements for herring spawning in the Kodiak area may be more dependent on degree days rather than absolute temperatures.

MANAGEMENT AND RESEARCH

Present herring management activities in the Kodiak area include biological sampling from the fishery as well as limited gillnet sampling from known spawning areas. The sampling program began on a limited basis in Zachar Bay in 1967 and now includes most areas where commercial herring fishing occurs. Data is collected on age, length, weight, and roe weight and condition. Water temperature is also taken. Age composition of herring stocks has been utilized as a method to interpret the general condition of the stocks. A stable distribution of age classes indicates a relatively stable population dynamics.

The Kodiak herring fishery is monitored with the aid of the vessel the M/V Smolt as well as through aerial surveys and processor and fishermen contacts.

There is no closed season for herring fishing in the Kodiak area, however, present regulations state that from March 1 through June 30 the commercial herring season will be closed when 3,400 tons of herring have been taken. Present herring regulations restrict the commercial herring fishery in bays closed to salmon fishing from June 1 through October 31. Permits are required for use of enclosures for retaining live herring and for the taking of herring spawn.

Table 85 Commercial herring catch, Kodiak area, by year, in tons of fish, 1912-1974. 1)

Year	Catch in tons	Year	Catch in tons
1912	20.0	1935	No data
1913	No harvest	1936	24,748.0
1914	No harvest	1937	27,659.3
1915	No harvest	1938	24,522.0
1916	70.0	1939	38,600.5
1917	137.9	1940	22,677.0
1918	118.4	1941	40,083.5
1919	259.7	1942	16,791.0
1920	45.9	1943	35,352.0
1921	944.9	1944	26,835.0
1922	1,482.6	1945	31,114.0
1923	321.5	1946	47,505.9
1924	4,823.0	1947	50,743.0
1925	9,997.0	1948	46,428.0
1926	2,680.9	1949	No harvest
1927	2,592.9	1950	44,132.5
1928	625.0	1951	4,299.0
1929	No data	1952	1,389.0
1930	622.0	1953	725.0
1931	1,000.0	1954	No harvest
1932	3,594.0	1955	No harvest
1933	2,312.5	1956	13,524.0
1934	120,797.0	1957	21,818.5

continued

1) Source - A.D.F.&G., 1974 Kodiak Annual Management Report.

Table 85 (continued) Commercial herring catch, Kodiak area, by year, in tons of fish, 1912-1974.

Year	Catch in tons	Year	Catch in tons
1958	1,711.0	1967	1,662.4
1959	3,831.0	1968	2,000.6
1960	No harvest	1969	1,130.0
1961	No harvest	1970	341.6
1962	No harvest	1971	284.3
1963	No harvest	1972	215.0
1964	567.8	1973	867.4
1965	657.2	1974	877.9
1966	2,769.3		

Table 86 Commercial herring catch, Kodiak area, by geographical area, in tons of fish, 1964-1974. 1) 2)

Year	Afognak	Chiniak & South Marmot Bay	Eastside	Uganik Bay	Uyak Bay	Sturgeon R.	Total
1964		309.78			258.00		567.78
1965		44.82			612.38		657.20
1966	36.38	144.92		67.00	1,746.35	774.63	2,769.28
1967					1,642.98	19.38	1,662.36
1968		15.00			1,985.63		2,000.63
1969		22.69	163.12	163.61	780.50		1,129.92
1970		17.67	26.04	27.00	270.91		341.62
1971	44.36	6.92	25.00	.02	208.00		284.30
1972		10.31		41.90	162.88		215.09
1973	139.41	248.51	9.67	70.12	399.68		867.39
1974	372.84	88.14		198.71	218.20		877.89

1) Source - A.D.F.& G., Kodiak Annual Management Reports.
2) No herring were commercially harvested in Kodiak from 1960-1963; the sac roe fishery began in 1964.

KODIAK AREA HALIBUT FISHERIES

INTRODUCTION

The Kodiak Island halibut fishery is unique in comparison to all other developed fisheries in the area. Management and research concerning this fishery is in the hands of the International Pacific Halibut Commission (IPHC), based in Seattle, Washington. As implied by the name of the managing agency, this is an international fishery with Canadian and American fishermen operating simultaneously on the same fishing grounds. Kodiak Island waters are included in the IPHC management area 3A which extends from Cape Spencer to Kupreanoff Point (Figure 5).

COMMERCIAL FISHERIES

The commercial halibut fishery around Kodiak Island began in the early 1900's as Seattle based vessels expanded efforts in search of untapped stocks. The eastside of Kodiak Island, particularly on Portlock Banks and around Chirikof Island, proved to be extremely productive areas. The development of the halibut fishery in terms of pounds landed for catch area 3A can be seen in Table 87.

The halibut fishery consists of two segments. The majority of the commercial catch comes from larger vessels capable of fishing far offshore grounds. Along with the offshore fishery, a substantial small boat fishery works inshore areas. These smaller vessels typically fish halibut as a supplement to salmon.

Historically, the halibut fishery has consisted of schooner type vessles roughly 80 feet in length. Most of these vessels were comissioned in the early 1900's and originally powered by a combination of motor

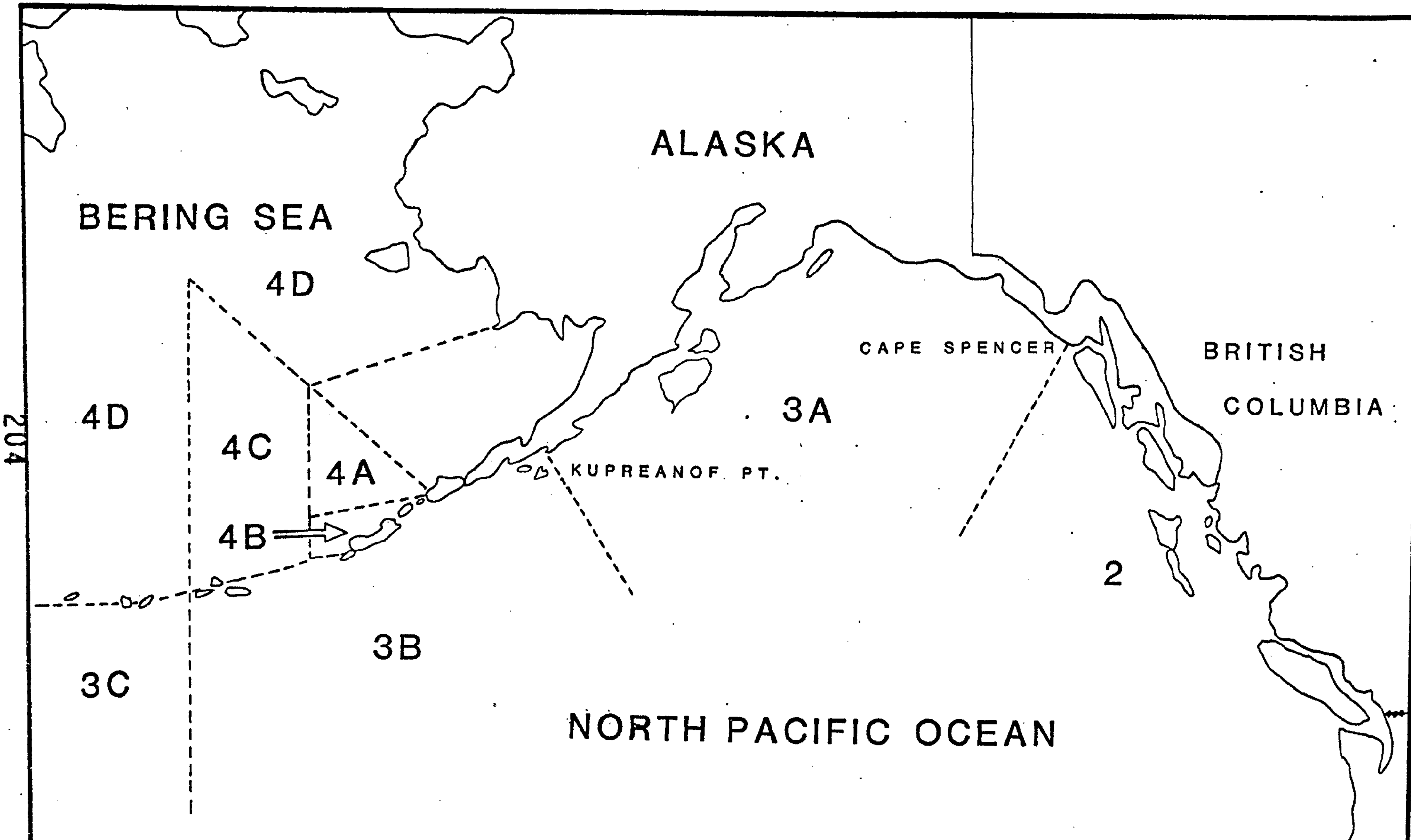


Figure 5 . Regulatory areas of the International Pacific Halibut Commission.

power and sails. All vessels still operating have been updated to utilize diesel engines and incorporate the latest electronic equipment. Few new vessels have been entered into the fishery.

Halibut are fished by means of a setline type gear referred to as a "skate." Larger vessels carry ice to preserve caught halibut in their holds. Trips vary in length but large vessles commonly fish over 20 days before delivery loads of up to 65,000 pounds of fish. Smaller vessels usually deliver on a day by day basis although some are capable of icing down their catch and therefore making longer trips.

All other means of harvesting halibut are illegal. In addition, all halibut taken incidentally in any other fishery must be returned unharmed to the water.

The current halibut regulations provide for a season opening May 1 and closing by emergency order dependent upon catch but not later than September 6.

The spring 1976 price of $1.29 per pound makes halibut the most valuable fish product per pound in the Kodiak area. It is impossible to determine exactly the economic value of halibut to Kodiak because landing of Kodiak halibut may take place as far away as Seattle.

DISTRIBUTION

Data collected by IPHC, NMFS and ADF&G fairly well define the distribution of halibut on the Kodiak shelf. Major stocks lie east and south of Kodiak with particular population densities near PortlockBanks and off Chirikof Island. IPHC has designated the 150 to 200 fathom area east of Chirikof Island as an important spawning area.

LIFE HISTORY

Halibut life history is described in the generalized life history found in the Appendix. Information specific to the Kodiak area is largely unavailable.

MANAGEMENT

The halibut fishery of the entire Pacific Ocean has been managed jointly by Canada and the United States during the past forty years under the International Pacific Halibut Commission. The sole objective has been to provide a sustained maximum yield.

Major problems involved with the management of halibut stocks come from the incidental catch and subsequent mortality subjected to halibut by other fisheries. Halibut are commonly caught in both shrimp trawls and crab pots. No clear solution to this problem is available at this time.

RESEARCH

The IPHC undertakes annual trawl surveys in the Gulf of Alaska. Most waters east of Kodiak receive some sample effort. Data from this work is used to assess stock size and recruitment. Halibut catch quotas are developed using this data.

Table 87 Commercial halibut catch in the Gulf of Alaska, Halibut Commission area 3A, in pounds, 1960-1974 1/.

Year	Catch in Pounds ($x10^6$)
1960	30.0
1961	33.9
1962	34.6
1963	32.9
1964	33.1
1965	33.7
1966	34.4
1967	30.9
1968	27.1
1969	30.3
1970	30.3
1971	26.1
1972	25.9 2/
1973	17.3
1974	9.6
Average	28.7

1) Source - International Pacific Halibut Commission Annual Reports.
2) Catch reported as a total for both area 3A and 3B. Area 3B production is small, generally less than 12% of the total area 3A catch.

KODIAK AREA GROUNDFISH FISHERIES

INTRODUCTION

Kodiak groundfish stocks must be discussed in a totally different context than other contemporary fisheries for three reasons: 1) groundfish are a major resource inhabiting the continental shelf of the United States that are exploited almost entirely by foreign fishing fleets, 2) although grouped under the catch-all term "groundfish," this is actually a multi-species fishery including pollock, Pacific cod, lingcod, blackcod, Pacific Ocean perch, assorted rockfish, sculpins and all flatfish excluding halibut, and 3) comprehensive research describing the range and abundance exclusively for these species has not been carried out.

COMMERCIAL FISHERIES

The majority of all commercial fishing activity for groundfish stocks along the Kodiak shelf is carried out by Japanese and Russian fleets. These foreign fishing fleets initially entered the area in the early 1960's. Effort has increased steadily since that time with vessels operating both singularly and in groups including factory ships. Specific data involving foreign fishing activity is beyond the scope of this report. The remainder of this discussion will be concerned with domestic activity and species profiles.

Groundfish stocks in the Kodiak management area support a minor domestic fishery at this time. The majority of the groundfish catch is marketed locally as bait for the king and tanner crab fisheries.

Alaska Department of Fish and Game has catch statistics dating back to 1972 when 55,600 pounds of Pacific cod and pollock were landed (Table 88). Catches are increasing but until a market develops the domestic fishery should not expand significantly. In 1974, 715,101 pounds of groundfish were marketed in Kodiak. Most of the 1974 catch was Pacific cod and assorted flatfish.

No data is currently available concerning fleet size or effort dynamics. Most groundfish landings come from shrimp vessels. However, a few crab fishing vessles are rigged to trawl for their own bait.

The economic value of groundfish in the current Kodiak bait market is $.20 per pound. This figure makes the 1974 catch worth $143,020.00 to the fishermen. Because of the undeveloped nature of this fishery any discussion of potential value would be speculation.

Although interest in a domestic groundfish fishery has been growing, no plans to market the product for human consumption are likely to mature this year. A Kodiak based group of fishermen have formed a corporation and purchased a processing vessel. Their ultimate intent is to market groundfish products from the Kodiak shelf but initially they will process shellfish and salmon.

SPECIES PROFILES

Pollock (*Theragra halcogrammus*)

Exploratory fishing drags of the National Marine Fisheries Service (NMFS) indicate a major concentration of pollock south and east of Kodiak along Albatross Banks. The International Pacific Halibut Commission (IPHC) trawl data indicates catches of pollock from the gully and canyon areas of the continental shelf. Concentrations of pollock have been documented at depths from 50 to 150 fathoms. Life history of pollock has not been studied in the Western Gulf. In other North Pacific areas pollock form dense schools in the spring. These schools of pollock migrate to shallower inshore waters to spawn. Females contain between

.2 and 1.5 million eggs each. After spawning and fertilization the eggs are planktonic. Hatching occurs in the upper portion of the water column where temperatures range from 6 to 7°C. As juveniles develop, they progressively become more bottom dwelling in habitat. Pollock mature at three to four years of age and may live as long as fifteen years.

Pollock prefer planktonic crustaceans and small fish as food. Daily vertical movements of both juvenile and adult pollock are probably related to feeding habits.

Pacific Cod (*Gadus macrocephalus*)

Exploratory fishing by both NMFS and IPHC has located scattered concentrations of Pacific cod on the Kodiak shelf in depths between 45 and 90 fathoms.

Pacific cod have well defined seasonal movements which appear to be controlled by water temperature. They migrate to shallower water in spring and summer. Spawning takes place during late winter and spring. Females each contain between 1.4 and 6.4 million eggs. Hatching occurs at the bottom in 4°C water. Maturity is reached in about three years in the Gulf of Alaska. Individuals may live eight to ten years.

Pacific cod feed on other fish and crustaceans, particularly shrimp and tanner crab.

Blackcod (*Anoplopoma fimbria*)

Blackcod are uncommon along most of the Kodiak shelf. The only documented concentrations are found east of Kodiak in 180 to 275 fathoms. A life history synopsis is presented in the Appendix.

Pacific Ocean Perch (*Sebastes alutus*)

Large quantities of this species have been recorded east of Kodiak over the outer continental shelf and slope. Scattered concentrations have been recorded in the Shelikof Straits. Ocean Perch appear most commonly between 80 and 125 fathoms. A life history synopsis is presented in the Appendix.

Flatfish (excluding Halibut)

Flatfish typically make up over half of any exploratory trawls made on the Kodiak shelf. Thirteen species are commonly found. These include turbot, mottled sand dab, sand sole, starry flounder, Alaska plaice, English sole, Dover sole, slender sole, yellowfin sole, rock sole, butter sole, flathead sole and rex sole.

Distribution of species is related to depth. Concentrations can be found in depths from 30 to 150 fathoms.

Flatfish reproduction and life cycles are not well known. Spawning is believed to occur in spring along the coastal shallows. Size at maturity and life spans vary among species.

Lingcod (*Ophiodon elongatus*)

There is no data available defining lingcod distribution. A life history sketch is presented in the Appendix.

Sculpins and Irish Lords

Incidental catch reports from both shrimp and crab research fishing indicates that sculpins and Irish lords are abundant throughout the Kodiak shelf. No life history work has been conducted on these species around Kodiak.

Table 88 Commercial groundfish catch, Kodiak area, by species, in pounds, 1972-1974. 1)

Year	True Cod	Flounder	Sablefish	Red Snapper-Rockfish	Ling Cod	Bullhead	Pollock
1972	50,295						5,305
1973	13,093	111,064	37,603		6,050	1,096	53,116
1974	156,630	418,433		1,705	15,241	58,761	64,331

1) Source - A.D.F.&.G., Kodiak Annual Management Report.

KODIAK KING CRAB FISHERIES

COMMERCIAL FISHERIES

The Kodiak Island king crab fishery ranks as one of the most important shellfish fisheries in the world. Exploitation of king crab in the Kodiak area began around 1936. Commercial catch records date back to 1950. This report will be concerned with data collected since 1960.

The king crab fishery was pioneered by salmon fishermen, utilizing small boats during the off-season fall and winter months. The gear types included tanglenets, otter trawls and light weight pots. Pots gradually became the exclusive gear; tanglenets were too difficult to fish and trawls were outlawed in 1960 for damaging incidentally caught females and undersized males.

Commercial harvests increased rapidly during the 1960's as markets and technology developed. Yearly harvests rose from 16.8 million pounds in 1960 to a record high of 90.5 million pounds in 1966 (Table 89). The large harvests of the mid 1960's constituted overfishing. The fleet continued to expand operations to more distant grounds but the annual catch dropped steadily to a low of 12 million pounds by 1970. Since 1970 stocks have slowly been staging a comeback. The 1974 harvest of 23 million pounds was the largest in seven years.

Salmon vessels continued to dominate through the early 1960's. In 1963 larger vessels, specifically designed for crab, began entering the fishery. In 1964 fifteen vessels larger than 80 feet fished Kodiak king crab for the first time. Total number of vessels participating rose from 143 in 1960 to a high of 227 in 1967 (Table 91). Since that time, reduced seasons and harvest levels have caused the number of participating vessels to drop to a low of 88 in 1972. Currently the Kodiak king crab fleet consists of about 200 vessels, 20 percent of which are greater than 80 feet in length (Table 92).

The economic value of king crab to Kodiak fishermen has varied a great amount over the years due to variability in catches and market conditions. Sale price per pound paid to fishermen varies depending upon location of the buyer and the interval during the season when the sale occurs. Accurate records of these variables have not been maintained.

Generally speaking prices held steady through the 1960's ranging from eight to twenty-five cents per pound. Prices rose with the decreased harvests of the early 1970's to the average 1973 price of fifty-five cents per pound. Poor market conditions in 1974 caused a drop in price to forty cents per pound. Average economic value is usually calculated by taking the current price times the average harvest for the last five years. This calculation does not give a clear picture of worth for the Kodiak king crab fishery. More applicable is taking the current price per pound times the current harvest since stocks are rebuilding. Using that method the current economic value to the fishermen is nearly 10 million dollars (Table 93). Kodiak king crab harvests are improving and if prices do not decline, 10 million dollars could be a conservative estimate of value.

DISTRIBUTION

King crab (*Paralithodes camtschatica*) are distributed throughout the entire Kodiak area out to a depth of 200 fathoms. Crabs are not distributed uniformly throughout the area, but congregate in schools. Consequently, crab are abundant in some locations and absent from others.

Crab distribution varies between months as the crabs migrate for food and mating. Migratory patterns of male king crab in the Kodiak area have been extensively studied and are well documented. Movements of sixty to seventy miles during one year's time are common. Males not molting tend to move further and have a greater tendency to move into bays and shallow locations than molting crab. The most complete migratory studies have been carried out on stocks inhabiting the southeast side of Kodiak. Typical travel exhibited by these crab includes northward movement from the Tugidak Island grounds to Sitkinak grounds and northward movement out of the deep grounds east of the Geese Islands up into Sitkalikak Straits.

Further analysis of migratory patterns has enabled biologists to define six distinct stocks of crab within the Kodiak management area. Data suggests that little or no interaction between stocks exists. Stock I comprises the area northeast of Kodiak including Portlock Banks. Stock II lies southeast of the island. Stock III is adjacent to Stock II on the southwest side of the island. Stocks IV through VI are of minor importance. They are located within the Shelikof Straits between Kodiak and the Alaskan Peninsula (Figure 6).

Spawning and rearing areas are widely distributed off Kodiak Island. The inshore and nearshore areas are the most critical spawning areas. Offshore regions such as Marmot Flats, Portlock Banks and Albatross Banks also make important contributions. The shallow area surrounding Chirikof Island north to the Trinity Islands is particularly vital for both spawning and rearing king crab. Research fishing since 1971 has consistently located concentrations of immature crab in this area.

Small numbers of blue crab (Paralithodes platypus) and brown king crab (Lithodes platypus) are harvested from Kodiak waters simultaneously

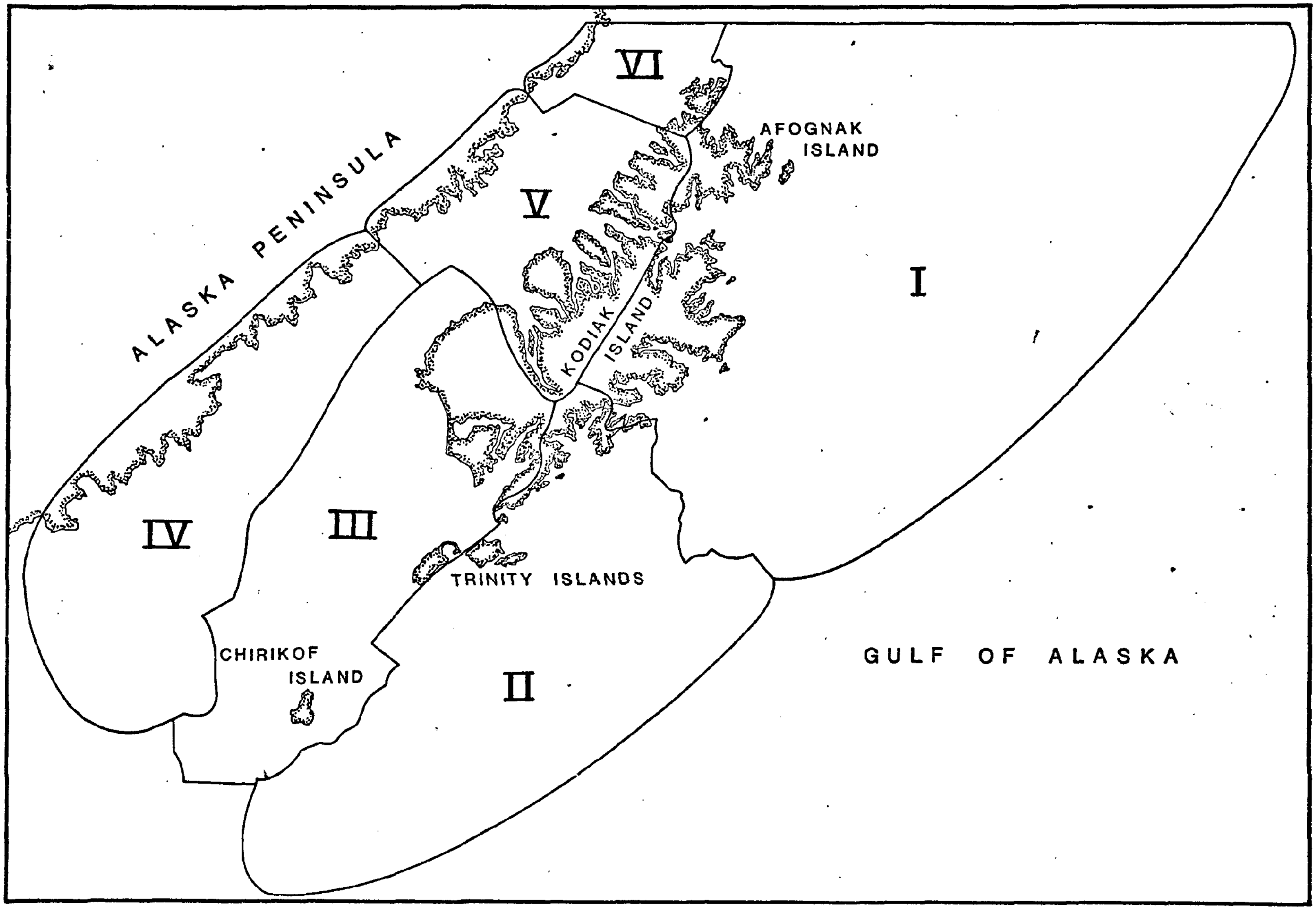


FIGURE 6. KODIAK AREA KING CRAB STOCKS.

with red king crab (P. camtschatica). The catch of these incidental species is minimal.

LIFE HISTORY

Around Kodiak, king crab begin a yearly mating migration to shallow water in December and January. This migration continues into the spring months. The majority of males that will molt do so during this migratory movement. Females reach the mating grounds in pre-molt condition. Peak mating periods are April and May. Females mate immediately following ecdysis (molting). Eggs are incubated for twelve months with the egg hatch preceeding the females annual molt. Following the mating season king crab gradually move back into deeper water. Research conducted in July typically finds mature king crab back in 50 to 80 fathoms.

A complete life history profile for king crab is presented in the Appendix.

ABUNDANCE

Population estimates, by stock, by year, are being formulated using the Petersen single census method with king crab tag data. These estimates are not available for this report.

MANAGEMENT

Kodiak king crab management philosophy has developed steadily through the years in response to fishery research, evolution of gear and improved technology. The goals toward which king crab fishery management has strived are to obtain a maximum sustainable yield and reduce severe fluctuations in catch.

Kodiak king crab fishery has had a males only harvest since its inception. The first important effort to manage crab stocks was a 6 1/2" size limit imposed in 1949. Trawls, as a means of harvesting crab, were made illegal in 1960 because of their damaging effect upon undersize and female crab. In 1963 the size limit was raised again, this time to 7 inches because studies revealed that weight increases due to growth were exceeding mortality loses for crab this size.

The commercial fishery expanded in the early 1960's. By 1965 the large modern fleet, fishing year round, was capable of harvesting crab far in excess of what the stock could replace through recruitment and growth. Resulting from this period of overfishing was a decline in standing stock. Catch sampling in 1971 showed that the fishery was totally dependent upon only the recruit age class. Optimally at least three age classes of crab would support the fishery. The incidence of unmated females, which was once a very rare occurrance, was rising steadily, indicating an insufficient number of breeding males.

Management philosophy changed as overfishing occurred. A mating season closure was adopted in 1969 but this alone was not adequate to rebuild stocks. The Kodiak area could not be managed intelligently as one unit. Management by individual stock and often just portions of stocks was begun. The Alaska Board of Fish and Game adopted a 14 million pound quota for the 1970-1971 season. The division of the harvest between stocks was left to the discretion of Kodiak staff. The 14 million pound quota proved to be too high. During the six month fishing season a fleet of 115 vessels was able to land only 12.2 million pounds. Consequently the quota was reduced to 10 and 12.5 million pounds respectively for 1971-1972 and 1972-1973 fishing seasons.

Concurrent with the restrictive catch quotas was the initiation of the king crab population indexing research charters. This indexing program was proposed as a ten year study. It encompasses as much of the Kodiak crab habitat as is economically feasible. Research biologists fish randomly selected stations with pots capable of retaining pre-recruit and smaller crab. This study takes place annually during mid summer after the molting and mating season. Crab captured are counted, measured and classified by shell condition. Legal size male crab are tagged in proportion to their availability and released. Mature females are checked for egg clutch content.

Data collected is analyzed by computer systems and printouts are available to management personnel prior to the August 15 opening of commercial crab fishing. This data is essential in determining the strength of age classes entering the fishery. Tag recovery is facilitated by the commercial fleet.

Tag recovery data continues to serve varied research goals. Migratory movements, growth, mortality (both fishing and natural) and population size are all being estimated through the tagging program.

As mentioned before, crab management strives to create a multi-age class harvest. Kodiak king crab management programs accomplish this by outlining the harvest such that one third of all recruit crab are harvested annually. Of those post recruits in the fishery for the second year a harvest of one half is called for. For crab surviving past their second year a 100% harvest is desired.

Since 1971, management efforts have resulted in increased harvests. Today the Kodiak area is divided up into four major fishing districts, Northeast, Portlock Southern and Shelikof. Each of these districts contain several subareas that are regulated during each season. The Department utilizes flexible harvest guidelines set each year by the Alaska Board of Fisheries at the request of research and management staffs. This concept enables the management staff to maximize the harvest within each fishing district based on crab abundance estimates gathered from the population indexing program.

The present king crab season opens August 15 and closes when the desired harvest level is reached. An eight inch season usually takes place in November or December to assure a more complete harvest of older crab. If the desired level is not reached the season will close no later than January 15.

RESEARCH

King crab research continues to be centered around the annual population indexing program. Statistical analysis of the sampling and tagging scheme followed by necessary improvements have established the program as a valuable tool in estimating total population, recruit class strength, and fishing mortality. Refinement and update of these estimates provide management with necessary data.

Another ongoing research effort is the refinement of the data analysis systems. Computer time is being reduced for existing programs and additional programs are being examined.

Table 89 . Commercial king crab catch, Kodiak area, by month, in pounds, 1960-1974. 1)

Month	1960	1961	1962	1963	1964	1965	1966
January	2,859,931	3,377,821	5,331,595	5,378,414	6,031,312	5,991,722	15,827,776
February	3,782,857	6,577,186	3,987,906	6,632,833	4,110,648	7,241,286	14,765,106
March	3,581,478	2,339,638	4,187,869	3,210,892	1,161,482	7,112,165	9,141,789
April	40,187	217,890	434,097	165,848	1,120,319	2,524,603	2,166,806
May	24,480	935,066	215,539	569,727	193,019	646,122	32,354
June	77,143	1,576,868	635,817	2,004,861	640,115	889,014	91,080
July	525,037	1,468,972	4,216,237	5,383,428	1,165,932	2,241,719	2,837,315
August	629,540	2,270,749	3,320,908	4,129,022	1,983,899	6,428,575	7,308,417
September	981,142	2,241,257	2,760,691	3,999,988	3,650,912	9,047,305	10,928,378
October	1,264,096	2,423,545	3,545,094	4,408,893	3,396,365	10,364,728	6,316,926
November	930,541	3,096,422	2,824,033	2,712,544	3,039,496	12,330,530	7,751,325
December	2,110,500	2,732,263	2,410,939	2,103,528	4,148,139	11,824,164	13,360,076
TOTAL	16,806,932	29,257,677	33,870,725	40,699,978	29,641,538	76,641,933	90,527,348

continued

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.
2) Season closed.

Table 89 (continued) . Commercial king crab catch, Kodiak area, by month, in pounds, 1960-1974.

Month	1967	1968	1969	1970	1971	1972	1973	1974
January	10,069,175	2,477,773	1,503,469	1,285,374	935,842	2)	2)	2)
February	5,701,469	1,775,617	492,842	2)	2)	2)	2)	2)
March	7,108,878	886,405	28,666	2)	2)	2)	2)	2)
April	1,413,738	113,525	2)	2)	2)	2)	2)	2)
May	741,556	236,700	2)	2)	2)	2)	2)	2)
June	161,796	277,099	2)	2)	2)	2)	2)	2)
July	9,400,180	23,838	2)	2)	2)	2)	2)	2)
August	10,121,138	6,165,281	1,715,458	1,688,227	1,781,625	7,600,357	10,570,808	7,071,543
September	6,349,113	3,881,905	4,591,930	3,692,455	5,657,591	6,555,850	1,702,709	13,782,400
October	5,183,060	3,020,140	2,724,621	2,465,456	3,444,936	648,478	2,123,770	849,823
November	3,746,248	1,946,381	627,734	1,723,207	2)	491,456	2)	1,127,545
December	2,897,669	1,313,117	1,255,454	1,214,783	2)	183,775	2)	200,062
TOTAL	62,894,020	22,097,781	12,940,174	12,069,502	11,819,994	15,479,916	14,397,287	23,031,373

Table 90 . Commercial king crab catch, Kodiak area, by stock, in pounds, 1960-1974. 1)

Fishing Year	Stock I	Stock II	Stock III	Stock IV-VI	Total
1960-1961	2,165,810	7,222,186	7,465,905	2,214,182	19,068,083
1961-1962	4,715,761	8,831,367	9,698,995	6,966,160	30,212,283
1962-1963	9,225,745	11,868,151	10,790,854	3,949,855	35,834,605
1963-1964	17,316,680	12,300,269	5,780,145	4,071,828	39,468,922
1964-1965	13,523,880	21,162,531	3,452,449	2,817,291	40,956,151
1965-1966	23,340,867	58,567,160	12,095,984	1,769,045	95,773,056
1966-1967	14,932,618	39,229,139	15,555,808	3,361,190	73,078,755
1967-1968	9,932,530	8,377,550	21,131,988	4,424,755	43,866,823
1968-1969	5,087,077	4,162,539	6,728,071	2,628,085	18,605,722
1969-1970	2,921,083	3,464,744	3,120,577	2,644,744	12,151,148
1970-1971	3,142,881	4,216,123	1,998,344	2,370,462	11,727,810
1971-1972	658,749	4,579,149	5,128,154	518,100	10,884,152

continued

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.

2) Source - A.D.F.&.G., Report to Board of Fisheries, 1976.

Table 90 (continued). Commercial king crab catch, Kodiak area, by stock, in pounds, 1960-1974.

Fishing Year	Stock I	Stock II	Stock III	Stock IV-VI	Total
1972-1973	1,039,847	6,600,988	6,844,092	994,989	15,479,916
1973-1974	1,648,990	7,896,548	4,092,729	759,020	14,397,287
1974-1975 2)	4,623,233	8,072,710	9,079,311	1,191,066	22,966,320

Table 91 . Kodiak area king crab, number of vessels, 1960-1975. 1)

Fishing Year	Number of Vessels Fishing	Number of Vessels Registered	% of Registered Vessels Resident	Non Resident
1960-1961	2)	143	81%	19%
1961-1962	2)	148	68%	32%
1962-1963	2)	195	73%	27%
1963-1964	2)	181	70%	30%
1964-1965	2)	190	71%	29%
1965-1966	2)	175	70%	30%
1966-1967	2)	213	70%	30%
1967-1968	2)	227	83%	17%
1968-1969	2)	178	82%	18%
1969-1970	2)	154	90%	10%

continued

1) Source - Kodiak Shellfish Management Registraticn Files.

2) No data.

Table 91 (continued). Kodiak area king crab, number of vessels, 1960-1975.

Fishing Year	Number of Vessels Fishing	Number of Vessels Registered	% of Registered Vessels	
			Resident	Non Resident
1970-1971	115	144	81%	19%
1971-1972	89	106	91%	9%
1972-1973	88	115	83%	17%
1973-1974	129	170	77%	23%
1974-1975	158	182	82%	18%

Table 92 . Length frequencies of Kodiak king crab vessels that made landings, 1960-1974. 1)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
0-29	16	14	28	22	27	17	16	15	2	4	5	1	-	1	5
30-39	92	82	83	59	61	38	55	51	31	39	20	16	15	24	37
40-49	19	28	34	30	29	33	28	29	37	34	20	18	10	22	26
50-59	3	13	14	12	9	14	26	36	16	13	15	8	15	13	16
60-69	7	5	16	17	21	23	22	24	25	18	16	11	14	20	19
70-79	5	5	14	20	21	30	36,	36	30	16	12	12	12	18	24
80-89	1	1	3	10	10	10	17	22	21	18	19	16	18	19	19
90-99	-	-	1	4	4	4	4	5	5	3	3	2	1	4	4
100-119	-	-	1	3	3	3	3	4	5	6	2	3	1	4	3
120-149	-	-	1	4	4	3	3	2	3	2	-	1	-	1	2
150-170	-	-	-	-	-	-	3	3	3	1	3	1	1	3	3
TOTAL	143	148	195	181	189	175	213	227	178	154	115	89	88	129	158

1) Source - A.D.F.&.G., 1976 Report to the Board of Fisheries.

