M E M O R A N D U M

TO: Council, SSC, and AP members

FROM: Jim H. Branson
Executive Director

DATE: March 20, 1981

SUBJECT: King Crab Fishery Management Plan

ACTION REQUIRED

1. *Review and approval of Joint Statement of Principles between North Pacific Fishery Management Council and Alaska Board of Fisheries.*

2. *Review and approval of draft Bering Sea/Aleutian Island King Crab Fishery Management Plan. Review to include Council action to obtain a preferred option on the remaining points left undecided from the December meeting (determination of optimum yield; registration areas; and gear placement and storage).*

BACKGROUND

1. The Council reviewed the draft Joint Statement of Principles during the February meeting and recommended a few minor changes. The changes have been made and the revised draft is now presented in its final form for Council approval and discussion with the Board. This document is an attempt to formalize the roles of both organizations in order to achieve the most effective and efficient management of fisheries off Alaska. Initially it is designed to apply only to king crab, but could serve for other fisheries of mutual responsibility in the future.

   Attached are the responses to the Joint Statement that we have received from members of the fishing industry. Mr. Joe Easley raises two good points: "If the Council and Board agree to co-manage the king crab fishery without a formal MFCMA FMP, might the Board want reciprocity in other fisheries that are currently covered by a MFCMA FMP.", and "If no formal procedure for settling disputes is established they could drag on to the ultimate harm of the resource and industry."

2. At the February meeting the Council directed the king crab PDT to modify the DFMP so it would be acceptable to both the Council and Board of Fisheries. The Council subgroup met with the PDT in Seattle on March 16

to review the revised FMP and make any further changes. As a result of those efforts the new DFMP is a generic document, without specifically referencing any organization. The DFMP still maintains the original goal as a general, multi-year plan. If the Council and the Board adopt this document it will be sent out for public review.

It should be re-emphasized that this was prepared as a reference document which the Council can use to show that additional conservation and management is not necessary (as determined by the Council) beyond that currently in effect by the State of Alaska. If this document proves to be unacceptable to the Board, then a formal FMP will probably have to be prepared.

For a formal plan the following items will require a Council decision on a preferred option.

2.4 Management Options

2.4.1. Determination of Optimum Yield

Three different management strategies are proposed for the king crab resource, each of which would result in different Optimum Yields.

Option 1. Season and size limit management.

A closed season would be established to protect the mating and molting stages of the stocks and a minimum harvestable size limit set. No quota would be set; the harvest unlimited during the open season. The optimum yield is defined as all crab which can be harvested during the open season which would be from August 1 to January 15th for 6 1/2" crabs (carapace width) and larger.

This option maximizes the yield from the resource and spreads the fishing effort out over several months. It would require a change in the industrial cycle which is now set up to process large volumes of crab in a short time. The fishery would be based predominantly on one or two age classes and would be subject to recruitment variables, possibly resulting in substantial fluctuations in annual harvests.

Option 2. Multiple age class management.

Under the current State management strategy, a two-part season and size limit spreads the effort over at least three age classes. A guideline harvest level is established based on an exploitation rate for each of the different age classes. This option establishes the fishery on several age classes which tends to buffer the industry against dramatic annual fluctuations. Depending on the status of stocks and the results of the first season fishery, a second fishing season for larger, older crab may be allowed.

Optimum yield would be 40% of the recruit class and 50% of the two older age classes.

Option 3. Procedural management.

The management strategy approach of this option would ensure a minimum spawning stock of fertilized females. The minimum female stock would be established by analysis of the stock recruitment relationship and the stock yield calculated using exploitation rates and size limits that vary according to the condition of the stock. The resulting estimate is equal to the Acceptable Biological Catch (ABC). For those stocks at a low level, or where data are insufficient, (ABC) is set at a level which maintains full (near 100%) female fertilization. Currently that would take an exploitation rate of .4 and minimum size limit of 6.5 - 7 inches, depending upon the management area.

This procedure would be used annually by the Council and the Board of Fisheries. The estimation of ABC could be modified depending on analysis of the economic impacts of catches allowed by ABC guidelines and through public comments. This would result in an Estimated Annual Catch. This option would take advantage of the surplus crabs which are not necessary for maintaining the full reproductive potential of the stock. For instance, in years when recruitment is above average, the size limit may be lowered to harvest a significant portion of the prerecruit crabs. Conversely, in years of below average recruitment, the size limit may be raised in order to ensure reproductive success.

2.4.4 Registration Areas

Option 1. Kodiak, Alaska Peninsula, Dutch Harbor, and Bristol Bay are exclusive registration areas. Adak and Bering Sea are non-exclusive areas. The vessel may register for only one exclusive area during any one fishing season. All vessels may freely register for any non-exclusive registration area.

Option 2. Eliminate the exclusive and non-exclusive registration system presently in use by the State. Adoption of this option would freely permit vessels to fish in any or all king crab statistical reporting areas.

2.4.6 Gear Placement

Option 1. King crab pots must be removed from the water or stored in designated storage areas within 72 hours following the closure of any district, subdistrict, bay, or other portion of a king crab statistical reporting area. Within 7 days following a closure of a statistical reporting area, all gear must be removed from the grounds or stored in designated storage areas.

Option 2. No king crab pots should remain on the fishing grounds after the closure of the season. Crab pots must be stored in designated storage areas.

2.4.7 Gear Storage

Option 1. King crab gear may be stored in 25 fathoms of water or less with bait and bait containers removed and with doors locked open.

Additionally, two crab pot storage areas off of the fishing grounds are provided for in the Bering Sea.

Option 2. Require king crab gear to be removed from the water during closed fishing periods.

Option 3. Allow pot storage on the fishing grounds. Gear remains on grounds at all times.

This option assumes that the cost of removing the king crab gear from the grounds between king crab seasons outweighs the enforcement costs associated with openings and closures of the season, the fair and equal start of the king crab season among all users, and the potential biological risks to crabs and other fishes from being retained in pots between active fishing seasons.

Since the proposal by the crab pot storage Ad Hoc Workgroup falls within Option 3, it was felt that comments to their proposal from enforcement agencies would be valuable to the Council.

Lt. Clinton Converse, Fish and Wildlife Protection, Alaska State Department of Public Safety, does not recommend approval of the proposed storage area since the area would lie on important crab fishing grounds. The proposed area would increase enforcement costs significantly by requiring crab pot examination and increased surveillance.

A report from NMFS Law Enforcement Division and the U.S. Coast Guard is attached. These agencies do not recommend approval of the proposed storage area since it may encourage illegal fishing by catcher/processor vessels and create conflicts between stored crab pots and trawl gear.

