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9.0 APPENDICES

9.1 National Standards of the Magnuson Fishery Conservation and Management Act

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

2. Conservation and management measures shall be based upon the best scientific information available.

3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and inter-related stocks of fish shall be managed as a unit or in close coordination.

4. Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (a) fair and equitable to all such fishermen; (b) reasonably calculated to promote conservation; and (c) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

5. Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Conservation and management shall, where practicable, minimize costs and avoid unnecessary duplication.

9.2 State of Alaska Management Structure

Institutions: The State Organizational Act of 1959 provided for Alaska Statutes, Title 16, which deals with Alaska Fish and Game Resources. Article 1 provides for a Department of Fish and Game whose principal executive officer is the Commissioner of Fish and Game. The Commissioner is appointed by the Governor for 5 years.

The Commercial Fisheries Division was established to manage all commercially harvested fish species in Alaska. The Division is headed by a director who supervises four regional supervisors. The regions are further separated into management areas. Area management biologists are responsible for collecting catch data and monitoring fisheries in their areas.

A Subsistence Section within the Commissioner's Office was recently established to document subsistence needs and utilization and to make recommendations for developing regulations and management plans to ensure subsistence use preference.

The enforcement of fish and game laws and regulations is provided by ADF&G and Alaska Department of Public Safety (ADPS). The Fish and Wildlife Protection officers of the ADPS operate independently of the Department of Fish and Game although communication between the two departments is maintained and activities are coordinated.

Jurisdiction: The Alaska Department of Fish and Game (ADF&G) has management authority over all migratory fish and shellfish species which enter and leave territorial waters of the State during any given year including the migratory fish and shellfish taken from State waters which are indistinguishable, in most instances, from those taken from adjacent high seas areas. Regulations governing migratory fish and shellfish apply in both areas and are enforced by the State's landing laws. These landing laws prohibit the sale or transportation within State waters of migratory fish and shellfish taken on the high seas unless they were taken in accordance with State regulations (1981 Shellfish Regulations, ADF&G).

The Fisheries Regulatory Process: The Alaskan system has a seven member Board of Fisheries, composed of fishermen and other businessmen appointed by the Governor, which considers both public and staff regulatory proposals in deciding on regulatory changes. The adoption of these regulations constitute the State's management plan for its fisheries.

The Alaska Board of Fisheries is required by law to meet or hold a hearing at least once a year in each of the following areas of the State: (a) Upper Yukon-Kuskokwim-Arctic; (b) Western Alaska (including Kodiak); (c) South-central; (d) Prince William Sound (including Yakutat); and (e) Southeast, in order to assure all people of the State ready access to the Board.

Since the late 1960's, the Alaska Board of Fisheries and, before it, the Alaska Board of Fish and Game has held a minimum of two meetings annually to adopt changes in the fisheries regulations. The fall Board meeting, traditionally held in early December, considers proposals for changes in sport fishing regulations and in commercial and subsistence finfish regulations. A spring Board meeting, usually held in late March or early April, considers commercial and subsistence shellfish regulatory proposals.

Regulations which may be adopted by the Board of Fisheries cover seasons and areas, methods and means of harvesting, quotas, and times and dates for issuing or transferring licenses and registrations.

Advisory committees, composed of people informed on the fish and game resources of their locality, serve as local clearinghouses and sources of proposals for Board consideration.

Following submission of public proposals, Department staff members review the proposals and redraft the wording, when necessary, to conform to the style required. The Department also submits proposals for the Board's consideration.

In adopting new regulations, the Board of Fisheries follows Alaska's Administrative Procedure Act. This act has several requirements: At least 30 days prior to the adoption of new regulations, a notice giving the time and place of the adoption proceedings, reference to the authority under which the regulations are proposed, and a summary of the proposed action must be published in a newspaper of general circulation and sent to all interested people who have asked to be informed of the proposals. During the proceedings, the

public must be given an opportunity to testify on the proposed changes. If a new regulation is adopted, it must be submitted to the Lieutenant Governor through the Attorney General's office. Thirty days after being filed with the Lieutenant Governor, the new regulation becomes effective. Because of these requirements, new regulations usually do not become effective until about two months after being adopted by the Board of Fisheries.

Regulatory flexibility is given to the Commissioner of Fish and Game and to his authorized designees to adjust seasons, areas, and weekly fishing periods by emergency order.

The requirements of the preceding paragraph do not apply in the case of emergency regulations, which may be adopted if needed for the immediate preservation of public peace, health, safety, or general welfare. An emergency regulation remains in effect 120 days unless it is adopted as a permanent regulation in the procedure described above. Emergency regulations have the same force and effect as the permanent regulations. The Board has delegated authority to the Commissioner to adopt emergency regulations where an emergency exists as described in AS 44.62.250.

9.3 Biological and Environmental Characteristics of the Resource

9.3.1 Life History Features

Description of Species

There are three commercially important species of king crab in Alaskan waters. The species commonly referred to as the king crab or red crab is Paralithodes camtschatica. The other two commercial species are the blue king crab, P. platypus, and the brown or golden king crab, Lithodes aequispina.

King crabs are not true crabs, such as the Dungeness crab of the Pacific Coast, but are more closely related to hermit crabs. Members of the genera Paralithodes and Lithodes are noted for their large size at maturity, spinate bodies, and only three pairs of walking legs. Fleshy abdomens of king crabs are compressed under their bodies and are covered by a series of protective plates. The abdomen of the female is fanshaped and functions as a brood chamber for fertilized eggs. The legs of king crab are jointed to fold behind the body instead of being jointed forward as are the legs of true crabs. The legs and carapace are spiny, which provides protection from predators.

Sexual dimorphism in adult king crab of the same age is extreme (Figure 4). Only the large male crab are currently of economic importance. Male king crab may grow as large as 24 pounds in 15 years while a similarly aged female is but 10 pounds. Commerically caught males average about 7 pounds and are 7 or 8 years old. Crabs this size measure about three feet across with legs extended.

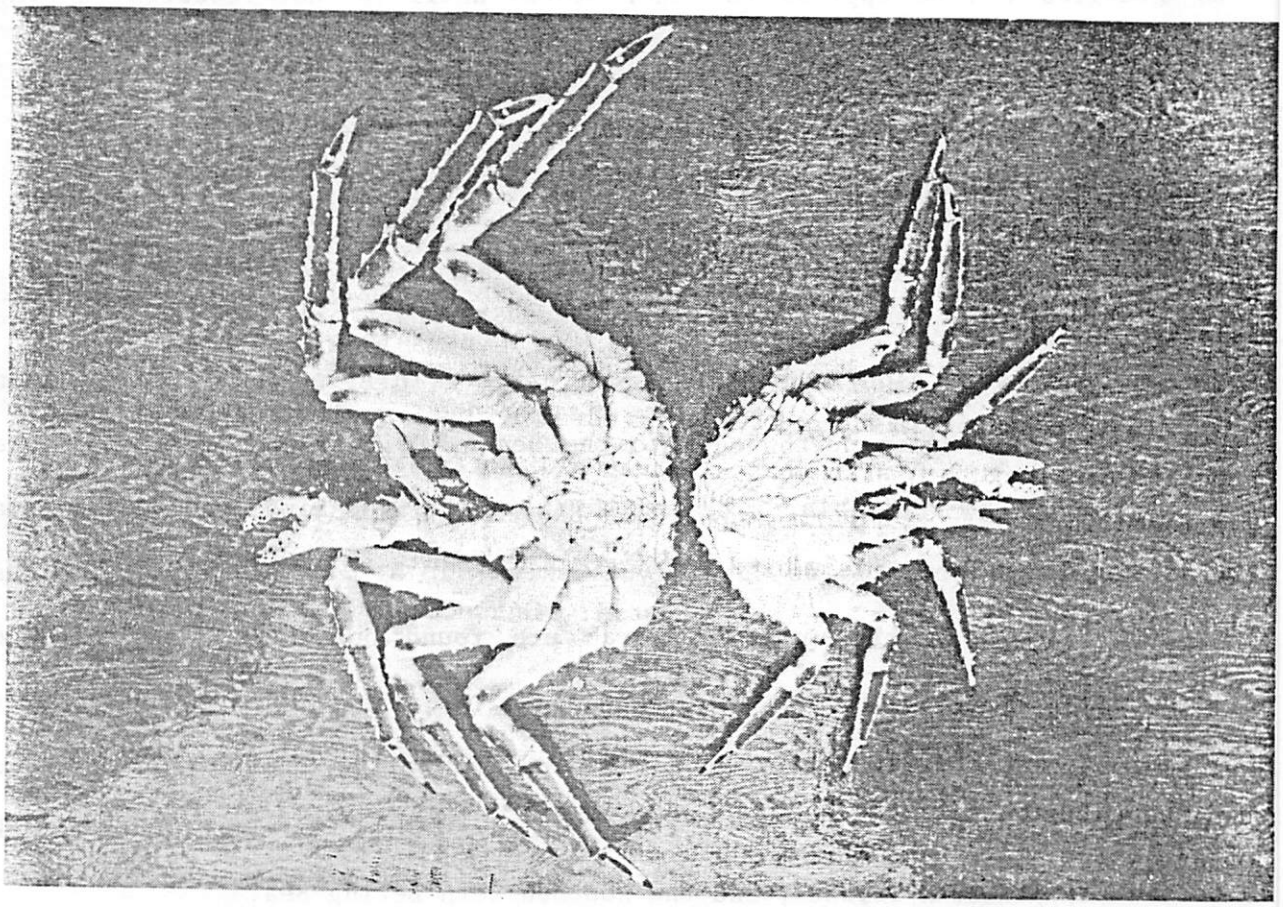

Figure 4. Sexual dimorphism of king crab (male left; female right).

Photo from G. Powell

The majority of king crab research has been directed towards the red king crab because of its commercial importance. Consequently, this section emphasizes the life history of this species. Much of the life history research on king crab has been conducted on stocks of crab around Kodiak Island. The results to a degree can be applied to other stocks until further research on other important stocks is conducted.

General Distribution

The red king crab is the most widespread and abundant of the three commercial species harvested along the North Pacific rim. 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 of red king crab on the Asian coast has been reported as Cape Olyutorskiy (60° N. latitude). On the west coast of North America red king crab are found northward from Vancouver Island, British Columbia to Norton Sound in the Bering Sea. King crab are abundant in the Western Gulf of Alaska and the Bering Sea. Major fisheries exist at Cook Inlet, Prince William Sound, Kodiak Island, south Alaska Peninsula, Aleutian Islands, and the southeastern Bering Sea.

The blue king crab has a more limited distribution with scattered populations along the Asian coast (Marukawa 1933). Other populations are found in the eastern Bering Sea, Olga Bay on Kodiak Island, and in Icy Strait, Auke Bay, and Gambier Bay in Southeast Alaska (Wallace et. al. 1949).

The brown king crab is the least abundant king crab in Alaskan waters. It characteristically inhabits deeper waters along the continental slopes of the

North Pacific Ocean, the Bering Sea, and the Okhotsk Sea. This crab enters the commercial catch in limited quantities in Southeast Alaska, Kodiak, and Adak. Little is known of its life history.

The distribution of red king crab in the southeastern Bering Sea is related to the bottom temperature. Data compiled over a five-year period and analyzed by Stinson (1975) indicate that males inhabit a temperature range from 0 to 5.5° C with a maximum abundance at 1.5° C during summer months. Adult females inhabit the same temperature range with maximum abundance between 3° and 5° C. King crab have been found in depths of 200 fathoms (fm) or more although the majority of the commercial fishery is taken from depths less than 150 fm. Juveniles are abundant in inshore waters and in relatively shallow (less than 75 fm) waters offshore. Most king crab are harvested from soft substrates of mud or sand.

Although adult king crab are found in most Alaskan waters, tagging evidence demonstrates that they belong to discrete stocks rather than one population. During the course of tagging studies in the southeastern Bering Sea, thousands of king crab have been tagged but none have been recovered in the Gulf of Alaska (Simpson and Shippen 1968). Moreover, Hayes and Montgomery (1963) reported that crab marked in the Shumagin Islands area had never been reported in either the Bering Sea or Kodiak Island fisheries. Crab tagged in the Kodiak Island fishery have not been recovered in other fisheries (Powell and Reynolds 1965).

Age and Growth

King crab like all crustaceans have rigid exoskeletons and must molt (ecdysis) to increase in size. Growth in length occurs immediately after molting and before the new exoskeleton hardens. Growth therefore is divided into two parts: the increase per molt and the frequency of molting. Unlike the smooth growth function in fishes where growth may take place relatively continuously through the year, growth in length in crabs is a step function.

Several studies of king crab growth are presented in the literature for the Bering Sea (Weber and Miyahara 1962; Weber 1965; Hoopes and Greenough 1970; Balsiger 1974;) and Gulf of Alaska (Powell 1967; Eldridge 1975; McCaughran and Powell 1977). All these studies (except Weber) examined tagged king crab in the commercial fishery.