Table 93 . Value of commercial shellfish catch to the fishermen, Kodiak area, by species, in dollars, 1960-1974. 1)

Year	King Crab	Tanner Crab	Dungeness Crab	Shrimp	Scallops	Razor Clams	Total
1960	1,259,807			135,160		44,275	1,439,242
1961	2,486,902			443,340		40,205	2,970,447
1962	3,217,719		171,401	506,172		31,315	3,926,607
1963	4,069,998		223,876	354,148		36,466	4,684,488
1964	2,964,164		374,596	177,611			3,516,371
1965	7,664,193		397,389	621,473		5,000	8,688,055
1966	11,586,103		184,103	1,084,370		6,192	12,860,768
1967	6,951,552	7,767	866,277	1,548,924	545	862	9,375,927
1968	5,833,814	256,069	956,069	1,378,749	618,057	2,554	9,045,312
1969	3,308,296	750,474	930,186	1,649,742	1,012,860	4,812	7,656,370
1970	3,379,460	847,888	803,801	2,487,248	1,417,612	52,904	8,930,543

continued

1) Source - A.D.F.&G., Kodiak Area Annual Management Reports.

Table 93 (continued). Value of commercial shellfish catch to the fishermen, Kodiak area, by species, in dollars, 1960-1974.

Year	King Crab	Tanner Crab	Dungeness Crab	Shrimp	Scallops	Razor Clams	Total
1971	3,549,998	815,188	260,256	3,286,149	883,271	57,118	8,828,269
1972	6,037,167	1,547,852	823,814	3,064,320	1,194,612	53,240	12,720,029
1973	7,918,508	5,358,407	1,000,263	5,640,918	1,122,846	66,113	21,515,457
1974	10,260,342	5,095,927	354,718	4,339,424	192,329	99,191	20,341,931

KODIAK TANNER CRAB FISHERIES

COMMERCIAL FISHERIES

The Kodiak tanner crab fishery has been in existence since 1967. During the years from 1967 to 1972 the fishery played a minor role. Typically, 50 to 80 vessels utilized tanner crab as a supplemental resource. February through May were the most productive months, primarily because of the king crab season closure.

Through the year 1972 the commercial harvest never exceeded 12 million pounds (Table 94). In 1973 a major expansion of the fishery took place. Calendar year 1973 ended with 31.5 million pounds harvested by a fleet of 130 vessels. Favorable and established markets, a very short king crab season, better price and large untapped stocks of tanner crab all contributed to make this a dominant fishery during the winter and spring months.

Fishing effort for tanner crab has been evenly split between four geographic regions (Table 95). The northeast, east, and Shelikof Straits areas receive the bulk of the winter effort. The southend and far offshore eastside become more heavily utilized in March and April as winter storms subside.

The Kodiak tanner crab fleet currently consists of around 125 vessels, one fourth of which are at least 80 feet long (Table 96). A trend to increased vessel size has opened the previously unfished offshore grounds to exploitation by this winter fishery.

The Kodiak tanner crab fishery developed slowly from 1967 to 1972. Much of the reason for this was unstable markets and low prices. Tanner crab fishermen were paid an average of only 11 cents per pound prior to 1973. The price of live crab went to 20 cents per pound in 1973 and

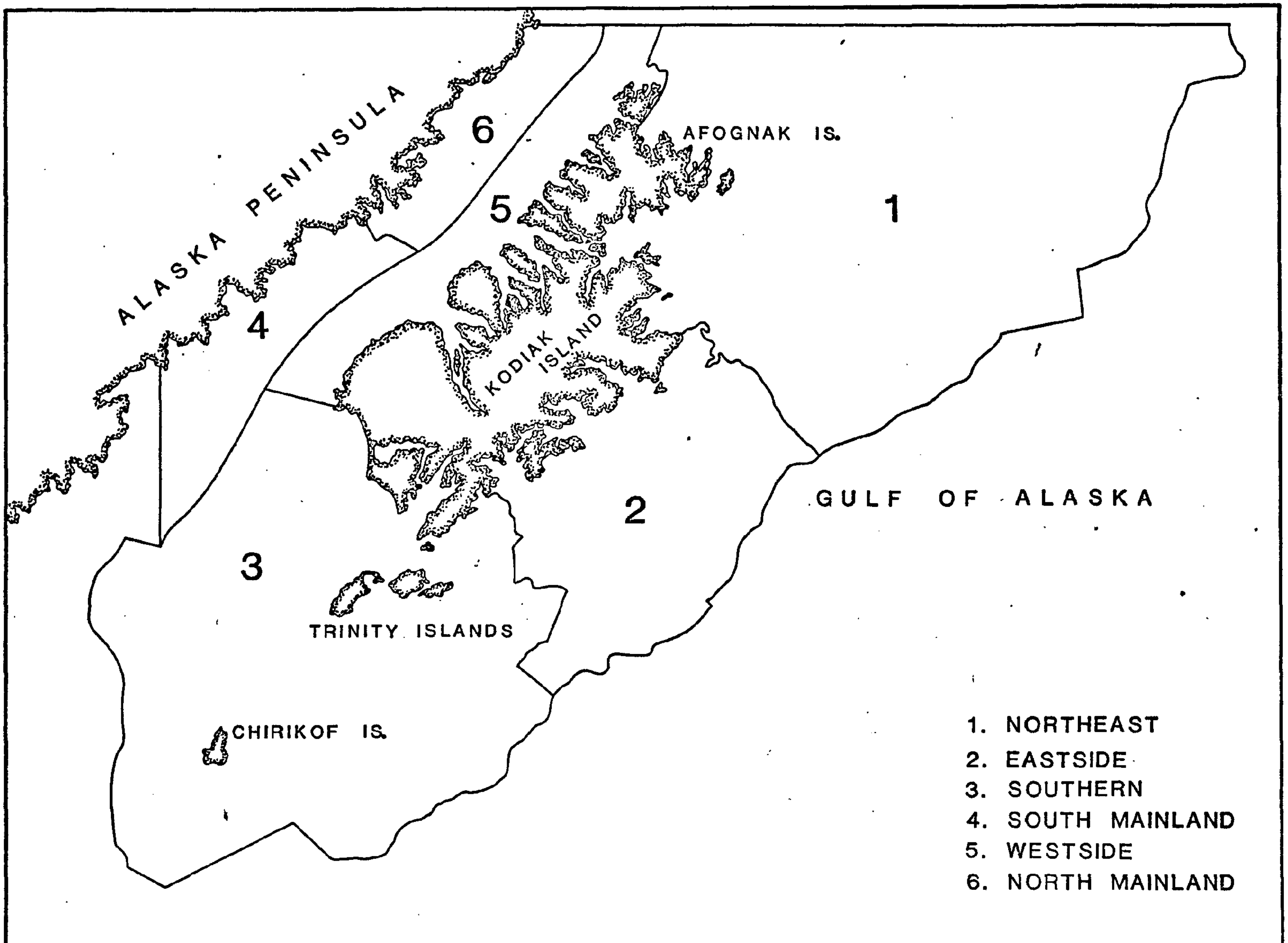


FIGURE 7. GEOGRAPHICAL FISHING DISTRICTS FOR TANNER CRAB FOR THE KODIAK MANAGEMENT AREA.

with the exception of 1974-75 season has held at that point. With harvest guidelines set at up to 25 million pounds, tanner crab currently brings 5 million dollars to Kodiak fishermen each season (Table 93).

DISTRIBUTION

Tanner crab (*Chionoecetes bairdi*) are known to inhabit the entire Kodiak shelf to a depth of over 200 fathoms. Alaska Department of Fish and Game research charters have shown that the largest concentrations are found deeper than 75 fathoms, with a preference for mud bottoms. In general, the bathymetric and spacial distribution of tanner crab with regard to season, sex or age is not well documented. Both sexes are known to occupy the same depths at times but segregation by age and sex is suspected.

A large amount of commercial fishing effort is concentrated in areas where bottom drop-offs occur. Such edge areas as Chiniak Gully, Two Headed Island, the southwest edge called the "Compass Rose" and Ugak Bay produce a major portion of the catch.

Tagging studies to document migration have not uncovered widespread movement by tanner crab. Typical distance difference between release and recapture stations for one year is fifteen miles. No regular movement with regard to depth can be seen.

LIFE HISTORY

Specific life history information for Kodiak tanner crab stocks has only recently been made available. The yearly cycle begins in April and May with the majority of eggs hatching at that time. This is immediately followed by the deposition of new egg clutches.

Once hatching occurs the larvae become free swimming in the water column. During this free swimming phase their appearance is more shrimp like and they are less than 3 mm in width. Tanner crab settle out of the water column at approximately 3.4 mm and molt 10 to 12 times before reaching sexual maturity at five to six years of age. The average male reaches maturity at 111 mm. The size at which 50% of the female crab are mature is 84 mm. The natural life span of tanner crab is 8 to 12 years.

A close association exists between molting and mating in tanner crab. Female crab exhibit morphological changes in the abdomen and structure of the pleopods during the molt to maturity. Immediately after this molt the female may mate with a male who has grasped her before and during this molting period. Mating for primiparous (first time) spawners is accomplished while the female is still soft shell. After mating, ovulation occurs. This molt to maturity is the last molt for a female except in extremely rare cases. It is unknown at this time to what extent hardshell females participate in mating. Females are able to fertilize successive egg clutches from stored sperm and therefore may mate less often than annually, possibly only once, at the molt to maturity. Once fertilized, eggs are attached to the pleopods and held by the female for about twelve months.

The reproductive season, in total, is composed of three significant events: 1) molt to maturity and mating of primiparous spawners from January through early June, 2) peak of egg hatch in April and May and 3) deposition of new egg clutches by multiparous (one plus spawners) crab in April and May. If hardshell females mate that too must take place during April and May. Therefore, it appears that the early egg deposition to the late egg hatch extends from January to July with April and May the most critical months.

ABUNDANCE

Abundance estimates for Kodiak tanner crab stocks have not yet been completed. Shellfish management, however, moniters such indices of abundance as catch per pot and size frequency. Due to the fact that new areas have been exploited each year as the fishery developed no conclusive data is available to indicate a change in stock size.

MANAGEMENT

Management strategy for Kodiak tanner crab stocks has been adjusting rapidly since 1973. Prior to that time, the only regulation called for a male only harvest. Comprehensive commercial catch sampling and research advances have prompted development of season definition, size limits, and harvest guidelines. The Alaska Board of Fisheries established the first guideline for management in 1973. A season opening Nov. 1 and closing June 30 was set with a quota not to exceed 30 million pounds.

Recently the Board updated these efforts by adopting three major revisions: 1) a harvest guideline level was set at 15-25 million pounds for established fishing grounds, 2) in response to research, a 5 1/2" mininum size limit was set to allow the average male at least one chance to participate in mating before entering the fishery, and 3) a January 1 through April 30 season to reduce conflict with the king crab fishery and provide protection during the peak of the mating and egg hatch cycle.

Current management problems are mainly centered around accurate estimation of fishing mortality and recruitment.

RESEARCH

Research dealing with tanner crab in Kodiak has been limited in the past but in recent years programs have been expanded. The Kodiak tanner crab research program is presently involved in studies to supplement life history knowledge, improve upon the mark recapture program and index population trends.

Research efforts in the area of life history are centered on establishing a size-age model. This information will allow biologists to examine both the commercial and research catches in terms of individual year classes. Year class breakdown will enable a more accurate estimation of recruit class strength.

Additional emphasis is also being placed on determining reproductive potential of female crab. The number of actual matings, if more than one, and also the total number of egg clutches an average female will produce in her life span are the objects of this research.

A mark-recapture program was initiated in 1973 but emphasis on growth had precluded statistical evaluation of the program. Attempts are being made to develop a tagging scheme that will enable researchers to accurately estimate population size, differentiate individual stocks and assess fishing mortality.

Annual research charters have been set up to index king and tanner crab populations since 1971. Indicators of general population strength such as relative abundance and the incidence on non-ovigerous(barren) females show up in the data collected.

Table 94 . Commercial tanner crab catch, Kodiak area, by month, in pounds, 1967-1974. 1)

Month	1967	1968	1969	1970	1971	1972	1973	1974
January	3)	59,447	182,054	705,490	273,647	457,230	1,714,562	4,632,198
February	3)	103,233	172,459	1,208,112	744,696	824,237	2,523,044	4,351,677
March	9,900	131,514	1,182,569	2,726,522	1,373,148	1,096,515	5,306,645	7,214,709
April	3)	348,175	2,177,392	1,700,150	1,331,674	2,084,305	10,249,098	8,961,449
May	20,300	653,672	1,390,753	760,464	1,804,407	2,549,301	5,743,278	319,684
June	3)	393,052	589,765	183,724	792,975	1,374,056	1,642,236	2)
July	3)	309,443	504,665	144,156	354,068	693,662	2)	2)
August	3)	120,357	50,329	2)	21,981	43,419	2)	2)
September	6,600	102,401	48,565	14,002	8,854	36,947	2)	2)
October	9,900	162,275	304,840	14,476	17,634	133,750	2)	2)
November	32,800	86,108	78,636	118,058	201,176	1,128,444	1,739,041	3)
December	31,600	91,010	145,285	132,924	486,545	1,484,692	2,602,141	3)
TOTAL	111,100	2,560,687	6,827,312	7,708,058	7,410,805	11,906,558	31,520,045	25,479,717

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.
2) Season closed.
3) No catch reported.

Table 95. Commercial tanner crab catch, Kodiak area, by district, in pounds, 1972-73 through 1974-75 fishing seasons. 1)

District	1972-73	1973-74	1974-75
Northeast	4,431,357	6,152,046	2,764,127
Eastside	5,936,085	6,920,373	2,855,975
Southend	9,711,116	7,981,834	4,130,145
N. Mainland	6,732,774	7,009,117	3,536,872
S. Mainland	120,124	50,419	191,554
Westside	2,860,544	1,722,389	171,293
TOTAL	29,792,000	29,836,178	13,649,966

1) Source - A.D.F.&.G., Report to the Board of Fisheries, 1976.

Table 96. Keel length frequencies of Kodiak tanner crab vessels which made deliveries, 1969-1974. 1)

Vessel length	1969	1970	1971	1972	1973	1974
0-20	-	2	-	-	-	-
20-29	1	1	-	-	1	3
30-39	11	10	8	13	29	23
40-49	25	18	17	11	25	23
50-59	7	13	6	13	11	11
60-69	13	11	5	7	18	14
70-79	11	5	5	9	20	19
80-89	11	15	12	10	19	18
90-99	2	3	-	-	4	4
100-119	3	2	-	1	1	5
120-149	-	-	-	-	1	0
Over 150	1	1	-	-	1	3
TOTAL	85	81	53	64	130	123

1) Source - A.D.F.&.G., Report to the Board of Fisheries, 1976.

KODIAK DUNGENESS CRAB FISHERIES

COMMERCIAL FISHERIES

A fishery for dungeness crab has existed in Kodiak since 1962. Since its origin the fishery has experienced considerable variation in catch and market conditions. Landings have varied from 6.8 million pounds in the late 1960's to a low of 0.75 million pounds in 1974 (Table 97).

Since 1962 the number of vessels participating in the dungeness fishery has varied from 12 in 1966 to a maximum of 43 in 1968. The fleet consisted primarily of small vessels (40-60 ft.) until 1968. At that time, declining catches in Oregon, Washington and California forced larger, nonresident vessels into the Kodiak fishery (Table 98). With the increase in vessels, the catch remained high during 1969 and 1970, with landings of 5.7 and 5.8 million pounds respectively. Following the 1970 season both the total harvest and the number of vessels dropped off drastically. In 1974 only 750,000 pounds of crab were landed by 23 vessels.

Major fishing areas for dungeness crab in the Kodiak area have shifted as fishing grounds were exploited. In the initial years (1962-1963) more than 50 percent of the catch was harvested between Kukak Bay and Cape Douglas on the Alaskan Peninsula. In 1964 fishing effort began shifting to Kodiak's eastside and south of Trinity Islands. Present fishing effort is concentrated in westward bays and south of the Trinity Islands (Table 99).

Present economic value to the fishermen based on the 1974 price of 47 cents per pound on a harvest of 750,057 pounds is $354,718. However, when this price per pound is computed with the last five year average catch of 2.4 million pounds the value to fishermen is 1.13 million dollars. With proper management efforts the Kodiak dungeness crab fishery could continue to be a 1 million dollar fishery.

DISTRIBUTION

Dungeness crab (Cancer magister) inhabit all bottom areas above 50 fathoms with distinct preference for sand or sand-mixed substrate. The life history profile, contained in the Appendix, outlines documented distribution of the species along the Pacific Coast of North America. With specific regard to Kodiak, those coastal areas presently supporting a commercial catch can be considered areas of population density. Distribution of dungeness larvae and early juvenile stages is not documented. A tagging study to document migrations was initiated in 1970 but dropped again in 1971 because of funding cuts.

LIFE HISTORY

Timing of the yearly life cycle of dungeness crab is highly temperature dependent. Kodiak stocks are believed to behave similarly to the generalized outline found in the Appendix but with slight adjustment of dates. Around Kodiak, mating occurs from July to September with the peak period usually in August. The egg hatch takes place in the spring, April and May being the most critical months. After hatching, larvae remain in the water column for up to three months.

Both sexes of dungeness crab reach sexual maturity at age three. Males are larger at maturity than females. At age three, males have typically reached 140mm carapace width, females 100mm. Both sexes molt annually after reaching maturity. The minimum legal size for male crab is 178mm (7 in.) in carapace width. There is no fishery on females.

This allows the average male crab two years for mating before entering the fishery.

Similar to other West Coast stocks, 5 year old crab dominate the commercial catch. This means that the strength of a year's fishery depends almost entirely upon a single year class of crab.

ABUNDANCE

No population estimates exist for Kodiak dungeness crab stocks. Indices of abundance are arrived at from catch and effort data. All current indications suggest a decline in stock abundance. Since 1969 catch per pot has fallen from 12 crab to 3 crab in 1974. Average weight per crab has decreased by 0.5 pound since 1970. No explanation for these ovservations are available.

MANAGEMENT

Dungeness crab management in Kodiak centers on information gathered through the dockside sampling program and fish tickets. The dockside program includes an interview with the vessel operator to determine location of fishing and a size frequency sample of the catch. Fish ticket data includes total catch in pounds, average weight of crab and number of pots pulled. Analysis of this data has indicated a decrease in both average size and catch per pot in recent years suggesting a decline in population.

The Alaska Board of Fisheries recently set the Kodiak dungeness crab season to open May 1 and close December 31. This closure was enacted to assure removal of gear from fishing grounds. No harvest guidelines are set at this time. If deemed necessary, seasons may be closed by emergency order.

RESEARCH

No research is currently being conducted. Management biologists feel that in light of low population levels extensive indexing and tagging programs may be the only means of regaining stock levels common in the late 1960's.

Table 97 . Commercial dungeness crab catch, Kodiak area, by month, in pounds, 1962-1975. 1)

Month	1962	1963	1964	1965	1966	1967	1968
January	0	0	0	105	0	13,352	0
February	0	0	0	974	15,841	5,335	92
March	0	0	0	3,411	0	9,811	3,323
April	0	0	0	56,626	0	1,450	41,536
May	47,550	48,490	51,146	46,230	29,150	414,967	342,335
June	573,175	361,505	468,461	526,728	218,248	1,220,028	1,321,935
July	415,787	921,853	812,083	861,424	170,242	2,021,921	1,974,251
August	456,061	679,186	1,335,928	977,179	350,981	1,332,017	1,384,323
September	397,605	357,305	997,450	655,072	264,142	903,094	822,707
October	14,389	60,359	373,113	128,453	49,743	527,542	676,828
November	0	47,059	111,953	54,677	42,748	195,233	214,831
December	0	11,755	12,048	692	7,505	18,918	46,900
TOTAL	1,904,567	2,487,512	4,162,182	3,311,571	1,148,600	6,663,668	6,829,061

continued

1) Source - A.D.F.&.G., Report to Board of Fisheries, April 1976.

Table 97 (continued). Commercial dungeness crab catch, Kodiak area, by month, in pounds, 1962-1975.

Month	1969	1970	1971	1972	1973	1974
January	14,955	3,789	9,110	7,380	427	12,718
February	813	0	0	2,814	15,265	2,530
March	460	0	52,109	0	1,960	4,750
April	6,895	0	0	0	35,464	2,110
May	104,708	156,352	5,278	9,834	148,867	23,929
June	422,329	732,837	44,289	155,165	277,312	157,075
July	1,983,621	1,906,177	188,333	536,335	552,192	202,143
August	1,765,757	1,512,963	304,714	558,635	377,665	88,647
September	999,113	779,188	368,498	445,349	328,189	82,695
October	352,060	550,753	424,158	190,250	112,974	113,757
November	146,870	126,798	44,595	85,702	111,335	43,324
December	37,047	22,581	4,780	68,072	38,876	16,379
TOTAL	5,834,628	5,741,438	1,445,864	2,059,536	2,000,526	750,057

Table 98. Length frequencies of Kodiak area dungeness vessels which made deliveries, 1964-1974. 1)

Vessel length	1964 2)	1965 2)	1966 2)	1967	1968	1969	1970	1971	1972	1973	1974
0-20	-	-	-	-	1	-	1	1	1	10	-
20-29	-	-	-	-	3	2	3	4	1	3	-
30-39	-	-	-	5	7	5	5	3	9	11	7
40-49	-	-	-	5	11	11	8	6	7	12	7
50-59	-	-	-	3	8	6	5	2	6	4	2
60-69	-	-	-	3	4	1	2	4	4	5	1
70-79	-	-	-	-	3	2	4	1	2	4	5
80-89	-	-	-	2	3	1	5	2	4	2	-
90-99	-	-	-	-	3	1	-	-	-	-	-
100-119	-	-	-	-	-	-	-	1	-	-	-
120-149	-	-	-	-	-	-	-	-	-	-	-
TOTAL	29	26	12	18	43	29	33	24	34	42	22

1) Source - A.D.F.&.G., Report to the Board of Fisheries.

2) No data available.

Table 99 . Commercial dungeness crab catch, Kodiak area, by district, in pounds, 1962-1974. 1)

Year	Northeast	Eastside	Southend	No. Mainland	So. Mainland	Westside	Total
1962			495,187	1,085,603		304,731	1,904,567
1963	174,126	49,750	199,001	1,741,258		323,377	2,487,512
1964	166,487	790,815	1,082,167	1,581,629		541,084	4,162,182
1965	165,579	827,892	927,240	894,124	99,347	397,389	3,311,571
1966	57,430	493,898	229,720	195,262	114,860	57,430	1,148,600
1967	66,637	1,332,734	4,664,567	333,183		266,547	6,663,668
1968	273,162	956,069	4,234,018	819,487		546,325	6,829,061
1969	233,385	933,540	3,967,548	641,809		58,346	5,834,628
1970	114,829	1,205,702	3,272,620	918,630		229,657	5,741,438
1971	28,917	404,842	549,428	245,797	14,459	202,421	1,445,864
1972	185,358	617,861	720,838	288,335		247,144	2,059,536
1973	102,929	729,930	303,619	274,045	42,196	547,807	2,000,526
1974	30,125	331,156	42,741	29,418	116,341	200,276	750,057

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.

KODIAK SHRIMP FISHERIES

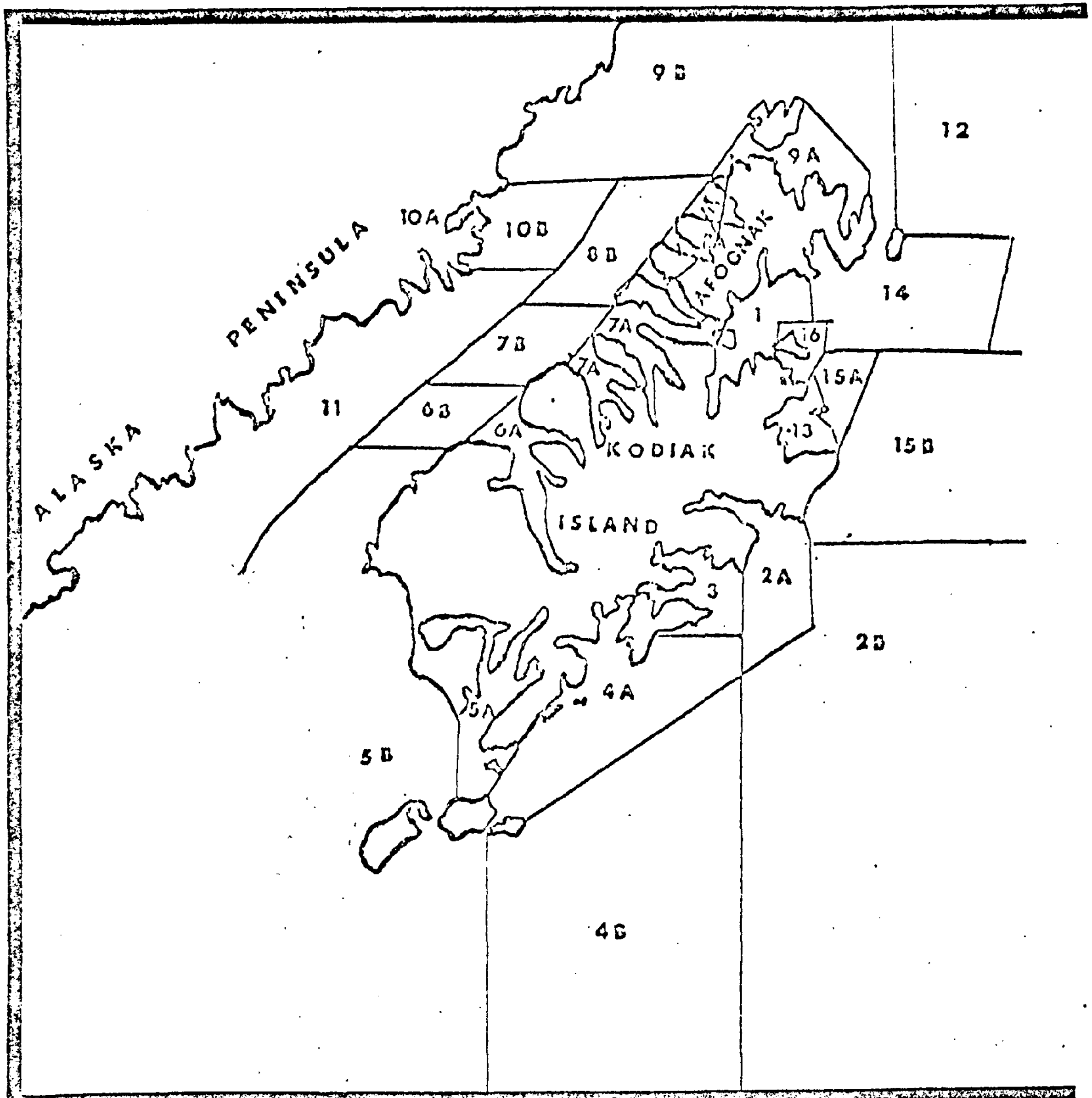
COMMERCIAL FISHERIES

The Kodiak Island management area has developed into the leading west coast shrimp fishery. Exploratory trawl fishing in 1957 discovered concentrations of commercial shrimp species off Kodiak. Processing commenced in 1959 with an annual harvest of 2.9 million pounds. Annual harvest increased sharply during the late 1960's to a high of 82.2 million pounds in 1971 (Table 100). The decline in catch since 1971 is a result of more conservative quotas imposed to assure a biological surplus and equalize annual harvests.

The shrimp fleet increased from 11 vessels in 1960 to 26 in 1970 and 79 in 1974. Along with the number, the efficiency of vessels increased tremendously. Prior to 1971 the Kodiak shrimp fleet was composed of 50 to 70 foot single rigged otter trawl vessels. The first Gulf of Mexico style double-rigged vessels began fishing in 1971. During the 1973-1974 season, half of the 30 otter trawl vessels in the fleet were double rigged. Modern double rigged vessels are typically constructed of steel and range in keel length from 80 to 100 feet. Most are capable of carrying 200,000 to 300,000 pounds of shrimp when fully loaded.

The beam trawl fishery for shrimp has existed since 1970. The fleet, comprised of 25 to 40 foot seine type vessels, has increased from 2 vessels in 1970 to 16 in 1974.

Three basic gear types are used. Along with the previously mentioned otter and beam trawls, a relatively minor fishery utilizing pots exists. Many of the larger otter trawl vessels are equipped to participate in crab fisheries. Beam trawls are utilized by smaller vessels attempting to supplement their normal income from salmon fishing.



1. Inner Marmot Bay District
2. Ugak Bay District
   2A. Inner Ugak Bay Section
   2B. Outer " " "
3. Kiliuda Bay District
4. Two Headed Island District
   4A. Inner Two Headed Island Section
   4B. Outer " " " "
5. Souther District
   5A. Inner Alitak Bay Section
   5B. Outer " " "
6. Uyak Bay District
   6A. Inner Uyak Bay Section
   6B. Outer " " "
7. Uganik Bay District
   7A. Inner Uganik Bay Section
   7B. Outer " " "
8. West Afognak District
   8A. Inner W. Afognak Section
   8B. Outer " " "
9. Northern District
   9A. Inner North Afognak Section-
   9B. Outer " " "
10. Kukak Bay District
   10A. Inner Kukak Bay Section
   10B. Outer " " "
11. South Mainland District
12. Portlock District
13. Kalsin Bay District
14. Marmot Island District
15. Chiniak Bay District
   15A. Inner Chiniak Bay Section
   15A. Outer " " "
16. Spruce Island District

FIGURE 8. KODIAK AREA SHRIMP MANAGEMENT DISTRICTS. A.D.F.&G., 1976.

Simultaneous with the change from small, single rigged to large double rigged otter trawl vessels has been an evolution of the trawl itself. Prior to 1970 the fleet used west coast manufactured trawls ranging from 60 to 100 feet (foot rope length). Double rigged vessels in 1971 and 1972 utilized Gulf of Mexico manufactured trawls which appeared to be more efficient. This evolution of gear type continued in 1973 when most otter trawl vessels changed to a newly designed high opening trawl. Many fishermen now use trawls custom designed to their own specifications. Single rigged vessles use trawls with ground lines from 70 to 125 feet in length, while double rigged vessels use 70 to 100 foot trawls. Accompanying this trawl improvement has been improvements in electronic gear such as fathometers and radar. These factors combined account for a tremendous boost in fishing efficiency.

Since the first processing began in 1959, Kodiak shrimp grounds have expanded but major productive areas were soon defined. The primary areas fished from 1959 through 1970 were Kiliuda Bay, Ugak Bay and Twoheaded Island. A shift in fishing effort from Ugak Bay to Marmot Bay occurred in 1971 and 1972. (Table 101). This shift, which was due to reduced catches in Ugak and imposition of catch quotas in other areas, caused fishermen to expend more effort in the offshore Marmot area. The principal catch areas today are Kiluida Bay, Twoheaded Island and Marmot Bay.

The commercial shrimp fishery has provided Kodiak with a tremendous economic boost. In recent years, the annual value to fishermen has been 5 million dollars. Fishermen receive between 8 and 9 cents per pound for raw shrimp. In many instances other services, such as fuel, ice and food are provided by the canneries in addition to the price paid for product. Table 93 shows the economic value to fishermen since 1960.

The stable nature of this fishery, illustrated by the figures in Table 100, accentuates the economic value to the community.

DISTRIBUTION

Shrimp are known to inhabit the entire Kodiak continental shelf out to a depth of over 100 fathoms. Concentrations of shrimp inhabit specific areas around Kodiak and these have been well documented. Major concentrations of shrimp are found in Kodiak's eastside bays and nearshore areas. Less abundant stocks are found in all westside bays and along the Alaskan Peninsula. Emphasis is placed on bay areas as being particularly critical spawning and rearing habitat. Offshore gullies, particularly those east of Kiliuda Bay and Twoheaded Island, also contribute extensively as spawning and rearing areas.

It is not known to what extent, if any, shrimp migrate along the Kodiak shelf. Since no migration to "mating grounds" is documented, all areas inhabited by shrimp should be considered as contributing to spawning and rearing.

The Kodiak area shrimp fishery is a multispecies fishery. Northern shrimp, Pandalus borealis, most commonly referred to as pink shrimp, comprise at least 85 percent of all trawl caught shrimps. Other pandalid species, namely Pandalus hypsinotus (coon stripe), Pandalus goniurus (humpy) and Pandalopsis dispar (side stripe) are most often taken incidental to the fishery for P. borealis. The latter two species are at times dominant in trawl catches from specific areas and occasionally support small fisheries. Pandalus platyceros (spot or prawn) supports a small pot fishery.

Further information concerning distribution of Pandalus sp. is available in the Appendix.

LIFE HISTORY

Life history descriptions for Kodiak shrimp species closely correspond to the general outline presented in the Appendix. Mating takes place in September. The fertilized eggs are carried by the females until the following March and April when hatching takes place.

The Kodiak commercial harvest consists primarily of two and three year old shrimp. Because of their size, the three year old age class is the most sought after.

ABUNDANCE

Stock assessment surveys are conducted around Kodiak Island. Data from these surveys is used to calculate population estimates and the confidence intervals around the estimates. During 1975-1976 season the most extensive surveys to date took place. Bays on the west side were surveyed once. Results of that indicated relatively small areas of trawlable grounds. Population estimates for Uganik and Uyak Bays were 1.2 and 1.9 million pounds, respectively. No shrimp were found in Viekoda Bay. Also surveyed was the Marmot system. The inner bay indicated 19.3 million pounds while the outer portion had 26.4 million pounds.

Population estimates for Kiliuda and Twoheaded stocks were collected throughout 1975. Kiluida estimates ranged from 5 to 12 million pounds. Twoheaded estimates range from 12 to 21 million pounds. Estimates were also made for Alitak and Ugak Bays, with 12 and 3 million pounds respectively. These estimates are subject to extreme variation due to commercial catch and seasonal fluctuation and should be considered indices of population size rather than actual pounds of shrimp. Population abundance estimates for selected systems from 1971 to 1975 are shown in Figure 9 .

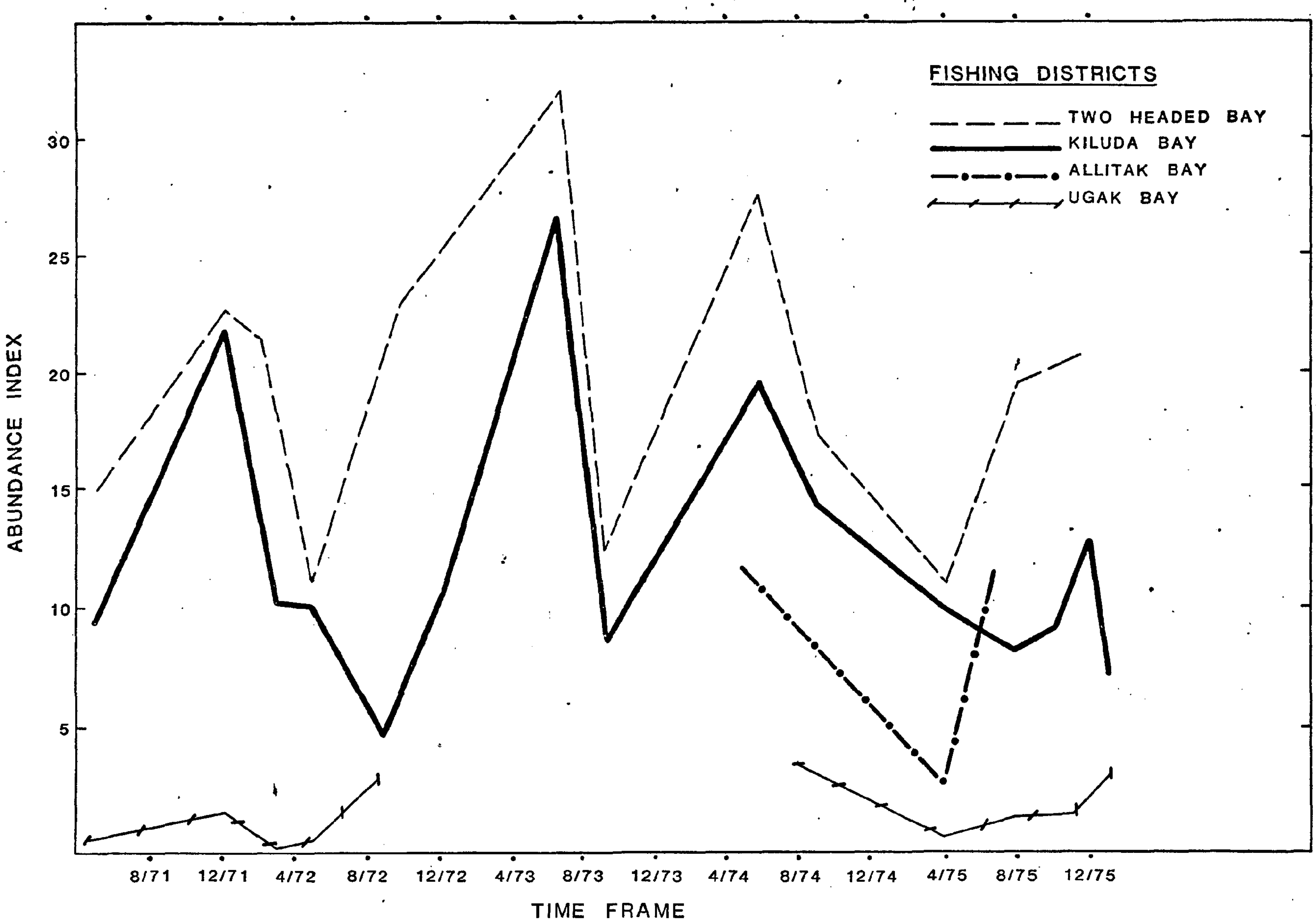


FIGURE 9. KODIAK SHRIMP ABUNDANCE INDICES; 1971 - 1975.
SOURCE - A.D.F.&G., 1976, REPORT TO BOARD OF FISHERIES.