A copy of a letter from Dennis Peterson of Ocean Spray Fisheries Inc. is attached. Mr. Peterson expresses his concern about delaying the opening date of king crab season to later in the winter. He feels that due to poor weather conditions, the risk to vessels, gear, and fishermen safety may be too high.

NORTH PACIFIC FISHING VESSEL OWNERS ASSOCIATION
Building C-3, Room 218
Fishermen's Terminal
Seattle, Washington 98119
Phone: (206) 285-3383

March 23, 1981

Clement V. Tillion
Chairman
North Pacific Fishery Management Council
P.O. Box 3136 DT
Anchorage, Alaska 99510

Dear Mr. Tillion:

The North Pacific Fishing Vessel Owners' Association opposes adoption of the "Joint Statement of Principles between the North Pacific Fishery Management Council and the Alaska Board of Fisheries on the Management of Domestic Fisheries." The reasons for its opposition to this agreement and its desire for a Council fishery management plan for king crab which is submitted to the Secretary of Commerce for review and implementation are detailed in the Association's written comments on the "Western Alaska King Crab Draft Fishery Management Plan" (September 15, 1980 version). These comments were submitted to the Council and the Board in December 1980.

The Association does not believe the Council has the authority to enter into this proposed agreement. The execution of the joint statement is not an activity which is required or provided for in the Magnuson Fishery Conservation and Management Act (MFCMA). Nor is the agreement an activity which is "necessary and appropriate" to the functions of the Council which are set out in Section 302 (h) of the MFCMA. Since the Council requested comments on the proposed agreement, however, the Association would be remiss if it did not make the following observations.

Title

The title should be changed to indicate that this agreement only relates to the Bering Sea king crab fishery.

Preamble

Paragraph 1

The Council does not have "a legal responsibility for reviewing and recommending to the Secretary of Commerce the conservation and management [sic] of the fisheries of the North Pacific Region...." The Council has much more authority than is stated in the joint statement. According to Section 302(h)(1) of the MFCMA, the Council has the legal responsibility to "prepare and submit to the Secretary a fishery management plan with respect to each fishery...." within that region. The Secretary just reviews the plan to determine if it is consistent with the national

standards of the MFCMA. The preamble should be rewritten to indicate the major role that the Council has in the management of the North Pacific fisheries.

Paragraph 2

Unless a vessel is registered under the laws of the State, Alaska cannot enforce its regulations outside of state waters. Alaska can only enforce federal regulations in the Fishery Conservation Zone (FCZ) if it has entered into an agreement with the Secretaries of Commerce and Transportation.

Management responsibilities cannot be divided. Section 102 of the MFCMA vests "exclusive fishery management authority" in the FCZ to the United States. Management responsibilites for the FCZ fisheries reside in the Council.

This paragraph is not in logical sequence in the joint statement. It should follow Paragraph 3.

Paragraph 3

The statement which refers to extension of state management into the FCZ is inappropriate for this agreement. It is a distortion of decisions by Alaska state courts which condoned the expansion of Alaska's management authority for fisheries beyond state waters; these decisions were handed down prior to the enactment of the MFCMA. The Council should not be making any acknowledgements that Alaska's exercise of fishery management authority in the FCZ is legally valid.

The sentence which talks of "substantial investments by the State" and refers to "experienced [state] personnel" should be deleted. It implies that the federal government does not have a signficant financial stake in fisheries management in Alaska; federal fisheries personnel are not experienced; and these federal employees are not capable of undertaking extensive management, research and enforcement programs. If the latter two points are true, why is much of the Bering Sea king crab research being conducted by the National Marine Fisheries Service?

It is suggested that Paragraph 3 be rewritten around the second and third sentences of this proposed paragraph. The other materials contained in this paragraph are not relevant to the agreement.

Paragraph 4

This paragraph should be amended to indicate that the joint statement applies only to the Bering Sea king crab fishery.

Section I

Paragraph 1

The phrase "Memorandum of Understanding and" should be stricken.

The justification for the Council's determination that the Bering Sea king crab fishery "does not need a formal FCMA Fishery Management Plan and implementing Federal regulations" should be made part of the joint statement. The Council's reasons and findings should be subject to public review.

If, as stated in the preamble, "the State effectively (and out of necessity) extended its management into the Fishery Conservation Zone to encompass the fisheries throughout their ranges," the State has a substantial financial investment in fisheries management, and the State has experienced personnel, why does this proposed joint statement only encompass the Bering Sea king crab fishery? Why shouldn't the proposed agreement cover all the king crab fisheries off Alaska? There is no justification in the joint statement for singling out the Bering Sea king crab fishery for "special treatment."

Section II

Note: All references to "management plans" should be changed to "management plan." Only one fishery is the subject of this proposed agreement.

Paragraph 1

This paragraph should be corrected to indicate "joint management of the Bering Sea king crab fishery" rather than "joint management of domestic fisheries." Thus far, this agreement applies to only one fishery.

Paragraph 2

According to the proposed agreement, the plan will contain "applicable management standards (including the national standards of the FCMA and statutory standards of the Fish and Game Code of Alaska)...." It seems that these two sets of standards are not mutually compatible. For example, the Alaska Fish and Game Code requires the Commissioner of the Department of Fish and Game to "manage...the fish resources of the state in the interest of the economy and general well-being of the state." The Code also establishes subsistence use as a priority over maintenance of stocks on a sustained-yield basis, if fishing is to be restricted. Should consumptive use have to be limited, local residency is one of the Code criterion to be used in setting priorities. Furthermore, Article VIII, Section 2 of the Constitution of Alaska states "The legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State...for the maximum benefit of its people." How will these statutory and constitutional standards be reconciled in the fishery management plan with National Standard 4 of the MFCMA which states

> 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 manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

Another readily apparent conflict is between Article VIII, Section 4 of the Constitution of Alaska which requires management on a "sustained yield principle" and National Standard 1 of the MFCMA which mandates management on the basis of "optimum yield." How are these conflicts to be resolved? Are the national standards of the MFCMA to bow to the statutory and constitutional provisions of Alaska? The proposed joint statement should indicate which of these sets of standards are to have precedence.

Another problem to be resolved before the proposed agreement is signed is who is to determine whether the plan's management measures are consistent with the MFCMA's national standards? Obviously, the Board of Fisheries is not the proper judge. And as the Council is aware, consistency determinations are the province of the Secretary of Commerce. Again, the consistency "arbiter" should be spelled out in the proposed agreement.