A model for king crab growth in the Bering Sea is presented in Figures 5 and 6. Some age specific conversion factors for southeastern Bering Sea male red king crab are presented in Table 2. A similar model for the Kodiak area is presented in Figure 7. Molting frequency schedules for the Bering Sea and Kodiak are presented in Figures 8 and 9.

The time interval between molts progressively increases from a minimum of approximately three weeks for early post-larval juveniles to a maximum of three years for adult males. Molt frequency for juveniles of both sexes is similar. After attaining sexual maturity in the fifth year, young adults molt annually. An agelength key is presented in Table 3. Molting of adult females is correlated with mating and occurs annually just prior to copulation.

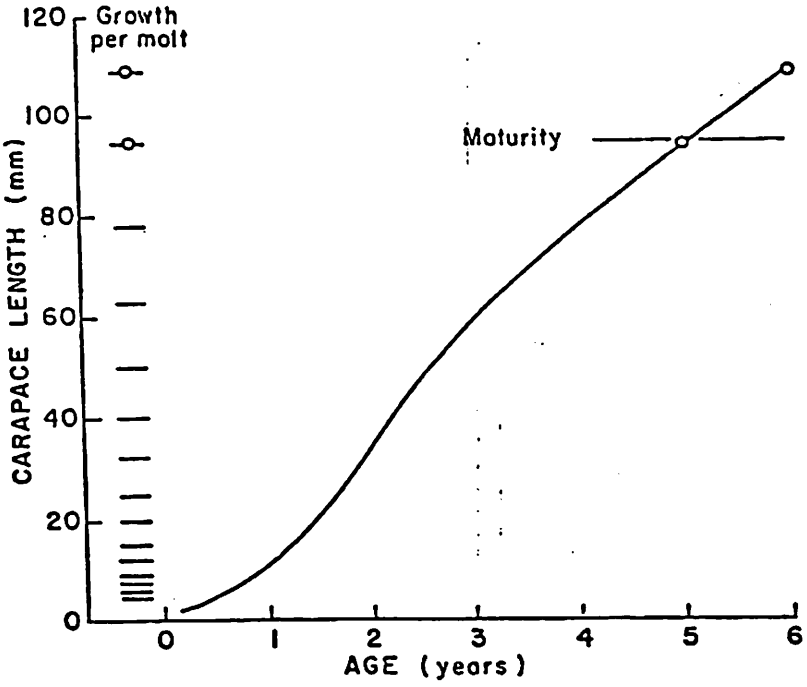

Figure 5 Growth curve for the southeastern Bering Sea immature king crab. Cumulative growth per molt is shown on the left.

Source: Weber (1965)

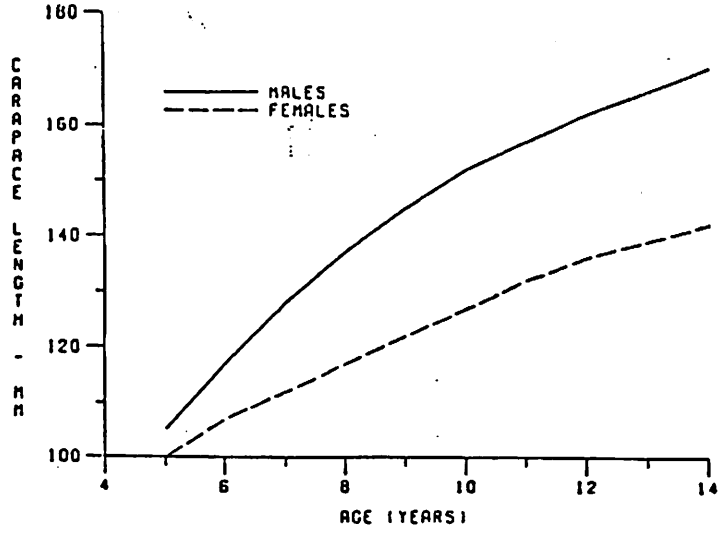

Figure 6 Growth curve used in simulation for adult male and female red king crab in the southeastern Bering Sea.

Source: Reeves and Marasco (1980)

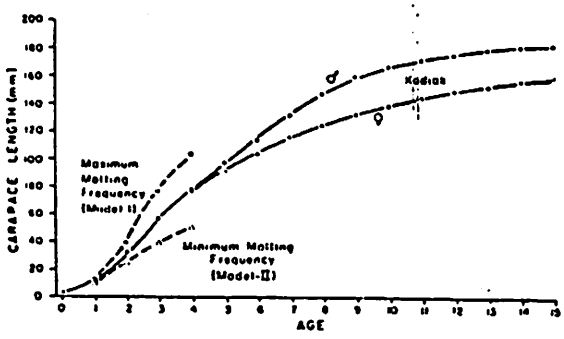

Figure 7 Simulated mean carapace length as a function of age for Kodiak male king crab and simulated mean carapace lengths under maximum and minimum probability of molting for juvenile male king crab.

Source: McCaughran and Powell (1977)

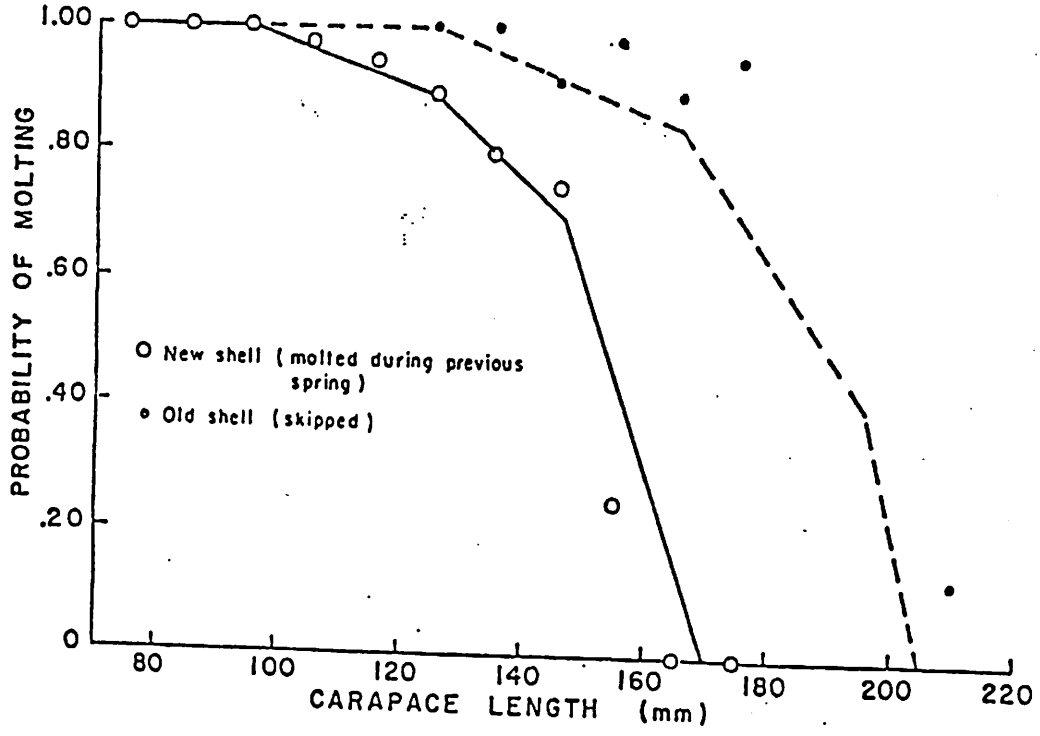

Figure 8 Probability of molting of male king crab from the Bering Sea.

Source: Balsiger (1974)

Table 2. Age-specific conversion factors for Southeast Bering Sea male king crab.

Age	Average Length (mm)	Average Width (inches)	Average Weight (lbs)
4	85	4.2	1.0
5	105	5.2	1.9
6	117	5.8	2.7
7	128	6.3	3.6
8	137	6.7	4.5
9	145	7.1	5.4
10	152	7.5	6.2
11	157	7.7	6.9
12	162	8.0	7.6
13	166	8.2	8.2
14	170	8.4	8.9

Source: Reeves 1980 (unpublished data)

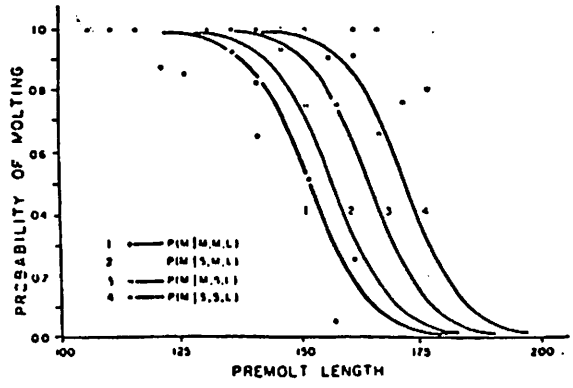

Figure 9 The conditional probability of molting given premolt length and the previous 2 years of molting history for male king crab near Kodiak Island. (Carapace length in millimeters)

Source: McCaughran and Powell (1977)

Table 3 Growth simulation of individual king crab carapace lengths taken from the Kodiak Island area. N = 2000. (Carapace length in millimeters)

	Male king crabs			Female king crabs		
Age	Mean length	SD	Mean length ± 2 SD	Mean length	SD	Mean length ± 2 SD
1	12.58	1.71	9.16–16.00	12.65	1.72	9.21–16.09
2	33.44	5.97	21.49–45.39	33.40	5.90	21.60–45.20
3	57.85	12.08	82.00–33.69	57.35	12.00	45.35–69.35
4	78.87	16.90	45.08–112.67	77.36	14.84	48.80–105.92
5	95.52	18.86	57.80–133.24	91.01	14.31	62.39–119.63
6	113.62	20.24	73.15–154.09	103.67	12.74	78.19–129.15
7	131.57	19.38	92.82–170.33	114.63	10.92	92.79–136.47
8	146.97	16.40	114.17–179.76	123.88	9.25	105.38–142.38
9	158.29	12.60	133.13–183.45	131.57	8.13	115.31–147.83
10	165.89	9.70	146.48–185.28	137.59	7.30	122.99–152.19
11	170.90	8.36	154.19–187.61	143.64	6.61	130.42–156.86
12	174.63	7.47	159.70–189.56	148.49	6.20	136.09–160.89
13	177.59	6.74	164.10–191.07	152.69	6.00	140.69–164.69
14	179.66	6.36	166.95–192.38	156.42	5.96	144.50–168.34
15	181.63	5.96	169.71–193.55	159.73	5.91	147.91–171.55

Source: McCaughran and Powell (1977)

Ecdysis of males apparently is a function of growth independent of reproduction. Most adult males molt annually through the seventh year. During the eighth and succeeding years increasing proportions of the age class begin to molt every two years. The probability of molting for male crabs that have skipped two molts is very high, hence, very few male crab molt less frequently than biennially.

A study by Powell et al. (1973) indicates that both sexes in the Kodiak area attain sexual maturity at approximately the same size (4 inches in carapace length) and the same age (5 or 6 years). In the southeastern Bering Sea both sexes mature also at approximately 4 inches in carapace length and are 5 or 6 years of age (Weber 1967).

Mortality

Eldridge (1975) summarized mortality rates in exploited king crab populations. He examined data from the Kodiak fishery and reviewed studies presented by other authors for different fishing locations, primarily the Bering Sea. Mortality rates of king crab are very difficult to estimate. The major problem in developing these estimates is the difficulty in accurately aging king crab. There may also be effects of the commercial fishery which may alter the size or age.

The data suggest that natural mortality of male king crab increase with size. Smaller males appear to have a relatively low natural mortality rate. Eldridge's best estimates indicate that for the Kodiak fishery males between the size of 125 and 163 mm in carapace length have an annual instantaneous

mortality rate of approximately 0.15. Further he suggests the upper limit for the natural mortality rate for larger males may be equal to or less than 0.40.

Balsiger (1974) examined mortality rates of king crab in the southeastern Bering Sea. He used tagging data to distinquish between fishing and natural mortality rates. Later, Reeves and Marasco (1980) developed estimates of natural mortality rates for king crab based on survey estimates of abundance by age. An overall estimate of natural mortality was obtained by averaging over the years 19701979. This average of M .26 was determined to be 24 percent lower than the weighted average of .34 calculated from Balsiger's (1974) M schedule. Reeves (unpublished data) has therefore adjusted age-specific values of M for ages 9-14, leaving estimates for ages 5-8 unchanged. His estimates of natural mortality and average length for ages 5-14 are presented in Table 4.

Reproduction

Around Kodiak Island migration of spawning males to shallow water areas begins in January and continues through April as males search for adult females. The character of the migration varies by year and area depending upon environmental conditions.

One feature of king crab life history is that the ratio of males to females varies between adjacent areas, indicating segregation between sexes. Segregation occurs upon attainment of sexual maturity and is maintained to a large extent during much of each year except during the mating season. Adult king crab also segregate by size and shell age within sexes (Miyahara and Shippen 1965; Powell et al. 1974).

Table 4. Age-specific population parameters used in king crab simulations.