MANAGEMENT

Alaska Department of Fish and Game management policy toward Kodiak shrimp was initiated in 1969 with the adoption of a March-April closure in certain bay and nearshore areas. This closure provided protection to egg hatching females in those closed areas. In 1970 the Alaska Board of Fish and Game designated twelve geographic catch areas. These were expanded in 1971 to a total of eighteen. Quarterly catch quotas were set for ten districts; the remaining eight were defined as nonquota districts. In 1973 the March-April egg hatch closure was expanded to include the entire Kodiak management area. Added to this was the adoption of a 55 million pound quota. The season was further divided with a summer beam trawl opening prior to the regular season. Individual districts were managed on a harvest level concept with no set quotas. The Department exercised emergency order power to close districts as conditions warranted.

For purposed of shrimp management, Kodiak area is presently divided into 16 districts (Figure 8). Quotas have been replaced by a harvest guideline range of 45 to 71 million pounds. The distribution of catch is designed to provide maximum benefit to the community by: 1) potentially allowing a more even flow of harvest, 2) avoid opening major bay systems during "green head" condition, 3) reduce the harvest season overlap with other species, and 4) allow for inshore fishing during the winter while encouraging offshore fishing in milder months.

RESEARCH

Shrimp research by the Alaska Department of Fish and Game was initiated in 1967 around Kodiak. Management strategies are currently determined by results of this research. The objectives of the current research program are: 1) to determine the distribution and abundance of major exploited shrimp stocks, 2) to determine the effects of fishing on major shrimp stocks, 3) to determine optimum harvest levels and seasons, 4) to provide management personnel with essential data, 5) to evaluate trawl surveys as a tool for establishing abundance indices, 6) to test and refine current program sampling design and 7) to develop a valid population model for the major exploited shrimp stocks.

Catch per unit effort (pounds caught per hour of trawling) data has traditionally been vital to shrimp stock management. Kodiak research staff have conducted a logbook program to moniter effort since 1967. As previously described, the size and efficiency of shrimp vessels has increased dramatically. An increase in efficiency is able to mask declines in stock abundance when effort data alone is used as an index. A primary concern of research is to standardize the CPUE data from past years with current data. A valid comparison can then be made.

In addition to analysis of CPUE data, Kodiak shrimp research is concerned with comparing strength of successive year classes of pink shrimp. This is accomplished by monthly sampling of commercial catches from each district. Subsamples of these are measured and sexed by the Department biologists.

Table 100 . Commercial shrimp catch, Kodiak area, by month, in thousands of pounds, 1964-1974. 1)

Month	1964	1965	1966	1967	1968	1969
January		357,148	422,803	2,285,259	1,681,424	2,985,722
February		691,245	2,669,128	2,405,073	1,775,495	3,140,290
March	41,000	327,585	817,474	3,294,218	2,922,150	3,823,140
April	286,750	1,255,970	2,658,198	3,225,900	2,733,412	3,246,913
May	350,279	1,451,138	2,990,511	3,527,674	1,903,386	2,789,940
June	660,890	963,304	2,111,087	5,013,775	4,718,613	3,834,163
July	939,820	1,029,158	3,166,922	4,887,364	3,923,232	4,071,038
August	229,685	1,690,384	2,302,613	4,729,599	4,018,709	4,198,001
September	624,821	1,839,267	1,611,314	2,675,237	3,452,640	4,129,684
October	706,180	1,301,008	1,963,983	3,318,636	3,357,756	2,865,645
November	382,089	1,778,887	2,255,739	1,893,049	2,195,279	3,767,514
December	117,600	1,138,865	1,127,369	1,012,072	1,786,617	2,496,661
TOTAL	4,339,114	13,823,959	24,097,141	38,267,856	34,468,713	41,348,711

continued

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.

2) Season closed.

Table 100 (continued). Commercial shrimp catch, Kodiak area, by month, in thousands of pounds, 1964-1974.

Month	1970	1971	1972	1973	1974
January	4,792,225	4,720,469	5,443,042	8,272,387	1,893,571
February	4,149,937	5,641,777	2,362,990	8,421,843	493,174
March	4,532,288	5,915,418	1,425,671	2)	119,984
April	4,989,570	941,240	338,256	2)	2)
May	2,474,784	6,588,420	585,677	518,231	565,883
June	6,090,921	9,112,040	7,758,627	1,664,986	719,060
July	8,482,388	10,950,762	14,940,751	50,807	718,844
August	7,801,186	10,824,986	7,577,000	12,546,193	9,411,166
September	5,679,848	8,039,530	1,130,142	12,125,260	6,684,842
October	5,258,860	6,525,843	9,227,500	9,424,761	11,353,284
November	4,404,249	7,868,900	4,926,906	9,404,814	10,114,335
December	3,524,948	5,024,339	2,635,757	8,082,195	6,697,232
TOTAL	62,181,204	82,153,724	58,352,319	70,511,477	48,771,375

Table 101 . Commercial shrimp catch, Kodiak area, by district, in thousands of pounds, 1960-1974. 1)

	1960	1961	1962	1963	1964	1965	1966	1967
N. Afognak	96.2					56.7	621.1	1,385.1
Marmot Bay	701.2	894.1	1,218.5	759.0		636.7	2,814.4	2,675.7
Chiniak Bay	4.4	1.9		122.5	62.1	15.9	584.1	870.3
Ugak Bay	351.0	41.4	1,347.1	1,559.7	557.9	652.7	3,399.0	9,575.2
Sitkalidak Str.	1,529.1	9,902.5	10,019.2	7,138.3	3,221.0	10,993.1	15,910.3	19,939.0
Kiluda Bay	2)	2)	2)	2)	2)	2)	2)	2)
Twoheaded Gully	2)	2)	2)	2)	2)	2)	2)	2)
Albatross Bank		178.7						
Alitak Bay	568.2	64.9	50.0		105.9	1,001.0	162.0	580.3
Uyak Bay 3)								2,072.2
Kukak Bay	128.9		19.5	386.3		454.4	606.2	389.6
Malina Bay				152.7				
Sitkinak Bay								
North Shelikof								
South Shelikof								
Central Shelikof								
Portlock Bank								

continued

1) Source - A.D.F.&.G., Kodiak Area Annual Management Report, 1969, and Report to the Board of Fisheries, 1975.

2) Sitkalidak Str. area divided into Kiluda Bay and Twoheaded Gully 1968.

3) Includes catches from Viekoda and Uganik Bays.

Table 101 (continued). Commercial shrimp catch, Kodiak area, by district, in thousands of pounds, 1960-1974.

	1968	1969	1970	1971	1972	1973	1974
N. Afognak	210.5	576.0	1,568.9	4,565.3	1,496.7	2,129.4	3,086.7
Marmot Bay	3,356.5	2,168.4	2,629.0	27,547.1	18,671.9	19,081.3	13,276.0
Chiniak Bay	270.0	20.6	475.8	1,356.3	1,539.8	206.9	1,791.1
Ugak Bay	12,242.9	8,846.7	14,925.9	6,711.2	3,494.4	2.2	63.2
Sitkalidak Str.	2)	2)	2)	2)	2)	2)	2)
Kiluda Bay	7,424.4	6,387.9	8,032.6	12,028.8	6,987.8	5,982.1	7,935.4
Twoheaded Gully	6,220.5	17,197.9	29,764.2	23,847.8	18,872.7	14,768.2	12,909.1
Albatross Bank				17.2			
Alitak Bay	102.1	79.3	963.6	2,003.9	3,661.4	1,406.9	5,015.4
Uyak Bay 3)	2,930.0	1,906.8	914.7	1,373.7	1,576.4	2,067.7	2,221.3
Kukak Bay	896.6	3,183.5	1,179.4	288.8	102.2	1,400.5	489.2
Malina Bay	815.2	672.0	1,269.4	153.3	559.2	878.5	
Sitkinak Bay		172.3	111.5	82.5			
North Shelikof		166.4	369.9				1,296.4
South Shelikof					252.8	7,194.5	
Central Shelikof		17.0	163.0	116.4			
Portlock Bank				2,075.5	1,052.7	593.8	567.6

KODIAK SCALLOP FISHERIES

COMMERCIAL FISHERIES

Weathervane scallops are harvested primarily in two management areas in the Gulf of Alaska. The commercial fishery continually moves between Kodiak and Yakutat. Of the major production areas, Kodiak has been the most important.

The first exploratory scallop fishing occurred in 1967. During the early years catch expanded rapidly (Table 102). Peak catch years were 1968 and 1969 each with 1.8 million pounds landed. More recently the commercial harvest has averaged 1 million pounds of shucked meat. The decline in scallop harvests during the 1970's has resulted from various causes including area and seasonal restrictions, limited stocks available and the entry of scallop vessels into more lucrative fisheries. Without the discovery of major new scallop beds this fishery should remain static at 1974 levels.

The scallop fishery is typically a bottom dredge operation composed of vessels from the east coast. The number of vessels participating in the fishery has varied from a high of 7 in 1969 to 3 vessels at present (Table 103). Dredges are generally 11 to 13 feet in width utilizing 4 inch rings in the drag gear.

The first scallop stocks exploited were those northeast of Kodiak Island on Marmot Flats and Portlock Banks. Fishing effort expanded south along Kodiak's eastside and exploration began to the west and southwest. Present area restrictions have limited expansion of this fishery. Current scallop harvests come primarily from the eastside, north to Portlock Banks, with minor fisheries on the westside.

The present economic value to the fishermen based on the 1974 catch of 148 thousand pounds and price of $1.40 per pound is $207,200. The value for the average catch over the last five years based on 1974 price is over $900,000.

DISTRIBUTION AND LIFE HISTORY

Distribution and life history information is contained in the Appendix. The literature used as reference for the life history profile was prepared from data collected in Kodiak.

ABUNDANCE

No conclusive data concerning abundance of weathervane scallops is available for the Kodiak area.

MANAGEMENT

Kodiak scallop management is based on data collected through commercial catch sampling. Prior to 1972 analysis of the age composition revealed 75 percent of all scallops captured were 7 years of age or older. As older age classes were harvested, younger age scallops began to appear more frequently in the catch. This shift in age composition occurs in most fisheries being exploited for the first time and should not necessarily be interpreted as a sign of over fishing. Scallops less than age 6 comprise a small portion of the catch. Since the age at maturity is 3 years, it is felt by management biologists that adequate brood stocks remain.

Management of the scallop fishery is complicated by the incidence of king and tanner crab caught during scallop dredging. Research done by Kodiak shellfish staff in 1972 documented an average of 9 king crab and 26 tanner crab captured in each tow. Because of this conflict, areas of known scallop abundance have been closed to commercial fishing.

Current regulations state that scallops may be taken from June 1 through March 31 in the Pacific Ocean waters north of 57° 37'07" N. lat., and east of 152°09'01" W. long. (Cape Chiniak light) and the waters of the Shelikof Straits north of 57°17'20" N. lat. (the latitude of Cape Ikolik). In the waters south of the latitude of Cape Chiniak light and waters east of the longitude of Cape Barnabas, excluding those waters northwest of a line from Cape Barnabas to Narrow Cape, scallops may be taken from July 15 through March 31.

Table 102 . Commercial scallop catch, Kodiak area, by month, in pounds, shucked weight 1967-1974. 1)

Month	1967	1968	1969	1970	1971	1972	1973	1974
January	3)	107,352	36,016	3)	3)	19,660	3)	3)
February	3)	16,569 16,625(4)	47,898	19,462	40,689	50,444	53,124	6,662
March	3)	14,552 30,160(4)	61,128	65,278	35,253	52,915	33,098	22,582
April	3)	10,442	69,491	76,481	3)	43,890	33,350	2)
May	3)	8,914	89,636	154,749	3)	15,266	2)	2)
June	3)	4,108	51,980	175,464	138,727	207,525	88,803	2)
July	3)	2,026	148,792	353,171	113,267	202,241	226,013	2)
August	206 4)	3)	157,268	239,598	189,132	157,671	170,121	11,860
September	3)	164,398	161,685	188,631	97,769	140,795	138,308	41,007
October	3)	299,792	82,666	73,245	168,999	64,126	129,017	18,948
November	2,903 4)	86,632	63,007	47,273	35,654	47,483	39,902	28,427
December	4,679 4)	111,236	43,293	24,260	21,721	36,777	23,967	18,459
TOTAL	7,788 4)	718,671 154,137(4)	1,012,860	1,417,612	841,211	1,038,793	935,705	147,945

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.
2) Season closed.
3) No catch reported.
4) Unshucked weight.

Table 103 . Length frequencies of Kodiak area scallop vessels which made landings. 1)

Vessel length	1969	1970	1971	1972	1973	1974	1975
0-20							
20-29							
30-39							
40-49	1						
50-59							
60-69	2	2					
70-79	2	2	1	1		1	
80-89	2	3	4	4	4	2	3
90-99							
100-119							
120-149							
Over 150							
TOTAL	7	7	5	5	4	3	3

1) Source - A.D.F.&.G., Report to the Board of Fisheries, 1976.

KODIAK RAZOR CLAM FISHERIES

COMMERCIAL FISHERIES

The Kodiak razor clam fishery dates back to the mid 1920's, making it the oldest shellfish fishery in the area. Recorded catch statistics exist from 1929 to the present. Major fluctuations in catch and market conditions have occurred, prompted by both economic and environmental influences. The scope of this report will include only data from 1960 to 1974.

The razor clam fishery for human consumption was carried out between 1960 and 1964. One processing plant accepted raw clams for processing. Hydraulic dredge systems were being tested to determine economic feasibility. Operations were discontinued in 1964 following the total destruction of processing facilities by the Alaska earthquake and subsequent tsunami. Facilities capable of processing razor clams for human use have never reopened. Some clams have been marketed fresh locally.

Government regulations presently require clam beaches to be certified safe before commercial harvesting for human consumption. This was prompted due to the risk of paralytic shellfish poisoning (PSP). A description of this condition is presented in the generalized life history (Appendix).

Since the mid 1960's, razor clams have been harvested primarily for dungeness crab bait. Harvests remained nominal after the earthquake until 1970 when, once again, well over 100,000 pounds were taken by commercial diggers (Table 104). Small operations, most utilizing aircraft delivery, have attempted to market fresh clams with moderate success.

During the 1974 digging season diggers were paid an average of 50 cents per pound (unshucked). Based on the 1974 harvest of 198,400 pounds, the current return to diggers is $99,200. The 1974 market was primarily a bait market. It is not presently known what influence a human comsumption market would have on the value of the fishery. Because of this and the fact that only a small portion of the available commercial clam grounds are utilized, the potential value of the Kodiak razor clam fishery is incalcuable.

DISTRIBUTION

Pacific razor clams (Siliqua patula) are found on surf-swept, sand beaches on the Kodiak-Alaskan Peninsula coast. Early exploration exposed high densities of razor clams in three Alaska Peninsula Bays, Kukay Bay, Hallo Bay and Swikshak Bay. Since that time known distribution of razor clams has been expanded to include twenty-one beaches within the Kodiak management area. Fourteen of these beaches have at one time supported some degree of commercial harvest (Table 105). Presently Swikshak Beach is the only Kodiak area beach certified safe for human consumption. Efforts to certify additional beaches are being made. More information concerning distribution of the species is available in the generalized life history found in the Appendix.

LIFE HISTORY

Kodiak razor clam life history closely parallels that described in the generalized life history. Egg development within the ovary begins in May and June. During this time the clams are referred to as "fat." This is the most desirable time of year for commercial harvest. Ovulation and fertilization take place in July and August. The duration of the mating period is approximately two tide cycles. Timing is highly dependent upon temperature. Because razor clam reproduction takes place in such close proximity to shore, any onshore or nearshore disturbance could be highly destructive to razor clam stocks at this time.

Razor clam larvae settle out of the water column in September. The larval distribution of razor clams in the Kodiak area is not presently known.

Subtidal populations of razor clams exist off some Kodiak beaches. The influence these populations have on the total reproductive capability of an area is not known. Some researchers believe that these subtidal populations act as a buffer against over harvest by providing a brood stock below commercial digging levels. Another theory is that these subtidal clams do not reproduce due to unfavorable temperature conditions prevailing in deeper water. If this is true, then the subtidal clams are, in fact, a product of the intertidal population and would not serve to replenish over harvested intertidal stocks.

ABUNDANCE

Population estimates have been developed for two Kodiak area beaches, Swikshak and Big River. Estimates are arrived at by determining mean average density of clams larger than 115 mm in length per square yard, and multiplying that figure times the total square yardage of beach. Swikshak Beach was found to have an average density of 38 clams per square yard in 1974, giving it a total population of 1.4 million clams. Big River Beach contained an average 1.59 clams per square yard and a total population of 1.3 million. Data from these studies suggests that the highest densities of razor clams on Kodiak area beaches lie between the minus one and plus one tide levels.

MANAGEMENT

Management philosophy for razor clam stocks has remained fairly constant since 1941. A 4 1/2" size limit to protect immature clams was adopted at that time, along with a harvest quota of 400,000 pounds. In 1946, a Kodiak season from Sept. 15 to July 15 was established. This remained in effect until 1962, when the closure was eliminated by the Board of Fish and Game. Present management includes monitering size frequency of the catch and collection of catch per unit effort data.

RESEARCH

The Alaska Department of Fish and Game is presently conducting a razor clam habitat assessment survey in the Kodiak area. Specific objectives of this study are: 1) Investigate all beaches where razor clams are known to occur and map each location with regard to the extent of the species existance and density, 2) Collect clams at each beach to assess density along with length and age composition of population by tide level 3) Collect core samples of the substrate by tide level at each beach site to investigate substrate composition and 4) Combine past and current razor clam data for Gulf of Alaska areas to formulate the biological parameters of this baseline study.

Table 104 . Commercial razor clam catch, Kodiak area, by month, in pounds, 1960-1974. 1)

Month	1960	1961	1962	1963	1964	1965	1966	1967
January							572	
February								
March								
April	39,633	20,544		25,830			600	
May	162,822	140,906	123,262	166,753		20,000 2)	14,257	2,155
June	158,132	145,540	117,610	93,570	NO PRODUCTION			
July	53,143	74,979	56,644	37,604				
August								
September								
October								
November								
December								
TOTAL	413,730	381,971	297,516	323,757		20,000	15,429	2,155

continued

1) Source - A.D.F.&.G., Kodiak Area Annual Management Reports.
2) Exact catch data unknown - approximate poundage.

Table 104 (continued). Commercial razor clam catch, Kodiak area, by month, in pounds, 1960-1974.

Month	1968	1969	1970	1971	1972	1973	1974
January							
February							
March							
April			1,693	4,485		2,384	1,351
May	6,384	5,484	49,926	14,760	23,503	12,760	39,995
June		3,604	65,651	83,819	92,230	46,332	59,448
July		2,941	14,991	50,556	23,940	44,909	44,903
August				36,774	8,663	58,442	52,634
September					1,356	455	
October					2,424		
November							
December							
TOTAL	6,384	12,029	132,261	190,394	152,116	165,282	198,381

Table 105 . Kodiak area razor clam beaches. 1)

Location of Clam Beds	Extent	Abundance	Historical Utilization
Duck Bay	1/2 mile	fair	commercial/recreational
Buskin Beach	1 mile	poor	recreational
Middle Bay	1/2 mile	fair	recreational
Narrow Cape	5 miles	poor	minimal
Portage Bay	1/2 mile	poor	minor commercial/sport
Saltrey Cove	1/2 mile	poor	minimal
Ocean Beach	3 miles	fair	minimal
Rolling Bay	1 mile	fair	minimal
Tugiadak	10 miles	fair	commercial
Cape Alitak-Low Cape	10 miles	fair	commercial
Bumble Bay	2 miles	fair	commercial
Halibut Bay	5 miles	good	commercial
Carmel	2 miles	fair	minimal
Cape Douglas	25 miles	excellent	commercial

continued

1) Source - OCS Assessment Project, Razor Clam Habitat Survey, Annual Report, 1976.

Table 105 (continued). Kodiak area razor clam beaches.

Location of Clam Beds	Extent	Abundance	Historical Utilization
Swikshak, Big River & Village Beaches	20 miles	excellent	commercial/recreational
Halo Bay	7 miles	good	commercial
Kukak Bay	10 miles	excellent	commercial
Dakavak Bay	3 miles	good	commercial
Kashvik Bay	2 miles	excellent	commercial
Alinchak Bay	4 miles	good	commercial
Imwya Bay	2 miles	excellent	commercial

KODIAK AREA SUBSISTENCE FISHERIES

DESCRIPTION

Subsistence fish harvests in the Kodiak area consist almost entirely of sockeye, coho, pink and chum salmon with only small numbers of kings being taken. Much of the subsistence fishing effort in Kodiak is concentrated directly around the village sites. Other important areas include Old Harbor, Midway Creek, Barling Creek and Chiniak Bay. Fishing effort for sockeye salmon migrating to the Buskin River is largely composed of non-native residents. This probably includes a percentage of "recreational oriented" subsistence fishermen.

While most village residents still utilize subsistence caught fish as an important food source, many of the people participating in the fishery are newly-arrived to the area or have subsistence fished in the past and continue to do so for recreational purposes. This portion of the fishery, however, is pretty much limited to the Kodiak road system.

Concentrated subsistence fishing effort is directed towards the early run of sockeye salmon to the Karluk River as well as the late-running coho salmon. Much subsistence fishing also occurs on stocks of coho salmon returning to Spruce Island. On Afognak Island, significant subsistence fishing effort takes place in the Afognak Bay area.

Table 106 shows the subsistence catch in the Kodiak area for the years 1962-1974. These figures represent only reported catches and have not been expanded to reflect total subsistence harvests. Only about 25% of the permit holders report their catches.

ECONOMIC CONDITIONS IN THE AREA

While there are some people who "subsistence" fish for purely recreational reasons, most of the village residents in the Kodiak area still depend on subsistence fishing as a means of supplementing their food supply. Fisheries are the mainstay of the Kodiak economy and during years of poor commercial harvests, employment opportunities (such as cannery work, etc.) may become scarce. During these years, subsistence fishing acts as a partial substitute for a cash income.

METHODS OF FISHING

State regulations in this area require that any gear used for subsistence fishing between June 1 and September 15 must not be registered for commercial use. This restriction applies to purse seine vessels as well. Consequently, most subsistence fishing is done with old segments of set gill nets, although some purse seines are used after September 15.

PROBLEMS

During the past few years, the price of halibut has increased to the point that selling salmon as bait to halibut fishermen has become a profitable business. Commercial fishermen have done this for some time in a legal fashion, either to halibut boats or processors. At present, however, there are many small, local boats engaged in halibut fishing and some of these people use their subsistence permits to catch salmon bait for themselves and to sell to others. Presently, no restrictions on a bait fishery are in existence in the Kodiak area.

Another problem concerns the illegal sale of subsistence caught fish on the commercial market. This is done by packing and salting the fish in barrels, then selling them during open commercial periods. This technique is also used to sell fish that were illegally caught during a closed commercial period. However, there is no effective means of stopping this practice.

A chronic problem in this area involves subsistence permit holders that do not return their permits at the end of the season. This makes it very difficult for biologists to monitor the subsistence fishery and adjust harvest levels to meet escapement goals.

Table 106 Subsistence salmon catch, Kodiak area, by year, in numbers of fish, 1962-1974 1/ 2/.

Year	Permits Issued	Permits Returned	King	Sockeye	Coho	Pink	Chum	Total
1962 3/	74	13	0	0	433	397	20	850
1963	74	15	0	297	576	836	195	1,904
1964	43	9	6	332	184	88	71	681
1965	67	7	2	19	318	244	12	595
1966	48	13	0	295	331	334	393	1,353
1967	84	29	2	1,306	571	894	344	3,117
1968	132	28	0	658	433	529	45	1,665
1969	242	30	1	481	338	620	30	1,470
1970	213	49	1	959	939	797	265	2,961
1971	267	131	5	3,442	1,720	1,276	472	6,915
1972	329	176	11	3,633	1,531	2,516	2,729	10,420
1973	400	149	7	4,453	2,289	1,393	1,166	9,308
1974	367	90	1	1,909	846	1,094	128	3,978

1) Source - A.D.F.&G. Kodiak Management Area Subsistence Fishery Report, Report to the Board of Fish and Game, April 1973 and Annual Management Reports.
2) These represent actual figures and have not been extrapolated to reflect a "real" subsistence catch value. Only about 25% of the permits are returned.
3) Subsistence permits were not required in the Kodiak area until 1962, thus catch and effort data not available prior to 1962.

KODIAK AREA SPORT FISHERIES

INTRODUCTION

Description of the Region

The Kodiak region consists of the Kodiak-Afognak Island group and is separated from the Alaska Peninsula by Shelikof Strait. It also includes the Barren, Trinity and Semidi Islands. Kodiak and Afognak Islands, the two largest islands, are rugged and mountainous, and the shoreline is highly irregular, broken by numerous fiords, bays and islands. Streams are generally short and swift, and few are longer than 15 miles in length. Small lakes and ponds are widely scattered.

The climate is marine and is characterized by cloudy skies, moderately heavy precipitation and cool temperatures. Winters are mild and summers are cool. Precipitation ranges from 20 to 60 inches annually.

Fish Distribution

Regional sportfish distribution and abundance are listed in Table 107. Dolly Varden are assumed to be distributed throughout all anadromous stream and lake systems and rainbow-steelhead trout are found in almost all sockeye lake systems.

SPORT FISH LIFE HISTORY AND HABITAT

Dolly Varden

Dolly Varden life history patterns and habitat requirements in the region follow the generalized life history (Appendix), with some local variations in timing. Winter outmigration of immatures and adults from

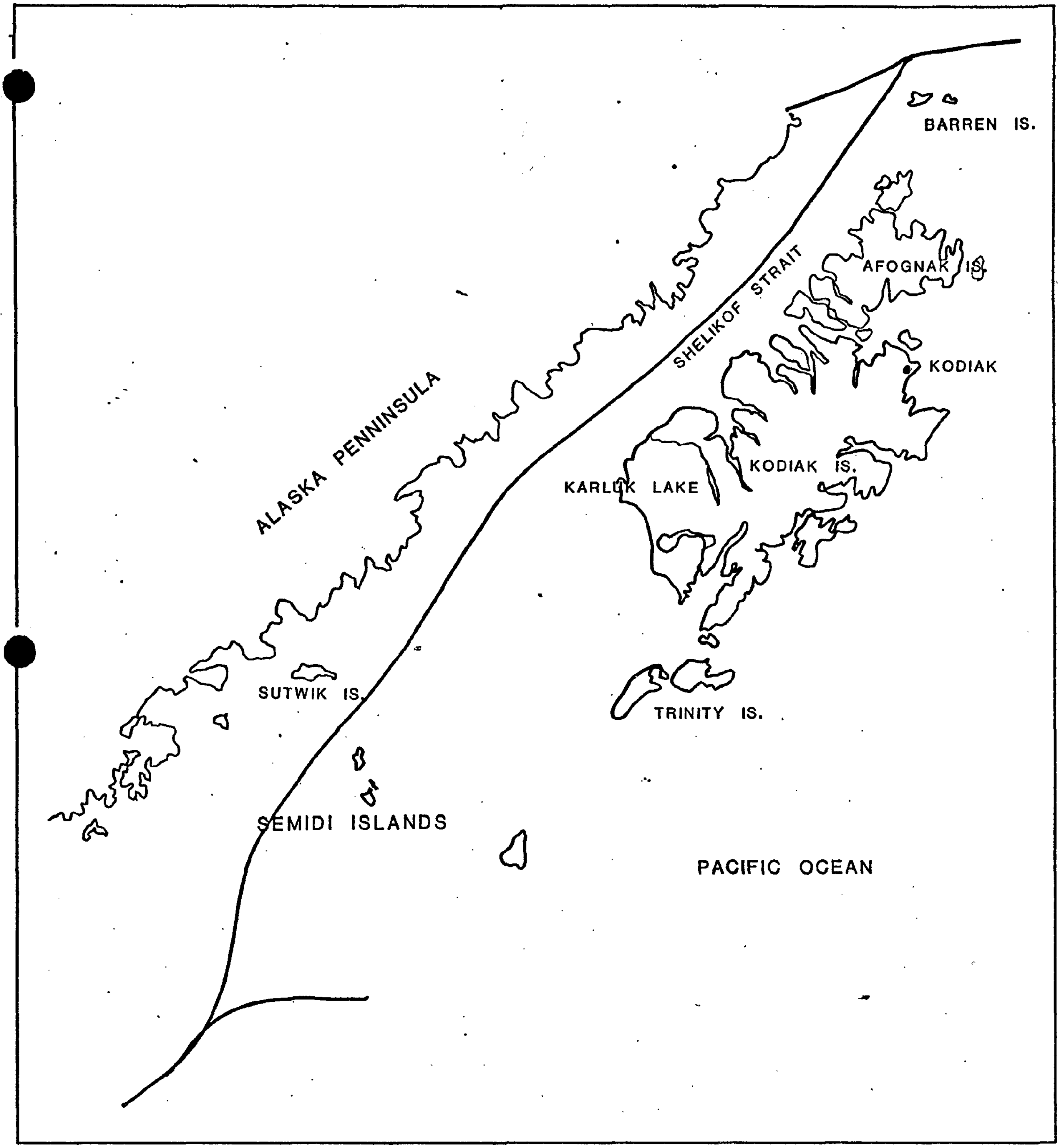


FIGURE 10. KODIAK REGION

overwintering lakes begins in mid-April and ends in June. The saltwater feeding and migration period is brief, as fish again appear in local streams in mid-July. A limited tagging study indicated that saltwater migration is short, less than 50 miles (Marriot, 1967).

Marriot (1966) noted the disappearance of Dolly Varden in American River, a nonlake system, from mid-September to late October, when mature spawners reappeared. A few fish spawned in springfed tributaries but the bulk of the run spawned later in the main stream, starting in late November. The fish apparently stayed until early February. In Saltery River, a lake system, mature fish were observed concentrated in riffles below the lake in late September and then moved into the lake by mid-October to spawn. Inlet streams are primarily used for spawning in lake systems. Nonlake systems are also important for spawning. Small streams are important for juvenile rearing. Marriot (1967) observed American River Dolly Varden juveniles rearing only in side tributaties and none were seen in the main river. Kodiak Dolly Varden rear three to four years before entering saltwater for the first time.

Critical Dolly Varden habitat in the Kodiak region is the overwintering lake systems. Some important systems on Kodiak Island include Uganik, Little River, Karluk, Ayakulik (Red River), Akalura, Saltery, Buskin, and Barabara Lakes. Buskin Lake serves as the overwintering area for all Chiniak Bay fish (Kodiak area), holding up to 200,000 fish a season.

Rainbow-Steelhead

Natural populations of rainbow trout and steelhead are found in lakes characterized by having inlets/outlets capable of rearing fish (Murray and Van Hulle, 1974). Resident rainbow spawn primarily in inlet streams, with fast moving sections for juvenile rearing, where sticklebacks cannot compete. The young fish rear in the inlets several years until they attain a length of 8-10 inches. The fish then drop out into the lake to feed and mature.

On anadromous systems, most rainbow and steelhead spawn in the outlet streams. Kodiak region steelhead are fall-run fish which enter the streams in mid-August with the bulk of the runs entering the rivers in September-October. The fish overwinter in deep river holes or the lakes and then spawn in the outlet rivers in May. Marriott (1966) reported that two separate steelhead populations were found in the Karluk system. One population winters in Karluk Lake and spawns in the upper mile of river. The other winters in the Portage area and spawns in the lower half of the river.

Most Kodiak steelhead rear in freshwater 1-2 years, primarily in outlet streams, and then migrate out to spend 1-3 years at sea. Repeat spawners on the Karluk River have varied from 10-43%.

Grayling

Grayling are not native to the Kodiak region, but have been introduced by fish plants. These have met with limited success, and reproducing populations have been establihsed in Cascade, Cicely, and Aurel Lakes near Kodiak. Spawning occurs in small inlet streams.

PRODUCTIVITY AND PRODUCTION

Productivity

Kodiak region lakes and water may be low in productivity, but large numbers of salmon are produced which rear in the ocean. The lakes are generally oligotrophic, low in basic nutrients for biological activity, slightly acid, and they have rapid flushing rates. Many of the small ponds have marginal conditions for supporting salmonids. Winter fish kills are occasionally a problem for small, shallow ponds. Some of the most productive lakes are Buskin, Karluk, Saltery, Frazer, Uganik, Upper Station and Akalura, which support significant salmonid populations, particularly sockeye and/or coho salmon.

Production

Few population counts or estimates of sport fish production, other than for salmon, are available for any Kodiak region system. Marriott (1966-1968) reported that the Karluk was probably the most important steelhead system in the region,.but that the runs were depressed, only amounting to several hundred spawners a year. In previous years, native subsistence catches were reported as 3,000-5,000 fish annually, but by 1965 the harvest was observed to be several hundred. Spring fishing closures were initiated to protect spawning populations. The population appears to have increased substantially since the mid-1960's estimates.

Estimates of Dolly Varden populations are also sparse. In 1964, the Buskin Lake spawning population was estimated to be less than 500 fish, although the overwintering population was substantially larger. Van Hulle (pers. comm., 1976) estimates the average annual overwintering population to be around 200,000 fish. Marriott (1968) reported counting about 1,000 Dolly Varden at Saltery Creek in July 1967, and counting 600-800 fish in American River between August and October, 1967. No other estimates have been reported.

Many small lakes and ponds around the town of Kodiak have been stocked since the 1950's with rainbow, grayling and coho salmon. Naturally reproducing populations have been established on some, but most lakes require occasional re-stocking or rehabilitation to eliminate competitors (primarily stickleback). Winter kill by oxygen depletion also has affected populations on small, shallow ponds in severe winters. Rainbow growth and survival generally is good through age two, when the fish enter the fishery, but they normally are harvested or are lost to the fishery by age three.

Grayling stocking has had limited success. Survival has been poor for most lakes stocked but reproducing populations have been established in Cascade, Cicely and Aurel Lakes (Table 108).

Coho stocking has been very successful in the partially saline environments found in coastal lagoons. These plants have experienced good growth and survival. Most coho plants are made in land-locked ponds and lakes, but a few plants in anadromous systems, such as Island and Mission Lakes, have produced good anadromous runs. A total of 30,000 coho are planted annually in 5 lakes (Table 108), and mostly support productive fisheries.

Presently, the stocked systems around Kodiak are probably producing up to their full potential for sport fishery utilization. Most major systems outside this area, however, are under-utilized and could receive more angler use. Pink salmon, chum salmon, and Dolly Varden could also absorb more sport fishing effort.

SPORT FISHERIES

Freshwater salmon and trout fisheries are the primary sport fisheries in the Kodiak region, accounting for about 80-85% of the total angling effort. Beach fisheries for salmon and Dolly Varden account for most of the saltwater effort. The saltwater boat fishery for salmon is very minor although relatively stable fisheries for halibut and rockfish exist. Most of the total regional effort centers in the northeast part of Kodiak Island around Kodiak and the Kodiak road system. Total regional catch information is not available, but Harmer (1974) estimated that total angler effort in 1973 was 72,741 angler days. Total salmon and Dolly Varden catches for the northeast section of Kodiak Island have been estimated for 1973 and 1974, using a postal card survey, and have averaged 10,500 salmon and 45,000 Dolly Varden annually (Table 109). Significant fishing areas are characterized in Tables 108 and 110.