The proposed joint statement requires that the plan and its amendments must be agreed to by the Council and the Board. Are votes taken by both bodies as a whole, or does each body vote separately? Does a majority vote constitute approval or is a greater number required? The proposed joint statement should clarify these issues.

Paragraph 4, which discusses the purposes of the joint hearings, should be integrated into this paragraph. Otherwise, it appears that Paragraph 4 joint hearings are different from the hearings set forth in this paragraph.

Paragraph 3

Beyond calling for annual meetings on the State's regulatory program, the proposed statement fails to specify when these hearings should take place. To have joint hearings before the Board has set regulations for the upcoming season deprives the Council of any meaningful management authority; all the Council can do is approve or disapprove of the state regulations which were in effect the previous season. If the joint regulatory meeting is held after the Board's shellfish proposal meeting then unnecessary duplication arises. It is suggested that the Board and Council meet together during the Board's shellfish proposal meeting. At this time, the public can present its proposals and comments on proposals relating to the Bering Sea king crab fishery, and both management bodies can together pass on the regulatory measures which implement the fishery management plan. This arrangement should be stated in the proposed agreement. It is also assumed that the Council and Board must both agree to the regulations; therefore, the proposed joint statement should indicate what vote constitues approval and whether the Council and Board vote as a whole, or as separate bodies.

It is not clear whether the annual hearings are held only for the purpose of reviewing the state's regulatory scheme (which implies that the Council will comment on last season's regulations but have no say on proposed regulatory changes) or the annual review constitutes a part of these hearings. It is assumed that the latter interpretation applies; the joint statement should be rewritten to incorporate this intent.

What are "interested agencies?" Does this term include industry associations? Although the hearings are termed as"public," will the public be able to comment on regulations and actively participate in the hearings or is the public's role to just sit and listen?

Will the annual public hearings on the state's regulatory program include hearings in Seattle? If so, this paragraph should incorporate this desire.

Paragraph 4

See observations on Paragraphs 2 and 3 (above).

Paragraph 5

If this joint statement applies only to the Bering Sea king crab fishery, why does this paragraph speak of assuring "effective management of the domestic fishery resources of the North Pacific Region?"

Paragraph 6

This paragraph would be clearer if it read:

> 6. seek assistance as needed from other Pacific Coast states to assure full compliance by all fishing vessels with the management plan and implementing regulations promulgated by the State of Alaska.

Paragraph 7

Does this paragraph mean that the Council and Board are agreeing to submit conflicts to binding arbitration? If so, who is to be the arbiter? The procedures for resolving conflicts should be stated in the proposed agreement; "all appropriate means" is too indefinite.

Section III

This section causes great concern to non-resident fishermen. Some of the problems which the Alaska Constitution and the Alaska Fish and Game Code raise with respect to managing fisheries for Alaska's residents are addressed in the Association's comments on Paragraph 2

of Section II (above). In addition, when the Board's procedures were established, convenient access by non-residents to the regulatory process was not a consideration.

The Board was created "[f]or purposes of the conservation and development of the fishery resources of the state...." Its members are appointed by the governor and they must be residents of the State. The Board has regulation-making powers, and in furtherance of this function, it solicits proposals and holds public hearings on proposed regulatory changes.

For all user groups, resident and non-resident, the Board's procedures make it extremely difficult to make substantive comments on proposed regulations. Those who offer proposals are only required to submit a blanket statement of reasons for the proposed changes; no substantiating data has to be presented. As a result, every person who opposes a proposal has to treat it as if it were worthy of consideration. The burden falls on the opponent to gather data against the proposal; his time has to be spent making a case against a proposed regulatory change that may have no basis in fact.

Another difficulty with the Board's regulatory procedures is the Board's failure to publish its rationale and supporting data for a regulatory change. User groups are only aware of a change; they do not know why the Board took the actions it did. The Board's "failure to explain itself" causes dissatified user groups to attach motives to the Board's actions which may not have existed in the minds of its members. In addition, the lack of justification for a regulatory change makes it difficult for one to propose an amendment; one has to guess that the conditions which brought about the regulation no longer exist. Finally, the Board's failure to give a rationale for a regulation change leaves it open to a claim in a law suit that the Board acted in an "arbitrary and capricious manner."

Assisting the Board in its regulatory function are the local advisory committees. These committees represent all resident user groups within a fish resource management region. Members must be residents of that area. Local advisory committees were established"to provide a local forum for the collection and expression of opinions and recommendations on matters relating to the management of fish...resources." In carrying out this task a committee may develop regulatory proposals for submission to the Board, and evaluate regulatory proposals submitted to it and make recommendations on them to the Board. More importantly, the local advisory committee can initiate emergency closures of fisheries within its area of jurisdiction.

As indicated above, access to the Alaska regulatory system is difficult for non-residents. For non-residents to participate in local committee meetings would involve substantial travel costs. Usually, non-residents are not even aware of advisory committee meetings because the meetings are only advertised locally. The recommendations of the advisory committees are not given wide distribution; and even though the minutes of local meetings must be sent to the Board, these records rarely go into the substance of the discussions. Local committees can also rely on the advice and information of Alaska Department of Fish and Game employees at their meetings; this gives local residents an advantage in preparing proposals for the Board meetings. Finally,

it is conceivable that a local advisory committee, through its emergency closure powers, could shut a fishery down and non-residents, who may be affected the most by the closure, would have no say in the committee's actions.

As the Council is aware, the MFCMA process ensures that all fishermen, regardless of residence, can have equal access to the management process. Members of the Council reside in Alaska, Oregon and Washington. Notice of its meetings and public hearings are given widespread distribution, and its public hearings on fishery management plans are conducted in areas where the affected user groups reside. The Council is required to gather and analyze all relevant information on fishery management plans and give the public ample opportunity to digest this data before it adopts or amends a management plan. Through its Advisory Panel and Scientific and Statistical Committee, the Council makes certain that industry and the scientific community have had an opportunity to be involved in the development and review of fishery management plans.

Once a plan is submitted by the Council to the Secretary of Commerce and found to be consistent with the national standards of the MFCMA, the public is again given an opportunity to comment on the plan and the regulations which are proposed to implement it. Through the provisions of the Administrative Procedure Act, when final regulations are published, they must be accompanied by a rationale and supporting data. These extensive opportunities to comment on the plan and regulations result in a better management scheme because those who are being regulated are informed about the goals which the Council hopes to achieve.

In comparing regulatory systems, an issue which deserves special mention is access to the courts. Non-residents generally must hire an attorney in their place of residence. This attorney then affiliates with an attorney in Alaska who is licensed to practice in the state courts. This "dual representation" only serves to greatly increase the already substantial costs of litigation. The MFCMA offers dissatisfied parties access to any federal court.