Age	NATURAL MORTALITY (annual M)		AVERAGE LENGTH (mm)	
	Male	Female	Male	Female
5	.13	.58	105	100
6	.12	.58	117	107
7	.08	.58	128	112
8	.08	.58	137	117
9	.11	.58	145	122
10	.23	.58	152	127
11	.50	.58	157	132
12	.57	.58	162	136
13	.61	.58	166	139
14	.76	.58	170	142

*Ages 5-7 estimated by back-calculation using the natural mortality schedule.

Source: Reeves 1980 (unpublished data)

The female migration begins at about the same time as the male migration. When the females arrive on the spawning grounds they form large congregations and emit a pheromone which attracts the males. For mating to be successful among the females of each congregation, an adequate number of capable males must be present in the vicinity of the aggregation during the relatively brief receptive period following female ecdysis. Mating will be unsuccessful for those females which must wait for a male partner for more than 5 days after molting (Powell et al. 1974).

Males select females according to their behavior and relative size. Males in nature almost always select females the same size or smaller. The mating procedure requires the male to "grasp" the female while he waits for her to molt; however, as pointed out by Marukawa (1933), it is not necessary that males be present for the female to be able to molt.

The male king crab grasps the female by the meropodite of both chelipeds while oriented anteriorly. The "grasping" seems to serve three functions: (1) keeping breeding adults together until mating has occurred; (2) the male protects the female during the molting process; and (3) aiding the female to exuviate (Powell and Nickerson 1965).

After assisting the female to molt, the male regrasps his soft partner in the same manner as before. He inverts her beneath his body and spreads spermatophore bands over her gonopores. Ovulation usually occurs after this procedure and the eggs are fertilized before they attach to the pleopod. The eggs remain there, protected by the abdominal flap, for about eleven months.

Males leave the female after fertilization and search for another female. Male king crab are polygamous and are capable of fertilizing an average of seven females (Powell et al. 1974).

From 1963 through 1971, 3,509 grasping pairs were observed by divers along 150 miles of Kodiak's eastern shoreline (Powell et al 1974). Analysis of the size of breeding males reveals that only 0.2 percent of the males were smaller than 4 inches, 3 percent were smaller than 5 inches, 14 percent were smaller than 7 inches, and 83 percent were 7 inches or larger. Recently molted males constituted 39 percent of the graspers while 61 percent were skip molts.

Examining the data on undersize males showed that the sublegal broodstock was comprised primarily of oldshell crab (70%). This is particularily interesting since the population of sublegal males was comprised of only 2 percent oldshells (Eldridge, Powell, and Chapman 1980). Several authors have reported finding oldshell crab congregated with females in the mating season (Gray and Powell 1966; and Miyahara and Shippen 1965). Males that molt during the mating season may not mate after molting because molting may interfere with mating, molting areas may be distant from mating grounds, or recently molted males may not be able to compete with hardshell nonmolting males. Size differences between partners reveal that 97 percent of brood males are larger than their female partners. Of 14 matings where females were larger than their male partners, 11 produced partial clutches (Powell, James, and Hurd 1974). Small males probably produce less spermatophore bands than large males, and as a result, may be less capable of fertilizing the greater egg masses of large females.

Observations indicate that small adult males do not participate in mating until 2 years after attaining sexual maturity. The extent to which small adults attempt to mate and their ability to compete with larger males remain unknown.

Female king crab carry the fertilized eggs for about 11 months before hatching occurs. The eggs hatch during the three-month period of March, April, and May. Upon hatching, zoea larvae are about 1 mm in width and are capable of swimming, but are largely dependent on the flow of currents for movement and distribution.

The lack of oceanographic current data limits the knowledge of king crab larval drift. Studies of the drift of halibut larvae have been completed in some areas of Alaska (Thompson and VanCleve 1936) providing at least some information upon which assumptions of crab larval drift can be based. The currents distribute the larvae into nursery areas that are shallow and close to shore. As crab larvae molt through their successive stages, they gradually settle in the water column until they assume a benthic existence. After the sixth molt, the first recognizable adult form is attained, with a size of about 2 mm in carapace length.

Juvenile king crab less than 2 years old exist mainly as solitary individuals, living under rocks and debris. Juvenile king crab increase in size at the rate of 25 percent per molt. In their second and third year, crab begin to form tightly packed schools called "pods". These pods contain as many as 6,000 individuals with up to 50 crabs stacked on top of each other (Powell and Nickerson 1965; Powell 1974). After reaching puberty the crab segregate by sexes and begin an annual cycle of movements typical of the adult.

Predation

A high mortality occurs during the larval stages due to plankton feeding animals. Juveniles, because of their small size, are susceptible to predation by fish and large invertebrates. Powell (1974) has observed sculpins feeding on juveniles.

Adult crab are particularly susceptible to predation when they are in the softshelled stage. The only animals known to prey upon larger king crab for much of their diet are halibut and marine mammals. Gray (1964) removed 3 mature female king crab from the stomach of an 80 pound halibut. All were softshelled and the largest measured 4.9 inches. Wallace et al. (1949) stated that newly molted crab are frequently found in the stomachs of halibut, cod, and sculpins.

Recruitment

King crab are recruited into the commercial fishery when they molt to the minimum legal size. Accurate recruitment data are only available for those fisheries which have a stock assessment program. The only two areas which have had a long term research programs are the southeastern Bering Sea and Kodiak. Recruitment data from these fisheries are presented in Tables 5 and 6. Although research surveys have been conducted along the Alaska Peninsula, Dutch Harbor, Adak, the Pribilof Islands, and the northern Bering Sea, these programs are too new and/or too limited to yield sufficient data to accurately reflect recruitment trends.

Table 5. Estimates of recruitment to the legal-sized male red king crab population in the Southeastern Bering Sea stock as measured by millions of 5 year old male crabs.

Year	No. of Recruits (millions)	Year	No. of Recruits (millions)
1968	9.5	1975	18.3
1969	15.9	1976	27.2
1970	3.4	1977	45.6
1971	--	1978	20.5
1972	7.4	1979	10.6
1973	19.2	1980	14.9
1974	14.7		

Source: Reeves 1980 (unpublished data)

Table 6. Research stock assessment estimates of recruitment to the legal-sized male red king crab population in the Kodiak crab fishery.

Year	Million of Pounds
1974	37.8
1975	26.0
1976	17.7
1977	13.6
1978	23.5
1979	53.8
1980	39.1
7 year average	30.2

Source: Alaska Department of Fish and Game
Westward Region (unpublished data)

Recruitment in king crab is known to fluctuate greatly, for example, the harvest of king crab from the Kodiak area during the mid 1960's to early 1970's. The management strategy under which the fishery operated allowed a year round fishery on crabs above a specific size limit. During this period the annual catches increased to 94 million pounds in 1965 and then rapidly declined to 10 million pounds by 1971. Although there are no recruitment values for the Kodiak fishery during this period, it is assumed that the 9-fold decrease in catches directly resulted from poor recruitment into the fishery.

King crab recruitment into the Bering Sea fishery, based on trawl survey catches of 5-year old crab, has shown record recruitment during the past several years. This trend is reversing and the recruitment is expected to decline to the previously documented average levels.

Recruitment estimates in the Gulf of Alaska fisheries are based on the catch composition correlated to population estimates from pre-season surveys using pot gear. For the past seven seasons the average annual recruitment to the Kodiak fishery has been 30 million pounds. This average recruitment is from a time period in which the recruitment is strongly suspected of being below that of mid 1960's.

9.3.2 Habitat

Due to the complexity of the habitat in which king crab exist, this section will be limited to a review of related studies.

INPFC annual reports and associated documentation provide a summary of oceanographic research conducted by the United States, Canada, and Japan in the waters that are inhabited by king crab. The series entitled Soviet Investigations in the Northeast Pacific (Moiseev 1964) provides a fairly complete analysis of the Bering Sea as a habitat. A more recent comprehensive review of the Bering Sea environment is given in Oceanography of the Bering Sea (Hood and Kelly 1974). McLain and Favorite (1976) describe recent anomalous climatic conditions in the Bering Sea and discuss the possible effects on fisheries. Bright et al (1960) and Trasky et al (1977) have summarized environmental data for the Kachemak Bay area of Cook Inlet. Pereyra et al (1976) and Wolotira et al (1977) describe the baseline biological surveys conducted as part of the Bureau of Land Management Outer Continental Shelf Environmental Assessment Program.

9.3.3 Ecological Relationships

Very little is known about the interactions of king crab with their physical and biotic environments. Most of the information about king crab pertains to natural history or descriptive bionomics. Knowledge of the functional aspects (intra- and interspecific relationships) is still rudimentary.

Marine Mammal/King Crab Interactions

In general, there is minimal interaction between king crab and marine mammals. The major exceptions are the bearded seals (Erignathus barbatus) and the sea otter (Enhydra lutris).

Unlike most seals which are pelagic feeders, the bearded seal is a benthic feeder. Tanner crab and, to a lesser extent, king crab constitute part of the diet. The king crab taken by the bearded seal are generally smaller than commercial size so direct competition with the commercial fishery is avoided, though the commercial fishery is deprived of potential harvests. The degree of predation upon crab by bearded seals has not been quantified.

The sea otter feeds upon a wide variety of fish, sea urchins, clams, mussels, crabs and octopus. Sea otters may take any size of king crab including commercial sized crab. The frequency and significance of such predation are unknown. There has not been any documentation of intensive feeding of sea otters upon king crab. In near shore areas where sea otter occur, there exists the potential for incidental mortality when sea otters enter king crab pots and cannot escape. Sea otters regularly dive to 30 fathoms in search of food and have been recorded at depths as great as 50 fathoms. There is the potential for conflicts between fisherman and sea otters when crab pots are set in relatively shallow water near shore. The occurrence of sea otter mortality due to drowning in crab pots is rare but it is a possible occurrence where sea otters and crab fishing areas overlap.

Indirect interaction between the pelagic-feeding seals and king crab does occur, in the sense that, king crab larve constitute part of the zooplankton utilized by the forage fish, such as herring and capelin, which are preyed upon by these seals. The contribution of king crab larvae to the diets of these forage fishes, the subsequent impact of this predation on the population of adult king crab and any role played by seals in regulating the numbers of these fishes are unknown. Subsequent research will have to investigate the significance of the interactions between these species.

9.3.4 Catch and Effort Data

The State has maintained a commercial catch fish ticket system since statehood (1959). Prior to statehood, the Bureau of Commercial Fisheries collected similar data. Currently the state requires the buyers of commercially-landed king crab to complete a record of sale at the time of landing. This record includes the buyer's name, vessel number, type and quantity of gear used; catch by species in numbers of fish or weight; statistical reporting area; and value of catch. Each ticket is collected by the Department, edited for accuracy, then key punched for data processing. A variety of reports are generated for management purposes. This data base does not include a minor subsistence fishery. In recent years deadloss (wastage) by the commercial fleet has been estimated and included in the final season totals.

Effort data are recorded on each fish ticket as the number of crab pots pulled for each landing. The use of these data has two serious limitations. Reporting the exact numbers of pots pulled is the greatest source of error, followed by the problem of standardizing effort. At best these estimates of effort can only show gross trends in the fishery. The historical catch and effort data by management area are presented in Tables 7-10.

In 1962, a voluntary logbook program was instituted in Kodiak. This program was found to be inadequate and was replaced in 1973 by a vessel captain interview program. The dockside vessel captain interview and commercial catch sampling programs are now the primary means of collecting effort information from the fleet. The interview system collects information on effort levels, precise fishing locations, and tag recoveries to determine fishing mortalities.

Table 7. Catch and effort statistics for Southeast Bering Sea red king crab and Pribilof blue king crab fishery.

Fishing Season	Species	No. Vessels Making Landings	No. Landings	No. Pot Lifts	No.[1/] Crab	No.[1/] Pounds	No. Crab Per Pot	Ave. Lbs. Per Crab
1966-67	Red	9	15	2,720	140,554	997,321	51.7	7.1
1967-68	Red	20	61	10,621	397,307	3,102,443	37.4	7.8
1968-69	Red	59	261	47,496	1,278,592	8,686,546	26.9	6.8
1969-70	Red	65	377	98,426	1,749,022	10,403,283	17.8	5.9
1970-71	Red	51	309	96,658	1,682,591	8,559,178	17.4	5.1
1971-72	Red	52	394	118,522	2,404,681	12,945,776	20.3	5.4
1972-73	Red	64	611	205,045	3,994,356	21,744,924	19.5	5.4
1973-74	Red	67	441	194,095	4,825,963	26,913,636	24.9	5.6
	Blue	--	13	6,814	174,420	1,276,578	25.6	7.3
1974-75	Red	108	599	211,918	7,653,944	41,945,768	36.2	5.5
	Blue	--	101	45,519	908,072	7,107,294	19.9	7.8
1975-76	Red	102	592	205,096	8,745,294	51,326,259	42.6	5.7
	Blue	20	54	16,297	314,931	2,433,714	19.3	7.7
1976-77	Red	141	984	321,010	10,653,288	63,919,728	33.0	6.0
	Blue	47	113	71,738	855,505	6,611,084	12.1	7.7
1977-78	Red	130	1,020	451,273	11,857,895	69,967,868	26.0	5.9
	Blue	34	34	28,521	807,092	6,456,738	8.0	7.9
1978-79	Red	162	926	406,165	14,962,951	87,618,320	36.0	5.8
	Blue	58	154	101,117	789,569	6,395,512	8.0	8.1
1979-80	Red	236	889	315,226	16,806,605	107,828,057	53.0	6.4
	Blue	46	115	83,527	778,601	5,995,231	9.0	7.7
1980-81	Red	236	1,251	567,292	20,845,350	129,948,436	37.0	6.2
	Blue	110	258	167,684	1,497,101	10,970,246	9.0	7.3

1/ Beginning with 1974-75 deadloss included.