Saltwater

Saltwater fishing occurs primarily in the summer and early fall. The beach fishery begins in mid-July with the incoming pink run and extends into mid-September with the coho fishery. Beach fisheries occur mainly along the Kodiak road system. The beaches with heaviest angler use are Pasagshak, Woman's Bay, Middle, Kalsin, Monashka, and Anton Larsen Bays in that order.

The boat fishery is primarily directed at halibut, but pinks, coho, rockfish, greenling and cod are also caught. Most of the salmon effort is directed at coho salmon. Halibut sport fishing is limited primarily to the northeast section of the Kodiak Island, with most effort concentrated in Chiniak Bay, but extending into Ugak and Kizhuyak Bays. Catches have remained relatively stable and were estimated at 1,000 to 1,500 pounds in 1975. A fairly substantial sport rockfish fishery exists in Monaskha and Chiniak Bays, but no catch statistics are available. A minor razor clam sport fishery exists, primarily in Woman's Bay, Middle Bay and Buskin Beach, all in the immediate vicinity of the town of Kodiak. A small fly-in fishery occurs at Swikshak. No estimates of razor clam sport harvest or effort are available.

In 1973 and 1974, the saltwater salmon catch in the northeast Kodiak Island area was 1,450 and 2,300 fish, respectively, and the Dolly Varden catch was 3,900 and 4,900 fish, respectively. The saltwater salmon catches account for about 12-13% of the total area catch. No other saltwater catch and effort information is available.

Freshwater

All five species of salmon are caught in freshwater, as well as Dolly Varden, rainbow, steelhead and grayling. Most effort is directed at cohos, pinks and Dolly Varden, but the other species are all sought where available.

The main freshwater fishing season begins in April when fishermen seek Dolly Varden migrating to sea from overwintering areas. Effort switches to king and sockeye in-migrations in June on several systems. Pink fishing begins in late July and coho fishing extends from August into October. Dolly Varden fishing extends into October and November. A small winter ice fishery occurs in stocked lakes from December through March or April.

Catch and effort information has been collected for the Buskin River, the major fishing system in the region, and for the Karluk River, the major king and steelhead stream in the region, since 1965. Census or estimation methods have varied between years, however, so the information presented in Tables 111 and 112 serves mainly to indicate the magnitude of these fisheries. In addition, seasonal catch estimates have been made for selected coho systems along the Kodiak road system. Estimates of total salmon and Dolly Varden catches were also made for these systems in 1973 and 1974.

The Buskin Lake system is the most heavily used fishery in the region for several reasons: 1) It is the most accessible system, 2) It has all species of salmon except kings, 3) It has a very large overwintering Dolly Varden population, and 4) It has the longest fishing season. About a third of the Kodiak area salmon catches and over half of the Dolly Varden catch are taken from the Buskin system. An average of 1,300 coho, 350 sockeye, and 2,700 pinks have been taken annually since 1969. The annual Dolly Varden harvest has averaged 17,100 fish since 1971 (Table 111). Total seasonal effort data is not available.

The Karluk River system has provided the largest king salmon and steelhead fishery in the region, but catch and effort is relatively light, compared with other sport fisheries. Sexsmith (1963) reported that it sustained a yearly steelhead take of about 1,000 fish. By the mid-1960's, however, the run had dropped substantially. The run has apparently increased in recent years. Fall catches currently average 100-150 fish (Table 112). The king fishery occurs in June and July and sustains an average seasonal catch of 100-300 fish. Coho, pink, sockeye, Dolly Varden, and rainbow are taken incidentally.

The coho sport fisheries are quite intensive in the Kodiak area. The Buskin Lake, Pasagshak River (Lake Rose Tead) and Saltery River systems are the largest producers, averaging 1,300, 800 and 350 fish harvested a year, respectively, for each system (Table). Catch to escapement ratios are quite high on many systems, and up to 72% of the total estimated run has been harvested on the Buskin system (Table 114). The Pasagshak system has one of the highest catch per angler ratios in the state for an intensive fishery.

Of the sport salmon catch, pinks are harvested in greatest numbers by sportsmen, with catches averaging 4,500 fish a year in the Kodiak area (Table 109) during 1973 and 1974. Buskin, Pasagshak, American, and Saltery Rivers are the largest producers. In contrast to coho catches, the pink harvest is usually only a small percentage of the total run in any system, (Table 115). The Buskin system also produces the largest annual sockeye and chum catches.

Dolly Varden comprised the largest catch in the Kodiak sport fisheries during 1973 to 1974 with average freshwater catches of 41,200 fish a year (Table 116). The main fishery occurs in spring on the Buskin Lake outmigration in which 50-70% of the total season's harvest of that system is taken.

Fishing effort, apart from the salmon and Dolly Varden fisheries, is comparatively minor. The stocked lakes along the road system and on several islands near Kodiak offer fair to very good fishing for rainbow, landlocked coho and grayling (Table 108). A small winter ice fishery for rainbow, coho and Dolly Varden on these lakes receives from 750 to 1,000 angler days of effort in the season.

A number of lakes and streams off the Kodiak road system on Kodiak and Afognak Islands provide good fly-in fisheries for salmon and trout (Table 110). Afognak Island provides some excellent resident rainbow trout fisheries which receive minor effort throughout the summer season.

MANAGEMENT AND RESEARCH

Sport fish management and research activities have primarily included catalog and inventory assessments, enhancement and creel census work, life history studies, and some habitat protection work. Catalog and inventory work has been fairly extensive, with most lakes and streams along the Kodiak road system inventoried for sport species. Many other lakes and streams on Kodiak and Afognak Islands have also been inventoried.

Enhancement by fish stocking and lake rehabilitation has been done on many roadside lakes with easy access from Kodiak. Re-stocking and monitoring growth and survival of stocked populations is a continual process. Numerous egg takes have also been conducted. Dolly Varden eggs have been taken from the Buskin and Pasagshak systems, and rainbow-steelhead eggs taken from Karluk River.

Creel census work was concentrated on determining catch and effort for the Buskin and Karluk systems, but now is aimed at calculating area-wide and region-wide catch information using an annual mail survey, with computer data analysis. Ground surveys, however, continue to be important for making the total estimates.

Limited work on steelhead and Dolly Varden life history data collection has been done. Coho salmon escapement counts have been collected annually since 1967, and annual king salmon counts have been made on the Karluk system.

Habitat protection work is done as the need arises, primarily in connection with land-use developments affecting streams around Kodiak and with timber sales on Afognak Island. Public access recommendations and easement acquisition is done as need arises.

Table 107 . Kodiak region sport fish distribution and abundance.

Species	Forms Resident	Forms Anadromous	Abundance	Remarks
Dolly Varden Char	X	X	High	Universally distributed in all anadromous systems. Resident population also found in any streams with falls.
Rainbow Trout	X		Moderate-High	Found in all sockeye salmon systems, many stocked pop. around Kodiak. Natural pop. most abundant on Afognak Is.
Steelhead Trout		X	Moderate	Found in all sockeye systems, but most pop. small. Karluk L. has largest run.
Land-Locked Coho Salmon	X		Low	Stocked in a few lakes around Kodiak. May be locally abundant.
Grayling	X		Very Low	Stocked in 4-5 lakes around Kodiak. Not naturally occurring. Most lakes require frequent re-stocking.
Smelt			High	Capelin found on several beaches around Chiniak, Ugak Bays. Are beach spawners, not anadromous or resident.

Table 108 . Stocked lakes around the Kodiak area. 1)

Lake Name	Location TWS RNG SEC	Species	Stocking Frequency 2) FREQ.	Stocking Frequency 2) INFR.	Stocking Rate 3)	Remarks
Tanigak	27S-19W-3	RT	X		6,500	
Abercrombie	27S-19W-15	RT	X		3,600	
		GR	X		55,000	
Island	27S-19W-21	DV			NR	Originally stocked, good production, all year fishery.
		RT		X	NR	
		SS				
Dark	27S-19W-28	DV			NR	RT, SS originally stocked, established population.
		RT		X	NR	
		SS				
Long	29S-19W-34	DV			NR	Lake was rehabilitated in 1972. Will be stocked annually with RT and GR.
		RT				
		GR				
Cascade	27S-21W-12	GR		X	NR	Good grayling population established best grayling fishery, good RT.
		RT		X		
Una	28S-19W-3	RT		X	1,000	Good productivity, good potential.
Dolgoi	28S-19W-12	DV			NR	
		SS		X	NR	
		RT		X	NR	

continued

1) Source - A.D.F.&.G., 1970-1975. Inventory and cataloging of sport fish and sport fish waters of southwestern Alaska. Fed. Aid in Fish Restoration, Vol. 11-16.
2) FREQ. - frequent, stocked every year or two or most recently. INFR. - infrequent, stocked before 1971.
3) NR - Natural reproduction, established population.

Table 108 (continued). Stocked lakes around the Kodiak area.

Lake Name	Location TWS RNG SEC	Species	Stocking Frequency FREQ.	Stocking Frequency INFR.	Stocking Rate	Remarks
Southern	28S-19W-14	SS	X		3,250	Good winter ice fishery.
Devil's	28S-20W-3	DV			NR	
		RT		X		
Genevieve	28S-20W-10	DV			NR	
		RT	X		NR	
Louise	28S-20W-10	DV			NR	
		SS			NR	
Lupine	28S-20W-10	RT	X		1,800	
Margaret	28S-20W-11	RT	X		1,600	
Lilly	28S-20W-27	RT	X		1,500	
		SS		X	1,500	
Beaver(Bridge)	28S-20W-31	DV			NR	
		RT		X	600	
Orbin	28S-20W-31	DV			NR	Migrants from stocked lake, (Beaver Lake).
		RT				
Dragonfly	28S-20W-34	DV			NR	Heavily fished for RT.
		RT	X		1,600	
Snag	28S-20W-35	RT	X		1,500	
Horseshoe	20S-20W-35	RT	X		1,400	Heavily fished.
Aurel	28S-21W-36	RT	X		3,000	GR migrated from Cicely L., established population.
		GR			NR	

continued

Table 108 (continued). Stocked lakes around the Kodiak area.

Lake Name	Location TWS RNG SEC	Species	Stocking Frequency FREQ.	Stocking Frequency INFR.	Stocking Rate	Remarks
Caroline	28S-21W-12	RT	X		1,300	
		GR		X		Original plant 10,000
Jack	28S-21W-18	RT	X		900	
Cicely	28S-21W-36	GR		X	10,000	Established population.
Lee	28S-21W-36	RT	X		2,800	
Pony	29S-19W-36	SS	X		2,800	
Mayflower	29S-20W-23	DV			NR	
		SS		X	2,500	
Heitman	29S-20W-5	RT		X		
Saturn	30W-18W-18	RT	X		2,400	Heavy effort in June, popular hike-in.
Summit	30S-20W-31	DV			NR	
		RT	X		7,400	
Jupiter	30S-21W-18	RT	X		3,600	Heavy effort in June, popular hike-in lake.
Barry Lagoon	31S-19W-28	DV			NR	
		SS	X		40,000	
Beaver	31S-20W-31	DV			NR	
		RT	X		600	
Bull	31S-20W-35	RT	X		3,000	Best growth of stocked lakes, moderately fished.

Table 109. Pink, chum, and sockeye salmon and Dolly Varden sport harvest estimated for selected northeast Kodiak Island systems, 1973-1974 1/.

	Pink Salmon		Chum Salmon		Sockeye Salmon		Dolly Varden	
System	1973	1974	1973	1974	1973	1974	1973	1974
American R.	344	886	150	171	--	--	1,084	3,628
Buskin L.	685	2,186	202	147	632	409	20,400	26,387
Kalsin R.	105	408	20	19	--	--	1,229	0
Old's R.	0	96	47	0	--	--	160	693
Pasagshak R.	1,004	537	78	44	56	160	2,134	8,032
Roslyn Cr.	123	177	0	0	--	--	595	287
Salonie Cr.	27	7	0	0	--	--	0	0
Saltery R.	320	615	197	109	--	--	4,345	6,207
Others	489	500	76	8	275	1,414	2,361	4,249
Total	3,256	5,772	770	498	963	1,983	32,892	49,474

1) Source: Alaska Dept. of Fish and Game, 1974-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid in Fish Restoration, Ann. Progress Reports, vol. 15,16.

Table 110 . Some Kodiak region sport fisheries. 1) (see also stocked lakes Table 108).

System	Location TWS RNG SEC	Species 2)	Remarks
	Kodiak Island Road System		
Anton Larsen Bay	27S-21W-2	PS,CS,DV	Good beach fishery, summer-fall.
Monashka Bay	27S-19W-19	SS,PS,DV	Good beach fishery, summer-fall.
Buskin L.	28S-20W-5	SS,PS,RS,CS DV,SH	Top fishery in region. Excellent spring DV fishery, good salmon fishery, summer-fall.
Woman's Bay	28S-20W-32	SS,PS,DV	Good beach fishery.
Russian R.	29S-22W-23	PS,DV	
Salonie Cr.	28S-21W-25	SS,PS	
Middle Bay	29S-20W-21	SS,PS,DV	Good beach fishery.
American R.	29S-21W-32	SS,PS,CS,DV	Good salmon, DV fishery.
Kalsin Bay	30S-20W-2	SS,PS,DV	Good beach fishery.
Old's R.	30S-20W-26	SS,PS,CS,DV	
Kalsin R.	30S-20W-34	SS,PS,CS,DV	Light fishing effort.
Roslyn R.	30S-19W-20	SS,PS,DV	
Twin Forks Cr.	30S-19W-16,20	SS,PS,DV	
L. Rose Tead	30S-20W-22	SS,PS,RS.CS,DV	Good SS,DV fishery.
Pasagshak Beach	30S-20W-23	SS,PS,DV	Good beach fishery.
L. Miam	30S-21W-30	SS,PS,RS,CS, DV,RT-SH	Light fishery.
Saltery L., Cr.	30S-22W-35	SS,RS,PS,CS, DV,RT-SH	Good DV,SS fishery.

continued

1) Source - A.D.F.&G., 1975. Alaska Sport Fishing Guide. Sport Fish Division, Juneau, Ak. 96p.

2) Underlined species are primary species sought.

Table 110 (continued). Kodiak region sport fisheries (also see stocked lakes Table 108).

System	Location TWS RNG SEC	Species	Remarks
	Kodiak Wildlife Refuge		
Barbara L.	27S-23W-22	SS,RS,DV,RT	Productive lake, fairly popular with fly-in fishermen.
Uganik L., R.	29S-25W-7	SS,RS,PS, DV RT-SH	
Karluk L., R. & Lagoon	32S-30W-10 30S-32W-22	KS,SS,RS,PS, CS,DV,RT-SH	Former Navy recreation camp. Top KS, SH fishery in region, light to moderate effort. KS-June, July, SH-Sept., Oct.
Red L., R.	34S-32W-2	KS,SS,RS,PS, CS,DV,RT-SH	Good SH fishery. Light effort.
Upper Station Lakes	36S-31W-18,17	SS,RS,PS,DV, RT-SH	
Akalura L.	34S-31W-33	SS,RS,DV,RT-SH	
	Afognak Island		
Afognak L.,R.	24S-22W-15	SS,RS,PS,DV, RT-SH	Former Navy recreation camp. Very heavy effort then. Light to moderate effort presently. Excellent RT fishing.
Malina Lakes	23S-23W-25	SS,RS,PS,RT-SH,DV	Excellent RT fishery, light effort.
Little Afognak L.	23S-25W-27	SS,RS,DV,RT-SH	Excellent RT fishery, light effort.
Kitoi Lakes	23S-25W-16,10	SS,PS,RT,DV	Good RT fishery, light effort.
Portage L.	22S-25W-17	SS,PS,RS,RT-SH	Excellent RT fishery, light effort
Waterfall L.	21S-24W-15	DV	
Laura L. & Cr.	21S-25W-12	SS,RS,PS,DV, RT-SH	Excellent RT fishery, light effort.

Table 111 . Buskin Lake system sport fish catch and effort, 1965-1974[1/].

Year	Census Period	Angler-Trips	Angler-Hours	SS	RS	PS	CS	DV
1965	season estimates			80	120			
1966	4/29-5/30	1,130						3,487
1967	5/1-6/1	6,085						6,611
	7/1-8/1	1,847				1,547		
	season estimate			600				
1968	late April-May		5,397					12,807
	July-August		8,052			5,547		
	season estimate			1,200				
1969	8/27-10/12	4,494	9,374	2,112		804		3,319
1970	7/1-9/12	10,287	19,931	2,500[2/]	559	8,543		
1971	season estimates			850	50	1,100		4,000
1972	season estimates			700	50			
1973	season estimates[3/]			753	632	685	202	20,900
1974	season estimates[3/]			1,049	408	2,186	147	26,387

1) Source: Alaska Dept. of Fish and Game, 1966-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid in Fish Restoration, Ann. Progress Reports, vol. 7-16.

2) Estimate covers whole season.

3) Based on postal card survey.

Table 112 . Karluk River sport fish catch and effort, 1965-1974. 1)

Year	Census Period	Angler-Trips	Angler-Hours	KS	SS	Catch 2) RS PS	SH	DV	Area
1965	season estimate	--	--	70	--	--	--	--	
1968	season estimate	--	--	150	--	--	--	--	
1971	season estimate	--	--	150	--	--	--	--	
	10/6-10/29	30	283	--	108(1)	--	217(65)	121	
1972	5/16-7/8	--	--	87(56)	--	1(1)	51(2)		Lower Portage
	6/6-8/4	143	1,256	170(123)	--	6(2)	50(15)	10(2)	area
	9/30-11/10	26	308	--	166(5)	--	348(56)	31(1)	
	TOTAL	169	1,564	257(179)	166(5)	7(3)	449(63)	41(3)	
1973	season estimates			200			100		
1974	season estimates			200			150		

1) Source - A.D.F.&G., 1966-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid in Fish Restoration, Ann. Progress Reports, vol. 7-16.

2) Numbers of fish retained in parenthesis.

Table 113 . Coho salmon sport harvest estimated for selected northeast Kodiak Island systems, 1967-1974 1/.

System	1967	1968	1969	1970	1971	1972	1973	1974
	Estimated Harvest							
American R.	60	150	--	50	250	50	42	--
Buskin L.	600	1,200	2,200	2,500	850	700	753	1,049
L. Genevieve	--	--	--	15	--	--	--	--
Hurst Cr.	--	--	--	--	75	10	--	--
Island L.	--	--	--	50	100	--	--	--
Kalsin R.	--	--	20	20	0	0	49	54
L. Miam	--	--	--	--	50	--	--	50
Mill Cr.	--	100	--	--	--	--	--	--
Old's R.	--	--	25	25	150	50	6	19
Pasagshak	100	300	--	1,000	1,350	1,400	1,129	609
Pillar Cr.	--	--	--	25	25	30	--	2/
Roslyn Cr.	40	50	25	--	--	--	74	35
Salonie Cr.	50	200	225	200	100	0	88	63
Saltery R.	--	100	200	--	100	1,100	--	340
Total	850	2,100	2,695	3,885	3,050	3,340	2,593	2,733

1) Source: Alaska Dept. of Fish and Game. 1968-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid. in Fish Restoration, Ann. Progress Report, vol. 9-16.

2) Fishery closed.

Table 114 . Percent of sport-caught coho salmon harvested from total estimated run in selected northeast Kodiak Island systems, 1967-1974 1/.

	Percentage of Total Run							
System	1967	1968	1969	1970	1971	1972	1973	1974
American R.	17%	18%	--	10%	50%	26%	46%	--
Buskin L.	21	36	72%	68	43	51	38	68%
L. Genevieve	--	--	--	30	--	--	--	--
Hurst Cr.	--	--	--	--	20	20	--	--
Island L.	--	--	--	45	14	--	--	--
Kalsin R.	--	--	15	12	0	0	40	42
L. Miam	--	--	--	--	7	--	--	3
Mill Cr.	--	33	--	--	--	--	--	--
Old's R.	--	--	8	8	--	--	2	28
Pasayshak	4	8	--	50	56	33	32	--
Pillar Cr.	--	--	--	42	50	88	--	2/
Roslyn Cr.	40	17	8	--	--	--	71	26
Salonie Cr.	77	22	50	29	50	0	54	17
Saltery R.	--	9	--	--	20	82	--	36

1) Source: Alaska Dept. of Fish and Game, 1968-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid in Fish Restoration, Ann. Prog. Report, vol. 9-16.

2) Fishery closed.

Table 115. Pink, chum and sockeye salmon sport harvest as a percent of total estimated runs for selected northeast Kodiak systems, 1973-1974 1/.

	Pink Salmon		Chum Salmon		Sockeye Salmon	
System	1973	1974	1973	1974	1973	1974
American R.	3%	5%	4%	--	--	--
Buskin L.	7	5	--	--	22%	20%
Kalsin R.	1	--	neg.	--	--	--
Old's R.	--	neg.	--	--	--	--
Pasagshak R.	--	--	--	--	28	4
Roslyn Cr.	21	4	--	--	--	--
Salonie Cr.	2	neg.	--	--	--	--
Saltery R.	3	4	1	21%	--	--

1) Source: Alaska Dept. of Fish and Game, 1974-1975. Inventory and cataloging of sport fish and sport fish waters in Southwest Alaska. Fed. Aid in Fish Restoration, Ann. Progress Reports, vol. 15-16.

Table 116 . Estimated total sport salmon and Dolly Varden harvest, northeast Kodiak Island, 1973-1974. 1)

Year	Fishery	SS	RS	PS	CS	Total Salmon	DV
1973	Freshwater	2,593	963	3,256	770	7,582	32,892
	Saltwater	233	--	974	235	1,442	3,934
TOTAL		2,826	963	4,230	1,005	9,024	36,826
1974	Freshwater	2,733	1,983	5,412	498	10,626	49,474
	Saltwater	264	--	1,966	63	2,293	4,877
TOTAL		2,977	1,983	7,378	561	12,919	54,351

1) Source - A.D.F.&G., 1974-1975. Inventory and cataloging of sport fish and sport fish waters in southwest Alaska. Fed. Aid in Fish Restoration, Ann. Progress Reports, vol. 15-16.

APPENDIX

LIFE HISTORY - KING SALMON

Taxonomy

King salmon (*Oncorhynchus tshawytscha*) are members of the family Salmonidae, and are the largest of the five Pacific salmon. Local names vary to location. In Washington and Oregon king salmon are called "chinook," while in British Columbia they are surnamed "spring salmon." Other local names are "quinnat," "tyee," " tule," and "blackmouth."

Distribution

King salmon range in western North America from Ventura River in southern California to Point Hope, Alaska, adjacent to the Chuckchi Sea. In Asia they range from Hokkaido, Japan, north to the Anadyr River in Siberia.

Physical Description

A mature king salmon averages 40 inches in length and 40 pounds in weight, however, a 126-pounder was taken near Petersburg, Alaska in 1949.

Adult king salmon are distinguished by the black irregular spotting on the back, dorsal fins and on both sides of the caudal fin. They are also characterized by a black pigment along the gum line. In the ocean, the king salmon is a robust, deep-bodied fish. It has a blue-green coloration on its back, fading to a silvery color on the sides with white on the belly.

Depending upon location and degree of maturation, spawning colors vary from red to copper to almost black. Males are more deeply colored than females. Males are also distinguished by their "ridgeback" condition and their hooked upper jaw.

In fresh water, juvenile king salmon are recognized by well developed parr marks which are bisected by the lateral line.

Life History

Like all species of Pacific salmon, king salmon are anadromous. They hatch in fresh water, spend part of their life in the ocean, then return to fresh water to spawn.

King salmon may become sexually mature between their second and seventh years. As a result, fish in any spawning run may vary greatly in size. For example, a mature three-year-old generally weighs less than four pounds, while a mature seven-year-old may exceed 50 pounds. Females are usually older than males at maturity. With the exception of six and seven-year age groups, male spawners generally outnumber female spawners. Small king salmon that mature after spending only one winter in the ocean are commonly referred to as "jacks". These are ususally males.

In Alaska, mature king salmon start to ascend larger rivers from May through July and often make lengthy freshwater spawning migrations to reach their home streams. Spawners destined for the Yukon River headwaters in Canada are known to travel more than 2,000 miles in a 60-day period.

King salmon do not feed during the freshwater migration, causing their physical condition to gradually deteriorate. During this period they utilize stored body material for energy and for the development of reproductive products.

King salmon may spawn immediately above the tidal limit, but most travel upstream. Spawning generally occurs in the main channels of larger streams. Optimum substrate composition is 55 to 95% medium and fine gravel (no more than 15cm in diameter) with less than 8% silt and sand. Optimum stream discharge is 0.5 to 2.0 ft^3/sec.

The spawning act is essentially the same for all five species of Pacific salmon. The female selects a spawning site, usually a riffle area, and digs the nest or redd by turning on her side and beating with her tail. Redd size varies from 1.2 to 9 meters in diameter. Usually a dominant and several accessory males are in attendance.
When the redd is completed and the female is ready to spawn, she swims across the redd and lowers her anal fin into it. The dominant male comes alongside the female and quivers. The eggs from the female and sperm (milt) from the male are released simultaneously. After egg deposition, the female digs upstream from the redd and covers the eggs with gravel. A female may dig several redds and spawn with more than one male. Males may also spawn with several females. Females may contain from 3,000 to 14,000 eggs. The eggs are comparatively large (six to seven millimeters in diameter) and are orangish-red in color. Shortly after spawning activity ceases, the adult king salmon die.

Dependent upon water temperatures, the eggs hatch in about seven to nine weeks. The newly hatched fish, called alevins, remain in the gravel for two to three weeks while they gradually absorb the food in the attached yolk sac. Fry emerge from the gravel by early spring. Following emergence they school, but soon become territorial. Juvenile king salmon predominately migrate to the ocean after hatching but may remain in freshwater one or two years before migrating.

During the freshwater stage they feed largely on plankton, aquatic insect larvae and terrestrial organisms. In the ocean king salmon consume a wide variety or organisms, including: herring, pilchard, sandlance, rockfish, eulachon, amphipods, copepods, euphausiids and larvae of crabs and barnacles. King salmon grow rapidly in the ocean, often doubling their body weight during a summer season. King salmon feed in marine waters for a period of one to six years before returning to spawn in freshwater.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of north western Canada and Alaska. Bull. 173. Fish. Res. Bd., Canada. 1970. 381 p.

LIFE HISTORY - SOCKEYE SALMON

Taxonomy

Sockeye salmon (*Oncorhynchus nerka*) is a member of the family Salmonidae, which includes Pacific salmon, Atlantic salmon, trout, Dolly Varden and Arctic char. Common names for sockeye salmon are "red salmon" and "bluebacks." The majority of sockeye salmon are anadromous. However, some individuals become "lake-locked," completing their life cycle in fresh water. These individuals are known as "kokanee."

Distribution

Sockeye salmon are native to practically all temperate and sub-arctic waters of the North Pacific Ocean.. The distribution along the North American coastline occurs from Point Hope, Alaska (adjacent to the Chukchi Sea) south to the Klamath River in California. On the Asiatic side, they have been reported from Cape Chaplina in the northern portion of the Bering Sea southward around Kamchatka Peninsula to the northern shore of the Okhotsk Sea off Siberia.

Coastal distributions of sockeye salmon are well known because of the historical concentration of fishing effort along the coast and river esturaries. However, how far they move offshore and to what areas of the high seas they frequent during their one to five years of ocean residence is poorly understood. Investigations into the high seas distribution of sockeye by Davidson and Hutchinson (1938) and Fleming (1955) indicate that sockeye salmon are found where summer surface temperatures range from five to 16 degrees Centigrade, and where the summer surface salinities are generally less than 32.2 percent.

Forrester (1968) indicates that salmon normally occupy the upper 60-100 feet strata. These ranges were calculated from gill net catches of the Japanese high seas fishery and from Canadian and United States Exploratory fishing vessels.

Description

Anadromous sockeye may reach (33 inches) in length and weighing up to 15.5 pounds. However, the average is 24 inches in length and six to nine pounds in weight. The nonanadromous form (Kokanee) seldom exceed 16 inches and one pound in weight.

During their marine life adult sockeye salmon are metallic, greenish-blue on the dorsal surface with fine black specklings. In fresh water, mature breeding males develop a humped back, hooked upper jaw and brilliant red on the back which eventually blends to a deep, dark red on the sides. The head is olive-green, and the lower jaw and underside are pale white. The breeding female lacks the characteristic humped back and hooked jaw of the male. It generally has greenish-yellow patches on its dark red sides.

Juvenile sockeye salmon have dark, mottled green backs blending to an iridescent green and silver on the sides. They are distinguishable by the six to 10 dark oval parr marks on the sides. The parr marks are about the same width as the eye, barely extend below the lateral line and are irregularly spaced along the side of the body.

Life History

Differential distribution of anadromous sockeye salmon coincides with specific stages in its life cycle. Each spring sexually mature sockeye salmon leave their feeding grounds in the north Pacific Ocean and migrate over the continental shelf, eventually finding the spawning rivers from where they emerged. Sockeye salmon reach the spawning stage at varying ages. They may spend from one to five years in marine waters, thus reaching sexual maturity at ages ranging from two to seven years. Sockeye salmon undergo many morphological changes as they near fresh water in preparation for spawning. Feeding discontinues and their digestive systems become nonfunctional and degenerate. Nourishment is derived from the fat and protein sources of their flesh, skeletal structures and scales. As sockeye salmon enter freshwater, they begin developing the characteristic spawning coloration.

In Alaska, the spawning season for sockeye salmon extends from late July to early October, depending upon the geographic location. Spawning rivers usually have lakes in their systems. Spawning occurs in inlet and outlet streams and along the gravel shoals of lakes, often to a depth of 100 feet. In general, spawning coincides with water temperatures of 40 to 50 degrees Farenheit.

Fish breeding in lakes or in their outlets spawn later than those in streams. This is because lake waters generally cool off more slowly in late summer than do runoff waters in lake tributaries.

Factors determining the selection of spawning sites are variable. They include stream gradient, water depth and velocity, and size of streambed materials. Spawning sites are usually selected where there is good waterflow through the gravel, enabling the eggs to receive the essential amount of oxygen. Optimum substrate composition is fine-medium gravel with no more than 1% of the gravel being 15cm or more in diameter. The nest, or redd, generally averages $1.75m^2$ in diameter, although they are usually larger and more irregular in lake spawning areas. Kokanee redds are considerably smaller.

After egg deposition and fertilization, the female covers the eggs with a layer of material from the streambed. This act is similar in all species of Pacific salmon. The total number of eggs found in samples of North American female sockeye ranges from 2,200 to more than 4,500. The average is approximately 3,500. Fecundity depends primarily upon the size of the female.

The egg incubation period depends primarily upon the temperature of water flowing through the nest, or "redd." Under normal conditions the period may vary from 80 to 140 days. When the eggs hatch, the young (alevins) remain in the gravel for three to five weeks. During this time they derive nourishment from the attached yolk sac. Full formed and free-swimming fry emerge from the gravel in early spring (April and May).

After emergence into lake tributaries, fry move downstream into the lake. Those hatched in lake outlets must move upstream into the lake. In some river systems, "races" of sockeye salmon exist which spawn in streams without associated lakes. In these cases, fry drop down directly to the sea, or rear in backwater streams or eddies.

When fry first enter a nursery lake they work along the shore for a few weeks. They soon move out into deeper water of the lake and concentrate in the top 10 to 20 meters. Fry have been found at depths greater than 40 meters.

Food during the nursery period consists primarily of insects and their larvae (in shallow water). Later they feed primarily on Cladocera, copeods and amphipods. In addition to competing with their own species for food, sticklebacks, whitefish and other freshwater species are significant competitors. Predators of sockeye fry include Dolly Varden, Arctic char, squawfish (Ptychodheilus oregonensis), rainbow trout, coho salmon and prickly sculpin (Cottus asper).

Sockeye fry may remain in freshwater for a period from one to four years. When surface waters in nursery lakes approach 39 to 45 degrees Farenheit, the young salmon, now called "smolts", begin their seaward migration. Depending upon genetic makeup and freshwater growth factors, sockeye smolt range from three to six inches in length.

Upon reaching saltwater the smolt generally remain inshore in estuarial areas. Food at this stage consists of insects, crustaceans such as copepods, amphipods, decopods, barnacle larvae, astrocods and euphausiids. Smolt also feed upon young fishes and larvae such as sandlance, bigeye, whiting, rockfishes, eulachon, starry flounder, herring, prickleheads and hake.

Sockeye salmon remain in ocean feeding areas from one to four years. With the onset of sexual maturity, they begin migrating back to coastal waters and finally their native streams.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Davidson, F.A. and S.J. Hutchinson. 1938. The geographical distribution and environmental limitations of the Pacific salmon (genus Oncorhynchus). Bull. Bur. Fish., 48:667-692. (Bull. No.26.)

Fleming, R.H. 1955. Review of the oceanography of the North Pacific. Intern. North Pacific Fish. Comm., Bull. No.2, 43 p.

Foerster, R.E. 1968. The sockeye salmon. Bull. 162, Fish. Res. Bd. Canada. 422 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

Hartman, Wilbur L. 1971. Alaska's fishery resource - the sockeye salmon. U.S. Dept. of Commerce, Nat. Oceanic and Atmospheric Admin., NMFS leaflet 636.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bull. 173. Fish. Res. Bd., Canada. 1970. 381 p.

LIFE HISTORY - COHO SALMON

Taxonomy

Coho salmon (Oncorhynchus kisutch) is a member of the family Salmonidae, which includes the rest of the Pacific salmon, Atlantic salmon, trout, char and Dolly Varden. In common usage, coho salmon are generally referred to as "silver salmon."

Distribution

Coho salmon are distributed in western North America from Monterey Bay, California, north to Point Hope, Alaska. In northeastern Asia they range from Hokkaido, Japan, north to the Anadyr River in Siberia. In Alaska cohos are abundant from the Dixon Entrance (Southeastern Alaska) north to the Yukon River. Evidence suggests cohos are rare north of Norton Sound.

Physical Description

The average weight of a mature coho salmon is from six to 12 pounds. The average length at maturity is 29 inches. During ocean residency adults are metallic blue on the dorsal surface, silvery on the sides and ventral surface and caudal peduncle. Irregular black spots are present on the back and usually on the upper lobe of the tail. Spots and gums are not as darkly pigmented as in king salmon. The caudal peduncle is unusually broad, and a silvery plate is evident on the tail. During the spawning phase, both sexes turn dark, with a maroon-reddish coloration on the sides. The male developes an extremely hooked snout and its teeth become enlarged. The male also developes a "humped" back, but it is not as extreme as those found in spawning sockeye or pink salmon males. Occasionally males return to spawn after only three to six months at sea. These small "jacks" resemble adults, but possess more rounded tail lobes.

Juvenile coho have parr marks evenly distributed above and below the lateral line. The parr marks are narrower in width than the interspaces. No black spots are visible on the dorsal fin. The anal fin has a long, leading edge usually tipped with white. All other fins are frequently tinged with orange.

Life History

In Alaska, coho salmon enter spawning systems from August through November, usually during periods of peak high water. Actual spawning occurs between September and January. Although spawning may occur in main channels of large rivers, locations at the head of riffles in shallow tributaries or narrow side channels are preferred. Optimum substrate composition is small-medium gravel. However, coho salmon are extremely adaptable and will tolerate up to to 10% mud. Optimum stream discharge is 3.4 $ft.^3$ sec. Nest, or redd, site is generally larger than that for sockeye salmon and averages 2.8 m^2 in the Columbia River basin.

Fecundity ranges from 2,400 eggs to 5,000 eggs in larger females. Eggs are orangish-red in color and smaller than most other salmon eggs, ranging from four to six millimeters in diameter.

Eggs in the gravel develop slowly during the cold winter months, hatching in about six to eight weeks. The sac-fry remain in the gravel and utilize the yolk material until emerging two to three weeks later (May-June). Upon emergence the fry school in shallow areas along the shores of the stream. These schools break up rather quickly as fry establish territories. The fry defend these "territories" from other juvenile coho with aggressive displays. This territory is usually along the shoreline or behind a log or boulder. From such a location the young fish do not have to fight the current, and can dart out to feed on surface insects or drifting insect larvae.

Juvenile coho grow rapidly during the early summer months, and spend the winter in deeper pool areas of spring-fed side ponds. Coho salmon also rear in ponds or lakes, where they feed along shoreline areas. Rearing also occurs in brackish, lagoon areas.

In the spring of their second, third or fourth year, coho smolts migrate to the sea. They remain inshore and near the surface during the first few months, feeding on herring larvae, sandlance, kelp, greenling, rockfish, eulachon, insects, and various crustaceans such as copepods, amphipods, barnacles. They also feed on crab larvae and euphausiids. After several months inshore, they move out into the open ocean where their principal foods are squid, euphausiids and various species of small fish.