Section IV

Is a "failure of the consultative approaches and processes here outlined" the only way that this proposed joint statement can be voided? If not, list other ways in the proposed agreement. Can either party void the agreement? If so, by what vote. Does a voiding require that notification be given to the other party? Must this notification be written? Does notification have to be given a certain number of days in advance before the agreement can be terminated?

Other Matters

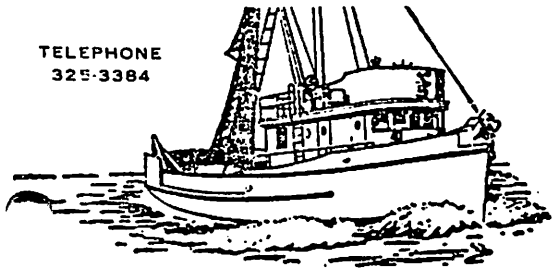
What roles,if any, will the Council's Plan Development Team, Advisory Panel, and Scientific and Statistical Committee play in promulgating regulations under this proposed agreement?

Thank you for the opportunity to comment on the proposed joint statement.

Sincerely,

Richard J. Goldsmith
Executive Director

TELEPHONE
325-3384



AGENDA E-3(a)
March 1981

ACTION	ROUTE TO
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	5D

STATE OF OREGON
OTTER TRAWL COMMISSION OF OREGON
250 - 36 TH STREET, ASTORIA, OREGON 97103

March 10, 1981

Mr. Jim Branson, Executive Director
North Pacific Fishery Management Council
P.O.Box 3136 DT
Anchorage, Alaska 99510

Dear Jim,

I have looked over your Draft Statement of Principles between the Council and the Alaska Board of Fisheries and having done so I can't help but make a couple of comments.

Most of the seven points are a lot like Mom and apple pie. I am refering to the seven points listed under II " The North Pacific Fishery Management Council and the Board of Fisheries will." I think it is desirable to have a memorandum of understanding and a joint statement of principles with the Board of Fisheries that applies to domestic fisheries which the Council determines does not need a formal MFCMA Fishery Management Plan and Federal regulations. Has any thought been given to the point that the Board of Fisheries might want reciprocity in fisheries that are covered by a MFCMA Fishery Management Plan and would it be legal?

Number VII "Gets to Resolving Conflicts" it would appear that through all appropriate means could leave industry hanging in limbo for long periods of time. I wonder about the word "arbitration" being included, it may not be applicable between an entity such as the Council and the Board of Fisheries.

Sincerely,

OTTER TRAWL COMMISSION OF OREGON

Joe Easley,
Administrator

JE:g

ENFORCEMENT OF PROPOSED CRAB POT STORAGE AREA IN OUTER BRISTOL BAY

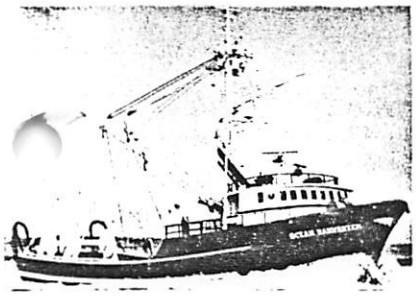
The January 20, 1981, report by the Ad Hoc Group on storage of king crab gear which proposes a revision of the storage areas in outer Bristol Bay could create a situation, by allowing pot storage directly on important crab fishing grounds, that encourages illegal fishing outside the established season.

To effectively enforce a crab fishing season, a patrol unit must be able to detect baited pots while they are stored in the fishing area. This requires the ability for the patrol unit to haul a significant number of the so-called stored pots to determine if the doors are open and the pots are unbaited. That pot-hauling capability does not exist on the Coast Guard ships used for Federal fisheries enforcement. On-the-ground patrol may be less vital if vessel tank inspection prior to the opening of the season is continued, although the large and increasing number of catcher/processor vessels would still pose vexing enforcement challenges if they have processed product on board that could have been legally taken in another area; i.e., North Sound.

The proposed storage area also carries a potential for increased gear conflicts. The western portions of the proposed area have been the scene of an intensive trawl fishery for flounders and we question whether the designation of a pot storage area is sufficient basis for another area trawl closure.

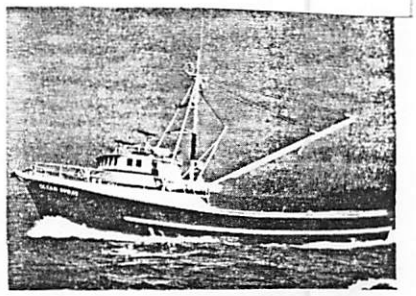
Prepared 3/19/81 by:

CGD17, OIL, and NMFS, Juneau



Ocean Spray Fisheries, Inc.

4315 11TH AVENUE NORTHWEST
SEATTLE, WASHINGTON 98107
Harvesters of The North Pacific Fisheries since 1968
Member of North Pacific Fishing Vessel Owners Association



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Eves: 783-6703

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SD
MAR 9 1981

March 5, 1981

Jim Branson
Executive Director
North Pacific Fisheries Management Council
P.O. Box 3136 DT
Anchorage, Ak 99510

Re: 1981 king crab opening

Dear Jim:

It is my strong feelings for the safety of our fishermen of the Bering Sea king crab fleet that prompts me to pass on my thoughts as regards the 1981 king crab opening. After having read several proposals made by the processing segment of our industry, I feel that it is extremely important that the council be made aware that we fishermen have serious concerns as to moving the season opening into the middle of the winter and the horrendous weather patterns that are prevalent at that time. The losses of life, vessels and gear by extreme weather and ice moving onto the fishing grounds and the many more serious injuries inherent at that time of year are some of our prime concerns.

In past years, we have also found that the crab's condition varies at different times of the year and moving the season opening around is no guarantee that the processors will end up with high recovery rates as they expect. If we move the date to October 10th, which many of my peers have mentioned as a favorable date and which I favor, we very well could end up with the same quality problems as were supposedly prevalent in 1980. However, this date, I feel, would be something we could live with and it would perhaps work to the processors benefit. Any later date, though, I would strongly reject as would most other fisherman experienced with the area during the winter. It's no place for any sane man.

My respects and hopefully you'll include this request for the council's considerations.