Source: Westward Region Shellfish Report to the Alaska Board of Fisheries, March, 1981.

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Table 8. Catch and effort statistics for the Adak king crab fishery.

Fishing Season		No. Pounds[1/]	No. of Vessels Making Landings	Landings	No. Pot Lifts
1971-72		15,475,924	40[2/]	166[2/]	46,011[2/]
1972-73		18,702,464	53	308	80,457
1973-74		9,742,731	56	235	69,457
1974-75		2,774,963	40	97	32,540
1975-76		437,073	21	26	8,616
1976-77	Brown	2,285	2	2	110
1977-78	Red	905,527	12	18	7,269
	Brown	47,445	1	1	1,200
1978-79	Red only	807,195	13	27	13,948
1979-80	Red	467,229	18	23	9,757
	Brown	23,485	1	1	325
1980-81[3/]	Red	1,419,513	18	52	--
	Brown	58,914	--	3	--

1/ Includes all species of king crab unless otherwise designated.

2/ Does not include western Aleutians vessel effort.

3/ Preliminary data.

Source: Westward Region Shellfish Report to the Alaska Board of Fisheries, March, 1981.

Adak, Western Aleutians Monthly Shellfish Report, 1981.

Table 9. Catch and Effort Statistics for the Dutch Harbor King Crab Fishery.[1/]

Fishing Season	No. Pounds (thousands)	No. Vessels Making Landings	No. Landings	No. Pot Lifts
1961-62	533	4	69	--
1962-63	1,536	6	102	--
1963-64	3,893	4	242	--
1964-65	13,761	12	336	--
1965-66	19,196	21	555	--
1966-67	32,852	27	893	--
1967-68	22,709	34	747	--
1968-69	11,300	44	--	--
1969-70	8,950	41	375	72,683
1970-71	9,652	32	268	56,198
1971-72	9,392	32	210	31,531
1972-73	10,450	51	291	34,037
1973-74	12,723	56	290	41,840
1974-75	13,991	87	372	71,821
1975-76	15,907	79	369	86,874
1976-77	10,198	72	287	83,094
1977-78	3,684	33	234	47,429
1978-79	6,824	60	300	51,783
1979-80	14,980	104	540	120,354
1980-81	18,902	121	947	260,602

1/ Deadloss included beginning in 1974-75.

Source: Westward Region Shellfish Report to the Alaska Board of Fisheries, April, 1979.

Westward Region Shellfish Report to the Alaska Board of Fisheries, March, 1981.

Table 10. Western Alaska king crab catch by fishing season by domestic fishermen from 1966-67 through 1980-81[1/] in millions of pounds.

Fishing Season	Kodiak	Alaska Peninsula	Dutch Harbor	Adak	Western Aleutian[2/]	Bering Sea
1966-67	73.8	24.4	32.8	5.9	--	1.0
1967-68	43.4	12.6	22.7	14.1	0.8	3.1
1968-69	18.2	10.9	11.3	16.1	1.9	8.7
1969-70	12.2	4.1	9.0	18.0	1.6	10.4
1970-71	11.7	3.4	9.6	16.0	0.5	8.6
1971-72	10.9	4.1	9.4	15.4	0.0	13.0
1972-73	15.5	4.1	10.4	18.0	0.7	21.7
1973-74	14.4	4.3	12.7	9.0	0.7	28.2
1974-75	23.6	4.6	14.0	2.5	0.2	49.4
1975-76	24.1	2.6	15.9	0.3	0.1	53.3
1976-77	18.0	1.0	10.2	0.0	--	69.6
1977-78	13.5	0.7	3.7	1.0	--	78.0
1978-79	12.0	3.1	6.8	0.8	--	98.1
1979-80	14.6	4.4	15.0	0.5	--	117.3
1980-81	20.4	5.1	18.9	--	--	143.2

1/ Deadloss included beginning 1974-75.

Source: Westward Region Shellfish Report to the Alaska Board of Fisheries, April, 1978.

Westward Region Shellfish Report to the Alaska Board of Fisheries, April, 1979.

Westward Region Shellfish Report to the Alaska Board of Fisheries, March, 1981.

This information is used to edit fish tickets and is the primary source of data for monitoring the progress of the fishery.

9.3.5 Survey and Sampling Data

There are currently three programs used to monitor the conduct of the commercial fisheries. These are the dockside catch sampling program, the high seas stock assessment program, and aerial surveys to determine fleet effort and distribution.

The dockside sampling program began in 1959. The purpose of this effort is to provide information on catch composition by year class as the fishing season progresses. Currently this program is conducted in conjunction with the vessel captain interview and tag recovery efforts. These data are summarized and compared to the age structure analyses from the stock assessment cruises. Further, tag recoveries by the commercial fishery are compiled by statistical fishing area and fishing mortalities are closely monitored.

The high seas stock assessment program is conducted by the Department of Fish and Game for the Gulf of Alaska and by NMFS for the Bering Sea. The Department of Fish and Game, using pot gear, has conducted surveys of the Kodiak area since 1972. Later these surveys were expanded to the Alaska Peninsula, Dutch Harbor, and Adak. NMFS has conducted annual trawl surveys in the Bering Sea since 1968. Both of these surveys are designed to 1) determine the abundance of each size group; 2) assess female ovigerity; and 3) determine the level of acceptable biological catch. The Bering Sea population estimates are obtained using a combination of the area swept technique (Alverson &

Pereyra 1969; Hoopes and Greenough 1970) and stratified random sampling techniques (Cochran 1963). Stratification is based on the density of crabs for each species. Variance of population estimates, used in computing confidence intervals, are also derived according to stratified sampling theory. Using these techniques, survey information directly provides estimates of stock size. Results of these surveys are published as processed reports from NMFS Kodiak facility (see Otto et al 1979). The Department's surveys in the Gulf of Alaska provide indirect estimates of population size. An estimate of fishing mortality is made by using the Peterson single census method (Ricker 1975). Preseason population estimates are obtained from the commercial fisheries performance during the previous season in combination with the age-class structure and relative abundance determined from the survey results. In-season estimates of fishing mortality provide the basis for adjustments of harvest levels during the conduct of the commercial fishery. Results of these surveys are published in annual shellfish reports to the Alaska Board of Fisheries (see Powell 1980).

Aerial surveys of the fleet to determine distribution and effort have been used in the Kodiak area since 1975 to assist in management decisions. This technique is also used in the Alaska Peninsula and Dutch Harbor area but to a lesser degree due to restricted budgets. Aerial surveys have become necessary in rapidly expanding fisheries on a dwindling resource. In many smaller geographical areas, the harvesting capacity of the fleet exceeds the available resource thereby intensifying the management problems associated with the fishery.

9.3.6 Current Status of Stocks

Maximum Sustainable Yield

The maximum sustainable yield (MSY) for the fisheries management unit described in this plan is 119 million pounds per year.

The plan development team examined several methods of calculating MSY: (1) averaging the historical catches; (2) various stock production models, e.g. Schaefer's method (Ricker 1975), Gulland's method (Ricker 1975), and a modification of Pella-Tomlinson's GENPROD model (Rivard and Bledsoe 1978); and (3) the Alverson-Pereyra (1969) method using biomass estimates and an estimate of natural mortality. The use of stock production models was rejected by the team due to inconsistent results generated with the above methods. Therefore, the team deemed the long-term catch to be the best estimate of MSY for the BS/AI area except where limited exploitation has occurred as in the Bering Sea northern district red and blue crab fishery. For this area the Alverson-Pereyra method was used.

The MSY for the Bristol Bay management area is 48 million pounds of red king crab per year. This MSY was determined by averaging the long-term foreign and domestic annual harvests from 1960 through 1979. MSY for the Pribilof district of the Bering Sea management area is 5 million pounds of blue king crab per year. The annual harvest from 1974 through 1979 were averaged to determine MSY for the Pribilof district. MSY for the northern district of the Bering Sea management area is 7 million pounds of blue king crab and 4 million pounds of red king crab. The Alverson-Pereyra method was used to estimate the

MSY king crab in the northern district. For the Dutch Harbor and Adak fisheries the MSY are 12 million and 9 million pounds, respectively. The values represent the mean of long-term (1960-1979) annual harvests for each area.

Future Outlook

The outlook for each of the king crab management areas was recently presented by ADF&G and NMFS staff to the Alaska Board of Fisheries meeting April 1981. A summary of these reports follows:

Bristol Bay: Healthy stock conditions are indicated by present survey and harvest data. A series of above average recruit classes began entering the fishery in 1976 and peaked in 1979. The recruitment trend indicates above average stock levels for the 1981 fishery. Recruitment will continue to decline in 1981.

Dutch Harbor: Depressed stock conditions due to poor recruitment persisted from 1975 through 1977. Recruitment was strong in 1977 and research data suggested good fishing during the 1980-81 season. The projection was borne out by the highest commercial catches in 12 years. The 1981-82 fishery should have fairly high catches due to carry over of legal size crab, but recruitment to the fishery appear to be low.

Bering Sea:

1. The Pribilof district blue king crab fishery appears to be stable based on limited survey, effort, and catch sampling information.

2. The Northern district blue king crab resource appears to be widely distributed but low in concentration. There is no reliable stock abundance, however based on historic catches and biological information, the stocks appear to be stable.

3. In the Norton Sound section red king crab fishery stocks appear to be composed of large, old male crab. Recruitment for the 1981 fishery appears to be low. Record catches are projected for the 1981 season.

Adak: Depressed stock conditions have prevailed since 1974. Based on the 1977 charter data, recruitment will continue to be low at Adak for the next several years.

9.3.7 Research Needs

Research studies by the U.S. on king crab since the 1950's have contributed greatly to the general knowledge of distribution, abundance, recruitment and basic life history in many areas of the State. In order to achieve the objectives listed in this plan, an expansion of studies is required to determine the following: (1) accuracy of reported domestic catches and

deadloss; (2) level of incidental king crab catches in the foreign fishery; (3) estimates of current and future biomass; (4) effects of gear (stored and fishing) on king crab and other important fishes such as halibut; (5) accuracy of current growth, mortality and recruitment rates; (6) accuracy of the bioeconomic model for the southeast Bering Sea king crab fishery; and (7) the utility of ecosystem modeling.

9.4 Description of the Fishery

King crab have been exploited commercially in Alaska since the 1920's. Except for fishing by the Japanese during the 1930's, there were no major fisheries for king crab. Commercial fishing for king crab was restarted after the war by domestic fishermen in 1948. Both the Japanese and the Russians entered the postwar fishery for king crab off Alaska, primarily in the Bering Sea. The efforts of both the Russians and Japanese increased into the mid 1960's until bilateral agreements began to set limits on their catch. By 1975, through diplomatic negotiations, Russia and Japan were eliminated from the fishery. The king crab fishery thus became solely a domestic fishery before passage of the MFCMA. The domestic and foreign harvest of king crab from the waters off Alaska between 1953 and 1980 is presented in Table 11.

The domestic commercial harvest of king crab is unique to the State of Alaska. Of three species of king crab found in Alaska waters the red king crab is the most significant in economic value to fishermen and processors. In fact, the red king crab fishery has a cash value which is more than double that of any other seafood species (i.e., sockeye salmon, halibut, Tanner crab, etc.) caught in Alaska.

Table 11. Estimated annual king crab catches in the Eastern Bering Sea, including Bristol Bay, by the United States, Japan, and USSR, 1953-1980.[1/]

Year	United States[2/]	Japan[3/]	USSR[3/]	Total
1953	2,000	11,356	0	13,356
1954	2,329	8,086	0	10,415
1955	1,878	8,693	0	10,571
1956	1,896	8,308	0	10,204
1957	588	8,548	0	9,136
1958	7	8,136	0	8,143
1959	0	9,432	2,170	11,602
1960	598	13,838	10,773	25,209
1961	459	21,581	18,581	40,863
1962	74	35,152	18,114	53,340
1963	747	36,142	20,529	55,003
1964	910	40,676	22,400	63,986
1965	1,762	27,826	13,579	43,167
1966-67	997	29,918	14,080	44,995
1967-68	3,102	24,090	8,438	35,630
1968-69	8,687	24,661	3,020	36,368
1969-70	10,403	12,231	1,882	24,516
1970-71	8,559	11,234	1,696	21,489
1971-72	12,995	4,784	1,404	19,183
1972-73	21,744	4,721	0	26,465
1973-74[4/]	28,190	1,279	0	29,469
1974-75[4/]	49,373	2,618	0	51,991
1975-76[4/]	53,300,067[6/]	0	0	53,300,067[6/]
1976-77[5/]	69,655,485	0	0	69,655,485
1977-78[5/]	78,010,444	0	0	78,010,444
1978-79[5/]	98,104,376	0	0	98,104,376
1979-80[5/]	117,342,890	0	0	117,342,890
1980-81[5/]	143,154,503	0	0	143,154,503

1/ Weights in thousands of pounds, (1,000 pounds = 0.489 metric tons); all estimates were made by multiplying reported catch in numbers times an estimate of average weight.