Information concerning the coho's ocean residency is scant. However, tagging in the Gulf of Alaska has indicated that a large number of southeast Alaska coho move north along the coastline until reaching the Kodiak Island vicinity. This movement corresponds with the Alaskan Gyre, which is a counterclockwise pattern of ocean currents moving across the North Pacific to the coast of British Columbia, northwest along the coast to the Gulf of Alaska and then southwest toward the Alaska Penninsula. Other species of Pacific salmon are thought to follow this counterclockwise pattern during ocean residency. Coho salmon spend from one to three years in marine waters before returning to spawn in their native streams.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bull. 173. Fish. Res. Bd., Canada. 1970. 381 p.

LIFE HISTORY - PINK SALMON

Taxonomy

Pink salmon (*Oncorhynchus gorbuscha*) are members of the family Salmonidae, which also includes the genera *Salmo* (Atlantic salmon and trout) and *Salvenlinus* (char and Dolly Varden). Pink salmon have also been called "humpy"or "humpback" salmon because of the enlarged hump that develops on the back of the spawning male.

Distribution

Pink salmon occur in streams from northern California to the Arctic Ocean in North America, and from the Arctic Ocean south to Hokkaido Island of northern Japan in Asia. Their oceanic distribution extends from North America to Asia north of the 40th parallel through the Bering Strait into the Arctic Ocean. Although several attempts have been made to transplant pink salmon to waters outside their natural range, no new fishery has been established to date.

Physical Description

The average length of a mature pink salmon is from 16 to 22 inches, with an average weight of four pounds. Adults have large black spots on the back, adipose and both lobes of the caudal fin. The spots on the caudal fin are oval. The largest of these spots are at least as large as the eye diameter.

Fry have a general silvery appearance and their backs are often deep blue to green. A lack of parr marks easily distinguishes them from other salmon fry. During the first three months after the fry's entry into the ocean, they have a silvery color common to all salmon. Pink salmon fry can also be readily distinguished by small and numerous scales, with subtle differences in scale shape, color and internal structure.

Spawning adult males develop an elongated and hooked snout, enlarged teeth and a pronounced hump behind the back. The back and sides of the fish become dark, with green-brown blotches on the sides. Spawning females do not develop these characteristics as distinctly.

Life History

In Alaska mature pink salmon begin migration to spawning streams from mid-June to late September, usually ascending streams only short distances. In British Columbia and California, some pink salmon have been known to migrate more than 200 miles, and in Asia migrations have been reported up to 400 miles from the sea.

In Alaska, pink salmon spawn in the lower reaches of short, coastal streams. Some prefer intertidal areas of these streams, where eggs are alternately bathed by fresh and brackish waters. Spawning areas with medium size gravel are preferred. Optimum stream flow is 0.03m/sec. or greater.

Spawning generally begins in August or September when stream temperatures are approximately 50 degrees F. Pink salmon tend to spawn earlier in colder streams and later in warmer ones. Because pinks are smaller than the other salmon, the nest, or redds, dug by the female are not as large. In Southeast Alaska, redd size averages 1.1m^2 in diameter and 9.3cm deep. The egg deposition and fertilization process is similar to the other species of Pacific salmon. The mature female usually carries between 1500 and 2000 eggs, which are orangish-red in color and roughly six millimeters in diameter. From the time of spawning to the fry's emergence from the gravel, less than 25 percent of the deposited eggs survive. This heavy mortality is caused by digging in the redds by other females, poor oxygen supply to the eggs, poor water circulation in the streambed, dislodgement of eggs by flooding and scouring, freezing of eggs during severe and prolonged cold, and predation by other fish.

The developmental period of the egg is critically affected by water temperature. Hatching normally occurs from December through February. Alevins remain in the gravel for several weeks and emerge in April or May. The fry migrate downstream to estuaries immediately after hatching, migrating at night and hiding in the gravel by day. Migrating fry generally do not feed, but if the distance is great they may consume larval insects.

Fry form large schools in estuarine areas, remaining inshore throughout their first summer. In September they move into deeper water. In April and June their principal food consists of copepods. By July, increased growth enables them to supplement their diet with larger organisms such as insects, and small fishes. In the estuaries of southeastern Alaska, fry may reach six to nine inches before migrating into the open ocean.

Maturing pink salmon remain in ocean feeding grounds until the following summer. Growth is rapid during the last spring and summer in the sea and throughout most of the spawning migration through coastal waters.

Pink salmon reach sexual maturity when they are 14 to 16 months old and average 16 to 22 inches in length. Little data concerning estuarial and ocean survival is available. Evidence suggests that roughly three-fourths of the fry entering estuary waters die before reaching the ocean. Of those entering the ocean, approximately three-foruths die before reaching sexual maturity. Predation is believed to be the principal cause of these mortalities.

Pink salmon have the shortest and simplest life history of any Pacific salmon. With a two year cycle they have two genetically distinct stocks. These stocks are called "odd" or "even" year, and are based upon the year adults spawn. Differences in the number and size of fish in the two stocks have been the subject of speculation for many years. In some areas of Alaska, only one stock spawns in significant numbers. In general, odd-year runs predominate in the Fraser River and in southern British Columbia. Even-year runs predominate in northern British Columbia and the Queen Charolette Islands. Switches from odd-year to even-year dominance have been recorded in Asian streams to a significant extent. Puget Sound and Southeastern Alaska odd-year runs dominate, while in Kodiak, Cook Inlet and Bristol Bay, even-year runs are in the majority. Long term averages in Prince William Sound indicate a higher abundance of even-year stocks, however, odd-year stocks have periodically sustained several years of high abundance.

Selected References

Baily, Jack E. 1969. Alaska's fishery resource - the pink salmon. U.S. Dept. of Int., Fish and Wildlife Service, Bureau of Comm. Fisheries. Leaflet 619.

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

Helle, J.H. 1962-63. Biological characteristics of intertidal and freshwater spawning pink salmon at Olsen Creek, Prince William Sound, Alaska. Special scientific report no. 602. U.S. Dept. Fish and Wildlife Serv. 1970.

Helle, J.H., Richard S. Williamson, and Jack E. Bailey. 1964. Intertidal ecology and life history of pink salmon at Olsen Creek, Prince William Sound, Alaska. Special scientific report no. 483. U.S. Dept. of Interior, Fish and Wildlife Serv. 1964.

McNeil, W.J. 1969. Survival of pink and chum salmon eggs and alevins, page 101-117. D.W. Chapman and T.C. Bjornn, distribution of salmonoids in streams, with specific reference to food and feeding, page 153-176, in symposium on salmon and trout in streams, U. of British Columbia. H.R. MacMillan lectures in fisheries, 1969.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bull. 173. Fish. Res. Bd., Canada. 1970. 381 p.

Prince William Sound Aquaculture Corp., 1975. Salmon culture program (unpublished).

LIFE HISTORY - CHUM SALMON

Taxonomy

Chum salmon (*Oncorhynchus keta*) are members of the family Salmonidae and sub-order Salmonoidea. Chum salmon are commonly referred to as "dogs" or "dog salmon." This name can be attributed to the hooked snout and protruding teeth of spawning males.

Distribution

Chums are the most widely distributed of the five Pacific salmon and second to the pink salmon in abundance. In western North America they range from California north to the Bering Strait and east to the MacKenzie River. In northeast Asia they run from near Pusan, Korea, north along the Asian coast to the Arctic Ocean. They also range west along the Arctic coast to the Lena River of Siberia. Primarily, distribution is above latitude 46°N in the colder waters of the subarctic region.

Physical Description

Adult chum salmon have been recorded as large as 40 inches in length and weighing as much as 33 pounds. The average is 30 inches long and eight pounds in weight. In marine waters they are metallic blue on dorsal surfaces with occasional black speckling. The pectoral, anal and caudal fins have dark tips. In fresh water maturing chums show reddish or dark streaks (or bars) and large blotches, with white tips on the pelvic and anal fins. The spawning male develops an elongated, hooked snout, and its teeth become enlarged.

Chum salmon fry have six to 14 short parr marks that rarely extend below the lateral line. The back is mottled green, while the sides and belly are silvery with a pale green iridescence.

Life History

From July through September, sexually mature chum salmon leave ocean feeding grounds and migrate to freshwater spawning habitat. These habitats may range from tidal flats of short, coastal streams to springs in the headwaters of large river systems. The longest known spawning migration occurs in the Yukon River, where chum salmon swim more than 1,500 miles upstream from the Bering Sea.

Spawning usually occurs in riffle areas, with gravel size comparable to that used by pink salmon. Spawning also occurs in coarser gravel and even in bedrock area atop loose rubble. Chum salmon generally avoid areas where there is poor circulation of water through the streambed. Optimum stream flow is 0.1-1.0 m/sec. Nest, or redd, size is considerably larger than that for pink salmon and has average $2.25m^2$ in diameter in the Columbia River basin. Optimal size is considered $3m^2$ in diameter.

Females produce an average of 3,000 orangish-red eggs approximately six to seven millimeters in diameter. Hatching occurs from December through March. Experiments have revealed that at a constant temperature of 50 degrees Farenheit, eggs hatch in about 50 days. Alevins emerge from the gravel from April through May to begin their seaward migration.

When fry reach the estuary they are usually about one and one-half inches long. They feed near shore for several months and migrate to open sea in September. Growth during the first months of marine residence is rapid, with juveniles reaching lengths of six to nine inches in their first year. The diets of maturing chum salmon is similar to that of other Pacific salmon.

Chum salmon return to spawn after spending two to four years at sea. Counting freshwater growth, they are between three and five years old when they leave the ocean.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

McNeil, W.J. 1969. Survival of pink and chum salmon eggs and alevins, page 101-117. D.W. Chapman and T.C. Bjornn, Distribution of salmonoids in streams, with specific reference to food and feeding, page 153-176, in symposium on salmon and trout in streams, U. of British Columbia. H.R. MacMillan lectures in fisheries, 1969.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bull. 173. Fish. Res. Bd., Canada. 1970. 381 p.

Merrell, Theodore, R. Jr. 1970. Alaska's fishery resource - the chum salmon. U.S. Dept of Int., Fish and Wildlife Service, Bureau of Comm. Fisheries. Leaflet 632.

Prince William Sound Aquaculture Corp., 1975. Salmon culture program (unpublished).

LIFE HISTORY - PACIFIC HERRING

Taxonomy

The Pacific herring is a member of the order Clupeiformes. Its family, Clupidae, is characterized by an elongate, compressed body. In general, all Pacific herring have similar characteristics, but minor differences may exist between the herring in Alaska and those in other areas.

Physical Description

The species can grow to lengths of 33 centimeters (13 inches), but an average large specimen is nine to 10 inches long, weighing about 1/3 pound. They are bluish-green dorsally and silvery on the ventral side, having relatively large scales. Herring are fast swimmers and occur in schools of up to one million or more fish. They feed principally on planktonic crustaceans and store large quantities of oil in their bodies. The common maximum life is about nine years, although some fish may live more than 15 years. They attain sexual maturity in their third or fourth year of life and spawn each year thereafter.

Distribution

Pacific herring occur all around the North Pacific rim, in the Bering Sea, and along the shores of the Arctic Ocean. In Alaska, the largest commercial quantities occur around Kodiak Island, Prince William Sound and in much of southeastern Alaska. Recent developments in fishing techniques and gear have resulted in the discovery of additional concentrations of Pacific herring in the Bering Sea, where thousands of tons are now taken annually by Soviet and Japanese trawlers.

Spawning

The life history of Pacific herring from the time adults spawn until the developing juveniles move from inshore waters is well documented, but little is known about what occurs in the 2 1/2 years while herring are maturing.

Adult Pacific herring usually mature at about age three or four years in Alaska at a size of about 150 to 200 mm. However, this may vary somewhat between areas. Spawning occurs throughout the spring months, late April through mid-June, slightly earlier in more southern areas. Water temperatures appear to be one of the main factors that influence spawning timing, and spawning usually begins when water temperatures reach approximately 39.5°-40.0° F.

A female can produce about 10,000 eggs when she is three-years-old and as many as 59,000 when she is eight. The older and larger females produce more eggs than the younger ones, but approximately 20,000 eggs per spawning is average. The eggs are adhesive, and the female deposits them on solid surfaces rather than broadcasting them loosely in the water. The generally preferred surface for spawning is living plants. Those plants most often used are eel grass (Zostera), rockweed (Fucus) and girdle (Laminaria).

A spawning female makes physical contact with the substrate and deposits her eggs in narrow bands upon it. The male herring does not pair off with any particular mate, but wanders among the spawning females extruding milt (sperm) at random. The thousands, or perhaps millions, of fish spawning on a beach usually produce so much milt that the water becomes discolored.

A heavy spawning does not always result in more adult herring. In some cases, mortality cuased by crowding of the eggs may actually produce fewer young herring than more moderate spawning. Moreover, if many of the eggs of a heavy spawning hatch sucessfuly, high mortality may result as the millions of larvae compete for a limited food supply.

The eggs of the Pacific herring are small (1.0 to 1.5 millimeters in diameter). They are spherical, slightly heavier than seawater, and adhesive. The incubation time is governed by the temperature of the water, and ranges between 12 and 20 days. Higher temperatures accelerate development. Even under ideal conditions, millions of eggs fail to hatch and mortalities in the egg stage can range from 50% to as high as 99%. During the incubation period, eggs laid within the intertidal area are alternately exposed and covered by tides. In warm weather, great numbers of eggs may dehydrate and die when exposed by low tides. Severe mortality may also result from coastal storms if the egg-covered eel grass or kelp is torn from the bottom and cast up on the beach. The alternatve exposing and covering of the eggs by the tide makes them available to both aquatic and terrestrial predators.

Upon hatching, a larva receives nourishment from a small quantity of yolk that remains in the egg. When the yolk has been utilized the larva begins to feed. The herring larva is almost transparent and about six millimeters (1/4 inch) long. The transition from yolk subsistence to active feeding is perhaps one of the most critical periods in the herring's life. If water currents are unfavorable, thousands of larvae may be swept out to sea or to areas without proper food. The larvae are constantly exposed to predation by marine animals such as arrow worms, comb jellies and other fish.

The change from a larva to a scaled juvenile takes place from six to eight weeks after the egg is hatched. At this stage the herring is approximately 65 millimeters (2 1/2 inches) long. The young collect in small schools and gradually move seaward toward the mouths of bays and inlets in which they were hatched. By early fall they are about 100 millimeters (4 inches) long and consolidate into large schools of perhaps one million fish or more. Most of the schools move into deep or offshore water by late fall. They return 2 1/2 years later as mature adults ready to spawn for the first time.

Selected References

Clemens, W.A., and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

McPhail, J.D. and C.C. Lindsey. 1970. Fresh water fishes of northwestern Canada and Alaska. Bull. Fish. Res. Bd. Canada 173. 381 p.

Reid, Gerald M. 1972. Fishery facts - 2, Alaska's fishery resources - the Pacific herring. U.S. Dept. Comm., NMFS, U.S. Government printing office, Wash., D.C. 20 p.

LIFE HISTORY - HALIBUT

Taxonomy

The Pacific halibut (Hippoglossus stenolepis) is a member of the order Pleuronectiformes, which includes such species as flounders, sole and brill.

Physical Description

The order Pleuronectiformes is characterized by a greatly compressed body (somewhat rounded on the eyed side) and flat body on the blind side.

In young flatfished, the body is upright and symmetrical with an eye on each side of the head. Very soon a metamorphosis occurs, in which one eye migrates to the opposite side of the head. Eventually both eyes are on the upper or darker side. The fish then settle to the bottom and swim horizontally.

In the Pleuronectidae or flounder family, to which the halibut belongs, the eyes and colored surface are typically on the right side of the fish (dextral). The halibut mouth is large and symmetrical, with the maxillary extending to the pupil of the eye or behind. The teeth are developed on both sides of the jaws, associated with their predatory nature.

Halibut are the largest of all flatfishes and one of the larger fishes in the world. The adult male halibut may reach 4 feet seven inches in length, and attains an average weight of 40 pounds. An adult female may grow to 8 feet nine inches. Females have been recorded weighing 470 pounds at an age of 35 years or more. The largest Pacific halibut on record was caught near Petersburg, Alaska, and weighed 495 pounds. Atlantic halibut up to 690 pounds have been recorded.

Halibut are dark brown in color on the eyed side and irregularly blotched with lighter shades. The blind side is white. By controlling the contraction and expansion of chromatophores of various colors, halibut and other flatfishes have the ability to change their external shades and color patterns to blend in with the immediate surroundings. These changes are activated by visual stimulation.

Distribution

The species range from Rosa Island off Santa Barbara in southern California to the Bering Sea, as far north as the Norton Sound. They are also distributed about halfway between St. Matthew and St. Lawrence Islands. On the Asiatic Coast, they range from the Gulf of Anadyr in the north as far south as Hokkaido, Japan. Halibut are found in very shallow waters and to depths of 600 fathoms. They generally range between 30-225 fathoms.

Spawning

Spawning takes place from November to January along the slopes of the continental shelf in depths from 125 to 250 fathoms. Some well known halibut spawning grounds are: Cape St. James, Whaleback, Cape Omanney, Yakutat Spit, Western Spit, Icy Bay Strait, "W", Seward Gully, Trinity Islands and Chirikof Island.

Fecundity in females is proportionate to the size of the fish. A large female of 140 pounds may have as many as 2.7 million eggs. The eggs, or ova, are about 1/8 inch in diameter and bathypelagic;

being laid and fertilized in proximity to the bottom but subsequently drifting in the middle to upper water levels. The eggs and larvae drift passively with the ocean currents at depths down to 375 fathoms. As development proceeds, they gradually rise toward the surface and drift into shallow water with the inshore surface currents.

The germinal disc of the egg goes through the normal processes of cell division to form the embryo that lives off the yolk. The yolk comprises the main mass of the egg. Eggs hatch after about 15 days, with the larvae living off nourishment from the yolk sac. After absorption of the yolk, post larvae must depend upon the external environment for their food. As with the eggs, the larvae and post-larvae continue to be free floating. They are transported many hundreds if not thousands of miles by the westward moving ocean currents.

The free floating stage lasts about six months. After rising to the surface water layers, they tend to be propelled by the prevailing winds toward the shallower sections of the continental shelf. The larvae undergo metamorphosis and commence their bottom existence far from the spawning grounds as juvenile halibut, but possessing the characteristic adult form. Thus the floating eggs, developing larvae and the post-larvae are dispersed far westward from the points where they were produced.

With advancing size and age the young halibut move into deeper water. Females grow faster than males. The age of sexual maturity in females is from eight to 16 years, averaging about 12 years.

Tagging operations have shown that immature halibut move within very restricted areas, whereas mature fish may migrate extensively to and from the spawning grounds. Some individuals have been known to migrate as far as 2,000 miles. Food for halibut consists of fishes, crabs, clams, squid and other invertebrates.

Selected References

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

Bell, H.F. 1972. The Pacific halibut - a managed resource. (In) a review of the oceanography and renewable resources of the Gulf of Alaska. Ed. Donald H. Rosenberg. IMS report R72-23.

LIFE HISTORY - PACIFIC COD

Taxonomy

The Pacific cod (Gadus macrocephalus) is a member of the family Gadidae and the order Anacanthini. The scientific name Gadus macrocephalus is derived from the Latin gadus (codfish) and the Greek macros (large and cephalos (head). Common usage may continue to refer to this species as "plain" cod, "gray" cod or "true" cod to distinguish it from the other species currently referred to as varieties of cod. Other members of the family Gadidae are: the whiting (Theragra chalcogrammus), pacific tomcod (Microgadus proximus), and longfin cod (Antimora rostrata).

Physical Description

The Pacific cod has a brown to gray coloration on the dorsal surface, shading into lighter hues on the ventral surface. Brown spots are numerous on the back and sides, and are more or less dusky on the fins. The outer margin of all unpaired fins are white, and the white becomes wider on the anal and caudal fins. The Pacific cod is noted for three separate dorsal fins, with the anus below the second dorsal fin. The barbel below the lower jaw is as long or longer than the eye. This species may attain lengths up to 3 feet 3 inches.

Distribution

Pacific cod are mostly benthic, but are occasionally taken in quite shallow water. They have been caught at depths up to 300 fathoms

(550 meters). The species ranges from Santa Monica in southern California through Alaska and the Bering Sea to the Chukchi Sea. On the Asian side, they are distributed past the Kuril Islands to Kamchatka, Okhotsk Sea, Sea of Japan, off Honshu, Korea and in the Yellow Sea to Port Arthur. Toward the southern part of its center of abundance, cod occur in temperatures throughout the year between 6° and 9°C.

Spawning

Spawning takes place in the winter. The eggs are slightly more than 1 mm in diameter and show no oil globule. The eggs are pelagic and slightly adhesive. They hatch in eight or nine days at 11°C and in 17 days at 5°C, but will take about four weeks at 2°C in northern waters. The hatching period for a batch of eggs lasts over several days. Egg survival is high at 5°C. Newly hatched larvae are approximately 4.5 millimeters in length. At 5°C, the yolk sac is absorbed in about 10 days. Young about 20 millimeters in length have been found to eat copepods.

Female cods sexually mature at approximately 40 centimeters of body length and two to three years of age. The length at which 50% of the females are sexually mature is 55 centimeters (Foerster, 1964). Half the males are mature at two years of age. At 60 centimeters, a female may produce 1.2 million eggs. At 78 centimeters, she may produce 3.3 million.

Cod generally move into deep water in the autumn and return to shallow water in the spring. Feeding includes a wide variety of invertebrates and fishes including: worms, crabs, molluscs and shrimps, herring, sand lance, walleye pollock and flatfishes.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

LIFE HISTORY-LINGCOD

Taxonomy

The lingcod (*Ophiodon elongatus*), is a member of the family Hexagrammidae in the suborder Scorpaenoidea. The scientific name *Ophiodon elongatus* is from the Greek ophis (snake) and odons (tooth) and the Latin elongatus (elongate). It is often referred to as "cultus cod". Other members of the family Hexagrammidae found in Alaskan waters include the kelp greenling (*Hexagrammos decagrammus*), rock greenling (*Hexagrammos lagocephalus*), masked greenling (*Hexagrammos octogrammus*) and whitespotted greenling (*Hexagrammos stelleri*).

Physical Description

Reaching a length of five feet (152 centimeters), the lingcod is recognizable by its rounded and once-notched long dorsal fin, large mouth, large teeth, thoracic pelvic fins and small, smooth scales covering its body and head. Its coloration is variable, with bold, darker mottling on many shades of brown, gray, or green on the back and sides, depending upon the environment. Some smaller individuals are strongly green with the color permeating the flesh.

Distribution

The lingcod ranges from Baja in southern California north to Kodiak Island to the Shumagin Islands south of the Alaska Peninsula. It is common along the northeastern shore of the Pacific Ocean, with its center of abundance in waters of British Columbia. Its habitat is near the bottom of the intertidal zone down to at least 60 fathoms, among kelp beds and reefs, especially where there are strong tidal movements. When resting on the bottom, the fish supports its weight by resting on its pectoral and pelvic fins.

Spawning

Spawning takes place from December to March. Females deposit their eggs in crevices or under rocks in shallow water, sometimes in the intertidal zone. Newly maturing females produce 100,000 to 150,000 eggs. Larger females (40 inches in length) may produce upwards of 500,000 eggs. When water hardened, lingcod eggs are approximately 3.5 millimeters in diameter, and have tough membranous shells. They adhere strongly to each other, producing large, thick masses weighing up to 30 pounds, with a pinkish opalescent color. The male lingcod guards the eggs against intruders and fans them with his large pectoral fins.

Hatching is progressive, with eggs on the outside of the mass hatching first. Newly hatched young are seven to 10 millimeters long, have blue eyes, and a bright yellow oil globule near the liver. They sink to the bottom in intense light. The yolk sac is absorbed in about 10 days.

At one year of age, lingcod average about 10.5 inches in length. Growth in females is faster, averaging roughly 2.7 pounds per year, while males average only 1.7 pounds per year. Females reach 36 inches in length at 10 to 14 years old, with males seldom exceeding 36 inches. Males reach sexual maturity at about 18 inches. Females reach maturity at 27.5 to 30 inches.

Lingcod show two main patterns of movement. Some individuals are obviously quite sedentary, making few, if any, movements. Tagging has shown that fish were recaptured at the same location years after release, however, migratory populations have been known to exist.

Lingcod are voracious feeders, eating herring and sand lance, when available, and a variety of bottom forms such as flounders, hake, walleye pollock, cod and rockfishes. Lingcod also eat crustacea and octopus, and are definitely cannibalistic. Juveniles feed extensively on copepods and other small crustaceans.

Selected References

Clemens, W.A., and G.V. Wilby. 1961. Fishes of the Pacific Coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

LIFE HISTORY - ROCKFISHES

Taxonomy

The rockfish family, Scorpaenidae, belongs to the order Scorpaeniformes and the suborder Scorpaenoidea.

These fishes frequently are called rockcods, but since they have no close relationship with the true cods, (Gadidae) it seems advisable to adopt the term rockfishes and discard the term "cod" in reference to members of this family.

Species of the rockfish family found in Alaskan waters include the blue rockfish (*Sebastodes mystinus*), black rockfish (*Sebastodes melanops*), orange rockfish (*Sebastodes pinniger*), blackblotched rockfish (*Sebastodes crameri*), redstripe rockfish (*Sebastodes proriger*), rougheye rockfish (*Sebastodes aleutianus*), longjaw rockfish (*Sebastodes alutus*), stripetail rockfish (*Sebastodes saxicola*), red snapper, (*Sebastodes ruberrimus*), flag rockfish (*Sebastodes rubrivinctus*), brown rockfish (*Sebastodes auriculatus*), copper rockfish (*Sebastodes caurinus*), quillback rockfish (*Sebastodes maliger*), yellowstripe rockfish (*Sebastodes nebulosus*), blackbanded rockfish (*Sebastodes nigrocinctus*) and spinycheek rockfish (*Sebastolubus alascanus*).

Among the numerous species of rockfish found in Alaskan waters, the red snapper (*Sebastodes ruberrimus*) is among the most important commercially. Adults reach lengths of three feet.

Physical Description

In the rockfishes, the body is elongate and the anterior (front) is stout. The head is large and usually bears prominent ridges and spines in definite positions. The scales are large and ctenoid. The dorsal fin is single with 13 to 15 spines and nine to 16 rays. The anal fin has three stout spines and five to nine rays. The pelvic rins are thoracic, each with a spine and five rays. Some species of rockfish average 3 feet in length, however, most species range between 20 and 30 inches long.

Species living near the surface are, for the most part, brown in color while those in deep water often have a red coloration.

Distribution

The rockfishes constitute a group of many species largely in the north temperate seas. More than 50 species are known along the eastern shores of the Pacific Ocean from California to Alaska. At least 24 of these species are found in British Columbia waters in the two genera: *Sebastodes* and *Sebastolobus*.

Many species inhabit rocky shores but the family has representatives in a vertical range from tidewater to 822 fathoms.

Rockfish populations in all regions are thought to be underestimated, since these groups are known to be distributed on the ocean bottom and at considerable distances above it. Test sampling conducted by the National Marine Fisheries Service and the National Ocean and Atmospheric Administration between 1950 and 1968 showed that the rockfish group comprised a greater number of species than any other fish group sampled. About 20 rockfish species, mostly from the genus *Sebastodes*, occurred in the Gulf of Alaska regions. The two species of the genus *Sebastolobus*, both of which are deep water inhabitants, constituted a large portion of the rockfish catches beyond 99 fathoms. Many of the *Sebastodes* species appear to be primary pelagic forms, and were reported taken in mid-water trawls. For this reason, these species had the greatest bathymetric range, occurring in all depth zones sampled.

During the exploratory fishing, rockfishes were mostly encountered in the offshore waters of all regions. They were rarely found in the inside waters of southeastern Alaska.

Spawning

All species of the genus Sebastodes have internal fertilization of the eggs and subsequent release of the young. These are less than 1/2 inch in length and are produced in large numbers during the summer months.

Selected References

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

LIFE HISTORY — SABLEFISH

Taxonomy

The sablefish (*Anoplopoma fimbria*) is a member of the order Scorpaeniformes, which was originally established to include those fishes having a perch-like form of body. The order now includes many groups that are quite varied from the basic percoid character. One of these is the suborder Scorpoenoidea, to which the sablefish belongs. Within its family Anoplopomatidae or the skilfishes, sablefish are known to various names such as "skil", "coalfish" and "blackcod." However, the latter term is inappropriate since the fish is not a cod.

Physical Description

The body of the sablefish is long and slightly compressed, tapering into a long, slender, caudal peduncle. It is usually slaty black or greenish-gray on its dorsal surface and lighter on the ventral side. Males do not get as large as females, and reach maturity at an earlier age. Females may attain lengths of one meter or greater. It is estimated that a 40 inch sablefish is about 20 years old. Large individuals three feet in length and 40 pounds in weight have been captured on the halibut banks at depths down to 170 fathoms. Their food consists of crustaceans, worms and small fishes. In captivity, sablefish are indiscriminate feeders. They have been observed actively feeding on saury and blue lanternfish.

Distribution

The species ranges from Cedros Islands in southern California to the Bering Sea and is quite abundant in Alaskan and Canadian waters. On the Asian side of the North Pacific, they range from Hokkaido, Japan, north to the Kamchatka Peninsula off Siberia. Commercial quantities of adults are most abundant in water deeper than 200 fathoms and down to 500 fathoms. Although tagging studies have shown certain individuals to travel more than 1,200 miles, sablefish tend to be localized in most cases.

Spawning

Sablefish spawn in the early spring with rising water temperatures and their eggs are pelagic, drifting with the current after fertilization. In late May, post-larval individuals have been found on the ocean surface at distances from 100 to 185 miles off the coast of Oregon. In the post-larval phase, sablefish are subject to heavy predation by larger organisms.

Selected References

Clemens, W.A., and G.V. Wilby. 1961. Fishes of the Pacific Coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

McPhail, J.D. and C.C. Lindsey. 1970. Fresh water fishes of northwestern Canada and Alaska. Bull. Fish. Res. Bd. Canada 173. 381 p.

LIFE HISTORY - FLOUNDER

Taxonomy

The flounder family, Pleuronectidae, belongs to the order Heterosomata. This family includes demersal flatfishes such as halibut, sole and brill. Of 15 flatfish caught commercially in Alaskan waters, the arrowtooth flounder or turbot (*Atheresthes stomias*) was the most dominant species.

Physical Description

In flounders the eyes and colored surface are typically on the right side of the fish (dextral). The pelvic fins are symmetrically arranged, with one on each side of the abdominal ridge.

The family may be divided into two groups. In one, as exemplified by the halibuts and related species, the mouth is large and symmetrical, the maxillary extends to the pupil of the eye or behind, and the teeth are well developed on both sides of the jaws, associated with the habit of actively pursuing fishes for food. In the other group, the mouth is small and asymmetrical, the maxillary does not extend to the pupil of the eye, and the teeth are confined largely to the sides of the jaws on the unpigmented side of the head. This is associated with the habit of feeding upon invertebrates and small fishes of the sea bottom.

The body of the flounder is rather elongate, slender and much compressed. The arrowtooth flounder (*Atheresthes stomias*) has an average length of 2 feet 9 inches. The starry flounder (*Platichthys stellatus*) has an average length of 3 feet.

Distribution

Flounder range from southern California to the eastern Bering Sea. They are present in all regions and depth zones of the continental shelf and slope in the Gulf of Alaska. As a group, they historically dominated the catches in the Gulf of Alaska regions. They are most frequently encountered in the offshore regions. Flounder are most abundant on the continental shelf (less than 100 fathoms) decreasing as it extends beyond the 150 fathom contour.

Spawning

Spawning generally occurs in late winter and early spring in a sandy substrate. In starry flounders (Platichthys stellatus), the eggs are pale orange, and their membranes have very fine vermiculate wrinkles, but no sculptured pattern. They have diameters between 0.89 and 0.94 millimeters, are slightly larger than sea water, and are non-adhesive upon hatching. Larvae are between 1.93 and 2.08 millimeters long. Like the other flatfishes, they are symmetrical. Young five to 12 millimeters long feed primarily on copepods and their nauplii, as well as barnacle larvae and Cladocera. The young are transformed to asymmetry at about 10.5 millimeters. Lengths corresponding to years of growth are: I, 105 millimeters; II, 310 millimeters and IV, 340 millimeters. Females are somewhat longer than males at higher ages and live longer.

Flounder consume crabs, shrimps, worms, clams and clam siphons, other small molluscs, small fishes, nemertean worms and brittle stars. At low water temperatures feeding stops. At this time, little digestion occurs and the stomach functions primarily as a food storage organ.

Selected References

Clemens, W.A., and G.V. Wilby. 1961. Fishes of the Pacific Coast of Canada. 2nd ed. Bull. Fish. Res. Bd. Canada 68. 443 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada. Bull. 180. 740 p.

LIFE HISTORY - KING CRAB

Taxonomy

King crabs are anomuran crabs of the superfamily Paguridea found throughout the circum-arctic region of North America. Eldridge (1972) has described its taxonomy as follows:

Order: Decapoda
Section: Anomura
Superfamily: Paguridea
Family: Lithodidae
Subfamily: Lithodinae
Genus: *Paralithodes*

Of three species found in Alaskan waters, the "red" king crab (*Paralithodes camtschatica*) are the most abundant and commercially valuable. Although the "blue" king crab (*Paralithodes platypus*) is not as abundant, it is morphologically similar to *Paralithodes camtschatica* and the Japanese have developed a modest fishery for this species in the Pribilof Island region of the Bering Sea. The "brown" or "golden" king crab (*Lithodes aequispina*) is found in the deep waters (100 to 200 fathoms) of southeastern Alaska. The Japanese refer to the king crab as "taraba-gani," whereas the Russians often call it the "Kamchatka" crab. Americans usually reserve the name "king crab" for *Paralithodes camschatica*. The term "king crab" will refer to *Paralithodes camschatica* for the remainder of this report.

Distribution

Paralithodes camtschatica) is abundant on both sides of the north Pacific Ocean. In Asian waters, it is found from the Sea of Japan northward into the Sea of Okhotsk and along the shores of the Kamchatka Peninsula; the northern limit on the Asiatic coast has been reported at Cape Olyutorskiy (60°N latitude). The species occurs throughout the Aleutian Islands and the southeastern Bering Sea, where large fisheries for it exist. On the western coast of North America, the northern limit for king crab appears to be Norton Sound (65°N latitude) in the northeastern Bering Sea. King crabs are also abundant in the Gulf of Alaska, where major fisheries for them exist in Cook Inlet, Kodiak Island and the south Alaska Peninsula. Moderate numbers of king crab are found in Prince William Sound and southeastern Alaska. The southern limit of this species in the northeastern Pacific appears to be Vancouver Island, British Columbia (Butler and Hart, 1962).

During their various life stages, king crabs appear to segregate themselves quite distinctly from one another. In particular, males are separate from females except during the mating season, and in general, adults appear to inhabit different areas from those frequented by juveniles. Catch statistics also indicate that male king crabs may school by size.

King crabs are distributed to depths of 1,200 feet, although the commercial fishery is generally confined to depths less than 600 feet. Females and smaller males appear to be most abundant in intermediate depths. Juveniles are most abundant in inshore waters and in relatively shallow waters, although they have been found to depths of 58 fathoms (Powell and Reynolds, 1965).

The favorite bottom habitat of king crabs appears to be mud or sand. King crabs are stenohaline and adapted to cold waters.

Maturity

King crabs of both sexes reach sexual maturity when their carapace (back) length becomes about 100 mm (3.9 inches), or at an age of about 5 years. Many females appear to participate in breeding shortly after attaining sexual maturity. However, it appears that few males less than 120 mm in carapace length actually mate.

Mating

King crabs follow distinct annual migration patterns associated with their mating season. During winter months they migrate to water depths of less than 50 fathoms along the shoreline and onto the offshore ocean banks. Young adults precede old adults; males precede females (Powell & Nickerson 1965). The females molt and mate during April and May. Females normally, but not necessarily, molt while being grasped by a male. This precopulatory embrace (grasping) is an intrinsic behavior of adult king crabs which serves to keep breeding adults together untill subsequent mating has occurred. It affords a protective mate to the female before and during the molt and aides the female in molting.

Immediately after the female molts, the attendant male deposits spermatophore material around the female's oviducts and releases her. The female then extrudes eggs into her abdominal pouch where they mix with the spermatophore material and are fertilized. Fertile eggs are carried by the female for 11-12 months, hatching prior to the females next annual molt. Female king crab, not mating after molting, will not extrude eggs. Over ripe eggs will die and decay in the ovaries of unmated females.

Female king crab mate with only one male annually. Male king crab are polygamous.