Sincerely,

Dennis Petersen

OCEAN SPRAY FISHERIES, INC.
Dennis Petersen

DRAFT

BERING SEA/ALEUTIAN ISLAND

KING CRAB

FISHERY MANAGEMENT PLAN

March 18, 1981

I have sent copies to

Bevan	Cochrane
Harville	Pennoyer
Reeves	Goldsmith
Somerton	Ray Lewis
Marasco	

I'll bring up the other 80 copies

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3.0 AREAS AND FISHERIES

This management plan presently applies only to the king crab (family Lithodidae) fisheries in the Bering Sea and Aleutian Islands (Fig. 2). These fisheries are described in the Alaska Shellfish regulations as the Bering Sea, Bristol Bay, Adak, and Dutch Harbor "statistical areas" (Areas Q, T, R, and O, see Fig. 2).

These areas describe geographically segregated stocks capable of being managed as independent units. Within each statistical area manageable portions of the stocks are further divided into fishing districts and sections. For a complete description of the statistical areas, fishing districts, and sections refer to the commercial section of the Alaska Shellfish Regulations.

4.0 MANAGEMENT OBJECTIVES

The management regime for the king crab fisheries is intended to achieve the following objectives. It is noted that these objectives are not in rank order nor mutually exclusive and that management measures may be designed to accomplish several objectives (i.e., achievement of one objective may be constrained by the need to also achieve another objective).

1. ACHIEVE REPRODUCTIVE REQUIREMENTS FOR INDIVIDUAL KING CRAB STOCKS.

The cornerstone of king crab fishery management is optimization of the reproductive potential of individual king crab stocks. At low population levels or in situations when there is insufficient knowledge of spawner-recruitment relationships to define spawning requirements it is prudent to strive for the maximum reproductive potential by assuring that enough males of the appropriate sizes remain in the population so as to guarantee full egg clutch development of all females. At high abundance levels full egg clutch development in all female crab is unnecessary. Additional harvest of male crab or allowing a harvest of female crab is under these circumstances consistent with the goal of achieving the reproductive requirement of individual

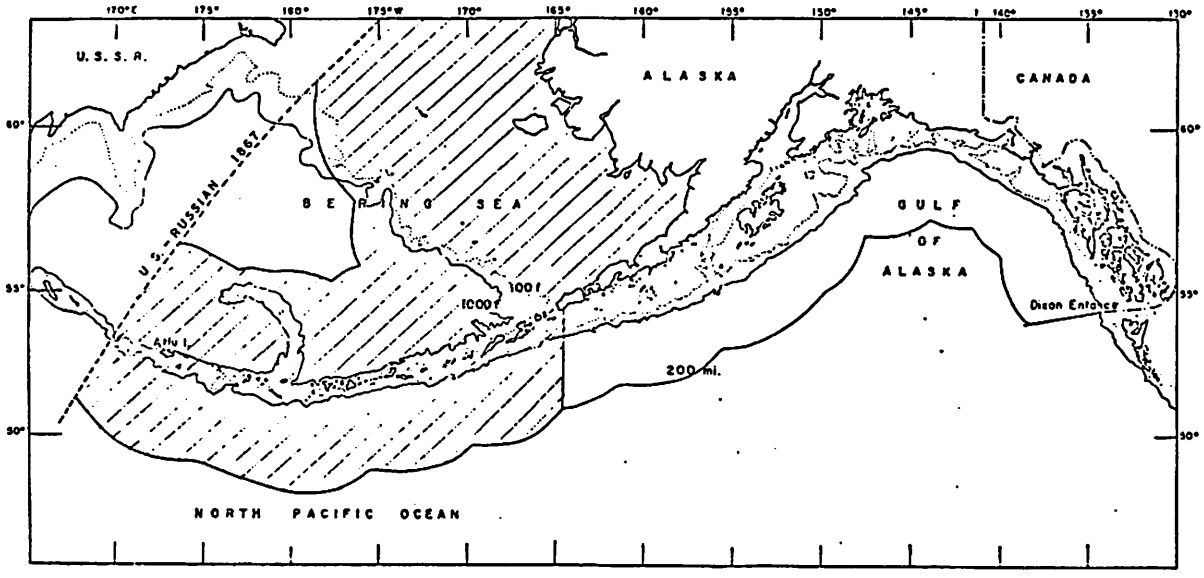

Figure 1. Area (diagonal lines) over which this fishery management plan applies.

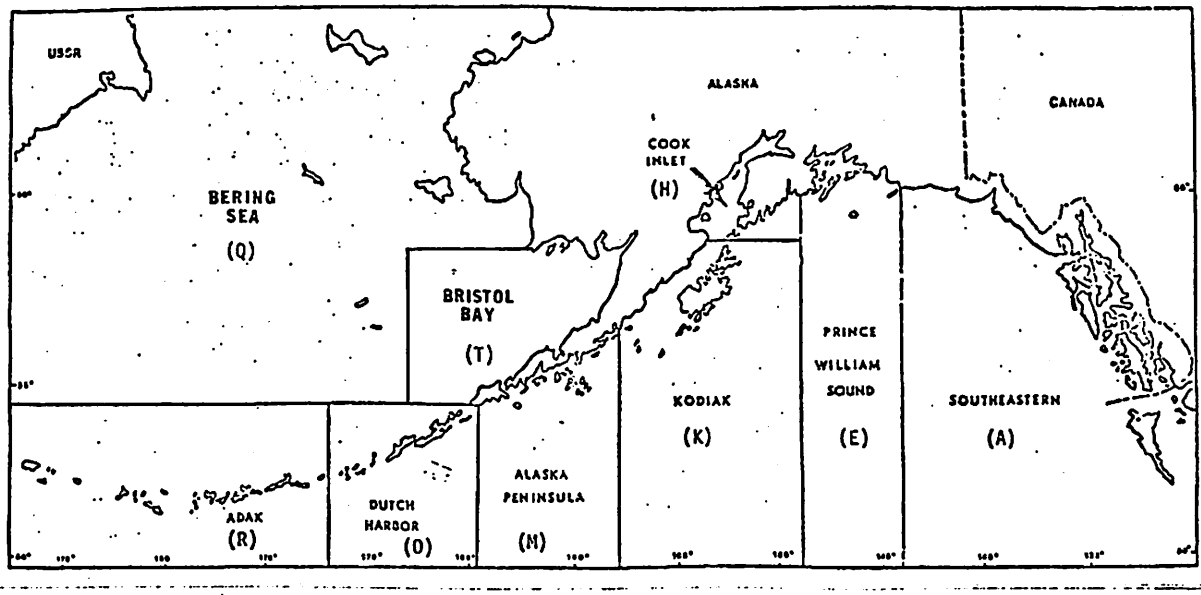

Figure 2. Alaska king crab statistical areas.

stocks.