2/ Weight estimates prior to 1966 are derived from INPFC statistics, average weights since 1966 are live crab as reported by ADF&G.

3/ Average weights computed from average carapace lengths and pack data given in INPFC annual reports (mostly Hoopes, Karinen and Pelto, 1970) and the length weight relationship given by Wallace, Pertuit and Hvatum, 1949.

4/ Includes Pribilof and Southeastern District king crab catches.

5/ Includes Pribilof, Southeastern and Northern District king crab catches.

6/ 1975-81 deadloss included.

Source: Westward Region Shellfish Report to the Alaska Board of Fisheries, March, 1981.

9.4.1 Domestic Commercial Fishery

General Description of the Fishery

The first commercial venture by American king crab processors was in 1920 from a shorebased cannery at Seldovia. Until the late 1940's, the fishing effort was sporadic, with limited packs at Hoonah, Seldovia, and Kodiak. Factors responsible for late entry into the king crab fishery by the American fishing industry were ignorance of Japanese canning techniques, a weak market at home, and a healthy salmon fishery which left little incentive for winter fishing (Gray et. al. 1965).

In March 1948, the factoryship PACIFIC EXPLORER left Seattle with a fleet of ten fishing vessels to fish for both groundfish and king crab, but primarily for king crab. This fleet utilized otter trawls and tangle nets and caught a total of 387,250 crab. The success of these and other exploratory fishing trips led to a small trawl fishery for king crab in the Bering Sea in the 1950's. Trawling for king crab, however, was later prohibited in 1960.

At the same time, crab fisheries were developing in the Cook Inlet, Kodiak Island, and south Alaska Peninsula areas. In 1953, production from these areas exceeded that from the Bering Sea for the first time. The development of the successful pot fishery for king crab south of the Alaskan Peninsula attracted the domestic crab fisherman from the eastern Bering Sea after the 1957 season. A token effort was resumed in 1960, but it was not until 1967, when the U.S. fishermen harvested 3.1 million pounds, that the U.S. began exploiting the Bering Sea king crab in earnest.

Early development of the Kodiak king crab industry lagged behind that of the Bering Sea. By 1954, however, Kodiak landings had increased to over 3,000,000 pounds which surpassed American catches in the Bering Sea (Gray et. al. 1965).

Initially, the fishery for king crab in the Shumagin Islands-False Pass area was conducted by salmon fishermen primarily during the winter. Their efforts depended greatly on economic conditions and especially on income received from salmon the preceding summer (Hayes and Montgomery 1963). A similar situation existed in the Kodiak fishery.

Until the late 1950's, Kodiak fishermen harvested salmon in the summer and fished king crab in the winter. Crab fishing usually commenced in September or October and ended in June, at which time the boats rigged for salmon. While exploring offshore grounds surrounding Kodiak Island, catches of 3,000 crab per vessel day were generally taken during July, August, and September of 1961. Some canneries and factoryships were unable to process the large number of crab being captured and in some instances were forced to limit the number of crab a boat could unload each trip.

During the greatest expansion of the Kodiak fishery, 1960 to 1966, the number of vessels registered to fish in Kodiak, (not necessarily the number that actually fished during this period) increased from 143 to 213. Moreover, the average size of vessels increased considerably. The increase in vessel size as well as numerous technological innovations such as the use of live tanks and the development of more efficient pots tremendously increased the fishing power of the fleet.

As the harvests declined in the Kodiak, Alaska Peninsula, and Dutch Harbor areas after 1966, interest in the Bering Sea area increased rapidly. In 1966, only nine vessels fished the Bering Sea but eleven years later in 1976, over 140 vessels were fishing there. Not only had the number of vessels fishing the Bering Sea increased greatly but the quality and efficiency of the vessels had increased. In recent years larger vessels have been built specifically for crab fishing. These vessels are capable of longer, faster trips in rougher seas, have larger tank and gear capacities, and utilize sophisticated electronics.

There is a wide range of commercial participants in the fishery, small vessel operators who harvest king crab for supplemental income after the end of salmon or halibut seasons to large vessel operators who fish exclusively for king crab.

There is not a licensed recreational fishery for king crab. The taking of king crab for personal use is permitted under subsistence fishery regulations. Though the subsistence harvest of king crab may be significant to those who participate in this fishery, the subsistence harvest is negligible relative to the commercial fishery.

Vessels and Gear Employed

The initial efforts to establish the domestic king crab fishery were conducted by trawler processors fishing off Kodiak and the Shumagin Islands and in the Bering Sea during the late 1940's. Local king crab fleets gradually developed in areas such as Kodiak and Cook Inlet during the 1950's. These local fleets

consisted of salmon purse seiners with a maximum legal length of 58 feet. These vessels were capable of handling tangle nets and most of them had gypsy winches which allowed the pulling of the modified dungeness traps. Crab were carried on deck or stacked in the hold and not immersed in water because these vessels lacked live tanks. Under average conditions king crab will not live out of water for more than 12 hours; hence the boats were forced to unload their catches daily or place the crab in underwater pens on the fishing grounds.

The gear employed in these initial years included tangle nets, otter trawls, and pots. However, tangle nets were prohibited in 1955 and trawling for king crab was prohibited in major areas in 1960. The reasons for the prohibitions were essentially the same, i.e, nonselectivity of the gear. With both methods many females, as well as softshelled and undersized male crab were captured resulting in injury or deadloss. At present, the only legal gear allowed for commercial king crabbing are pots, ring nets, or diving gear.

By 1960, many of the purse seiners continued to fish during the summer months. During the summer months, king crab migrate to the offshore waters forcing the fishermen to move out of the shallow bays into deeper water to make good catches. Purse seiners proved unsuitable for offshore fishing due to their small size and lack of live tanks. In the succeeding years several converted halibut boats and herring seiners entered the summer king crab fishery. These vessels were larger than the salmon purse seiners and had tanks with circulating systems for maintaining a constant flow of sea water that allowed crab to be held alive for several days. The range of the fleet was increased by utilizing live tanks, allowing vessels to follow the migrating crab from the shallow inshore banks to the deep offshore trenches.

Power scows also made their appearance as king crab vessels during the early 1960's. They became popular due to a large working space on deck.

Prior to the late 1960's all vessels in the king crab fleet were conversions. The fishery was so new that no vessel design peculiar to it had yet been developed. The first ship built for the king crab fishery entered the fleet in 1966. By 1972 there were about 40 of these specially designed vessels. These vessels were 80-100 feet in overall length with a live tank capacity of about 100,000 pounds of king crab.

At the present time, vessels used in the king crab fishery vary from skiffs fishing a few pots in sheltered bays to large vessels (up to 180 feet) equipped with multiple saltwater circulating live tanks, fishing 500 pots hundreds of miles from port. Beginning in 1973, new vessels have been designed and constructed specifically for fishing king crab in the Bering Sea. These vessels are well adapted to fishing in the adverse weather conditions common in the Bering Sea.

In the late 1970's, a new class of king crab vessels began to appear in the Bering Sea fishery. These vessels were large (130-160 ft.) multiple purpose vessels with the capacity to process their catch. In 1978 three catcher/processors were in operation. During the 1979 season, ten such vessels were operational and five new vessels were under construction. This is the first time that domestic crab fishermen have experimented with combined fishing and processing capabilities. The eventual success of catcher/processors in the domestic fleet is yet undetermined.

At present, the composition and size of the fleets operating in each of the major king crab fishing areas are closely related to the productivity of the area, the general weather conditions and any limitations on the quantity of gear that can be fished. The Bering Sea is fished by vessels which are predominantly over 75 feet in length. The adverse weather which is common in the Bering Sea and the high productivity of the area encourage the use of large vessels fishing numerous units of gear. The Kodiak area fleet is evenly distributed between large and small vessels. There are large areas of bays and sheltered waters suitable for smaller vessels and highly productive but exposed offshore areas where larger vessels are needed.

Three hundred and sixty-eight vessels harvested king crab in Alaskan waters during 1977. Of these, 133 were nonresident vessels, nearly all from Washington. Most of these nonresident vessels fished in the Bering Sea, the most productive area in the State. They accounted for twothirds of the statewide harvest of king crab (Table 12). Kodiak served as homebase for most of the resident fleet.

Catch Trends

The domestic king crab catch by management area since 1960 is shown in Table 11. Between 1960 and 1965, the domestic harvest of king crab increased rapidly to a peak of 152 million pounds. This increase in the statewide catch is attributable to the large increases in the catch from the Kodiak area. By 1965, almost two-thirds of the domestic harvest was from this one area.

Table 12. Catch and value (1977) for vessels whose owner's mailing address lies within the respective areas.

Area	Number of Vessels	Pounds Landed (thousand)	Ex-Vessel Value (thousand dollars)	Average Value Per Vessel (thousand dollars)	Total Value From All Fisheries[1/] (thousand dollars)	Percent of Total Value That is King Crab
Resident						
Kodiak	192	20,753	24,500	128	51,692	47
Alaska Peninsula[2/]	30	3,861	3,701	123	6,782	55
Dutch Harbor	13	4,120	3,923	302	5,049	78
Nonresident						
Washington	130	61,160	58,514	568	78,177	75
Other states[3/]	3	870	943	314	1,447	65

1/ King crab, Tanner crab, salmon, halibut, etc.

2/ Includes one owner from the Bering Sea. There were no owners in the Adak and Western Aleutians management area.

3/ Oregon, Idaho

Source: Commercial Fisheries Entry Commission and ADF&G Alaska Vessel Register.

From 1965 to 1970, the statewide harvest declined almost as rapidly as it increased during the preceding five years due to the decline in the catches in the Kodiak area. The decline in statewide harvests was arrested in 1970. Since then the annual catch has increased. The catch from the Bering Sea area now dominates the statewide harvest just as the Kodiak area did during the 1960's.

Value of Catch

In 1980, the king crab catch reached record levels. The Westward Region which includes Kodiak Island, Alaska Peninsula, Aleutian Islands and the Bering Sea, produced 98 percent of the State's catch. The Westward Region harvest of 187 million pounds was valued at about .95 cents per pound to the fishermen or about $177.6 million. This increase in value is caused by price increases of recent years (Table 13).

The landings and ex-vessel value of king crab, all shellfish, and all fish during the period of 1969-79, and the proportion of king crab to all shellfish and all fish landed in Alaska is given in Table 14. The 1979 king crab catch of 154 million pounds comprised 45 percent of the statewide shellfish catch and 17 percent of the statewide fish catch for that year. The number of vessels operating in each area within the State and the values of both the king crab catch and total catch for each group of vessels is presented in Table 15. Vessels which operated in more than one area are placed into their respective dominant area of catch in the second set of columns in Table 15. The average value of the king crab catch per vessel for each area for 1979 is also given in Table 15. The catch for the 239 vessels which fished in the

Table 13. Average statewide king crab vessel productivity data.

Year	Number of Vessels	Total Landings			Catch Per Vessel		
		Pounds (1,000)	$ Current (1,000)	$ Constant[1/] (1,000)	Pounds (1,000)	$ Current (1,000)	$ Constant[1/] (1,000)
1969	411	58,232	13,779 (24¢)[2/]	12,549	142	34	31
70	311	52,060	12,726 (24¢)	10,942	157	38	33
71	288	70,794	17,185 (24¢)	14,167	246	60	49
72	324	74,124	21,592 (29¢)	17,232	229	67	53
73	396	76,728	44,728 (58¢)	33,605	194	113	85
74	446	96,576	39,268 (41¢)	26,586	217	88	60
75	392	100,396	38,418 (38¢)	23,833	256	98	61
76	446	105,981	67,520 (64¢)	39,601	238	151	89
77	553	98,448	98,446 ($1.00)	53,358	178	178	96
78	576	122,921	155,861	53,358	213	271	
79	721	154,312	146,544		214	203	

1/ Deflated by the consumer price index (1967=100).

2/ Price per pound in current dollars.

Source: Commercial Fisheries Entry Commission

Table 14. Landings and ex-vessel value of king crab, total shellfish, and total fish (including shellfish) caught in Alaska, 1969-79 and the percentage king crab of the total shellfish and fish (in parentheses).