Fecundity

The number of eggs each female carries varies with their size. Female king crabs in Asiatic waters apparently carry less eggs than their counterparts in the northeastern Pacific. In this regard, Nakazawa (1912) reported that large females in Japanese waters could carry as many as 345,000 eggs while the average female carried approximately 220,000 eggs. A later study (Sato, 1958) found that the number of eggs carried by females in Japanese waters varied between 15,000 and 204,000, with a mean of 102,000 eggs.

At Kodiak, small females have been reported to carry between 50,000 and 100,000 eggs, with large females carrying as many as 400,000 eggs.

Eggs and Larvae

The eggs develop into pre-zoea within about 5 months and remain in this state while they are carried by the female. During this period, the eggs become well developed and are easily visible. During hatching, which occurs between March and June, all of the eggs carried by an individual will hatch in about a 5-day period. After hatching, the pre-zoea larva molts and assumes the first zoeal stage. During the pelagic phase, the larvae are active swimmers and feed primarily on diatoms. After the fifth molt, the larvae assume a benthic, or bottom, existence as glaucothoe larvae. In the next molt, which occurs during the first summer of life, they assume the first adult form.

Juveniles

During their first year of life, the juveniles assume a solitary, benthic existence, generally in shallow water. They appear to be quite abundant in waters close to shore in the Gulf of Alaska. In the Bering Sea, large concentrations of juveniles have been found in depths of 29 fathoms.

Two year old king crab are known to aggregate in large groups. Small crab commonly pile upon each other and move as a conglomerate. This practice known as "podding" is a social behavior which affords the crab protection from predators. Groups are maintained until crab attain sexual maturity. At that point crab segregate by sex and size.

Sculpins, cod and halibut have been reported to prey on juvenile king crabs. In addition, Gray (1964a) has reported that halibut prey on king crabs when they are in the soft shelled condition. Evidence suggests that once king crabs attain sexual maturity they are relatively immune to predation, except during the molting phase.

Growth

During the first several years of the king crab's life growth is rapid, and it molts or sheds the hard outer shell several times in order to accommodate the increased body size. At the time of molting, the crab sheds the carapace, eyes, antennae, mouth, esophogus, stomach, calcerous teeth, gills, tendons, and in general, the entire outer body covering. Juvenile male and female crabs steadily increase in carapace length at a rate of 24 and 23 percent respectively (Powell 1967) until reaching sexual maturity.

After reaching sexual maturity growth rates and molt frequency for male and female crab differenciate. Adult females molt annually and average 4 mm per molt. Adult males molt annually through the eighth year and averaged 20 mm per molt. After eight years an increasing proportion molt biennially. Few male crab molt less frequently than biennually. Maximum size is reached at an average of 14 years of age. Growth rate for males decreases slightly following the eight year.

Food Habits

The king crab is omnivorous during both its juvenile and adult stages of life. In a study of food items found in the stomachs of king crabs in the Bering Sea, the following occurred (in descending order or frequency): Mollusca (clams, etc.); Polychaeta (marine worms); Algae (marine plants); other crustacea and Coelenterates (jellyfish). Other food organisms found less frequently were foraminiferans, nematode worms, tunicates, echiuroids and fish (McLaughlin and Hebard, 1959).

Diseases

Sindermann (1970) has reported that *P. camtschatica* and *P. platypus* from the eastern north Pacific are occasionally affected by "rust disease" which seems to result from action of chitin-destroying bacteria of the exoskeleton. However, this disease appears to be relatively rare.

Sinderman (1970) has also reported that *P. platypus* from Alaskan waters are occasionally invaded by rhizcephalans. Moore and Meyer (1951) have reported that egg cases and adults of the leech (*Notostomobdella cyclostoma*) are common on Alaskan king crabs, particularly during the summer.

Literature Cited

Butler, T.H. and J.F.L. Hart. 1962. The occurrence of the king crab, *Paralithodes camtschatica* (Tilesius), and of *Lithodes aequispina* (Benedict) in British Columbia. J. Fish. Res. Bd. Can. 19(3):401-408.

Gray, G.W., Jr. 1964. Halibut preying on large crustacea. Copeia 1964(3):590.

McLaughlin, P.A. and J.F. Hebard. 1959. Stomach contents of the Bering Sea king crab. U.S. Fish and Wildl. Serv. Spec. Sci. Rept.-Fish. n. 291.

Moore, J.P. and M.C. Meyer. 1951. Leeches (*Hirudinae*) from Alaskan and adjacent waters. Wasmann J. Biol. 9:11-17.

Nakazawa, K. 1912. Report on king crab, *Paralithodes camtschatica*. In experiment report of fisheries training school 8(6):21. Translation file, U.S. Dept. of Commerce, Nat. Mar. Fish. Serv. Biological Laboratory, Auke Bay, Alaska.

Powell, G.C. 1967. Growth of King Crabs in the vicinity of Kodiak Island Alaska. Alaska Dept. of Fish and Game Info. leaflet no. 92.

Powell, G.C. and R.B. Nickerson. 1965. Reproduction of King Crabs, *Paralithodes comtschatica* (Tilesius). J. Fish. Res. Bd. Can. 22(1): 101-111.

Powell, G.C. and R.E. Reynolds. 1965. Movements of tagged king crabs. *Paralithodes camtschatica* (Tilesius), in the Kodiak Island-Lower Cook Inlet region of Alaska. 1954-1963. Alaska Dept. of Fish and Game. Info. leaflet no. 55.

Sato, S. 1958. Studies of larval development and fishery biology of king crab, *Paralithodes camtschatica* (Tilesius). Bull. Hokkaido Reg. Fish. Res. Lab. 17. 102 p.

Sindermann, C.J. 1970. Principal diseases of marine fish and shellfish. Acad. Press, New York. 369 p.

LIFE HISTORY - TANNER CRAB

Taxonomy

The tanner crab is a member of the brachyuran crabs of the superfamily Oxyrhycha found throughout the circum-arctic region of North America. Garth (1958) has described its taxonomy as follows:

Order: Decapoda
Section: Brachyura
Superfamily: Oxyrhyncha
Family: Majidae
Subfamily: Oregoniinae
Genus: *Chionoecetes*

The genus of *Chionoecetes* may actually consist of two polytypic species, *C. opilio* and *C. angulatus*. *C. opilio* may have given rise to *C. opilio elongatus* and *C. bairdi*; while *C. angulatus* may have given rise to *C. tanneri* and *C. japonicus* (Garth, 1958). All of these species are present in the North Pacific.

Crabs of the genus *Chionoecetes* have been referred to as spider, tanner, and snow crabs in the English literature. In Japanese literature, this genus is referred to as zuwai crabs. In an attempt, to capitalize on the excellent reputation of the king crab, American processors initially attempted to sell tanner crab under the trade name "Queen Crab". However, the U.S. Food and Drug Administration has since ruled that "Snow Crab" will be the official trade name for the tanner crab. In common usage, tanner crab has become the accepted name for the genus.

Distribution

The genus belongs to the subfamily, Oregoniinae, which has a circum-arctic distribution, extending into the temperate waters on the east and west coasts of North America and Eurasia. The genus' range is: the eastern Pacific from the Bering Strait and the

Aleutian Islands to Cortex Bank, opposite the United States - Mexico boundary; western Pacific, from Kamchatka to off Kinkazan, Japan, and Oki Islands in the Japan Sea; Siberian, Alaskan, and Canadian Arctic; and the Western Atlantic, from the west coast of Greenland to Casco Bay, Maine. Members of the genus are found in shallow waters to depths of 1,625 fathoms (Garth, 1958). The greatest concentrations occur along the outer continental shelf and upper continental slope. Trawl surveys conducted by the International Halibut Commission indicate that tanner crabs are quite abundant in the Gulf of Alaska and that they increase in abundance as one goes west toward the Bering Sea.

C. tanneri is typically found from the coast of Washington to the extreme southern edge of California. It occurs from depths of 29 to 1,062 fathoms with the greatest abundance in the 275 to 400 fathom interval. C. angulatus occurs along the 49 to 1,625 fathom interval from the eastern edge of Kamchatka to the Pribilof Islands in the Bering Sea, south along the Aleutians, and from British Columbia southward to Oregon. Because these two species occur in relatively deep water, intensive commercial exploitation of them is infeasible at this time.

C. bairdi and C. opilio typically inhabit shallow waters and are the principal commercial species in the Gulf of Alaska. C. bairdi occurs from the littoral zone to depths of 259 fathoms. Its range extends from Puget Sound, Washington, to the Aleutian Islands and the southeastern Bering Sea where it is reported to be the most common species in the commercial catch. C. opilio also occurs within the littoral zone and to depths of 300 fathoms. The greatest concentrations of C. opilio are west of longitude 163° W, with C. bairdi comprising the bulk of the Gulf of Alaska catch.

Tanner crab distribution and abundance appears to be inversely related to that of king crab. Preliminary evidence indicates that king and tanner crabs compete for space and food. Exploratory surveys in the southeastern Bering Sea indicate that both male and female tanner crabs of all sizes are most abundant at depths where the abundance of male and female king crabs is low. Although male tanner crabs may overlap considerably with king crabs of both sexes, female tanner crabs are most abundant in areas where no female king crabs are present (Haynes and Lehman, 1969).

Studies by Pereyra (1966) along the Oregon coast indicate a pronounced seasonal and sexual difference in the distribution of adult tanner crabs, C. tanneri. His studies indicated that C. tanneri were commonly present at depths from 250 to 850 fathoms. Furthermore, female tanner crabs were concentrated principally between 350 and 375 fathoms throughout the year; whereas the relative abundance of male tanner crabs changed seasonally by depth. During the spring and summer, males were most abundant at depths between 275 and 300 fathoms. With the onset of fall, the male population shifted back into deeper waters and mingled with the female population during the winter for the purpose of mating. Although specific observations are limited, the other species of tanner crab are believed to exhibit similar sexual and seasonal migrations.

Sexuality

The tanner crab is heterosexual and sexually dimorphic. There is considerable variation in morphology between male and female tanner crabs, with the males being significantly larger than the females. Adult males have an acute and narrow abdomen, while adult females have a round and broad abdomen.

Maturity

Due to the difficulty of aging crustaceans, the age at which tanner crabs reach sexual maturity is not known with certainty, although the size at maturity is known for most species. Alaska Department of Fish and Game tanner crab research has determined that the average male *C. bairdi* reaches maturity at 111 mm carapace width. The same research puts the size of 50% maturity for female *C. bairdi* at 84 mm (Donaldson 1976, personal communication). Studies conducted in the Japan Sea indicate that *C. opilio* reaches sexual maturity after about the 10th molt or six to eight years after hatching. Male and female *C. opilio* in Japanese waters reach sexual maturity at a size of approximately 50 to 65 mm in carapace width (Ito, 1970). Female *C. tanneri* off the Oregon coast reach sexual maturity at 75 to 126 mm in carapace width, while male *C. tanneri* mature at 103 to 181 mm in carapace width (Pereya, 1966).

Mating

As a genus, tanner crabs appear to be polygamous. Initial mating is believed to take place in the spring or early summer shortly after the female has molted and grown to maturity. At the present time, it is suspected that female tanner crabs can mate while hard-shelled. Some evidence is available which suggests that unlike king crab females, tanner crab females are capable of breeding while hard-shelled. Hartnoll (1969) contends that only hard-shelled male tanner crabs are successful at mating. Female tanner crabs are apparently capable of producing more than one hatch of fertile eggs from one mating (Watson, 1970 and Bright, 1967).

Fecundity

The number of eggs produced by female tanner crab is extremely varied. The range of 24,000 to 318,000 eggs per female *C. bairdi* (Hilsinger, 1975) compares with 20,000 to 140,000 and 6,000 to 130,000 eggs per female *C. opilio* in Canada (Watson, 1969) and Japan (Ito, 1963) respectively. The large egg number variation exists between females of both varying and similar sizes. Some of this variation can be accounted for by a decrease in clutch size in very old animals.

Eggs and Larvae

After mating, the female lays a clutch of bright orange eggs. The eggs stick to the female's abdomen and are carried for approximately twelve months before being released. A steady loss of eggs following fertilization has been documented for *C. bairdi* (Hilsinger, 1975) and *C. opilio* (Kon, 1974). The total loss may amount to as much as 45%. The decrease in egg number is attributed to death and disintegration of abnormal embryos and predation. Hatching of the eggs (larval release) appears to coincide with the plankton blooms. The free-swimming larvae molt and grow through several distinct stages before settling to the bottom as juveniles where they cover themselves with debris and begin feeding on detritus. The growth rate from larval to juvenile stage is dependent upon water temperature, with warmer temperatures producing faster growth. At water temperatures of 11° to 13° C, the free-swimming developmental period between the larval and juvenile stages may last approximately sixty-three to sixty-six days (Kon, 1970).

Plankton studies in the Japan Sea indicate that the free-swimming larva of tanner crab undergo diurnal vertical migrations. This migration is a feeding response to the diurnal movements of plankton blooms.

Juveniles

There is very little published material concerning the habitat and distribution of juvenile tanner crabs. Exploratory work in the Japan Sea indicates that juveniles settle out along the sea bottom at depths between 163 and 191 fathoms (Ito, 1968). Alaska Department of Fish and Game biologists in Kodiak, using scuba, have collected juvenile C. bairdi as small as 6.5 mm in 10 fathoms. The National Marine Fisheries Service have records of juvenile tanners as small as 12 mm caught in shrimp trawls off Kodiak in 30 to 80 fathoms. This information suggests that distribution of juvenile tanner crab is widespread and not depth dependent. The actual diet of the juvenile is uncertain, but they are believed to feed primarily on dead and decaying mollusks and crustaceans which accumulate in the detritus along the sea floor. Fish remains and small planktonic organisms are also ingested to a limited degree.

Adults

Adult tanner crabs are intolerant and restricted in their distribution by low salinities and high temperatures. Laboratory experiments in Canada have demonstrated that C. opilio will die within twenty-four hours if kept in salinities less than 22.5°/₀₀ (Anonymous, 1971). At a salinity of approximately 31 to 32°/₀₀ McLeese (1968) determined that C. opilio reached the 50°/₀₀ mortality point after 18.8 days when held at 16° C. Thus it is reasonable to expect that the southern range of tanner crab distribution may be limited if water temperatures exceed 16° C.

Adult tanner crabs appear to have few predators, although it is likely that during molting they may be vulnerable to large fish and perhaps other large crustaceans such as the king crab. In addition to predation, it is speculated that king and tanner crabs may compete for food and space. If this is true, then it would appear that the larger size of the king crab would give it a competitive advantage over the smaller tanner crab. The concept of competition between the king and tanner crab is interesting in that it poses the question of whether the populations of tanner crab are affected by the abundance of king crabs. In this regard, the depletion of the larger male king crabs by the present intensive fishery might have a favorable effect on the abundance of tanner crabs.

Growth

Dimensional growth occurs in tanner crab when the hard exoskeleton is periodically cast off or molted. The animal is then able to take water into its tissues and increase in size before the rehardening occurs. Male and female crab display similar growth rates and molt frequently prior to reaching sexual maturity. Males continue to molt after becoming sexually mature but the intervals between molts increase with age. Female crab normally do not molt after reaching sexual maturity. In females the molt to maturity is considered the terminal molt. Growth may vary from one geographic location to another. The maximum age of tanner crab is probably eight to twelve years, although this is not known with certainty.

Diseases

Tanner crabs, as are all organisms, are subject to disease. Brown (1971) reported a black encrustment on the shell which was labeled "shell syndrome". The meat of the crab is not affected by the "syndrome", but it may cause mortality in individuals which have undergone their terminal molt due to disablement of the mouth parts and eyes. There is some evidence that the indiscriminate dumping of wastes from crab processing plants may be a factor contributing to the spread of the disease.

Gordon (1966) reported that some polyclad Turbellaria are ectoparasitic on crabs. Specifically, *Coleophora chinonoecetis* has been found on the eggs of tanner crabs.

Oka (1927) reported that the leech, *Carcinobdella kanibir*, is occasionally found on *C. opilio* in Asiatic waters.

Migration and Local Movement

Little is known concerning the migrations and local movements of tanner crabs. However, tagging studies conducted by Canadian scientists (Watson, 1970) indicate that tagged male crabs travel relatively little with eight-five percent of the returns recaptured within ten miles of the release point. The farthest recapture in the study was a male that travelled twenty-eight miles. A limited tagging experiment in Auke Bay, Alaska, concluded that tanner crabs may return to a "home" area to mate and molt each year (Anonymous, 1971)

Numerous trawl surveys conducted in the Gulf of Alaska and the Bering Sea indicate that tanner crabs are more concentrated in some areas than others. These data indicate that tanner crabs may school, but further work is needed for clarification.

Literature Cited

Anonymous. 1971a. Review 1969-1970. The Fisheries Research Board Ottawa, Canada.

Anonymous. 1971b. Intern. N. Pacific Fish. Comm. Proc. of the Seventeenth Annual Meeting, 1970. Report of the subcommittee on King Crab and Tanner Crab. Appendix 5 (Doc. 1341). 247-257 p.

Bright, D.B. 1967. Life histories of the king crab and the "tanner" crab in Cook Inlet, Alaska. PhD. thesis. U. So. California 265 p.

Brown, R.B. 1971. The development of the Alaskan fishery for tanner crab, Chionoecetes species, with particular reference to Kodiak area, 1967-1970. Alaska Dept. of Fish and Game Info. Leaflet 153. 26 p.

Garth, J.S. 1958. Brachyura of the Pacific coast of America. Oxyrhyncha. Allan Hancock Pacific Expedition 21:854.

Gordon, I. 1966. Parasites and diseases of Crustacea. Mem. Inst. Fondam. Afrique Noire No. 77. 27-86 p.

Hartnoll, R.G. 1969. Mating in the Brachyura. Crustaceana 16:161-181.

Haynes, E. and C. Lehman. 1969. Minutes of the second Alaskan shellfish conference. Alaska Dept. Fish and Game Info. Leaflet 135. 102 p.

Hilsinger, J.R. 1975. Aspects of the reproductive biology of female snow crabs, Chionoecetes bairdi Rathbun, from Prince William Sound, Alaska. M.S. thesis, Univ. of Alaska 88 p.

Ito, K. 1970. Ecological studies on the edible crab, Chionoecetes opilio (O. fabricius) in the Japan Sea. III. Age and growth as estimated on the basis of the seasonal changes in the carapace width frequencies and the carapace hardness. Bull. Jap. Sea Reg. Fish. Res. Lab. 22:81-116.

Kon, T. 1970. Fisheries biology of the tanner crab. IV. The duration of planktonic stages. 1967. Fisheries of the United States. 1967. U.S. Fish and Wildlife Service, Bur. of Comm. Fish. C.F.S. No. 4700. Review (Crabs, king). xvii p.

McLeese, D.W. 1968. Temperature resistance of the spider crab, Chionoecetes opilio. J. Fish. Res. Bd. Can. 25(8):1733-1736.

Oka, A. 1927. Sur la morphologie esterne de Carcinobdella kanibir. Proc. Imp. Acad. (Tokyo) 3:171-174.

Pereya, W.T. 1966. The bathymetric and seasonal distribution of adult tanner crabs, Chionoecetes tanneri, Rathbun (Brachyura: Majidae) of the northern Oregon coast. Deep-Sea Res. 13(5)::1185-1205.

Watson, J. 1970a. Maturity, mating, and egg-laying in the spider crab, Chionoecetes opilio. J. Fish. Res. Bd. Can. 27:1607-1616.

Watson, J. 1970b. Tag recaptures and movements of adult male snow crabs, Chionoecetes opilio, (O. fabricius) in the Gaspe region of the Gulf of St. Lawrence. Fish. Res. Bd. Can. Tech. Rept. No. 204. 16 p.

LIFE HISTORY - DUNGENESS CRAB

Taxonomy

The dungeness crab, *Cancer magister*, is a member of the brachyuran crabs of the family Cancridae. Mayer (1972) described its taxonomy as follows:

Phylum: Arthropoda
Class: Crustacea
Superorder: Eucarida
Order: Decapoda
Suborder: Brachyura
Family: Cancridae
Genus: *Cancer*
Genotype: *Cancer magister* (Dana, 1852).

Crabs of the species, *Cancer magister* have been referred to as market crab, common edible crab, Pacific edible crab, commercial crab, dungeness crab, and dungeoness crab. At the present, dungeness crab is the accepted common name.

Distribution

Dungeness crabs are found in the shallow nearshore waters of the North Pacific along the western North American coast. They range from a northern limit of Unalaska to a southern limit in Monterey Bay, California (McKay, 1943). The crabs inhabit bays, estuaries, and open ocean near the coast from the intertidal zone to depths of 50 fathoms. Favored substrate is a sand or sand-mixed bottom, although dungeness crab may be found on almost any bottom substrate. Unlike the king and tanner crabs, they inhabit shallow water most of the year. Juveniles are commonly associated with stands of eelgrass, or masses of detached algae in the absence of eelgrass, which is believed to afford them protection (Butler, 1956).

Water temperatures and salinity appear to be controlling factors in the seasonal distribution. Studies by Cleaver (1949) indicate that crab abundance, as estimated from catch per unit effort data, increase with rising spring water temperatures and decrease with dropping fall temperatures. Changes in winter catch appear to be in response to fluctuating low salinities. McKay (1942) determined that adult dungeness crabs migrate offshore during the winter months and return to the nearshore in the early spring and summer.

Sexuality

The dungeness crab is heterosexual and sexually dimorphic. There is considerable variation in morphology between male and female crabs, with males being significantly larger than females. Adult males have an acute and narrow abdomen, while adult females have a round and broad abdomen.

Maturity

According to Butler (1960), male dungeness crabs from the Queen Charlotte Islands, British Columbia, reach sexual maturity at a carapace length of 110 mm, or at about three years of age. He found, however, that sexual activity was not appreciable until the crabs obtained a carapace width of 140 mm. McKay (1942) found by examination of gonads that male crabs matured at a carapace width of about 137 mm.

Butler (1960) found mature female dungeness crabs with a carapace width of 100 mm, which were approximately two years old. Weymouth and McKay (1936) also determined that female crabs reach sexual maturity at about 100 mm carapace width.

Mating

The mating of *C. magister* as observed in aquaria has been reported by Cleaver (1949), Butler (1960), and Snow and Nielsen (1966). No observations made under natural conditions have been reported. The crabs copulate only after the female has recently molted. Premating activity begins with the male crab firmly grasping the female with both of his chelae. The male then holds the female crab beneath himself so that both sterna are in contact. The male crab continues to restrain the female during her ecdysis, but allows her to move into an upright position. Snow and Nielsen (1966) found that within 1 hour and 32 minutes after the female has molted, copulation took place. The female is again held with both sterna in contact. The abdominal flaps of both individuals are flexed in the copulatory position with the gonopods inserted in the spermathecae. Snow and Nielsen (1966) also reported the occurrence of a post-mating embrace which lasted for two days.

Fecundity

McKay (1942) found that a single egg mass contained 1,500,000 eggs and speculated that a single female dungeness crab may spawn three to five million eggs during a lifetime.

Eggs and Larvae

After mating, the female's oviduct is closed by a secretion which hardens in contact with sea water. The spermatozoa are sealed in the oviduct where they remain viable for several months. Upon extrusion, the eggs are fertilized (McKay, 1942). Egg-bearing occurs during October to June in British Columbia. Larvae emerge from the egg masses between December and April in Oregon waters (Reed, 1969).

Egg and larvae development is dependent upon water temperature with warmer temperatures producing faster growth. In California waters, Poole (1966) determined that the developmental period between egg and juvenile may last 128 to 158 days.

Predation and cannabilism is a major source of mortality among larval dungeness crabs. Heg and Van Hyning (1951) found the larvae of C. magister as prey items in stomachs of chinook and silver salmon taken along the Oregon coast. McKay (1942) cites observations of C. magister larvae commonly found in the stomachs of salmon, herring, and pilchard.

Reed (1969) investigated the effect of temperature and salinity on the growth of laboratory reared C. magister larvae. He found that optimum ranges of temperature and salinity for C. magister larvae are 10.0 to 13.9°C and 25-35‰, respectively.

Juveniles

Juvenile dungeness crabs are commonly associated with stands of eelgrass, or masses of detached algae in the absence of eelgrass, which is believed to afford them protection from predation (Butler, 1956). Butler (1954) reports the common occurrence of juvenile crabs, about three-eighths of an inch, in the stomachs of adult crabs.

The diet of juveniles is assumed to be similar to adults with crustaceans and mollusks accounting for the principal food items.

Growth during the juvenile stage is fairly rapid with crabs reaching the eleventh or twelfth molt by age two.

Adults

After reaching sexual maturity at two or three years of age, dungeness crabs continue to grow, with males obtaining their maximum size at age five. Female growth is similar to male dungeness crab during the first two years of life, but decreases afterward (Butler, 1961). Butler (1960) concluded that the maximum age for C. magister is eight years. McKay and Weymouth (1935) felt that the maximum age was not more than ten years, with the average life expectancy being eight years.

The diet of adult dungeness crab is varied; consisting primarily of other crustaceans, mollusks, worms, and occasionally seaweed (McKay, 1942). The cannibalism of juvenile and larval crabs by adults is reported by Butler (1954).

Temperature tolerance for adult C. magister in Puget Sound, Washington, has been reported by Stober, Mayer, and Salo (1971). In general, no mortality was observed at temperatures below 24°C.

Adult dungeness crab are subjected to heavy predation, particularly while in the soft-shelled condition following a molt. Waldron (1958) found ling cod, the great marbeled sculpin, wolf-eels, halibut, octopus, and some rockfish to be voracious predators upon adult C. magister. Predation is particularly heavy on small, immature crabs, but is not exclusive of adults. McMynn (1951) observed two C. magister, which were 114 mm wide, and four smaller crabs in the stomach of one rockfish.

Diseases

A "black spot" or "rust spot" is occasionally found on the legs of C. magister. Although no discussion of this disease was found in the literature, it may be similiar to the chitininvrous bacteria-caused disease described for the European dungeness crab, C. pagurus (Sinderman, 1970).

The occurrence of a species of worm adhering to the carapace and among the egg masses was reported by McKay (1942). Sinderman believes the worms to have been a marine leech.

Migration and Local Movement

Little is known concerning the migrations and local movements of dungeness crab. However, Cleaver (1949) has divided the migration of _C. magister_ into two types: the onshore-offshore movements and coastwise. Cleaver concluded that adult crabs migrate offshore during the winter months and return to the nearshore in the early spring and summer. This seasonal migration is apparently in response to seasonal changes in water temperatures. Furthermore, Cleaver observed that crabs which were tagged in early winter moved northward with the approach of summer. Although he had no evidence of a return migration, he believed that one might exist in the deeper waters. Presumably, these migrations may also be in response to seasonal changes in water temperature.

Literature Cited

Butler, T.H. 1956. The distribution and abundance of early post-larval stages of the British Columbia commercial crab. Fish. Res. Bd. Can., Pac. Prog. Rept. 107:22-23.

Butler, T.H. 1960. Maturity and breeding of the Pacific edible crab, Cancer magister Dana. J. Fish. Res. Bd. Can. 17(5):641-646.

Butler, T.H. 1961. Growth and age determination of the Pacific edible crab, Cancer magister Dana. J. Fish. Res. Bd. Can. 18(5):873-891.

Cleaver, F.C. 1949. Preliminary results of the coastal crab (Cancer magister) investigation. Wash. State Dept. of Fish., Biol. Rept. 49A:47-82.

Heg, R. and J. Van Hyning. 1951. Food of the chinook and silver salmon taken off the Oregon coast. Fish. Comm. Oregon Res. Brief 3(2):32-40.

McKay, D.C.G. 1942. The Pacific edible crab, cancer magister. Bull. Fish. Res. Bd. Can. 62:32.

McKay, D.C.G. 1943a. The behavior of the Pacific edible crab, Cancer magister Dana. J. Comp. Psych. 36(3):255-268.

McKay, D.C.G. 1943b. Temperature and the world distribution of crabs of the genus Cancer. Ecology 24(1):113-115.

McMynn, R.G. 1951. The crab fishery off Graham Island, British Columbia to 1948. Bull. Fish. Res. Bd. Can. 91:1-21.

Poole, R.L. 1966. A description of laboratory-reared zoeae of Cancer magister Dana, and megalopae taken under natural conditions (Decapoda Brachyura). Crustaceana 11(1):83-97.

Reed, P.H. 1969. Culture methods and effects of temperature and salinity on survival and growth of Dungeness crab (cancer magister) larvae in the laboratory. J. Fish. Res. Bd. Can. 26(2):389-397.

Sinderman, C.J. 1970. Principal diseases of marine fish and shellfish. Academic Press: New York and London.

Snow, C.D. and J.R. Nielsen. 1966. Premating and mating behavior of the Dungeness crab (Cancer magister Dana). J. Fish. Res. Bd. Can. 23(9):1319-1323.

Stober, G.J., D.L. Mayer and E.O. Salo. 1971. Thermal effects on survival and predation for some Puget Sound fishes. Proceedings of Third National Symposium on Radioecology, May 10-12, 1971 (in press).

Waldron, K.D. 1958. The fishery and biology of the Dungeness crab (Cancer magister Dana) in Oregon waters. Fish. Comm. Oregon. Contr. 24:1-43.

Weymouth, F.W. and D.C.G. McKay. 1936. Analysis of the relative growth of the Pacific edible crab, Cancer magister. Proc. Zool. Soc. Part 1 (1936).

LIFE HISTORY - SHRIMP

Commercial catches of shrimp in the north Pacific Ocean are made up of three families: Crangonidae, Hippolytidae, and Pandalidae. The first species exploited by the west coast shrimp fisheries were members of the family Crangonidae in intertidal areas. Now, however, members of the Crangonidae and Hippolytidae are rarely taken and then only incidental to catches of Panalidae. Consequently, this life history report will consider only the pandalid shrimps.

Taxonomy

Fox (1972) defines the suprafamilial taxonomic relationships of the family Pandalidae as follows:

Phylum: Arthoropoda
Class: Crustacea
Subclass: Malacostraca
Order: Decapoda
Suborder: Natantia
Section: Caridea
Family: Pandalidae

Rathbun (1904) lists fourteen species of pandalid shrimps found off the northwestern coast of North America which are divided between the two genera *Panadalus* and *Pandalopsis*. They are as follows:

*Pandalus borealis**	Kroyer
Pandalus danae	Stimpson
*Pandalus goniurus**	Stimpson
Pandalus gurneyi	Stimpson
*Pandalus hypsinotus**	Brandt
*Pandalus jordani**	Rathbun
Pandalus leptocerus	Smith
Pandalus montagui tridens	Rathbun

Pandalus platyceros*	Brandt
Pandalus stenolepsis	Rathbun
Pandalopsis aleutica	Rathbun
Pandalopsis ampla	Bate
Pandalopsis dispar*	Rathbun
Pandalopsis longirostris	Rathbun

Only six, identified by asterisk above, of the fourteen species are caught by commercial fisheries in reasonable quantities in Alaskan waters. The remainder of this life history report will be devoted entirely to these six species.

Distribution

Shrimps of the family Pandalidae are found throughout the higher temperate and boreal latitudes of the world, with centers of concentration varying with the species. In the northeastern Pacific, shrimp are distributed in bays and on offshore banks. Their range extends from the Bering Sea to southern California with commercial fisheries occurring off every Pacific state. Specific distribution data for the six major shrimp species found in Alaskan waters is given as follows.

The pink shrimp, Pandalus borealis, has been found from the Bering Sea southward to the Columbia River in depths of 10 to 350 fathoms. It is the most abundant shrimp in the north Pacific Ocean. The greatest concentrations located by exploratory surveys occurred from the southeastern tip of the Kenai Peninsula, Alaska, westward along the southern side of the Aleutian Chain. Isolated concentrations also occur in portions of Prince William Sound and in Yakutat Bay. Optimum depth where the greatest commercial catches may be taken vary somewhat by area but are generally between 30 and 100 fathoms (Rathjen and Yesaki, 1966).

The "humpy" shrimp, <u>Pandalus goniurus</u>, has been caught from the Arctic coast of Alaska southward to Puget Sound, Washington, in depths of 3 to 100 fathoms (Rathjen and Yesaki, 1966). The greatest concentrations are off southeastern Kodiak Island and in the Shumagin Islands. Although overlapping in distribution, the "humpy" shrimp is not as abundant as the pink shrimp. Rathjen and Yesaki (1966) reported an index of relative density for "humpy" shrimp about twenty-three percent of that for pink shrimp from southern Kodiak Island.

The coonstripe shrimp, <u>Pandalus hypsinotus</u>, has been found from the Bering Sea to the Strait of Juan de Fuca in depths of 3 to 100 fathoms; very similar in range to that of the "humpy" shrimp (Fox, 1972). High concentrations occur off southeastern Kodiak Island and in the Shumagin Islands. Coonstripe shrimp comprise a relatively small portion of the commercial catch. Rathjen and Yesaki (1966) reported that the index of relative density for coonstripe shrimp off southeastern Kodiak Island was only six percent of that for the pink shrimp, <u>P</u>. <u>borealis</u>.

The ocean pink shrimp, <u>Pandalus jordani</u>, is distributed from Unalaska Island to southern California in depths ranging from 20 to 250 fathoms (Fox, 1972). The greatest densities are located off the northern coast of California to Cape Beale, British Columbia, with a peak density off Oregon (Dahlstrom, 1970). Greatest concentrations are found from 60 to 80 fathoms off California (Dahlstrom, 1970), and from 70 to 110 fathoms off Oregon, and from 60 to 90 fathoms off Washington (Ronholt, 1963). The ocean pink shrimp is primarily found in warmer waters. For this reason, and the fact that it is generally concentrated at depths below normal commercial trawling efforts, it is not found in abundance in the Alaskan shrimp harvest.

The spot shrimp, Pandalus platyceros, has been reported from Unalaska Island to San Diego, California, in depths of 2 to 266 fathoms (Fox, 1972). While the other pandalid shrimps are generally found in areas suitable for trawling, P. playtceros is found in rocky areas unsuitable for exploratory trawl surveys. Consequently, areas of major concentration are unknown. Ronholt (1963) reported small quantities taken off Lapush, Washington and in southeastern Alaska. In addition, pot fisheries are located in the Puget Sound-Vancouver Island area (Butler, 1964) and in scattered areas off central Alaska, principally Kachemak Bay (Barr, 1970a).

The sidestripe shrimp, Pandalopsis dispar, is distributed from the Bering Sea, west of the Pribilof Islands, southward to Manhattan Beach, Oregon, in depths ranging from 20 to 351 fathoms (Fox, 1972). Next to the pink shrimp, P. borealis, it is the most abundant shrimp in the north Pacific Ocean. The greatest concentrations occur off southeastern Kodiak Island and in the Shumagin Islands. The index of relative density for sidestripe shrimp off southeastern Kodiak Island is about ten percent of that for the pink shrimp (Rathjen and Yesaki, 1966). The greatest concentrations of sidestripe shrimp are somewhat deeper than pink shrimp, generally from 60 to 120 fathoms (Ronholt, 1963).

Most pandalid shrimps are found on mud or sand and mud-mixed bottoms. However, they are not found in all areas where these types of bottoms occur. References to green mud bottoms in relation to large concentrations of the pink shrimp, P. borealis, and the ocean pink shrimp, P. jordani, have been made by many authors who infer that the organic content of the bottom is more important in determining distribution than bottom consistency. It should be noted, however, that most sampling has been conducted with trawls which work well only on the type of bottom described above. It is, therefore, inconclusive whether or not many pandalid shrimp concentrate on harder or rockier bottoms. One species, *P. platyceros*, and perhaps *P. hypsinotus*, is known to prefer rocky bottoms (Fox, 1972).

Sexuality

The reproductive life history of pandalid shrimps is rather unique among shellfish. Although reproduction is bisexual, pandalid shrimps exhibit protandric hermaphroditism.

Pandalid shrimps mature first as males and then later in the life cycle transform into functional females. The morphological changes that accompany sex change usually occur quite rapidly. Individuals, who the previous year spawned as a male, will spawn the current year as a female. Once an individual has become a female, it remains so throughout the rest of its life.

The literature contains reports on a phenomenon called "primary" females. Primary females may be defined as those individuals who never function as males, or more strictly, as those individuals who mature directly as females, never being hermaphrodites. Dahlstrom (1970) reported primary females in *P. jordani* off northern California, a few were found by Tegelberg and Smith (1957) off Washington, and forty-seven of a sample by Butler (1964) off British Columbia were primary females. The production of early maturing (or primary) females may be environmentally related or may be a density dependent mechanism. At any rate, the early maturation of females is a survival mechanism beneficial to the population. Primary females have also been noted in *P. borealis* and *P. hypsinotus* in British Columbia (Butler, 1964).