2. OPTIMIZE THE NET VALUE OF THE FISHERY

The optimal harvestable surplus for the Bering Sea/Aleutian Island king crab fishery is not necessarily the maximum physical yield. Social, economic or ecological factors may change the yield. In particular, annual harvests that are relatively stable between years (i.e., where extreme fluctuations in annual harvests do not occur) are a goal because adverse socioeconomic consequences are associated with "boom and bust" crab fisheries. Management strategies should attempt to moderate peaks and troughs (which are a function of year class strength) with due regard for cost/benefit considerations.

Unless consideration is necessary for conservation or social objectives, management measures should not impose additional burdens on industry; cost effective harvesting and processing techniques should not be restricted; and production/marketing standards should be accommodated.

As an example, management strategies should avoid unnecessary vessel use, thus reducing operating costs associated with fuel consumption. As another example, since crab recovery rates (the ratio of recoverable meat to total body weight) increase dramatically during the period of rapid growth following molting, a delayed season opening can act to increase both the volume and value of the catch and final product, benefiting both fishermen and processors.

3. MINIMIZE ADVERSE SOCIOECONOMIC IMPACTS BY PROTECTING COMMUNITY AND INDUSTRIAL INVESTMENTS.

Because the Bering Sea/Aleutian Island king crab fishery is an existing, historic fishery with an established industrial system (harvesting and processing) and community infrastructures are dependent on the fishery, mechanisms may be necessary to protect investments that have been made.

These considerations are not solely economic but also social in nature. Changes made in the management of the fishery need to be evaluated in light of these previously made investments.

Examples of management measures that have been used to accomplish this objective are exclusive registration, "fair starts", and the setting of seasons in relation to other fisheries.

4. MINIMIZE ADVERSE INTERACTIONS AMONG FISHERIES

Modern management practices dictate that the management of a particular fishery consider the interaction with other fisheries. For example, crab trawls and tangle nets should not be used because they cause excessive mortalities of nontargeted species.

5. OPTIMIZE THE COST EFFECTIVENESS OF MANAGEMENT AND ENFORCEMENT

Fishery management should seek a reasonable balance between the enforcement and management costs borne by the public and by the impacts on industry and should seek to bring all costs within reasonable limits relative to the value of the fishery.

5.0 MANAGEMENT MEASURES

This section establishes a multiyear management regine for the Bering Sea/ Aleutian Islands king crab fisheries described in Section 3.0.

5.1 Determination of Optimum Yield

Two numerical values are addressed in this section. One is the Acceptable Biological Catch (ABC), which is based on the biological status of the stocks. The other is the Optimum Yield (OY), which represents a modification of the ABC for social, economic, or ecological factors. The ABC and OY for Bering Sea/Aleutian Island king crab stocks are determined annually.

ABC

The ABC will be based on the following estimates:

1) Stock abundance and distribution by sex and size class;

2) Natural mortality rates by sex and size class;

3) Fishing mortality rates from previous years by size class;

4) Growth rates by sex and size class;

5) Recruitment into the fishery;

6) Critical size necessary for reproductive needs;

7) Reproductive success given a specific population size, sex ratio, and distribution of spawning stocks; and

8) Environmental and ecological effects.

The ABC should maintain recruitment to the fishable stock at the highest possible level. Maintenance of this level of recruitment for king crab is achieved by perpetuating a minimum required spawning stock of fertilized females. When the stock is below the minimum, the fishery should be restricted to maintain full female fertilization. When the stock is above this minimum, higher exploitation or lower size limits on males may be permitted.

The procedure for determining ABC for king crab is as follows:

1. Establish the minimum required female spawning stock.

This is done by an analysis of the stock-recruitment relationship, based on abundance estimates from resource assessment surveys. This is an ongoing analysis which builds on the use of additional data as each survey is completed.

Information is not complete for all the king crab fisheries in Bering Sea/ Aleutian Islands. The Bering Sea area presently has the best data base and is experiencing high stock levels. A study by Reeves and Marasco (1980) which simulated the spawner-recruitment relationship, the copulation coefficient and the size of the Bering Sea fishery indicates that because of high stock levels

there is currently an excess reproductive potential. Further, Reeves (1981) has indicated that 40 million copulated females is a reasonable estimate of the minimum number necessary to sustain the population based on spawner-recruit information. Therefore, at the high population levels now apparent in the Bering Sea, a greater portion of males is surplus to reproduction and is available as ABC for the fishery. The ABC is estimated using this information combined with current survey estimates of abundance. A detailed example is provided by Reeves (1981).

2. ABC is set equal to the maximum catch (i.e., a given minimum size limit/exploitation rate combination applied to survey estimates of abundance) which still maintains the minimum required spawning stock.

Expected catches are calculated from survey abundance estimates by minimum size limit and exploitation rate. Acceptable catches are those which do not lower the expected spawning population of females below a minimum required. Such a reduction in spawning population operates through a presumed reduction in percent copulation. The highest of these catches is selected as the ABC.

3. For those stocks at a low level, or where data are insufficient for determining the minimum required spawning stock, ABC will be set at the maximum catch which still maintains full female fertilization.

For example, this catch currently corresponds to an exploitation rate of approximately .4 and a minimum size limit of 6.5 inches in the Dutch Harbor area. Fisheries where these parameters are in effect or where the exploitation rate is less than .4 (eq. Norton Sound) have not impacted on full female fertilization. Thus, until additional information indicates otherwise, and for stocks that are at a low level or whose abundance is unknown, management will be conservative and attempt to achieve maximum fecundity in the female population.

OY

The Optimum Yield for the Bering Sea/Aleutian Island king crab fishery is the preseason indication of the allowable harvest. The realized harvest may differ from the earlier specification of OY due to information gained during the season (see Section 5.9,In-season Adjustment of Time and Area).

The OY will equal the ABC unless there is social, economic or ecological rationale for harvesting more or less than the ABC. Agency reports, public comments, analyses of impacts on markets, the processing and harvesting sectors and the community infrastructures, etc. will serve as the basis of modifying ABC into OY.

5.2 Fishing 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. Because harvest levels are usually taken in two months or less there is opportunity to look beyond biological considerations in setting the date of the season opening.

In determining an appropriate data, several factors will be weighed. One factor to be considered 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.

A second factor to be weighed is weather conditionss. 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 operators of smaller vessels.

A third 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 lengthly period of time between the two fisheries will force vessels and processors to lie idle and may create additional startup costs.

A fourth 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 season opening should reflect a balance of attitudes within the industry with respect to the several factors described above.