Year	King Crab		All Shellfish				All Fish			
	1,000 lbs	$ 1,000	1,000 lbs	%	$ 1,000	%	1,000 lbs	%	$ 1,000	%
1969	58,232	13,779	128,556	(45)	18,513	(74)	384,994	(15)	68,028	(20)
1970	52,060	12,726	150,647	(35)	18,404	(69)	542,247	(10)	96,989	(13)
1971	70,794	17,185	182,631	(39)	23,137	(74)	451,779	(16)	77,403	(22)
1972	74,124	21,592	199,236	(37)	28,412	(76)	401,463	(18)	86,121	(25)
1973	76,824	44,728	265,001	(29)	68,350	(65)	465,563	(17)	146,271	(31)
1974	96,576	39,268	273,309	(35)	66,913	(59)	465,507	(21)	149,490	(26)
1975	100,396	38,418	249,303	(40)	55,813	(69)	444,309	(23)	128,799	(30)
1976	105,981	67,520	316,697	(33)	95,930	(70)	614,345	(17)	245,218	(28)
1977	98,399	98,446	314,084	(31)	151,815	(65)	670,828	(15)	351,996	(28)
1978[1/]	122,921	155,861	333,896	(37)	230,245	(68)	783,719	(16)	507,487	(31)
1979[1/]	154,312	146,544	344,576	(45)	235,564	(62)	884,811	(17)	623,587	(23)

1/ Preliminary data.

Source: Commercial Fisheries Entry Commission.

Table 15. Ex-vessel value[1/] from king crab and all other fishery resources for 1979.

Management Area	Estimated Ex-Vessel Value (in thousands of dollars) For King Crab For-- All Vessels Fishing These Areas[2/] Number of Vessels	Total Value	Average Value	Vessels Whose Only Or Dominant King Crab Catch Was In The Specified Area Number of Vessels	Total Value	Average Value	Estimated Ex-Vessel Value Of All Fishery Resources By Area Of Largest King Crab Catch[3/] Total Value	Average Value	Percentage King Crab of Total Value
Kodiak	258	18,669	72	244	17,753	73	47,363	194	37
Alaska Peninsula	66	5,076	77	50	3,950	79	16,625	332	24
Dutch Harbor	96	12,281	128	39	7,233	185	12,782	328	22
Adak-Western Aleutians	13	992	76	0	--	--	--	--	--
Bering Sea	239	107,457	450	228	104,780	460	159,152	698	66

1/ Estimated ex-vessel value is derived from applying a particular average price per pound for each species and area. These prices do not necessarily include payments in kind or bonuses.

2/ Since many vessels fish in more than one management area, these individual counts cannot be added to obtain total fleet size.

3/ This includes any fishery resource from any area that was harvested by the vessel.

Source: Commercial Fisheries Entry Commission.

Bering Sea averaged $450,000. The next highest average value ($128,000) was for the vessels that fished in the Dutch Harbor area. The vessels that fished in the Kodiak, Alaska Peninsula, and Adak-Western Aleutians area averaged $72,000, $77,000, and $76,000 per vessel respectively for their king crab catches.

Information on the number of vessels, ex-vessel values, and the harvest by fishing area for 1971-79 is presented in Table 16. Between 1971 and 1979 the total harvest has generally increased while the ex-vessel value has fluctuated.

Description and Value of Product

King crab is the major crab species commercially harvested in Alaska and is also the largest component of shellfish production in the State. Since 1969, the value of king crab production has varied between 51-64 percent of the total value of all shellfish production in Alaska and between 12-29 percent of the total value of all seafood products (Table 17). King crab production in terms of wholesale value has increased each year since 1969 in both current and constant dollars with the exception of 1974. In 1976, the wholesale value exceeded $100 million for the first time (Table 17).

King crab is processed into the following five forms: whole frozen, frozen sections, frozen meats, canned meats, and separate claws (Orth et. al. 1979). Frozen sections and frozen meats are now the predominant forms of processing (Figure 10). This is a significant change. In 1969, the value of crab sections was only half that of canned crab. The shift to frozen sections can be partially explained by reduced labor needed for this form of production.

Table 16. Domestic Bering Sea/Aleutian Island king crab catch, value and participation by area and year (not by season).

Year	Management Area	No. Vessels	Pounds (thousands)	Metric Tons	Ex-Vessel Value (thousand dollars)
1971	Dutch Harbor	307	11,110	5,039	2,777
	Adak	455	25,850	11,725	5,683
	Bering Sea	423	12,847	5,827	2,569
	Total	1,185	49,807	22,591	11,029
1972	Dutch Harbor	68	11,297	5,124	2,937
	Adak	50	16,235	7,365	4,219
	Bering Sea	4	20,963	9,509	5,241
	Total	122	48,495	21,998	12,397
1973	Dutch Harbor	59	12,723	5,771	7,634
	Adak	62	11,246	5,101	6,161
	Bering Sea	68	28,240	12,809	14,685
	Total	189	52,209	23,681	28,480
1974	Dutch Harbor	87	13,069	5,928	5,097
	Adak	39	1,335	606	521
	Bering Sea	105	49,374	22,396	19,256
	Total	231	63,778	28,930	24,874
1975	Dutch Harbor	81	15,049	6,826	5,719
	Adak	42	2,826	1,282	989
	Bering Sea	104	52,112	23,638	18,239
	Total	227	69,987	31,746	24,947
1976	Dutch Harbor	74	11,471	5,203	7,112
	Adak	20	386	175	236
	Bering Sea	142	70,411	31,938	43,631
	Total	236	82,268	37,316	50,979
1977	Dutch Harbor	58	4,131	1,874	4,001
	Adak	2	2	1	2
	Bering Sea	139	76,406	34,667	72,585
	Total	199	80,539	36,542	76,588
1978	Dutch Harbor	61	6,847	3,106	8,672
	Adak	12	954	433	1,182
	Bering Sea	167	98,170	44,530	119,802
	Total	240	105,971	48,069	129,656

Table 16. (continued)

Year	Management Area	No. Vessels	Pounds (thousands)	Metric Tons	Ex-Vessel Value (thousand dollars)
1979	Dutch Harbor	96	13,130	5,956	12,281
	Adak	10	808	366	992
	Bering Sea	239	118,666	53,826	107,457
	Total	345	132,604	60,148	120,730

Source: Compiled by the Commercial Fisheries Entry Commission.

Table 17. Value and poundage of king crab production (at processors' level) relative to all shellfish and all fish 1969-77.

Year	King Crab	All Shellfish	All Fish
	thousand dollars		
1969	26,582	42,765 (62)	144,200 (18)
70	24,836	47,487 (52)	213,932 (12)
71	32,252	53,819 (60)	198,658 (16)
72	44,045	77,380 (57)	202,951 (22)
73	72,868	142,480 (51)	307,587 (24)
74	48,410	94,754 (51)	254,366 (19)
75	83,838	131,506 (64)	293,192 (29)
76	104,267	178,905 (58)	452,267 (23)
77	165,781	279,226 (59)	644,126 (26)
	thousand pounds (product weight)		
1969	12,824	29,666 (43)	189,008 (7)
70	14,842	36,347 (41)	284,802 (5)
71	17,147	37,827 (45)	239,061 (7)
72	19,794	49,082 (40)	201,829 (10)
73	28,581	82,806 (35)	227,380 (13)
74	25,512	69,290 (37)	247,752 (10)
75	40,350	78,814 (51)	216,767 (19)
76	39,887	95,577 (42)	283,111 (14)
77	49,543	109,279 (45)	339,205 (15)

Numbers in parentheses represent the proportion of king crab.

Source: ADF&G, Catch and Production Statistics leaflet.

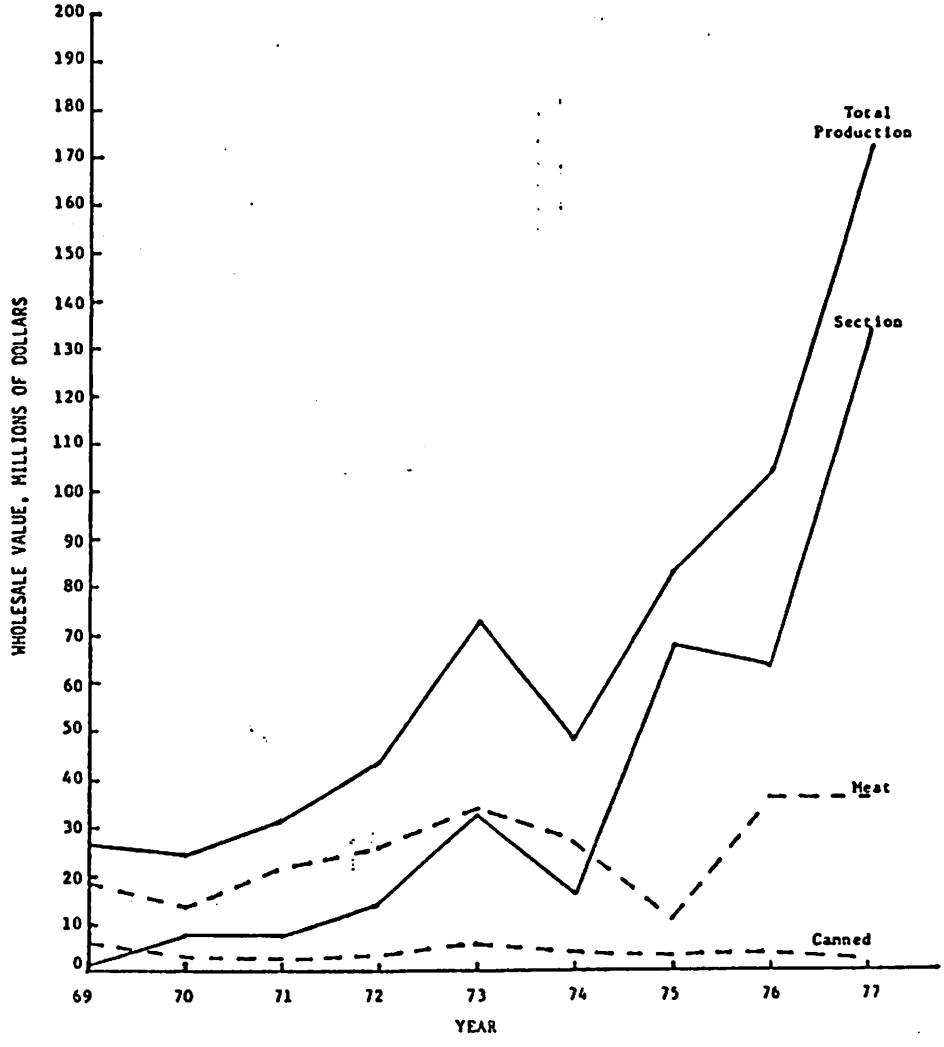

FIG. 10, WHOLESALE VALUE OF KING CRAB BY PRODUCT FORM, 1969-77.

SOURCE: ADF&G STATISTICAL LEAFLETS

Sales of whole frozen crab is limited to local markets within Alaska. Frozen claws are produced locally only in small quantities because it is cheaper to produce them from frozen sections elsewhere in the continental U.S.

In 1976, a total of 45 king crab processors operating in Alaska realized a gross income (at first wholesale level) of $100 million from king crab. Thirty-three of these processors operated in the Kodiak, Alaska Peninsula, and Dutch Harbor areas, including a floating processor which operated in the Bering Sea and Adak areas. The total gross income earned by all processors in 1977 was $248 million. Forty percent of this value was acquired from the processing of king crab (Table 18).

The dependence of processors upon king crab increases from Kodiak to Alaska Peninsula to Dutch Harbor. The processing of king crab accounted for 87 percent of the processing value for the Dutch Harbor management area. The processors in the Alaska Peninsula and the Kodiak areas derive 45 and 42 percent respectively, of their gross income from processing king crab.

In terms of gross annual income from king crab processing during 1977, processors in Dutch Harbor were highest at $4.4 million. In terms of average gross annual income from all fish processing, processors in the Alaska Peninsula area showed the highest income of $7.7 million. Gross annual income per processor for the 47 king crab processors averaged $3.4 million and $5.3 million from king crab and from all fish, respectively (Table 18).

Table 18. Productivity data for king crab processors, by management area, 1977.

Management Area	Number of Processors	Total Gross Income		Average Gross Income Per Processor		King Crab [1] Percent of Area's Processing Value
		King Crab	All Fish	King Crab	All Fish	
		thousand dollars				
Kodiak	18	38,174	91,265	2,121	5,070	42
Alaska Peninsula	4	13,932	31,052	3,483	7,763	45
Dutch Harbor [2]	25	109,684	126,156	4,387	5,046	87
Total	47	161,790	248,473	3,442	5,287	65

1/ King crab percentage of the total and average value from all species and products produced by area's processors.

2/ Includes communities of Dutch Harbor, Unalaska, Akutan, and Captains Bay. Confidentiality forced the addition of one processor that worked the Bering Sea and Adak areas.

Source: Commercial Fisheries Entry Commission

Markets

Almost all king crab harvested in Alaskan waters is shipped to Seattle after initial processing (Orth et. al. 1979). The product is then either exported to foreign markets or shipped to major domestic centers of distribution around the United States. In recent years the United States has become a net exporter of king crab (Figure 11). Exports increased from 1 million pounds in 1969 to 18 million pounds in 1977. Imports peaked in 1971 at 9 million pounds and were insignificant by 1974. The major destination of domestic king crab exports has been Japan. Tables 19 and 20 show U.S. exports of king crab, canned (1976 and 1977) and frozen (1979 and 1980), by country of destination. King crab exports are now mostly in the frozen form.