Maturity

The age at sexual maturity varies with the species and by geographical location within a species. The normal situation for pandalid shrimps is that they are protandric hermaphrodites, maturing first as males and then later transforming into functional females. *P. danae* and *P. goniurus* apparently mature as males during their first autumn and function again as males at one and a half years in British Columbia (Butler, 1964). The age at first maturity as males is one and a half years for *P. borealis*, *P. hypsinotus*, *P. jordani*, *P. platyceros*, and *Pandalopsis dispar* (Butler, 1964; and Dahlstrom, 1970). Ivanov (1964a) believes that *P. borealis* in the Pribilof Islands area of the Bering Sea do not mature as males until two and a half years. Such is the case for *P. borealis* around Kodiak Island; however, some may mature at one and a half years (McCrary, 1971).

The age at transition to functional female also varies with the species and by geographical location within the species. By and large, most shrimp function two years as a male before transforming to a female.

Mating

During September, eggs ripen in the ovaries of the females and the forming eggs may be seen as greenish masses lying dorsolaterally under the carapace. Spawning may occur from late September through mid-October (Fox, 1972). The male attaches a sperm mass to the underside of a female between the last two pairs of pereiopods (walking legs). This usually occurs within thirty-six hours sfter the female molts into breeding dress (Needler, 1931). Fertilization and oviposition occur as the eggs stream from the oviducts over the sperm masses and become attached to the forward four pairs of pleopods (abdominal appendages) and abdominal segments.

Fecundity

Pandalid shrimps have a high fecundity. The number of eggs per clutch ranges from 500 to 2,500 for *P. jordani* and *P. borealis* to over 4,000 for *Pandalopsis dispar* (Dahlstrom, 1970; and Hynes, 1929). The number of eggs extruded is positively correlated with the size of the shrimp. However, Rinaldo (Marine Department of Sea and Shore Fisheries, West Booth Bay Harbor, Maine as reported by Fox, 1972) related a study which indicated that the percentage of eggs surviving to hatching was lower for larger than for smaller shrimp. This would indicate that the effective fecundity may actually be rather constant with shrimp size.

Eggs and Larvae

Females carry their eggs externally for about five to six months until hatching. Hatching occurs mainly from March through April (Fox, 1972). The lengths of spawning, carrying and hatching periods vary inversely with the water temperature, at least for *P. borealis* (Haynes and Wigley, 1969). In laboratory studies, Berkeley (1930) found that most larvae hatch at night during periods of vigorous pleopod movement by the female. Hatching an entire clutch of eggs may take as long as two days.

Early larval stages have been found on or above the spawning beds (Berkeley, 1930; and Pearcy, 1971). There are no published reports of finding larvae in the surface waters, which indicates that in the absence of strong mid-water or bottom currents, larval drift may not occur to any appreciable degree. However, the time of day that the surveys are conducted may be important since it is known that mid-water zooplankton, of which shrimp larvae are presumably a part, perform diel migrations, rising near the surface during the hours of darkness. The larvae remain planktonic for about two to three months, passing through six stages to become juveniles, and then settle, taking up a benthonic existence like the adults (Berkeley, 1930).

Juveniles

Little information is available on juvenile shrimp prior to their maturation as adult male shrimp. Differential rearing areas and migration patterns appear to exist between juvenile and adult shrimps. More specific information on this is available in the Migration and Local Movement section of this life history report.

Adults

Mortality rates are high for adult pandalid shrimps. Virtually no P. borealis survive to be seven years of age off the Pacific coast, and this is probably true for the other pandalid species (Fox, 1972). Estimates of annual survival rates for P. jordani off California range from fifty-two to thirty percent for the years 1960-1966 (Dahlstrom, 1970). These estimates were made in the presence of a fishery, so they reporesent both natural and fishing mortality.

The growth of pandalid shrimps may be generalized as follows: (1) the animal molts, ridding itself of a rigid exoskeleton, (2) water is absorbed, increasing the size of the animal, (3) a new exoskeleton is formed, and (4) the water is gradually replaced by new tissue. Growth in size, therefore, is a step function, increasing in increments at each molt, but remaining constant between molting periods.

The most comprehensive study of the growth of Pacific pandalid shrimps is that of Butler (1964). He found, that based on ultimate size, P. platyceros becomes the largest followed by Pandalopsis dispar, and P. hypsinotus. However, until about two years of age, P. hypsinotus is larger than Pandalopsis dispar. Butler further reported that P. borealis and P. jordani both reach about the same size. Dahlstrom (1970) reports a somewhat faster growth rate for P. jordani off northern California and Oregon, but a slower growth rate off Washington. Studies by Ivanov (1969) indicate that the growth rate for P. borealis in the Bering Sea is slower than those of the western Gulf of Alaska or of British Columbia. Hence, it appears that the growth rate of P. borealis is dependent upon latitude and consequently water temperature. It is assumed that the other pandalid species exhibit similar growth characteristics.

Pandalid shrimps are carnivorous bottom feeders and feed both by scavengering dead animal material and by preying on living organisms such as amphipods, euphausiids, limpets, annelids, and other shrimps. Vegetative plant material is rarely found in the stomachs of pandalid shrimps (Berlekey, 1929).

Pandalid shrimps are subject to a high level of predation, both as planktonic larvae and as benthonic adults. Virtually any large fish in their vicinity is a potential predator. Those noted as feeding on shrimp include the Pacific hake, Pacific cod, sablefish, lingcod, arrowtooth flounder, petrale sole, yellowfin sole, rock sole, flathead sole, various rockfish, spiny dogfish, skates and rays, Pacific halibut, salmon, and even harbor seals (Skalin, 1963; Barr, 1970a; Butler, 1970; and Dahlstrom, 1970).

Pandalid shrimp distribution and range is dictated, to a large degree, by temperature and salinity tolerances. On the basis of water temperature, *P. borealis* and *P. jordani* are diametrically opposed, with *P. borealis* being concentrated in colder water (Fox, 1972). The other pandalid species are not so easily delimited. *P. goniurus*, however, is not found in appreciable quantities off British Columbia or southward, yet it is off Kodiak Island, Alaska. *P. goniurus* is apparently selective toward colder waters. Butler (1964) reported finding all species but *P. goniurus* in temperatures of 7 to 11°C off British Columbia. Butler's data does not represent minima and maxima since Dahlstrom (1970) reports *P. jordani* from 5.6 to 11.5°C off northern California. Ivanov (1964b) found fishable concentrations of *P. borealis* down to 0.5°C in the Bering Sea and Allen (1959) reported specimens of *P. borealis* taken from water -1.68°C off Europe.

Salinity tolerances are more difficult to find in the literature, with *P. jordani* having the highest range, 28.7 to 34.6°/oo, (Dahlstrom, 1970) and *P. borealis* the lowest, 23.4 to 30.8°/oo, (Butler 1964). The remaining ranges reported by Butler (1964) are *P. hypsinotus*, 25.9 to 30.6°/oo; *P. platyceros*, 26.4 to 30.8°/oo, and *Pandalopsis dispar*, 26.7 to 30.8°/oo.

Diseases

Little is known about the diseases and parasites of pandalid shrimps. Yevich and Rinaldo (1971) reported a condition in *P. borealis* off Maine termed the black spot gill disease. This disease results in the destruction of gill lamellae and in the formation of a chitinous growth over the damaged area producing a black spot. A similar condition was observed by Fox (1972) in a few specimens of *P. borealis* caught off Kodiak Island.

Butler (1970) reported the infestation of a male *P. platyceros* by a rhyocephalan, *Sylon* sp., in British Columbia waters. He stated that there are no records of isopod parasites on *P. platyceros*. However, Fox (1972) reports that most species of pandalid shrimps are parasitized to some degree by bopyroid isopods (*Bopyrus* sp.). The isopods, a large female and the smaller male together, attach in the gill area. The shrimp's carapace then forms around them after molting and produces the characteristic "bubble".

Migration and Local Movement

Pandalid shrimps are known to undergo migrations onshore-offshore, coastwise, and vertically in the water column. Extensive migrations in European waters are well documented (Mistakidis, 1957), but less so in the northeastern Pacific Ocean.

Migration associated with age has been documented by Berkeley (1930) for *P. borealis*, *P. hypsinotus*, *P. platyceros*, and *Pandalopsis dispar*. Freshly hatched larvae were found around or near the vicinity of the spawned adults. At about the third stage of development, the larvae were found segregated in shallower water 5 to 35 fathoms deep where they spent their first summer. Later, during their first winter, the juveniles joined the adult population in deeper waters. Dahlstrom (1970), however, states that juvenile P. jordani are found among the adults throughout their life cycle.

Area migrations of the adult populations are less well documented. P. jordani off California are known to exhibit short spawning migrations during the winter into deeper water and short summer migrations ostensibly in search of food (Dahlstrom, 1970).

Diel vertical migrations are common among some pandalids. Many P. borealis leave the bottom during late afternoon or evening and return to near, or on, the bottom about dawn in Kachemak Bay (Barr, 1970b). The period of time that the shrimp remained away from the vicinity of the bottom varied directly with the season's number of hours of darkness. Pearcy (1970) reported the same phenomenon for P. jordani off the coast of Oregon. He suggested that diel migrations are related to feeding behavior, since the shrimp fed mainly on euphausiids and copepods which also make diel migrations. Pearcy also suggested that these movements may be evolutionary protection and dispersal mechanisms. Chew et al. (1971) stated that P. platyceros exhibited a diel bathymetric distribution after finding high catches in shallow water at night in Dabob Bay, Washington, but in deeper water during the day.

Literature Cited

Allen, J.A. 1959. On the biology of Pandalus borealis Kroyer, with reference to a population off the Northumberland Coast. J. Mar. Biol. Ass. 38:189-220.

Barr, L. 1970a. Alaska fishery resources-the shrimps. U.S. Fish. Wildl. Serv., Fish. Leaflet 631. 10 p.

Literature Cited

Berkeley, A.A. 1929. A study of the shrimps of British Columbia. Biol. Bd. Can., Prog. Rept. (Pacific) 4:9-10.

Berkeley, A.A. 1930. The post-embryonic development of the common pandalids of British Columbia. Contrib. Can. Biol. 10(6):79-163.

Butler, T.H. 1964. Growth, reproduction, and distribution of pandalid shrimps in British Columbia. J. Fish. Res. Bd. Can. 21(6):1403-1452.

Butler, T.H. 1968. The shrimp fishery of British Columbia. FAO Fish. Rept. 57(2):521-526.

Butler, T.H. 1970. Synopsis of biological data on the prawn *Pandalus platyceros* Brandt, 1851. FAO Fish. Rept. 57(4):1289-1315.

Chew, K.K., J.W. Wells, D. Holland, D.H. McKenzie and C.K. Harris. 1971. January size frequency distribution of *Pandalopsis dispar* and *Pandalus platyceros* trawled in Dabob Bay, Hood Canal, Washington from 1966 to 1971. (Abstract) Nat. Shellfish Assn., 63rd Ann. Conv. (Unpublished.)

Dahlstrom, W.A. 1970. Synopsis of biological data on the ocean shrimp *Pandalus jordani* Rathbun, 1902. FAO Fish. Rept. 57(4):1377-1416.

Fox, William W. 1972. Shrimp resources of the northeastern Pacific Ocean. Pages 313-337 in Donald H. Rosenberg. 1972. A review of the oceanography and renewable resources of the northern Gulf of Alaska. University of Alaska, Institute of Marine Science.

Haynes, E.B. and R.L. Wigley. 1969. Biology of the Northern Shrimp, *Pandalus borealis*, in the Gulf of Maine. Trans. Amer. Fish. Soc. 98(1):60-76.

Hynes, F.W. 1929. Shrimp fishery of southeast Alaska. U.S. Rept. Comm. Fish. 1929. 1-18 p.

Ivanov, B.G. 1964a. Results in the study of the biology and distribution of shrimps in the Pribilof area of the Bering Sea. Trudy VNIRO, Vol. 49 (Soviet Fisheries Investigations in the Northeast Pacific, U.S. Dept Int. Trans., 1968, 115-125 p.).

Ivanov, B.G. 1964b. Biology and distribution of shrimps during winter in the Gulf of Alaska and the Bering Sea. Trudy VNIRO, Vol. 53 (Soviet Fisheries Investigations in the Northeast Pacific, U.S. Dept. Int. Trans., 1968, 176-190 p.).

Ivanov, B.G. 1969. The biology and distribution of the northern shrimp (*Pandalus borealis* Kr.) in the Bering Sea and the Gulf of Alaska. FAO Fish. Rept. 57(3):800-810.

Literature Cited

McCrary, J.A. 1971. Pandalid shrimp studies project, Ann. Tech. Rept. Comm. Fish. Res. Devel. Act. (Unpublished ms.)

Mistakidis. 1957. The biology of *Pandalus montaqui* Leach. Fishery Invest. (Gr. Britain), Ser. 2, 21(4):52.

Needler, A.B. 1931. Mating and oviposition in *Pandalus danae*. Can. Field Nat. 45(5):107-8.

Pearcy, W.G. 1970. Vertical migration of the ocean shrimp, *Pandalus jordani*: a feeding and dispersal mechanism. Calif. Fish and Game 56(4):125-129.

Pearcy, W.G. 1971. Diel changes in the behavior of pink shrimp. (Abstract) National Shellfish Assn., 63rd Ann. Conv. (Unpublished.)

Rathbun, M.J. 1904. Decapod crustaceans of the Northwest Coast of America. Harriman Alaska Series 10:1-210.

Rathjen, W.F. and M. Yesaki. 1966. Alaska shrimp explorations, 1962-64. Comm. Fish. Rev. 28(4):1-14.

Ronholt, L.L. 1963. Distribution and relative abundance of commercially important pandalid shrimps in the Northeastern Pacific Ocean. U.S. Fish. and Wildl. Serv., Spec, Sci. Rept.-Fish. No. 449. 28 p.

Skalin, V.A. 1963. Diet of flatfishes in the southeastern Bering Sea, Izvestiya TINRO, Vol. 51 (Soviet Fisheries Investigations in the Northeast Pacific, U.S. Dept. Int. Trans., 1968, P. 235-250).

Tegelberg, H.C. and J.M. Smith. 1957. Observations on the distribution and biology of the pink shrimp (*Pandalus jordani*) off the Washington coast. Wash. Dept. Fish. Res. Pap. 2(1):25-34.

Yevich, P. and R.G. Rinaldo. 1971. Black spot gill disease of *Pandalus borealis* (Abstract) Nat. Shellfish Assn., 63rd Ann. Conv. (Unpublished.)

LIFE HISTORY - WEATHERVANE SEA SCALLOP

Taxonomy

The weathervane sea scallop, Patinopecten caurinus, is a member of the Lamellibranchia clams of the family Pectinidae. Keen (1963) described its taxonomy as follows:

Class: Pelecypoda
Subclass: Pteriomorphia
Order: Pteroconchida
Superfamily: Pectinacea
Family: Pectinidae
Genus: Patinopecten [formerly known as Pecten (Gould)]

Distribution

Although small numbers of weathervane sea scallops have been taken incidental to other fisheries from California to Alaska, the major commercial concentrations of this species are centered in the Kodiak Island and the Cape Fairweather to Cape Saint Elias area (Yakutat region) of the Gulf of Alaska (Hennick, 1970a). Trace amounts of scallops have also been dredged off the lower Kenai Peninsula, Shelikof Strait, and off Montague Island. Exploratory surveys in the Bering Sea and Alaska Peninsula area have revealed no extensive beds of scallops (Hennick, 1970b). Ronholt and Hitz (1968) reported that commercial quantities of weathervane sea scallops did not appear to be present in waters off Oregon. Thus, it appears that the Kodiak Island and Yakutat areas are the only regions that can support commercial exploitation of scallops in the Gulf of Alaska.

Exploratory surveys, largely conducted by the National Marine Fishery Service, have indicated that weathervane sea scallops are most abundant in depths of between thirty and seventy fathoms (Alverson, 1968). Gravel and sand, with some mud, is typical of Alaska scallop beds (Hennick, 1973).

The three major commercial scallop beds in Alaska may be described as follows (Hennick, 1973):

AREA 1	Yakutat, between Cape Saint Elias and Cape Spencer. Primarily mud-sand-clay or silt overburden. Productive areas between thirty and sixty fathoms in depth, twenty to forty miles offshore.
AREA 11	Westside Kodiak Island, between Cape Skǒlik to Afognak Island including that area of the Alaska Peninsula bordering Shelikof Strait adjacent to Kodiak Island proper. Primarily gravel-sand-mud or silt bottom. Productive areas twenty to seventy fathoms within three miles of shore.
AREA 111	Albatross, Marmot, Portlock Banks. Primarily rock, gravel, and sand bottoms. Productive areas between twenty-five to seventy-five fathoms, extending inshore and out to fifty miles or more offshore.

Sexuality

The weathervane sea scallop is heterosexual and sexually dimorphic. The sex of mature adult scallops can be distinguished by the characteristic white coloration of the testes and the bright orange of the ovaries (Hennick, 1970a). There are no superficial characteristics that indicate the sex.

Maturity

Scallops are aged by counting the growth rings, or annuli, on the shell. Although this method may not always provide the correct age, especially with older scallops, it gives a good estimate of age for younger scallops. Studies conducted in the Yakutat and Kodiak areas indicate that most weathervane sea scallops attain sexual maturity at age three and that all scallops at age four are mature (Hennick, 1970a). In addition, Hennick found that most scallops which exceed 100 mm in shell height are sexually mature.

Mating

Studies conducted by Hennick (1970a) indicate that weathervane sea scallops spawn only once annually. The spawning period normally occurs during June and early July and is apparently triggered by rising water temperatures. The sexes are separate and fertilization occurs externally. As the eggs and spermatozoa ripen, they are released through the kidney and are expelled into the water where fertilization is a random occurrence.

Fecundity

No information is available in the literature describing the fecundity of weathervane sea scallops.

Eggs and Larvae

After fertilization occurs in the open water, the eggs settle to the bottom and become attached to objects in the substrate. Hatching occurs within two to three days time (Hennick, 1973). Development is dependent upon water temperature, with higher temperatures producing faster growth. The larvae at this stage are capable of swimming and become planktonic, drifting with the tides and currents. During this planktonic stage, metamorphological changes take place and within two and one-half to three weeks the larvae settle to the bottom substrate and assume an adult form (Hennick, 1973).

Mortality is high during the larval stage, both from environmental factors and predation. Planktonic feeders, both fish and shellfish, including adult scallops, feed upon the drifting planktonic scallop larvae.

Juvenile

Complete basic studies on the life history cycle of weathervane sea scallops have not been conducted, especially in the juvenile stage. Hence, little information is available for this life stage. Based on studies of sea scallops elsewhere, however, the following observations can be made. After the larva settles to the bottom, the juvenile scallop may attach itself to the bottom, move around through the use of the foot appendage which later becomes residual, or swim. The juvenile at this stage is leptocephalus or transparent. Within a few months, pigmentation of the shell takes place and the animal appears identical to the adult form.

Adults

After reaching sexual maturity at about three to four years of age, weathervane sea scallops continue to grow. Studies conducted by Hennick (1973) indicate that growth is more rapid during the first ten to eleven years, then tends to slow as age advances. The meats of old, aged scallops actually tend to decrease in weight

(Hennick, 1973). In light of this growth phenomena, weathervane sea scallops should ideally be harvested between seven and eleven years of age, both from a biological and economic viewpoint.

There is little documented information on the longevity of weathervane sea scallops. Exploratory surveys and commercial catch data indicate a scarcity of scallops over 15 years of age. However, Hennick (1973) reported scallops recovered with as many as twenty-eight annual rings.

The growth rate of weathervane sea scallops is subject to regional differences. Based on Hennick's (1973) studies, the meats of scallops from the Yakutat area at a given age are much smaller than those from either of the Kodiak Island areas. Additionally, scallops from the Marmot, Albatross, and Portlock areas of Kodiak Island are the largest at any given age of all scallops in the Gulf of Alaska This phenomena is of great importance to the commercial fishermen as scallops from the Kodiak area have average meat weights nearly twice as large as those from the Yakutat area, meaning only half as many need be handled in order to obtain the same volume of salable product.

Weathervane sea scallops are planktonic filter feeders, consuming bottom detritus and drifting plankton. The opening and closing of the valves draws water into the mantle cavity. The circulation of water within the mantle cavity and gill areas provides a food source and enables respiratory functions to occur.

It is interesting to note that scallops are the only bivalve molluscs capable of swimming (Hennick, 1973). This is accomplished through relaxation of the adductor muscle, causing the valves to part and draw water into the mantle cavity. The scallop then rapidly contracts the large adductor muscle forcing water out. Rapid repetition of this function enables the scallop to rise off the bottom and essentially swim.

Predation is often high on weathervane sea scallops, with the major predators including cod, plaice, wolffish, and starfish.

Disease

Hennick (1973) reported the presence of marine boring worms on the shells of weathervane sea scallops from the Yakutat region. Nearly all of the scallops were heavily infected. However, infestation by marine boring worms in the Kodiak region is rare.

Migration and Local Movement

Little information is available concerning the migrations and local movements of weathervane sea scallops. Adult scallops are capable of independent movement but the extent or direction of any movement is not known.

Literature Cited

Alverson, D.L. 1968. Fishery resources in the northeastern Pacific Ocean. In The future of the fishing industry of the United States. Univ. of Wash. publications in fisheries-New Series. 4:96-97.

Hennick, D.P. 1970a. Reproductive cycle, size at maturity, and sexual composition of commercially harvested weathervane scallops, Patinopecten caurinus in Alaska. J. Fish. Res. Bd. Can. 27:2112-2119.

Hennick, D. 1970b. The weathervane scallop fishery of Alaska with notes on occurrence in Washington and Oregon. 22nd Ann. Rept. of the Pac. Mar. Fish. Comm. 1969. Appendix 3-Spec. Rept. 33-34.

Hennick, D. 1973. Sea scallop, Patinopecten caurinus, investigations in Alaska. Completion report, Commercial Fisheries Research and Development Act, Project No. 5-23-R.

Keen, M.A. 1963. Marine molluscan genera of western North America. Stanford Univ. Press. 126 p.

Ronholt, L.L. and C.R. Hitz. 1968. Scallop explorations off Oregon. Comm. Fish. Rev. 30(7): 42-49.

LIFE HISTORY - CLAMS

The clam resource of the Gulf of Alaska consists of approximately one hundred and sixty different species of clams, about twenty-eight of which can be utilized commercially (Baxter, 1965). The fishery is essentially supported by three species, the razor clam, (*Siliqua patula*), the butter clam (*Saxidomus giganteus*), and the cockle (*Clinocardium nuttalli*). Minor species, usually taken in the sports catch, include the Manila clam (*Venerupus japonica*), the little neck clam (*Protothaca staminea*), the horse clam (*Schizothaerus nuttalli*), and gapers (*Tresus nuttali* and *T. capax*). In addition, there appears to be substantial stocks of soft-shell clams (*Mya truncata*) at Cold Bay, Kachemak Bay, and Prince William Sound, Alaska (Kirkwood, 1967). Large populations of surf clams (*Spisula alaskana*) also occur subtidally in many areas of central Alaska. However, the importance, size and distribution of populations of minor clam species which may have a commercial potential is largely unknown.

In the following section, a summary of the taxonomy, distribution, and life history of the three principal commercial species, razor, butter, and cockle clams, in Alaska is given.

Razor clams

Taxonomy

The razor clam, Siliqua patula, is a member of the Lamellibranchia clams of the family Solenidae. Nosho (1972) described its taxonomy as follows:

Phylum: Mollusca
Class: Lamellibranchia
Family: Solenidae
Genus: Siliqua
Species: S. patula

Distribution

The razor clam is found from Pismo Beach, California, to the Bering Sea (Amos, 1966). It occurs in commercial quantities from Tillammok Head, Oregon, to the western end of the Alaska Peninsula. In Alaska, commercial stocks are found on the shores of Cook Inlet, Orcas Inlet, the Copper River delta near Cordova, and the mainland side of Shelikof Strait.

Razor clams are found intertidally to several fathoms in depth on the sandy ocean beaches of the open coast. Fine sand with some glacial silt, as found at Karls Bar located at Orcas Inlet near Cordova, is typical of Alaska clam producing areas (Weymouth and McMillan, 1931). Near Kodiak, the large beds at Swickshak and Hallo Bay consist of fine sand, volcanic ash and some glacial mud. In Cook Inlet, razor clams are found in substrata varying from almost entirely coarse white sand (Deep Creek area) to a fine sand-clay-gravel mixture at Clam Gulch (McMullen, 1967).

Razor clams may be found in the mouths of coastal harbors, but growth is usually inferior in these locations. They are not found in enclosed bodies of water.

Sexuality

The razor clam is hererosexual and sexually dimorphic. However, only through examination of the gonads is it possible to tell the sex of the clam. There are no superficial characteristics that indicate the sex. Examination of the contents of the gonads reveals a marked difference between sexes. The female ova have a granular appearance, in contrast to the viscous homogeneous mass in which the sperm is found.

Maturity

Razor clams are aged from growth rings on the shell. Although the method may not always provide the correct age, especially with older clams, it gives a good estimate of age for younger clams. In addition, accurate aging is hindered by the presence of summer growth checks (false annuli) on the shell which, it is believed, are caused by disturbed growth through tidal action.

Razor clams in the northwest Pacific reach sexual maturity after two or more years, or a shell length of approximately 100 mm (Nosho, 1972). Razor clams of the northern beds do not reach sexual maturity until much later. Clams of the Swikshak and Cordova beaches do not mature until their fifth and sixth years, respectively (Weymouth and McMillan, 1925). However, Cook Inlet clams appear to grow much faster, reaching maturity in their third year (McMullen, 1967).

Mating

Spawning occurs in the spring or summer when rising water temperatures reach 13°C (Nosho, 1972). In Alaska, this usually occurs in July. Studies conducted in Prince William Sound indicate that spawning timing can be computed by monitoring the cumulative maximum daily water temperature (Personal communication with Richard Nickerson, A.D.F.&G., Cordova, 1975). Razor clams spawning occurs when the cumulative maximum daily water temperature reaches 1,350 temperature units; with the cumulative total computed by suming the daily maximum degree units above or below 32°F from January 1 on. The 50% spawning level is generally reached when the cumulative total reaches 1,500 temperature units.

Spawning occurs for several weeks as eggs and sperm ripen and are discharged through the excurrent siphon. Fertilization occurs in the open water with surf action mixing the eggs and sperm.

Fecundity

The number of eggs carried by the female razor clam ranges between six to ten million eggs annually (McMullen, 1967).

Eggs and Larvae

After fertilization occurs in the open water, the eggs hatch into larvae within a few hours to a few days. Development is dependent upon water temperatures, with higher temperatures producing faster growth rates. The larvae exists as free swimming veligers (ciliated larvae) for five to sixteen weeks (Oregon Fish Commission, 1963). After the veliger stage, the young clams develop a shell and settle to the bottom where they "set" into the top layer of sand upon reaching an average shell length of 13 mm (Tegelberg, 1964). In years of heavy setting, as many as 1,000 to 1,500 young clams per square foot of beach may be found.

Mortality is extremely high during the larval stage. The pelagic larvae are subjected to a high level of predation by planktonic feeders. Unfavorable currents may also carry the larvae away from desirable habitat.

Juveniles

After settling to the bottom, juvenile growth is slow throughout the fall and winter. Growth accelerates during the spring and summer with warmer waters and increased food supply. After the first winter, young clams reach a length of about four-fifths of an inch in the Cordova district. An average length of four and one-half inches is attained in three and one-half years in the southern beds as compared to six and one-half years in the Cordova region (Amos, 1966).

The growth rate varies with locality. In Alaska, initial growth rate is slower than in the northwest states; however, after several years, the relative growth rate is higher (Weymouth and McMillan, 1931). Generally, razor clams have a larger final size and grow older in the northern beds than in the southern beds.

Adults

The maximum age for razor clams is highly variable with clams of the northern beds living longer than those of the southern beds. Clams collected at Pismo Beach, California, do not exceed five years in age, while Washington clams grow up to nine years. In Alaska, ages up to nineteen years have been recorded (Weymouth and McMillan, 1931).

Adult razor clams live in the intertidal zone where they lie buried in the sand with their necks, or siphons, protruding above the surface. During the low water stages, when the clams are exposed, their siphons are covered with a thin layer of sand which makes detection of the clams difficult. The clams can move through the sand very rapidly, averaging several feet per minute. Their unusual ability to move so fast is due to their foot, which is an effective burrowing organ. In digging, the foot of the clam is projected half the length of the shell and pushed into the sand. Below the surface the tip of the foot expands forming a strong anchor. Then the foot muscles contract pulling the clam downwards. The clam can repeat this movement in rapid succession. It has been observed that clams laid on the top of the sand have buried themselves completely in less than seven seconds (Loosanoff, 1947).

Razor clams are filter feeders, consuming bottom detritus and drifting plankton. Food particles are brought in along with water through the incurrent tube. Small hairlike structures (cilia) on the gills filter the food particles out. The food particles are then passed to the sensitive palps near the mouth for sorting, and are then ingested.

Predation is often high on razor clams, with the major predators including starfish, crabs, rays, octopus, and starry flounders.

Disease

As with all animals, razor clams are subject to disease. Marine bacteria and fungi are often injurious to clam larvae. In addition, razor clams are also subject to the problem of paralytic shellfish poisoning (PSP), as are all bivalve mollusks. PSP is associated with plankton blooms and is properly called *Gonyaulax* poisoning (Hayes, 1967). The causative organisms are believed to be the dinoflagellates *Gonyaulax catenella* and *G. acatenella*. The toxin is accumulated as a direct result of feeding on these organisms. PSP is extremely toxic and is one of the most potent materials known to man. The poison is a metabolic product of the dinoflagellate. It is believed that PSP directly affects the nerve and muscle membrane, blocking the passage of nervous impulses, and eventually resulting in paralysis of the diaphragm and death by suffocation if enough toxin is ingested.

Razor clams, unlike other mollusks, do not retain the toxin over a long period of time. The toxin is rapidly eliminated from the tissue by normal metabolic activity. In addition, the toxin does not build up to high levels in the tissue, but is concentrated in the digestive tract. Thorough cleaning and removal of the digestive tract will remove most, if not all, of the toxin.

Migration and Local Movement

Little is known concerning the migrations and local movements of razor clams. At the present, there is little evidence that razor clams move horizontally or migrate between areas. However, heavy surf action along exposed beaches is often responsible for the movement of razor clams laterally along the beach as well as onshore-offshore movements.

Butter Clams

Taxonomy

The butter clam, *Saxidomus giganteus*, is a member of the Lamellibranchia clams of the family Veneridae. Nosho (1972) described its taxonomy as follows:

Phylum: Mollusca
Class: Lamellibranchia
Family: Veneridae
Genus: *Saxidomus*
Species: *S. giganteus*

Clams of the species, *S. giganteus*, have been referred to as Washington clam, quahog, Coney Island clam, beef-steak clam, butter clam, and great Oregon clam. At the present, butter clam is the accepted common name.

Distribution

The butter clam is found from Humboldt Bay, California, northward to the Aleutian Islands. They are distributed from the lower levels of exposed tide flats out to depths of over thirty fathoms in some areas (Amos, 1966). Baxter (1971) indicated that the optimum habitat for butter clams is narrowly defined by tidal levels; primarily between mean low water and lowest low water. Butter clams appear to prefer a mixed gravel-sand-mud substratum, although they occasionally occur in sand bottoms. They generally occupy the upper twelve inches of the substratum, most commonly six to ten inches beneath the surface.

Sexuality

The butter clam is heterosexual and sexually dimorphic. However, only through examination of the gonads is it possible to determine the sex of the clam. The female ova have a granular appearance, in contrast to the viscous homogeneous mass in which the sperm is found.

Maturity

As are all clams, butter clams are aged from growth rings on the shell. Although this method may not always provide the correct age, especially with older clams, it gives a good estimate of age for younger clams.

The growth rate for butter clams is extremely slow in Alaskan waters. Baxter (1965) reported that butter clams may take from fifteen to twenty years to reach sexual maturity at a size of two and one-half inches in diameter.

Mating

Spawning occurs in the spring or summer when rising water temperatures reach 20°C (Breese and Phibbs, 1969). Unlike most clams, butter clams require fairly warm water to successfully spawn. For this reason, successful spawning and setting of butter clams is at best sporadic in the cool Alaskan waters. Amos (1966) reported certain British Columbia butter clam beds that have had only one major spawning and setting in twenty years. This inability to reproduce was attributed to low water temperatures.

When water temperature requirements are met, spawning will occur over several weeks as eggs and sperm ripen and are discharged through the excurrent siphon. Fertilization occurs externally in the open water with surf action mixing the eggs and sperm.

Fecundity

Little information is available in the literature describing the fecundity of butter clams. However, like all clams, the number of eggs carried annually by the female is quite large.

Eggs and Larvae

After fertilization occurs in the open water, the fertilized eggs develop into free swimming larvae. The larvae exist as free swimming veligers (ciliated larvae) for 20 to 30 days before developing a shell and settling to the bottom where they "set" into the top layer of the substrate. The rate of development is dependent upon water temperatures with higher temperatures producing faster growth rates.

Mortality is extremely high for butter clams during the larval stage. The pelagic larvae are subject to a high level of predation by planktonic feeders. Adult butter clams, as well as other bivalve mollusks, contribute heavily to the predation upon the pelagic larvae. In addition to predation, unfavorable currents, generated by storms, may carry the larvae away from desireable habitat.

Juveniles

Progressive growth for juvenile butter clams is extremely slow, particularly in Alaska. Baxter (1965) indicates that butter clams in Alaskan waters may take from fifteen to twenty years to reach a size of two and one-half inches or sexual maturity.

Predation is often quite high on juvenile butter clams, particularly at the "setting" stage. The young clams are concentrated in the upper layer of the substrate and are vulnerable to predation by crabs, starfish, and numerous demersal fishes.

Adults

Adult butter clams live in the intertidal zone where they lie buried in the sand with their necks, or siphons, protruding above the surface. Food particles, along with water, are brought into the siphon through the incurrent tube. The food particles are filtered out by small hairlike structures (cilia) on the gills and are then passed to the sensitive palps near the mouth for sorting and ingestion. Butter clams are filter feeders, consuming primarily bottom detritus and drifting plankton.

Adult butter clams, as are the other life stages, are also subject to predation. Crabs, particularly dungeness crab, star fish, octopus, and numerous other demersal fishes are the major predators.

Disease

There is little documentation in the literature as to the specific diseases of butter clams. However, marine bacteria and fungi are known to often be injurious to clam larvae in general. In addition, butter clams are also subject to the problem of paralytic shellfish poisoning (PSP), as are all bivalve mollusks (refer to razor clam life history - diseases for specifics on PSP poisoning). Unlike razor clams, PSP toxin in butter clams is concentrated and retained in primarily the siphon tissue. The toxin is eliminated very slowly by metabolic activity. This retention is particularly dangerous in the northern part of the butter clams' range, where colder waters slow down metabolic activity. Butter clams in these localities may still retain lethal concentrations of the toxin one year or more after the initial exposure to PSP.

Migration and Local Movement

Little is known concerning the migrations and local movements of butter clams. At the present, there is little evidence that butter clams move horizontally or migrate between areas. However, heavy surf action along exposed beaches may be responsible for movement laterally along the beach as well as onshore-offshore movements.

Cockles

Taxonomy

The cockle, Clinocardium nuttalli, is a member of the Lamellibranchia clams of the family Cardiidae. Nosho (1972) described its taxonomy as follows:

Phylum: Mollusca
Class: Lamellibranchia
Family: Cardiidae
Genus: Clinocardium
Species: *C. nuttalli*

Clams of the species, *C. nuttalli*, have been referred to as heart cockle, basket cockle, and cockerel. In common usage, the simple use of the name cockle is primarily used.

Distribution

The cockle is found from San Diego, California, northward to the Bering Sea. It is most abundant in British Columbia and in Puget Sound, Washington; although minor concentrations exist in the Kodiak Island and Cordova regions (Nosho, 1972). Cockles are generally found in both intertidal and deep water, one to three inches beneath the surface of the bottom and are often only partially buried. They appear to prefer a substratum of mixed sand and mud and are commonly found on eel-grass flats (Quayle, 1970).

Sexuality

The cockle differs from razor and butter clams, as well as most other clams, in that it is hermaphroditic (Amos, 1966). Individuals produce both sperm and eggs during the same season.

Maturity

Cockles, as are other clams, are aged from growth rings on the shell. Although this method may not always provide the correct age, especially with older clams, it gives a good estimate of age for younger clams. Amos (1966) indicates that cockles reach sexual maturity at the age of two years.