5.3 Sex Restrictions

Common to nearly all crab fisheries is the restriction of taking only male crab. This restriction is assumed to contribute to maximium reproductive potential. The data base to support or reject an intensive harvest of female king crab is poor. Reeves and Marasco (1980) and Reeves (1981) indicate that there are probably surplus female crab which can be taken from the high stock levels now present in the Bering Sea. However, the accumulative effects of female harvests and the subsequent environmental impacts are not demonstrable at this time and may never be without actually harvesting the female population.

The potential harvest of female crab has not been an issue. Management philosophies endorse a limited fishery for females in years of high abundance; however, industry has shown little interest. Females are considerably smaller than males of the same age and the proportion of recoverable meat is much less than that of males.

At the request of industry, the feasibility of providing a limited harvest of female crab will be determined.

5.4 Exclusive Registration Areas

The designation of registration areas as exclusive or non-exclusive has been debated for years. Exclusive registration areas encompass generally well developed historical fisheries. Non-exclusive registration areas are generally areas where king crab fisheries are relatively unexplored, unstable or marginal. The socio-economic impact upon local communities withing an area has been a major consideration as to whether a registration area warrants exclusive or nonexclusive status.

The Board and Council will jointly meet to determine if statistical areas in the Bering Sea/Aleutian Islands king crab fishery should be designated as exclusive or nonexclusive registration areas.

OPTION 1. Maintain status quo.

The State's registration system establishes Dutch Harbor and Bristol Bay as exclusive registration areas. Adak and the Bering Sea are non-exclusive areas. Vessels may register for only one exclusive registration area during any one fishing season. All vessels may freely register for any nonexclusive registration area.

OPTION 2. Eliminate the exclusive and nonexclusive registration system presently in use by the State.

Adoption of this option would freely permit vessels to fish in any or all king crab statistical reporting areas of the State.

OPTION 3. Establish the Bering, Bristol Bay, Dutch Harbor, and Adak statistical areas (areas Q, T, O, and R) as a single exclusive registration area.

Adoption of this option would freely permit vessels to fish in any or all

king crab statistical areas Q, T, O, and R but not in any other king crab statistical area of the State.

5.5 Gear Placement

Determination of the need for regulations affecting gear placement or staging, (i.e., allowing fishing gear to be placed on the grounds prior to fishing and/or remain on the grounds after the season closure) will result from examining:

1) The biological impacts on target and nontarget species;
2) Enforcement problems and costs borne by the public versus by the industry;
3) Possible gear conflicts; and
4) The desire by the public to protect industrial and community investments.

5.6 Gear Storage

Between fishing seasons, king crab gear can be stored on land or at sea. The expense of storage on land is of course greater than at sea, however loss of gear is significantly reduced with on land storage. Under current State regulations, gear must be removed from the fishing grounds after the fishing season is over and stored on land, in shallow waters (less than 25 fathoms), or in specific high seas areas when there is insufficient shallow water storage. These designated storage areas have historically been areas of low crab abundance. Gear must be stored in a nonfishing condition; bait and bait containers removed and doors locked open.

Regulations which describe the means by which king crab fishing gear may be stored during the closed fishing season will continue to be developed. These regulations may range from random (at sea) storage to limited designated (at sea) storage areas, or complete removal of gear from the sea and will be based on analyses of the following information:

1) The biological impacts of storing gear at sea;

2) The enforcement costs of determining whether fishing gear stored at sea is in a nonfishing condition;

3) The costs borne by the fleet to store gear; and

4) Availability of on land or at sea storage areas.

5.7 Vessel Tank Inspection

Vessel tank (e.g., live hold) inspections are required under State regulations to meet the legal requirements for the State's "landing laws" (see Appendix 7.2). In order to pass inspection, the vessel must have no crab aboard. Generally, the tank inspection is performed by Department personnel during the 24-hour period preceding the season opening.

In determining the need for vessel tank inspection regulations consideration will be given to:

1) Enforcement requirements;

2) Documentation of commercial harvest location;

3) The fleet's ability to move freely from the fishing grounds to processing locations;

4) The time necessary to transport gear from the storage areas to the fishing grounds;

5) The increase fuel useage required by the fleet to effect this regulation; and

6) The desire by the fleet to insure a fair and equitable season start among the various participants.

5.8 Limited Entry

There is no present need to implement a limited entry program for vessels fishing the king crab fishery in the Bering Sea/Aleutian Island area.

5.9 In-season Adjustment of Time and Area

Optimum yields are based upon projections of the status of the stocks, economic, and other conditions several months in advance of the actual conduct of the fishery and may be found to be mis-specified in light of unpredicted and unanticipated adverse or favorable stock conditions which are revealed in-season. Under such circumstances it is appropriate to take immediate action by issuing emergency orders adjusting time and/or area restrictions. Therefore, this plan provides that seasons and area shall be subject to in-season adjustment based upon one or more of the following factors:

1. Distribution of fishing effort by time and area;
2. Catch per unit effort and rate of harvest:
3. Relative abundance of age classes of king crab within the area in comparison with preseason prediction;
4. The proportion of immature or soft shell king crab being handled; and
5. Any other factors relevant to the conservation and management of king crab.

6.0 ENFORCEMENT AND REPORTING REQUIREMENTS

Enforcement procedures are necessary for:

a. surveillance of fishing vessels to assure compliance with the registration and permitting regulations as well as area and season openings and closures.

b. surveillance of landings to assure compliance with size, sex, and species regulations;

c. surveillance of fishing gear to assure compliance with gear restrictions and gear storage areas.

Catch reporting by the fishermen and the buyers is necessary for proper management. When a king crab fisherman lands his catch, a report in the form of a "fish ticket" must be completed. The information required provides a statistical data base on the fishery and shall include information on: type and quantity of fishing gear used, catch by species in numbers of crab or weight thereof, areas in which fishing was engaged in, time of fishing, and number of hauls. Any fishing vessel which processes its own catch or the catch of other vessels must comply with this catch reporting requirement.

Fish buyers, processors, etc., who purchase, transport, and/or process king crab shall provide the following data:

1. The amount or tonnage of crab purchased, transported, and/or processed, by species.

2. Locations at which crab are received and/or processed, by species.

3. Limitations as to seasons, quantities, or quality standards of crab which apply to crab received and/or processed, by species.

4. Disposition of the crab received or processed, by species.

5. Prices paid for crab received, by species.

6. The amount or tonnage which the processor expects to purchase, transport, and/or process, by species, by year.

7.0 APPENDICES

7.1 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. Functions of the Commissioner are:

1. Supervise and control the Department, and he may appoint and employ division heads, enforcement agents, and the technical, clerical, and other assistants necessary for the general administration of the Department;

2. Manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the State in the interest of the economy and general well-being of the State;

3. Have necessary power to accomplish the foregoing including, but not limited to, the power to delegate authority to subordinate officers and employees of the Department.