Crab intended for domestic markets is shipped from Seattle in bulk packages weighing 75 to 100 pounds gross weight. Destinations include Los Angeles, Denver, Minneapolis, Chicago, Philidelphia, New York, and Boston. When they reach secondary processing centers, the bulk packages are processed into small blocks of meat.

The major buyers of king crab from wholesale centers are distributors supplying restaurants. This is a significant change from 10-15 years ago when a considerable amount of canned crab was sold through retail supermarkets. These sales have since declined substantially. Overall, the per capita consumption of king crab has increased, though somewhat erratically. From 1969 to 1976 domestic annual per capita consumption was up 40 percent from 0.32 pounds to 0.45 pounds (Table 21). In 1977, the consumption per capita dropped to 0.39 pounds.

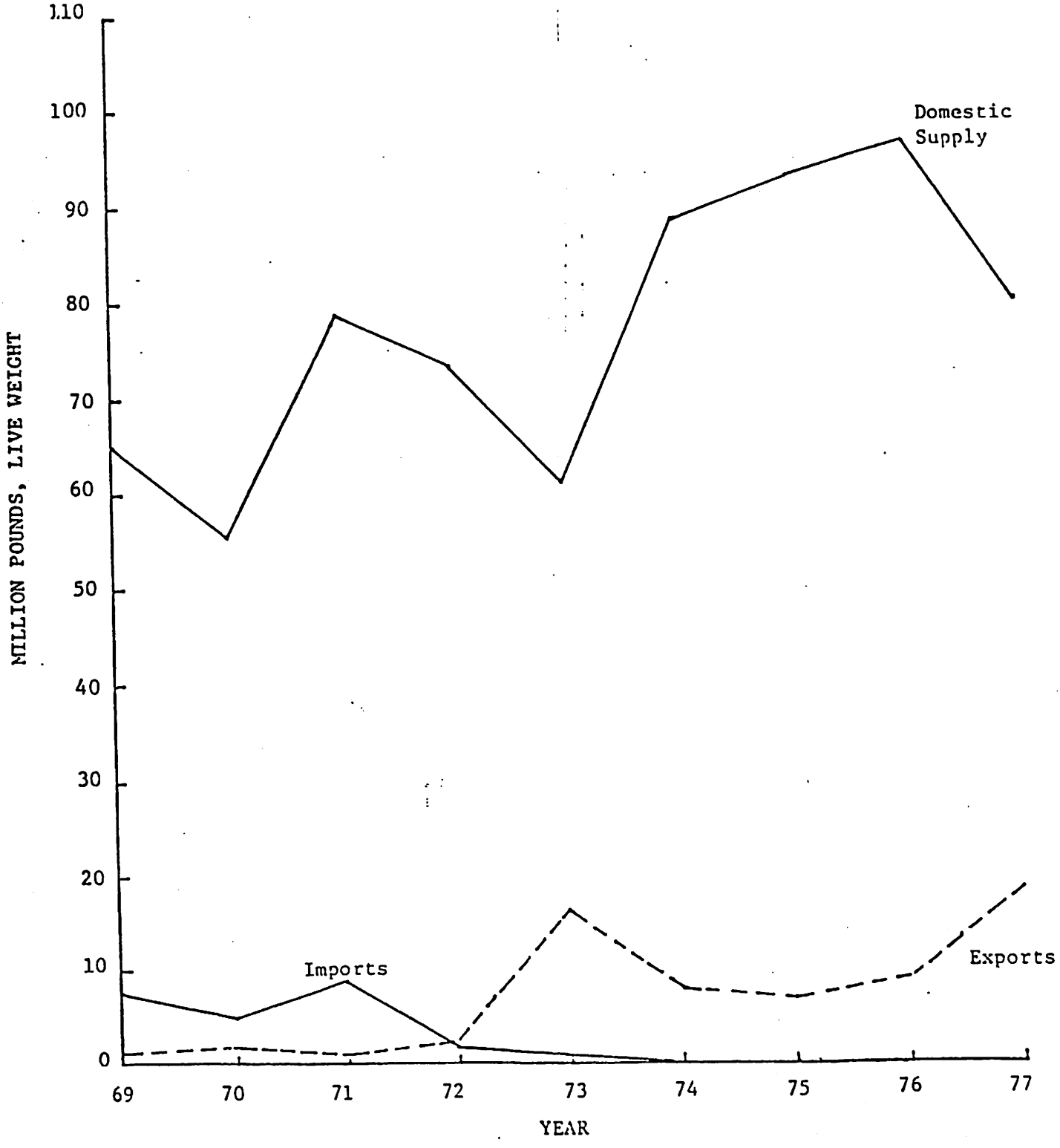

FIG. 11 U.S. KING CRAB SUPPLY, 1969-77

SOURCE: Landings - ADF&G Statistical Leaflets
Imports - FAO Yearbook of Fishery Statistics and Japan Tariff Commission publications
Exports - U.S. Bureau of Census, U.S. Exports/Schedule B, Commodity by Country, FT 410, various issues.

Table 19. U.S. exports of king crab, canned, by country of destination, 1976 and 1977

(Product weight)

Country	1976	1977	1977 as a percentage of 1976	Percentage of total exports	
				1976	1977
	Thousand pounds			Percent	
France	29	99	341.4	7.8	36.9
Japan	196	58	29.6	53.0	21.6
Canada	30	31	103.3	8.1	11.6
Netherlands	40	26	65.0	10.8	9.7
Belgium	17	24	141.2	4.5	9.0
Bermuda	17	9	52.9	4.5	3.4
Sweden	15	7	46.7	4.1	2.6
Norway	-	5	-	-	1.9
Other	26	9	34.6	7.0	3.4
Total	370	268	72.4	100.0	100.0

Source: Shellfish Market Review, NMFS, Washington DC Nov 1978

Table 20. U.S EXPORTS OF DOMESTIC FROZEN KING CRAB, BY COUNTRY OF DESTINATION, 1979 AND 1980

(Product weight)

Country	1979		1980	
	Thousand pounds	Thousand dollars	Thousand pounds	Thousand dollars
Japan	32,863	78,262	23,866	58,098
Canada	1,291	4,289	3,280	9,535
Netherlands	526	4,085	488	3,013
Belgium and Luxembourg	634	5,027	270	1,717
Australia	152	887	104	587
Italy	21	85	122	527
France	167	982	57	375
Mexico	21	43	187	360
Norway	63	312	82	353
Federal Republic of Germany	85	433	76	328
Switzerland	89	491	23	96
Other	307	1,450	316	1,420
Total	36,219	96,346	28,871	76,409

Source:--U.S. Department of Commerce, Bureau of the Census.

Table 21. U.S. king crab supply and domestic per capita consumption.

Year	Population	Landings	Imports [a/]	Exports [a/]	Total [b/] Supply	Consumption Per Capita
	million persons	thousand pounds (live weight)				pounds
1969	202.677	58,232	7,715	1,157	64,790	.32
70	204.878	52,060	5,070	1,873	55,257	.27
71	207.053	70,794	8,990	1,151	78,633	.38
72	208.846	74.124	1,795	2,514	73,405	.35
73	210.410	76,824	500	16,220	61,104	.29
74	211.901	96,576	45	8,139	88,482	.42
75	213,540	100,396	15	7,161	93,250	.44
76	215.120	105,981	-	9,303	96,678	.45
77	216.8	99,449	-	19,499	79,950	.39

a/ Converted to live weight based on the following factors:

meat to live 5.0
fresh/frozen sections to live 1.818

b/ Total supply is not adjusted for beginning and ending stocks.

Source: Population: U.S. Bureau of economic Analysis, Survey of Current Business, 1977.

Landings: Commercial Fisheries Entry Commission

Imports: FAO Yearbook of Fishery Statistics and Japan Tariff Commission publications

Exports: U.S. Bureau of Census, U.S. Exports/Schedule B Commodity by country, FT 410, various issues.

Some factors which might affect the king crab market in the future include the exchange rate between the Japanese yen and the American dollar and the potential for high seas green-frozen processing on a large scale. A green-frozen processor is one which immediately freezes the crab without cooking it first. If the yen continues to appreciate in relation to the dollar, Japanese imports will probably expand further as the effect is to reduce the price of U.S. crab to the Japanese. This could act to reduce the supply available to the domestic U.S. market which might drive prices higher, particularly if harvest levels drop concurrently for whatever reason. The advent of frozen processing vessels operating on the high seas would have a similar effect. Vessels would be able to export directly to Japan, reducing transportation costs and in effect increasing Japanese buying power.

Foreign Fishery

All foreign fishing within the FCZ was eliminated by bilateral agreements with Japan and Russia by 1975. Thus, even before passage of the FCMA, the king crab fishery had become an exclusively American fishery east of the U.S. Russia Convention Line of 1867. In addition, as later parts of this plan reveal, the domestic fishing capacity greatly exceeds the optimum yield for king crab. Thus, the domestic fleet will totally utilize the available harvestable resource and there will be no portion of the resource available for harvest by foreign fishermen.

9.5 History of Management

Foreign Fishery

Prior to 1964, there were no regulations for the foreign crab fisheries off Alaska except for a self-imposed size limit of 5.1 inches on male king crab which the Japanese instituted in 1955. In 1964, the United States ratified the Convention of the Continental Shelf and subsequently arranged bilateral agreements with Japan and the USSR. These agreements established quotas on the catch of king crab by each nation, limited the catch to hard shell male crab, and imposed a minimum carapace width of 6.25 inches. The agreements were renegotiated at two-year intervals with progressively lower quotas being set. As a result the USSR ceased fishing for king crab in the Eastern Bering Sea after 1971; the Japanese ceased fishing after 1974. In 1976, the United States enacted the Fishery Conservation and Management Act and subsequently adopted the Preliminary Management Plan for King and Tanner Crabs. This plan established a TALFF for king crab equal to zero, eliminating the possibility of any foreign fishing for king crab.

Domestic Fishery

Prior to Statehood, regulatory authority for the domestic fisheries off Alaska was vested in the US Bureau of Fisheries. The Bureau first promulgated regulations for the king crab fishery in 1941, establishing a minimum size limit of 5.5 inches and prohibited the retention of softshell or female crab. In 1950, the Bureau increased the size limit to 6.5 inches and closed an area to fishing at Canoe Bay on the Alaska Peninsula. The next significant addition

to regulations occurred in 1954 when the Bureau prohibited tangle nets and established a minimum mesh size for trawl nets. These measures were designed to protect female and immature male crab from the high mortality rates inflicted by these gear types. In 1955, the Bureau set a limit of fifteen on the number of pots that could be fished in Cook Inlet and also established a fishing season from June 1 to December 31 for this area.

In 1959, Alaska achieved statehood and, after a one-year transition period, assumed management authority over the fish and wildlife resources of the state. Regulatory authority was vested in the Alaska Board of Fish and Game; management responsibility was assigned to the Alaska Department of Fish and Game.

The Board adopted the Bureau's regulatory regime and added an area registration system. Under this system, State waters were divided into registration areas. Vessels were required to register for an area before fishing. Once a vessel had registered for one area, it could not fish in other registration areas for the balance of the season. This system was intended to protect local fleets and enhance management ability.

By 1960, the king crab fleet had expanded fishing effort into offshore areas beyond the State's three-mile jurisdictional boundary. The State then enacted landing laws which prohibited the sale or transportation within State waters of migratory fish and shellfish taken on the high seas unless they were taken in accordance with State regulations. These statutes withstood subsequent court tests and have remained an important component of the State's regulatory authority.

The Board of Fish and Game continued to modify king crab regulations throughout the 1960's but did not introduce any further innovations until 1970. At that time the Board responded to the rapid decline of the Kodiak king crab fishery by establishing a quota system. Under this system, individual fisheries were closed once the catch had reached a preset quota. Quotas were set at a level such that a significant portion of the recruit class would be held over for the next year. The intent was twofold: (1) to moderate the extreme fluctuations in harvest levels that were associated with the previous recruits-only fishery; and (2) to enhance the reproductive potential of stocks by maintaining a broader distribution of age classes among legal size male crab.

In 1975, the Board modified the catch quota system in recognition of the Department's greater inseason stock assessment capabilities. Instead of setting rigid quotas, the Board opted for guideline harvest levels which were expressed as a range instead of as a point estimate. This gave the Department greater flexibility in selecting the most opportune point at which to close individual fisheries; more weight could be given to data collected during the course of the fishing season.

9.5.1 Current Management Regime

The State of Alaska's management regime for the king crab fishery is a complex system of regulatory measures involving size, sex, season, area, and gear restrictions and a flexible catch quota system with an area registration system. These regulations vary between areas within the State to reflect local biological conditions and fleet characteristics. The regulations are

published annually in the Alaska Shellfish Commercial Fishing Regulations. The 1981-82 major regulations are summarized in Table 22.