Mating

The mating behavior of cockles is quite different from most clams in that it is hermaphroditic, i.e., individuals produce both sperm and eggs. Unlike pandalid shrimp, which mature first as males and then later as females, cockles produce both sperm and eggs within the same season. Usually, the eggs are discharged first and the sperm later in the season, although both may be liberated simultaneously.

Spawning occurs in the summer with rising water temperatures and continues for some time. Fertilization occurs externally in the surrounding waters with surf and wave action mixing the eggs and sperm.

Fecundity

Little information is available in the literature concerning the fecundity of cockles. However, like all clams, the number of eggs discharged annually is quite large.

Eggs and Larvae

After fertilization occurs in the open water, the eggs develop into free swimming larvae, or veligers. The veligers remain planktonic until they develop a shell and settle to the bottom. The rate of development is dependent upon water temperature with warmer temperatures producing faster growth rates.

Mortality is extremely high for the pelagic larvae. Predation by other mollusks, including adult cockles, and numerous plankton feeding fishes is quite high. In addition, mortality may result from the movement of the larvae to undesireable habitat by unfavorable currents generated by storms.

Juveniles

Similar to razor clams, the progressive growth of juveniles cockles is faster in its southern range than it is in the northern portion of its range (Amos, 1966). Growth is slow during the fall and winter, but accelerates rapidly during the spring and summer with warmer waters and an increased food supply.

Cockles are particularly vulnerable at the "setting" stage to predation by crabs, particularly dungeness crab, starfish, starry flounder, and other demersal fishes. Tidal movements or heavy storm driven wave activity may relocate the young juveniles into undesireable habitat which will slow or stop the growth rate.

Adults

The maximum age for cockles is somewhat variable, with some indications that cockles in the northern beds grow older than those in the southern beds. However, generally, they live to be about eight years old; although Amos (1966) reports a cockle which was ten years old. The average size of commercially marketed cockles is usually three to four inches. Amos (1966) reported one specimen as four and three-fourth inches from hinge to edge and weighing 26 ounces.

Cockles are filter feeders, consuming bottom detritus and drifting plankton. Free swimming planktonic cockle larvae should also be included as a food item, for these are ingested along with other planktons.

Disease

There is little documentation in the literature as to the specific diseases of cockles. Most bivalve mollusks, however, are subject to infestation by marine bacteria and fungi. In addition, cockles are subject to the problem of paralytic shellfish poisoning (refer to razor clams life history - diseases for specifics on paralytic shellfish poisoning). The toxin is concentrated in the muscle tissue of cockles and is only slowly released by normal metabolic activity. Consequently, the clams may remain toxic year-round following a paralytic shellfish poisoning outbreak. This is particularly true in the northern range where cooler waters slow down the metabolic rate.

Migration and Local Movement

The migrations and local movements of cockles are poorly documented. At the present, there is little evidence that cockles move horizontally or migrate between areas. Baxter (1971), however, indicates that the cockle is the only species of hard-shell clam in Prince William Sound, Alaska, that is capable of changing postion in the adult stage. However, their movement appears to be limited and rarely exceeds twenty feet. Heavy surf and wave action along exposed beaches may be responsible for movement laterally along the beach as well as onshore-offshore movements.

Literature Cited

Amos, M.H. 1966. Commercial clams of the North American Pacific coast. U.S. Fish and Wildl. Serv. Circ. 237. 18 p.

Baxter, R. 1965. The clam resource of Alaska. Pages 3-4 in W.A. Felsing, Jr. 1965. Proceedings of joint sanitation seminar on North Pacific Clams, Sept. 24-25, 1965. U.S. Public Health Service and Alaska Dept. Health and Welfare.

Baxter, Rae E. 1971. Earthquake effects on clams of Prince William Sound. Pages 238-245 in The Great Alaska Earthquake of 1964, Biology volume. Published 1971 by the National Academy of Sciences.

Breese, W.P. and F.D. Phibbs. 1970. Some observations on the spawning and early development of the butter clam *Saxidomus giganteus* (Deshayes). Proc. Nat. Shellfish. Assn., 1969. 60:95-98.

Hayes, M. 1967. Review of the shellfish toxicity problem in Alaska waters. Page 2 in E. Haynes and J. McCrary. Minutes of the first Alaskan shellfish conference, May 23-26, 1967. Alaska Dept. Fish and Game, Info. Leaflet No. 106.

Loosanoff, U.L. 1947. Commercial clams of the Pacific coast of the United States. V.L. Bur. Fish and Wildl. Fish Leaflet No. 223.

McMullen, J.C. 1967. Some aspects of the life history of razor clams *Siliqua patula* (Dixon) in Cook Inlet, Alaska. Alaska Dept. Fish and Game, Info. Leaflet No. 110. 18 p.

Nosho, Terry, Y. 1972. The clam fishery of the Gulf of Alaska. Pages 351-360 in Donald H. Rosenberg. 1972. A review of the oceanography and renewable resources of the northern Gulf of Alaska. University of Alaska, Institute of Marine Science.

Oregon Fish Commission. 1963. Razor clams. Educ. Bull. 4, Portland, Ore. 13 p.

Quayle, D.B. 1970. Intertidal bivalves of British Columbia. British Columbia Prov. Mus. Dept. Educ., Hand. No. 17.

Tegelberg, H.D. 1964. Growth and ring formation of Washington razor clams. Wash. Dept. Fish., Fish Res. Papers 2(3):69:103.

Weymouth, F.W. and H.C. McMillan. 1931. Relative growth and mortality of the Pacific razor clam (*Siliqua patula*, Dixon) and their bearing on the commercial fishery. U.S. Bur. Fish., Bull. No. 46. 543-567 p.

Weymouth, F.W., H.C. McMillan and H.B. Holmes. 1925. Growth and age at maturity of the Pacific razor clam, *Siliqua patula* (Dixon) U.S. Bur. Fish., Bull. No. 41. 201-236 p.

LIFE HISTORY - RAINBOW TROUT

Taxonomy

Rainbow trout, *Salmo gairdneri*, belong to the family Salmonidae. Anadromous rainbow are known as steelhead and are discussed separately.

Distribution

Rainbow trout are native to western North America, occuring from northwest Mexico to the Kuskokwim River. In Alaska, rainbows are found throughout southeast Alaska west to the Alaska Peninsula and as far up the Kuskokwim as the Stony River. Clear water lakes and streams in Bristol Bay drainages provide prime habitat. They occur naturally in the Susitna and the Copper River drainages and have been transplanted to several interior areas, mostly around Fairbanks.

Spawning

Rainbows reach sexual maturity at 3-5 years, with males often maturing a year younger than females. They spawn in the spring and exhibit a high degree of homing instinct for a specific spawning area. They generally spawn in smaller tributaries of the parent stream or the inlet or outlet streams of lakes. Spawning usually occurs in temperatures between 50°-60°F.

The female choses the spawning site and digs a redd, approximately 4-12 inches deep and 15 inches in diameter. Preferred site is a bed of fine gravel in a riffle above a pool. The eggs are deposited in the redd, fertilized, and covered with gravel. Total eggs range from 200-

8,000, depending on size of female. The eggs develop several weeks to four months depending on temperature. Rainbows may spawn up to five years consecutively, but survival is low and only 10% of a population may spawn more than once.

Habitat and Migration

Rainbow prefer cool clear streams and lakes. In stream populations, the young fry move into riffle areas of the spawning streams to rear for up to two years. Preferred adult habitat is found in areas of gravel bottoms, moderate flow, and pool-riffle configuration in rivers of small to moderate size. They remain in riffles in the summer, but move into deep pools in the fall to overwinter. In lake-dwelling populations, fry usually move into the lake immediately after hatching, but may stay to rear 1-3 years in the spawning streams. Lake residents are usually found in moderately deep to deep, cool lakes with adequate shallows and vegetation for good food production. For the lake populations to be self-sustaining, there must be a river with good gravel bottom for spawning. They are most successful in waters with temperatures less than 70°F.

LIFE HISTORY - STEELHEAD TROUT

Taxonomy

Steelhead trout, *Salmo gairdneri*, are the anadromous form of the rainbow trout. They are covered separately since their life history is markedly different from that of rainbow.

Distribution

Steelhead originally occurred from southern California to Alaska, but the southern end of the range has been reduced somewhat. In Alaska, steelhead occur throughout the southeast region, in the lower Copper River drainages, and on the lower Kenai Peninsula as far up as the Ninilchik River.

Spawning

Steelhead become sexually mature in 3-5 years, with males often maturing at a younger age than females. Spawning may occur in the fall, winter, or spring, depending on run timing. In Alaska, steelhead spawn in the spring between March and May. Steelhead spawn in small to medium-sized streams or in suitable sections of mainstem rivers. Suitable redd sites have gravel bottoms and moderate stream flow. Depth preference varies from 16 to 35 cm deep and redd sites are chosen in areas that would rarely be exposed by lowering stream levels (Jones, 1975). The female prepares the redd in riffle areas or the tail end of pools, and spawning occurs as for rainbow trout, except that redds are generally larger. Fecundity varies from 3,000 to 12,000 eggs.

After spawning, the spent fish move downstream and return to the ocean. Steelhead may spawn more than once, but initial spawning mortality is usually high. Egg incubation time varies with temperature but averages 50 days at 50°F.

Habitat and Timing

After emerging from the gravel, the fry remain in shallow gravel areas to feed. They move out into deeper waters as they grow older and establish territories among rocky areas. Young steelhead rear 2-4 years before migrating out to sea as smolts. Growth and size appears to determine time of smoltification. Most outmigration occurs in April through June.

Immature steelhead migrate out into the ocean to feed for several years. Tagging studies indicate that steelhead ocean migration is similar to salmon as they apparently circulate around the Gulf of Alaska before returning to their home stream to spawn. Steelhead may remain at sea 1-3 years. After their ocean stage, steelhead return to their home stream, exhibiting a very strong homing ability. Maximum age reported for steelhead has been eight years.

LIFE HISTORY - CUTTHROAT TROUT

Taxonomy

The cutthroat trout, Salmo clarki, is a member of the family Salmonidae. Two forms of the trout are recognized, the coastal form (coastal cutthroat) and the interior form (Yellowstone trout), which are separated on basis of location and external appearance. The Alaska cutthroat are of the former variety.

Distribution

Cutthroat trout occur in fresh, brackish and saltwater areas of western North America, from northern Califronia to Alaska. In Alaska, cutthroat are found throughout southeast Alaska up into Prince William Sound.

Spawning

Sexual maturity is reached by males as early as two years of age and as late as 5-6 years for females. The average age of spawners is 2-4 years. Spawning usually occurs between February and May. Spawning takes place in small, gravelly streams, and the female digs one or more redds about a foot in diameter and 4-5 inches deep. The eggs are deposited in the redd, fertilized, and covered with 6-8 inches of gravel. Fecundity of the female ranges from 400 to 4,000 eggs (females 8 to 17 inches long) and the average is 1,500 eggs. Spawning occurs primarily at night. Cutthroat may spawn more than once, but mortality is usually high.

After spawning, anadromous spawners will return to saltwater, but non-anadromous fish may remain in the tributary or else drop down to a larger stream or lake. The eggs usually hatch in 6-7 weeks, with the alevins remaining in the gravel several additional weeks.

Habitat and Migration

Cutthroat may be anadromous or non-anadromous. Adult habitat may be coastal streams and lowland lakes, inland alpine lakes, or inshore coastal areas. In British Columbia, Hartman and Gill (1968) described cutthroat habitat in British Columbia in relationship to that of steelhead trout. Cutthroat predominated in small, short drainages (less than 13 km^2). In drainages less than 120 km^2, cutthroat were found in streams that contained sloughs in lower sections. In large streams where both steelhead and cutthroat occurred, cutthroat usually predominated in small tributaries and headwaters.

Non-anadromous populations may remain in their parent streams all their life, remaining in a territory as small as 20 yards (Miller, 1957). Others may rear several years in small tributaries before moving into larger streams or into a lake.

Anadromous young fish rear in the spawning stream or connected lake two to four years before migrating to sea. Immature fish at sea may wander from stream to stream, feeding during the summer months; usually remaining fairly close to the stream of outmigration. Overwintering at sea is uncommon and in the fall both mature and immature cutthroat return to freshwater to overwinter in lakes or streams with deep holding areas. The fish may or may not overwinter in the the same system every year (Armstrong, 1971, Jones, 1974).

Many cutthroat live only a few years and spawn only once. For others, spawning may be non-consecutive. Ten years is probably maximum life expectancy with 4-7 years being more common.

Critical Habitat

Critical habitat for cutthroat consists of spawning, rearing and overwintering areas. Sloughs, side channels, deep pools, and beaver pond areas constitute important rearing areas.

LIFE HISTORY - DOLLY VARDEN

Taxonomy

The Dolly Varden char (*Salvelinus malma*) belongs to the family Salmonidae.

Distribution

Dolly Varden occur in eastern Asia and in western North America from northern California to Alaska. In Alaska, Dolly Varden distribution extends from southeast Alaska westward to the Aleutian Islands and into Bristol Bay. Occurrence of Dolly Varden has been reported in the Yukon River drainage, on the Seward Peninsula, and as far north as the Noatak River, but confusion exists as to whether these fish are Dolly Varden or Arctic char.

Spawning

Most Dolly Varden mature at age five or six. Mature fish migrate into their parent streams beginning in July and spawn from September to November. The female digs a nest (redd) in relatively uniform substrate of small to coarse gravel. The redd measures 12-24 inches in diameter and 6-8 inches deep. Blackett (1968) reported water velocities of 3-4 feet per second (fps) over the redd during construction, with water temperatures between 42-44°F. Females, depending on size, may deposit 600 to 6,000 eggs in the redd. The eggs are deposited in several pockets and each pocket is covered with gravel.

The eggs take about four to five months to hatch after fertilization, usually hatching in March. The alevins remain in the gravel until their yolk sacs are absorbed. Emergence usually occurs in April or May.

Habitat and Migration

Dolly Varden may be either anadromous or non-anadromous. Most life history information available on Dolly Varden pertains to the sea-run variety. Little is known concerning the habits on non-migratory Dolly Varden.

Young Dolly Varden rear in clear water streams from two to four years before their first migration to sea (anadromous form). The young fry keep to slow-moving waters, remaining hidden on the bottom in pools, undercut banks and sloughs. They continue to remain bottom dwellers during their rearing stage, although the larger juveniles move out into riffles and faster moving areas in the stream. Small feeder tributaries, side-channels and high water overflow areas also constitute important rearing habitat.

During the fall, rearing fish apparently seek out areas in the stream to overwinter. Studies on Dolly Varden rearing ecology by Elliott and other workers in southeast Alaska have noted an upstream migration of Dolly Varden into spring-fed areas in the fall (Elliott and Armstrong 1972, Elliott and Reed 1974, Dinneford and Elliott, 1975). The fish overwinter there until late spring when they again re-distribute themselves throughout the stream. The fall migration ceases when stream temperature drops below 4°C, and the spring migration begins when temperature increases above 4°C.

Anadromous Dolly Varden migrate to sea primarily as three and four-year-old fish, though some fish from lake systems migrate as two-year-olds. At this time they are about five inches long and are called smolts. This migration usually begins in March, peaks in May and June, with significant but smaller numbers migrating to sea in September and October. Once at sea, they begin a fascinating pattern of migration.

After their first seaward migration, Dolly Varden usually spend the rest of their life wintering in and migrating to and from lakes. Those hatched and reared in a lake system carry on annual feeding migrations to sea, in the spring and summer, returning to the lake each year for the winter. However, Dolly Varden originating from non-lake systems must seek a lake in which to winter. Recent research indicates that they find lakes by random searching, migrating from one stream system to another until they find one with a lake (Armstrong, 1974). Once a lake is found these fish may also conduct annual seaward migrations in the spring, sometimes entering other stream systems in their search for food.

At maturity, Dolly Varden return to their parent stream to spawn. The fish possess the ability to find their "home" stream without randomly searching as was the case in their original search for a lake. Those that survive the rigors of spawning return to the lake shortly thereafter. It is doubtful that much more than 50% of the Dolly Varden live to spawn a second time. A small number of them live to spawn more than twice. Some fish apparently spawn non-consecutively (Armstrong, 1974). Few Dolly Varden appear to live longer than eight years.

Critical Habitat

Critical habitat for Dolly Varden consist of rearing, overwintering and spawning areas. Blackett (1968) and Armstrong (1974) have discussed the importance of critical habitats in relationship to successful management. Non-lake systems are of primary importance for spawning and rearing while anadromous lake systems and large rivers are important for overwintering. For five to nine months a year, each overwintering lake harbors fish from many streams over a wide area. Depletion of these fish could severely reduce populations from many systems.

Migrations between streams and lakes also complicates management. Heavy fishing on one system or one area may severely affect populations in other areas, when these fish migrate into heavily fished areas. Spawners also remain in streams for much longer periods and would be more susceptible to the fishery. Spawning sites are quite specific and need to be identified and protected during spawning and egg incubation periods. Fishery closures may be used to protect spawning fish on the spawning grounds and on their migration to overwintering areas (October and November).

Rearing areas are often overlooked but are very critical. Side channels, undercut banks, sloughs, isolated pools and small tributaries provide critical rearing habitat. Land uses which disrupt or destroy these areas must be avoided. Overwintering rearing areas such as springs or open water areas are also critical.

LIFE HISTORY - ARCTIC CHAR

Taxonomy

The Arctic char (*Salvelinus alpinus*) is a member of the Salmonidae family.

Distribution

Arctic char are circumpolar in its distribtuion and are found in inshore marine waters, lakes and streams of the northern hemisphere. In Alaska, they are found north of the Brooks Range and extend southeast along the Bering Sea to include the Aleutian Islands and the Alaska Peninsula. Anadromous populations extend up the Yukon River into the Anvik drainage. In the Kuskokwim and Yukon systems scattered non-anadromous populations are found in lakes and clear rivers. A few non-anadromous Arctic char populations are also found in Cook Inlet on the Kenai Peninsula.

Spawning

Arctic char mature between their fifth and twelfth years of age. Mature char begin their spawning migration in late July and spawn between late August and mid-November. Spawning takes place over gravel beds in lakes, pools below rapids in rivers, and in spring areas.

The redd is constructed in small gravel in depths from 0.2 to 4.5 meters (m). A redd measured by Yoshihare (1973) was 1.2 m wide, 3.5 m long with eggs deposited 10 centimeters (cm) deep. Water depth was 0.2 m and water velocity over the redd was 0.6 meters per second (mps). Spawning takes place during the day in water temperatures around 4°C.

Anadromous females usually contain between 3,000-5,000 eggs. The eggs are buried after deposition.

The eggs remain in the gravel overwinter and hatch in April. The eggs are exposed to temperatures of 0.0°-2.2°C. They are killed by temperatures above 7.8°C. The alevins are thought to remain in the gravel until after ice break-up in June or July, before emerging.

Habitat and Migration

Arctic char may be either anadromous or non-anadromous. Little is known about the juvenile life stage of Arctic char. Anadromous char migrate to sea for the first time at two to seven years of age. Downstream migration occurs in June and early July. The fish usually remain near the estuary to feed, although tagged fish have been captured as far as 80 miles from its origin stream.

Anadromous char return to streams in July through September. Arctic char do not spawn every year (non-consecutive spawners) but may wait one or more years before spawning again. Both non-spawning char and spawning char enter the rivers at the same time during the fall migration. Spawners will later segregate out on the spawning grounds. The fish overwinter in lakes, deep river pools, or spring areas in streams.

Growth is generally slow. The oldest reported char was 24 years old.

LIFE HISTORY - LAKE TROUT

Taxonomy

Lake trout *Salvelinus namaycush* are not true trout (genus *Salmo*) but are classed as char (genus *Salvelinus*). They are the largest of the chars and are also Alaska's largest freshwater fish.

Distribution

Lake trout are found only in North America and almost entirely within the limits of Pleistocene glaciation. In Alaska, they are found in the Brooks Range, but are not found in lowland lakes on the North Slope. In the Kobuk drainage, they are not found closer than 400 miles from the Bering Sea. Lake trout are also found in Bristol Bay, the upper Susitna, and the Copper River drainages.

Spawning

Lake trout generally mature in 5-7 years and spawn in late summer and early autumn. Most lake trout are lake spawners, but river-spawning populations also exist. Lake trout may be non-consecutive spawners.

The male selects a spawning site over large boulders or rubble substrate in shoal areas. Suitable lake sites are often associated with windy areas. Unlike most salmonids, no nest is dug but the site is cleaned of silt and mud by brushing and fanning motions. The eggs are fertilized and broadcast over the bottom to settle into crevices in the rocks. Large females may contain up to 18,000 eggs. Depth of spawning ranges from six inches to 200 feet, but spawning typically occurs in depths less than 40 feet. Optimum spawning temperature is about 48°-50°F. Spawning almost always occurs at night. The eggs remain in the rocks overwinter and hatch in the spring.

Habitat

Lake trout are entirely freshwater dwellers and prefer large, cold, deep lakes, although some are found in shallow lakes or in rivers associated with lakes.

The young fish stay under cover until their yolk sacs are absorbed and remain on the bottom hiding from predators and feeding on plankton and bits of plant material. After growing to about six to eight inches, they leave the bottom and begin solitary wandering, which continues, except for spawning periods, throughout life.

Lake trout are found near the surface in the spring at the time of ice break-up. As the water warms up in summer, the fish move deeper to remain below the thermaline in the cold bottom waters, preferring temperatures between 40° and 50°F. In the autumn mature fish move into the shallows to prepare for spawning, returning to the same site in successive spawnings. After spawning, the fish disperse and wander throughout the system. Lake trout may be found at every level in the winter.

Growth is generally slow. Lake trout are long-lived, with one fish reportedly attaining 40 years of life.

LIFE HISTORY - EASTERN BROOK TROUT

Taxonomy

The eastern brook trout (Salvelinus fontinalis) is a char in the family Salmonidae.

Distribution

Brook trout are native to the eastern part of North America from the mountain streams in Georgia north to Hudson Bay. They have been widely introduced around the world, however, including Alaska. Numerous introductions were made in southeast Alaska in the 1920's and 1930's, but viable populations have survived only in a few lake and stream systems near Juneau, Ketchikan and Sitka.

Spawning

Sexual maturity is usually attained by age three, but some individuals may mature by age two. Brook trout are fall spawners, with spawning occurring between September and December in Canada. Spawning time occurs earlier with increased latitude. Spawning occurs primarily in shallow headwaters of streams, but fish will spawn in lakes in gravel areas with upwelling groundwater. The usual site is a riffle area with a substrate of small gravel. Spawning takes place in the daytime. Females, depending on size, deposit from 100 to 5,000 eggs. The eggs are covered within the redd.

Egg incubation depends on temperature. At 41°F eggs hatch in 100 days, at 50°F in 50 days. Young fry remain in the gravel until the yolk sac is absorbed.

Habitat

Brook trout are found in cool, clear, well-oxygenated lakes and streams. Anadromous populations may occur, but none are known in Alaska. Brook trout tend to mature early and can quickly over-populate a stream or small lake. Stunting of individuals is quite prevalent under these conditions. The brook trout is relatively short-lived, rarely living beyond five years and never beyond eight years.

LIFE HISTORY - WHITEFISH

Taxonomy

Whitefish will be dealt with as a group because of their overlapping ranges and biology. Whitefish belong to the subfamily Coregoninae of the family Salmonidae. Three genera with eight species are known in Alaska. The genera *Stenodus* is represented by the sheefish *S. leucichthys*, which is covered in another section. Genus *Prosopium* is represented by two species: *P. cylindraceum* (round whitefish) and *P. coultari* (pygmy whitefish). Genus *Corogonus* is represented by the following: *C. clupeaformis* (humpback whitefish), *C. nasus* (broad whitefish), *C. sardinella* (least cisco), *C. autumnalis* (Arctic cisco) and *C. laurettae* (Bering cisco).

Distribution

Whitefish are widespread in the cooler parts of the northern hemisphere. In Alaska, ranges and characteristics of these fish sometimes overlap. They are found in the large rivers in southeast Alaska which drain interior British Comumbia, in the Copper and Susitna River drainages and are widely distributed from Bristol Bay to the Arctic Ocean. They are also abundant in interior streams and lakes. The humpback whitefish is most widely distributed in Alaska, but broad and round whitefish are very common in the interior. Ciscos are very abundant along the Bering Sea and Arctic Ocean coast drainages.

Spawning

Whitefish are generally fall spawners in Alaska. Spawning migrations begin as early as mid-July and run as late as December. Spawning areas vary with the habitat of the population, but in general whitefish prefer the shallows of small rivers, tributaries, or river mouths, but may also use the shallows or shoals of lakes. Spawning takes place over sand, gravel or hard substrates. Stream temperatures during spawning vary from 42° to 32°F, and some fall spawning populations may spawn under ice. No nest or redd is built, so the eggs are dispersed more or less randomly to drift with the current.

After spawning, the adults leave the spawning grounds for feeding or wintering grounds. The eggs incubate during the fall and winter and hatch in March and April. By June the fry are dispersed to pools to rear.

Habitat

Further discussion of distribution, habits and habitat will be discussed separately by species.

Round Whitefish

Round whitefish primarily dwell in streams and lakes and are not found in estuaries. In rivers they may be found throughout the river but they seem to prefer swift currents in the clear headwater regions. They are most abundant in gravel-bottom streams throughout the interior and arctic regions, but are found down to the Taku River drainage in southeast Alaska.

Pygmy Whitefish

Pygmy whitefish have been reported in the clear rivers and lakes of Bristol Bay and the Alaska Peninsula. Their growth is slow and maximum size is seldom more than 7-9 inches. Little is known of their biology.

Broad Whitefish

Broad whitefish are widely distributed in Arctic Alaska, western Alaska, and in the Yukon and Kuskokwim drainages. They are not found in the Copper River or Susitna River drainages. They may be found in estuaries, rivers, and lakes, but are most common in large rivers. They are not found above rapids in the tributaries of large rivers, but prefer slower moving waters. They may have mid-winter downstream migrations, and they overwinter in main river channels and in large lakes.

Humpback Whitefish

Humpback whitefish (lake whitefish) are the most widely distributed whitefish in Alaska, ranging from the arctic coast down to the Alsek River near Yakutat. This includes the entire Yukon-Kuskokwim drainages, Bristol Bay, Susitna River and Copper River drainages. They are found in rivers, lakes, and brackish areas and have both anadromous and non--anadromous forms. Like the broad whitefish, they do not venture up past rapids into headwater streams. In lakes, the fish move into deep, cool waters in the summer,but come back into the shallows in the fall to spawn.

Arctic Cisco

In Alaska, arctic cisco occur in the coastal areas from Demarcation Point through the Beaufort, Chuckchi and Bering Seas to the Bristol Bay area. Arctic cisco are anadromous and reside primarily in nearshore areas or estuaries. They leave this area in the spring and summer, ascend coastal rivers to spawn, and then return to the sea again. They seldom are found very far inland from their home estuary. They overwinter in estuary or delta areas.

Least Cisco

Least cisco have the same general distribution as arctic cisco but are found throughout interior Alaska also. Both anadromous and non-anadromous populations are found. The anadromous populations behave similarly to arctic cisco.

Bering Cisco

Bering cisco are known to occur only in Alaska, from Cook Inlet north to the mouth of the Colville River. Very little is known about their biology but they are coastal and are probably anadromous.

LIFE HISTORY - SHEEFISH

Taxonomy

The sheefish, *Stenodus leucichthys*, is the only member of the genus *Stenodus* in the whitefish family, *Corigonidae*.

Distribution

Sheefish occur in northwestern North America and the arctic drainages of northern Asia to the White Sea. Sheefish in Alaska have been separated into five major populations: Minto Flats, upper Yukon, the lower Yukon, Kuskokwim and Selawik-Kobuk groups. Life history information differs greatly among these different groups.

Spawning

Sheefish age at first spawning varies with population, but males mature at ages 5-8 and females at ages 7-11. Spawning occurs in late September and early October in water temperatures near 40°F (Alt, 1971). Suitable spawning sites are critical and apparently must meet stringent criteria. Water depth is four to eight feet deep, current is fast, and the bottom is composed of differentially-sized gravel. Few spawning grounds are available and entire populations may use one spawning area.

Sheefish do not build a redd but broadcast eggs over the bottom. A 12-pound female may contain 100,000 eggs while a 50-pound female may have up to 400,000 eggs. The slightly adhesive, fertilized eggs fall to the stream bottom and lodge in the gravel. Spawning occurs at dusk and at night. Development of the eggs is slow, taking up to six months.

Habitat

Sheefish primarily reside in the mainstem and estuarine areas of the large rivers mentioned above.

After hatching, the fry drift downstream to begin feeding in the extensive delta areas of the large rivers. Young fish feed throughout the summer and fall months. The Minto Flats and upper Yukon populations overwinter in the mainstem Yukon in the central Yukon area while the Kuskokwim, lower Yukon and Kobuk-Selawik populations overwinter in the respective estuarine delta areas of these rivers.

After ice break-up, the sheefish begin moving upstream, feeding in the main rivers and tributaries. The feeders generally do not venture far awar from the main rivers. The migrations continue upstream through the summer months, but feeding slacks off and ends as the mature fish reach the spawning grounds. Sheefish may travel as far as a thousand miles to spawn. The post-spawning migrattion is rapid and the spent fish begin to feed as they reach their overwintering areas.

Sheefish appear capable of consecutive spawning, but Russian scientists believe that spawning everly two or three years is the rule. Sheefish on the Selawik-Kobuk area may live up to 21 years of age.

LIFE HISTORY - ARCTIC GRAYLING

Taxonomy

The arctic grayling, *Thymallus arcticus*, is a member of the subfamily Thymallinae of the Salmonidae family. Arctic grayling are commonly called grayling.

Distribution

Arctic grayling distribution is circumpolar in North America and Asia. In Alaska they are found north of the Chugach Mountains to the Arctic Ocean and west to Port Moller on the Alaska Peninsula. Grayling have been introduced to lakes in southeast Alaska and Kodiak Island. In general, these introductions have produced good sport fishing.

Spawning

Grayling occasionally become sexually mature at four years of age, but all are mature by their sixth year. Grayling spawn about ice breakup time on small streams, usually between April and June in Alaska. As the ice goes out in the small streams, adults migrate from ice-covered lakes and from larger rivers to small gravel or rock-bottom tributaries. Where no suitable small streams are available, spawning takes place in gravelly to rocky parts of the main rivers. Grayling may travel over 100 miles to reach their spawning grounds and will home to a particular stream (Reed, 1969).

On the spawning ground, the male establishes a territory in a riffle, usually 6-8 feet wide and 8-10 feet long. No redd is dug, but small depressions sometimes result from spawning activity. The eggs are fertilized and extruded over the gravel, where they settle and adhere. The female carries an average of 4,000-7,000 eggs. Grayling seem to prefer clear, moderately-flowing waters about 15 inches deep with temperature between 40-43°F for spawning. The eggs hatch in 8-25 days depending on stream temperatures. After spawning, the adults may migrate out to feed in another stream.

Habitat and Migration

Grayling are found in clear, cold waters of large rivers, rocky creeks, and lakes.

Downstream migration of mature fish to the tributary mouth begins in mid-June and coincides with the upstream movement of immature grayling to rearing areas in the tributary. These fish will migrate upstream into headwater areas until early September, when they then drift downstream out of the small tributaries into the main river or lake. All age classes overwinter in larger rivers and lakes.

LIFE HISTORY - SMELT

Taxonomy

Five species of smelt are significant in Alaska: *Mallotus villosus* (capelin), *Hypomesus olidus* (pond smelt), *Spirinchus thaleichthys* (longfin smelt), *Osmerus eperlanus* (boreal smelt) and *Thaleichthys pacificus* (eulachon). Eulachon or "hooligan" are the most often used as a sport species and are taken with hand-held and fine mesh gill nets.

Distribution

Smelt are found on the west coast of North America from San Francisco Bay, California to the Bering Sea. Eulachon are commonly taken in southeastern Alaska around Haines, in the Chilkat River, upper and lower Cook Inlet, and the estuary areas of Bristol Bay.

Spawning

Eulachon reach sexual maturity at 2-3 years of age. They spawn in the spring (May-June), and a few survive spawning and may return to spawn in a subsequent year. The anadromous run usually spawns in the lower few miles of coastal rivers.

The female produces about 25,000 eggs which are shed over sand or gravel. The larvae hatch in two-three weeks and are carried out to sea shortly after emergence.

Habitat and Migration

After entering the sea, eulachon spend the majority of their life in the inshore marine waters. They form part of the food of salmon and seals, and during spawning runs may be taken in great quantities by sturgeon. In fresh water they are taken in large numbers for human and animal consumption.

Arctic records of pond smelt are all from fresh water but littoral spawners exist further south. They are abundant in some of the large Alaskan salmon lakes.

Boreal smelt exist in both the anadromous and landlocked form in Alaska.

The longfin smelt is anadromous, with runs from October through December. It is recorded only from the Bristol Bay region.

The capelin is a beach spawner and is neither anadromous or resident. Spawning occurs in the late fall and early winter.

LIFE HISTORY - NORTHERN PIKE

Taxonomy

The northern pike, Esox lucius, is a member of the family Esocidae, and is often refereed to as pike or jackfish.

Distribution

Northern pike are circumpolar in distribution in the freshwaters of Eurasia and America. In Alaska, the pike ranges from the Alaska Peninsula streams that feed into Bristol Bay northward to the Arctic Coast and throughout the interior. An isolated population is found in the Ahrlin River, southeast of Yakutat, as well as in ponds in that area.

Spawning

Pike in southern Canada have been known to mature as early as age two. Maturity is delayed to age five and six in areas further north. Pike spawn in the spring, sometimes before ice breakup. They migrate under the ice from their wintering areas into shallow bays and sloughs along rivers or in lakes or ponds. They prefer quiet, shallow areas with mud bottoms and dense aquatic vegetation. Depth of spawning ranges from three inches to two feet. No spawning territory is established nor is a nest built. Pike spawn by swimming through the vegetation and randomly dispersing eggs. The eggs are very adhesive and cling to the vegetation. The number of eggs deposited is high (average of 32,000 per female), but egg to fry survival is usually less than 1%. After spawning, the adults disperse to summer feeding areas.

Hatching takes place in 10-12 days at 50°F. The eggs can develop in temperatures from 35° to 73°F.

Habitat

Pike generally prefer clear or brown-stained slow, vegetated rivers or warm, weedy bays of lakes. The young remain in the spawning area for several weeks after hatching. They then move out to establish territories where adequate food and cover exists. In general, pike are found in shallow water in spring and fall, but move into deeper water in summer. Their winter movements are largely unknown. Many of the summer areas dry up, freeze to the bottom, or become oxygen depleted. Pike are assumed to move into the large river systems and lakes to overwinter. Extensive movements have been suspected but not documented for some populations. Generally, movement from overwintering areas to spawning areas is quite short.

Pike are known as voracious feeders, but ae slow-growing in northern areas. Some fish have been reported to be up to 26 years old.

LIFE HISTORY - BURBOT

Taxonomy

The burbot Lota lota, is the only member of the family Gadidae (cods) to live in freshwater. The burbot is also known as freshwater ling, lawyer and lush.

Distribution

Burbot occur in Siberia, northern Europe and northern North America from the Great Lakes basin and the northern Rocky Mountains to Alaska. In Alaska, they occur in the Copper River drainage north and west to the Arctic Ocean and the Bering Sea.

Spawning

Burbot mature in four to seven years of age. In Alaska, spawning occurs under the ice from February through April. Burbot are primarily lake spawners, though some do move into rivers to spawn. The spawning site is usually in one to four feet of water on a sand or gravel bottom or in gravel shoals five to ten feet deep in quiet waters. No nest is made so the spawning fish broadcast eggs over the bottom. Spawning occurs at night. Number of eggs vary greatly depending on size of the female. A 343 millimeter (mm) female may have about 45,000 eggs while a 643 mm fish may have 1,362,000 eggs. The eggs remain on the bottom until they hatch, usually after about 30 days.

Habitat

Burbot generally prefer the cook deep waters of lakes and have been found to depths of 700 feet. In Alaska, they are common in many streams and in lakes of all sizes.

Little is known about the early life history of burbot. Burbot tend to move into shallow water in the summer to feed. Adults and young are often found in river channels, weedy areas of tributary streams and rocky lake shores. After spring spawning, burbot may move into tributary rivers. All movement seems to cease in July after the large fish head for deep water. In the winter burbot are mainly found in shallow areas under 20 feet deep.

After a four year spurt of early growth, burbot grow slowly. Fish over 16 years of age have been recoded in Alaska.