The reasoning behind many of the State regulations is quite complex and often involves a balance between conflicting objectives. A brief explanation of this reasoning follows:

Size Limits

Size limits are established to ensure that fishing mortality is not allowed on any year class until that class approaches maximum biomass; i.e. until loss due to natural mortality within that year class approaches the growth rate. This serves to maximize the total yield from each year class. It also helps to ensure that sufficient numbers of male crab are available to meet reproductive needs. Additional fishing mortality to older crabs occurs in the well developed fisheries by having a second fishing period for larger, older males.

Before a year class is recruited into the fishery, the male crab have been sexually mature for 3-4 years and sexually active for approximately one to two years. (see Section 8.3) Size limits are generally based on observed average growth rates. Because growth rates vary between areas, size limits also vary accordingly.

Sex Restrictions

The king crab harvest is limited to male crab. This restriction serves to maximize reproductive potential; it is common to nearly all other crab fisheries.

Table 22. 1981-82 Major State of Alaska Regulations for King Crab Fishing.

Management Area	Fishing Seasons	Guideline Harvest Levels	Minimum Size Limits	Legal Gear	Gear Storage
Dutch Harbor	Nov 15-Feb 15 6½" or greater. During periods opened and closed by emergency order 7½" or greater.	7 to 17 million lbs of red crab	6½" Nov 1-Feb 15. 7½" during periods opened and closed by emergency order.	Pot only	25 fathoms or less. In Hot Springs Bay, inside of a line from Ridge Pt. to 54°12'40" N. lat.; 165°52' W. long. In Kalekta Bay inside a line from Erskine Pt. to Cape Kalekta.
Adak	Nov 1 - Feb 15	0.5 to 3.0 million lbs of red crab	6½"	Pot only	30 fathoms or less
Bristol Bay	Sep 10-Apr 15 red, blue, and brown king crab 6½" or greater. During periods opened and closed by emergency order 7" or greater.	40 to 100 million lbs of red and brown crab	6½" for red, brown, and blue crab Sep 10-Apr 15. 7" red, brown, and blue crab during periods opened and closed by emergency order.	Pot only	25 fathoms or less, or in Southeastern waters north of 57° 30" N. lat., south of 58°30' N. lat., west of 164° W. long., and east of 166° W. long.
Bering Sea	Pribilof district: Sep 15-Apr 15 for red and brown crab 6½" or greater. During periods opened and closed by emergency order 7½" or greater.		Pribilof district 6½" red, blue, and brown crab Sep 15 - Apr 15. 7½" red and brown crab during periods opened and closed by emergency order.	Pot only	In the Northern district, only in waters north of 61° N. lat., south of 61°30' N. west of 169° W. long. and east of 169°30' W. long., or by removal from water.
	The Pribilof district blue crab fishery Sep 15-May 31.	5 to 8 million lbs of blue crab in the Pribilof district	Pribilof district 6½" blue crab Sep 15-May 31.		
	Northern district red and blue crab fishery Jul 15-Sep 3.	For red crab in the Norton Sound section: Jul 15-Sep 3 2 to 5 million lbs.	Northern district: 4-3/4" red crab Jul 15-Sep 3. 5½" blue crab Jul 15-Sep 3.		
	Norton Sound section of the northern district red and blue crab fishery Jan 1-Apr 30.	Jan 1-Apr 15 0.15 to 0.5 million lbs. 1.5 to 3.0 million lbs of blue crab in the Northern district.			

Source: ADF&G Alaska Commercial Fishing Shellfish Regulations, 1981.

The potential harvest of female crab has not been an issue. Managers would probably endorse a limited fishery for females in years of high abundance although the industry has expressed little interest; females are considerably smaller than males of the same age and the proportion of useable body meat is much less than that of males. At this time the harvest of females remains uneconomical.

Seasons

Fishing seasons have historically been used in the king crab fishery to protect crab during the mating, molting and growing periods of their life cycle. These conditions usually occur from mid-January through July in most areas of the State, leaving the months of August through mid-January during which crab fishing may take place. In several of the well developed fisheries, two distinct fishing periods are employed so as to increase fishing effort for larger, older crabs. Because the quota for each statistical area is usually taken in two months or less, there is an opportunity to look beyond biological considerations in setting the date of the season opening.

In determining an appropriate date, the Board weighs several factors. Perhaps foremost among these is the recovery rate (the ratio of recoverable meat to total body weight). Because the recovery rate increases dramatically during the period of rapid growth following molting, a delayed opening will generally act to increase both the volume and value of the catch and final product, benefiting both fishermen and processors.

A second factor to be weighed are weather conditions. These generally worsen as the year progresses; consequently a late season opening is likely to translate into more difficult fishing conditions. This will particularly disadvantage owners and operators of smaller vessels.

A third factor is crab migration patterns. King crab migrate outward from shore following the mating period; thus, a late season opening will cause the fishery to occur further offshore. This will again disadvantage smaller vessels whose lesser hold capacities cause more frequent trips between the fishing grounds and the processor. Smaller vessels are also less inclined to travel as far from shore late in the year when the weather is more severe and unpredictable.

A fourth factor is the timing of the king crab fishery relative to other fisheries, particularly the salmon fisheries. If the season opening for king crab occurs before the salmon fisheries are over, this will create difficulties for vessels and processors that normally participate in both fisheries. Conversely, a lengthy period of time between the two fisheries will force vessels and processors to lie idle and may create additional startup costs.

A fifth factor is the timing of the season openings for individual areas relative to one another. Most of the major king crab fisheries now open simultaneously. This distributes fishing effort at the start of the season, helps prevent gear saturation problems, and allows greater participation by local fleets.

The current season openings set by the Board of Fisheries reflect a balance of attitudes within the industry with respect to the several factors described above. Since the date of the season opening is largely dependent on economic factors, the Board has been inclined to go along with industry once there is substantial agreement on the need for a change of dates.

Quotas

Instead of allowing the fishery to take all crab available above the size limit, the Board has adopted a catch quota system. Once the quota has been achieved, no further fishing is allowed. Quotas are generally set at a level which allows 40 percent fishing mortality on the recruit class. If a quota were not in effect, fishing mortality on the recruit class might range as high as 70 to 80 percent before fishing became uneconomical.

By using the quota system to reserve a portion of each recruit class, two purposes are served. First, extreme fluctuations in harvest levels are moderated. During years of poor recruitment, crab which recruited in previous years will still be available to the fishery, acting to bolster what would otherwise have been a poor harvest. Second, the reproductive potential of the stock is enhanced. The current quota system acts to maintain a broader assortment of age groupings by geographical area. Because it is the larger males, particularly skipmolts, which predominate in mating (see Section 8.3), this may be critical.

The quota system now used by the Board is quite flexible. Prior to each season the Board establishes guideline harvest levels based on current

population estimates. These harvest levels are expressed as a range. Once the fishery is underway, the Department monitors the catch and uses data from tag returns and catch per unit effort to establish the point within the guideline harvest range at which the quota should be set. Once the quota is achieved, the Department closes the fishery by emergency order.

Gear Restrictions

Legal gear for king crab is limited to pots and ring nets in all areas. These gear types are selective in the sense that nonlegal crab may be returned to the water unharmed. Trawls and tangle nets are prohibited because of the high mortality rates which they inflict on nonlegal crab. Each king crab pot must contain a mechanism which will terminate its catching and holding ability within six months if the pot is not removed from the water.

Gear Limits

Historically, gear limits have been employed in the king crab fishery to reduce the overall effort and slow down the rate of harvest. Gear limits are intended to reduce the competitive advantage of larger vessels. Presumably, if these limits were not in effect in some areas, larger vessels would fish at a more rapid rate, reducing the length of the season and increasing the share of the total catch taken by these vessels. In addition, gear limits act to prevent gear saturation problems by allowing more vessels to fish in areas of high crab density. Gear limits have generally been set at a level which reflects the average fishing capability within the fleet.

Gear limits have benefited overall management of the fishery. Limiting the amount of gear a single vessel may employ has tended to reduce the possibility of overfishing a stock. Such a situation arises when the fleet's ability to harvest a stock greatly exceeds the OY. The manager in this situation, would not be able to allow the fishery to proceed because of the risk of overfishing.

Enforcement of gear limits has generally been difficult. However, in 1977, a regulation was implemented which required the identification of each crab pot fished in a registration area having gear limits using a registration tag issued by the Department. The number of tags issued by the Department to a single vessel owner may not exceed the gear limit. The 1979 season was the first year that the pot registration program was in effect.

Area Registration

Under State regulations, the king crab fishery is divided into eight statistical areas roughly conforming to biological boundaries of individual stocks. Before a vessel may fish in a particular area, it must register with the Department. A vessel is also required to land crab within the registration area in which the crab were taken unless other arrangements are made through the Department. These measures greatly enhance the management capability of the Department by making it possible to accurately monitor the total catch and the catch rate in individual areas.

There are two classes of registration areas: nonexclusive areas, and exclusive areas. A vessel which registers for an exclusive area, may also register for any or all nonexclusive registration areas, but may not register

for any other exclusive areas. The "exclusive" or "nonexclusive" concept applied to individual registration areas limits the number of areas in which a vessel may fish. This stimulates the development of local fleets.

Other Regulations

Tank inspections: The last step in the area registration process is a tank inspection after which the vessel may commence fishing. Tank inspections are conducted by State personnel during the 24 to 116 hour period (depending on area) preceding the season opening. In order to pass inspection the vessel must have no crab aboard.

Season closing: A vessel may not have crab aboard after the season has been closed for 24 hours unless the vessel operator has contacted the Department during that period and stated the volume of crab aboard and the port of landing. This insures that vessels will not fish beyond the season closing.

Gear removal and storage: Within 72 hours following a season closing, a vessel must either remove its gear from the water or secure all gear left on the grounds in a nonfishable condition. Within 7 days following a season closing, a vessel must have all gear removed from the grounds. Gear may be stored in 25 fathoms of water or less in most areas. The relatively long time period given vessels to clear gear from the grounds is primarily for smaller vessels which may require several trips.

State Revenues Derived From Fishery

Alaska collects revenues from the king crab fishery by the sale of permits and licenses as well as from raw fish taxes based on commercial sale. Table 23 provides information on revenues derived for 1975-1978. Only portions of the processor taxes and Commercial Fisheries Entry Commission permits can be directly attributed to the king crab fishery. In 1978, these two sources accounted for $2,366,158.

Beginning January 1, 1978, a combined license took effect. Prior to this time fishermen were required to purchase gear, vessel, and commercial licenses in addition to the interim-use permits. With the combined license that now exists a fisherman is required to possess only an interim permit and crewmen license.

The Alaska raw fish tax is an advalorem tax based on the value of the raw product sold to processors. For land-based crab processing plants this tax is 3 percent of the ex-vessel value. Floating crab processors pay 5 percent. If a fishery is designated by the Commissioner of Fish and Game as a developing fishery then the processor taxes on land-based and floating processors is equal to 1 percent and 3 percent, respectively. The only king crab fisheries to have been designated as developing are brown king crab statewide and all king crab fisheries north of 58°39'N latitude (Northern Bering Sea).

Table 23. State revenues related to king crab.

	1970	1975	1976	1977		1978
Processor Taxes	$239,099	633,869	1,080,102	1,654,675	Processor Taxes	$ 2,360,958
Interim-use Permits 2/	$ -	62,625	80,110	97,850	Interim-use Permits 1/	361,255
Processor Licenses	$ 6,425	5,325	5,450	5,375	Processor Licenses	5,200
Comm. Fish Licenses	375,240	334,510	391,550	444,920	Crewmen Licenses 2/	337,180
Vessel Licenses	161,863	158,704	163,180	179,142	Vessel Licenses	290,080
Gear Pot Licenses	18,225	28,875	31,410	39,690		

Source: Alaska Department of Revenue: except interim use permits and crewmen licenses which are from Commercial Fisheries Entry Commission.

1/ & 2/ The fishermen's fund is supported by sixty percent of the money collected from each crewmember fishing license issued, and from an equal amount of the money derived by the State from each commercial fisherman who is issued a permit.

Table 24. Current (FY 80) and projected annual costs of Western Alaska king crab management, research, and enforcement programs.

Program	Current FY 80 Expenditures 1/ (funding source)	Projected 1/ Funding Required
1. Program Management		
a. Regulation/mgt.	255.6 (ADF&G)	365.6
b. Biometrics/data processing	66.6 (ADF&G)	116.6
c. Research program mgt.	119.8 (ADF&G)	179.8
Total	442.0 (ADF&G)	662.0
2. Stock Assessment Program		
a. Kodiak	233.8 (ADF&G)	271.3
b. Alaska Peninsula	49.1 (ADF&G)	86.6
c. Aleutians	121.0 (ADF&G)	401.0
d. Bering Sea	563.0 (NMFS)	751.0
Total	966.9	1,509.9
3. Enforcement	147.0 (ADPS)	294.0

1/ Thousands of dollars

Costs of Management

Current and projected annual costs of western Alaska king crab management, research, and enforcement are summarized in Table. 24.