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.

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: (1) Upper Yukon-Kuskokwim-Arctic, (2) Western Alaska (including Kodiak), (3) Southcentral, (4) Prince William Sound (including Yakutat) and (5) Southeast, in order to assure 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

7.2 STATE LANDING LAWS (Migratory Fish and Shellfish)

Sec. 16.10.180. Legislative findings. The legislature finds and recognizes these facts:

(1) Migratory fish and migratory shellfish are present in commercial quantities inside and outside the territorial waters of the state.

(2) Migratory fish and migratory shellfish taken from the waters of the state are indistinguishable, in most cases, from those taken from the adjacent high seas.

(3) Substantial quantities of migratory fish and migratory shellfish move inshore and offshore intermittently and at various times during a given year and in so doing often enter and leave territorial waters of the state.

(4) To conserve the migratory fish and migratory shellfish found inside the waters of the state it is necessary to strictly enforce local laws and regulations.

(5) By making certain laws and regulations passed or promulgated for the regulation of the coastal fishery applicable to the adjacent high sea areas, enforcement of these laws and regulations is facilitated.

(6) Conservation regulations should not be promulgated to impose economic sanctions. (§ 1 ch 121 SLA 1960)

The legislature did not envision the highseas adjacent to Alaska as being formally within Alaska's boundaries, for those high seas are in fact distinguished several times from the territorial waters of the state. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

A state may reasonably extend its jurisdiction to control fish and game resources outside the limited area of its territorial sovereignty, if such an exercise is based on the conservation principles inherent in their migratory characteristics and not based on artificial boundaries or political circumstances. State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Alaska's interest in regulating extraterritorial fishing qualifies as one recognized for a legitimate exercise of police power. There is an established fishery with clear economic impact in the Bering Sea fishery area. The migratory habits of the crab are predictable and fishing outside the three-mile limit depends on growth and development within the limit. If the fishery outside the three-mile limit destroys the resource outside, it will similarly destroy the resource inside the three-mile limit. State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Purpose of applying fisheries laws to high seas. — Paragraphs (4) and (5) of this section make it clear that the purpose of the application of fisheries laws to the high seas is to conserve shellfish found "inside the waters of the state." State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

The method of accomplishing this purpose is reasonably related to the purpose; it is, therefore, permissible. State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

The intent of the state's laws and regulations is clearly not to effect extra-territorial activity to any greater extent than is necessary to preserve the king crab fishery within state waters. State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Alaska's crabbing regulations are not violative of the national government's exclusive prerogatives in the field of foreign affairs. State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Absence of clear indication of federal exclusivity or pre-emption in field of fishery regulation. — See State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Extent of state's control over fishermen. — See State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Sec. 16.10.190. Regulations. The Board of Fisheries may promulgate regulations to carry out the purposes of §§ 180 — 230 of this chapter defining the adjacent high sea areas, migratory fish and migratory shellfish and to make coastal fishery regulations governing the manner, means, conditions and time for the taking of migratory fish and migratory shellfish applicable in designated adjacent high sea areas. (§ 2 ch 121 SLA 1960; am § 21 ch 206 SLA 1975)

Effect of amendment. — The 1975 amendment substituted "Board of Fisheries" for "board" near the beginning of the section and deleted "rules and" preceding "regulations" near the beginning and near the middle.

Entire Bering Sea Shellfish Area not considered within territorial waters. — Reference to regulations promulgated to carry out the purpose of this article supports the conclusion that Alaska does not consider the entire Bering Sea Shellfish Area to be formally within its territorial waters. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

State regulation of certain extraterritorial conduct would pass constitutional muster if its regulations were directed at conserving the crab fishery within Alaska's waters by regulating crabbing in that area and in order to facilitate enforcement, by prohibiting the possession of crab in the state during the closed season, even if that crab were caught outside the state. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

State officials were enjoined from enforcing commercial fishing regulations 5 AAC 07.760 and 5 AAC 36.040, which, respectively, close the king crab fishing season in the Bering Sea Shellfish Area when 23,000,000 pounds of king crab have been taken during the period of June 15 through March 31 and prohibit transportation, possession, etc., of king crab and certain other sealife "taken in violation of the rules and regulations promulgated by the board," if such crab is taken "in any waters seaward of that officially designated as the territorial waters of Alaska." Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974). These regulations were subsequently repealed, and in Hjelle v. Brooks, 424 F. Supp. 595 (D. Alas. 1976), the district court vacated the injunctive order. — Ed. note.

Unlike the judicially approved "landing laws," Alaska's regulations purporting to close the crab fishery in the entire Bering Sea after the quota of 23,000,000 pounds of crab has been reached, and prohibiting the possession, etc., in Alaska only of that crab and sealife "taken seaward" of Alaska's territorial waters, have a direct rather than indirect impact on extraterritorial conduct, and Alaska's justification for this impact, the need to facilitate enforcement of state regulations aimed at conserving the crab fishery within Alaska's waters, simply does not seem to provide a nexus sufficient to withstand constitutional attack. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

Sec. 16.10.200. Unlawful taking prohibited. It is unlawful for a person taking migratory fish and migratory shellfish in high sea areas designated by the Board of Fisheries or in violation of the regulations promulgated by the Board of Fisheries governing the taking of migratory fish and migratory shellfish in the designated areas to possess, sell, offer to sell, barter, offer to barter, give or transport in the state, including the waters of the state, migratory fish or migratory shellfish. (§ 3 ch 121 SLA 1960; am § 22 ch 206 SLA 1975)

Effect of amendment. — The 1975 amendment near the middle of the section, substituted "Board of Fisheries" for "board" twice and deleted "rules and" preceding "regulations."

This section is a typical "landing law." State v. Sieminski, Sup. Ct. Op. No. 1339 (File No. 2544), 556 P.2d 929 (1976).

Applied in State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Cited in Hjelle v. Brooks, 424 F. Supp. 595 (D. Alas. 1976).

Sec. 16.10.210. Unlawful sale or offer prohibited. It is unlawful for a person to possess, purchase, offer to purchase, sell, or offer to sell in the state migratory fish or migratory shellfish taken on the high seas knowing that they were taken in violation of a regulation promulgated by the Board of Fisheries governing the taking of migratory fish or migratory shellfish in certain areas designated by the Board of Fisheries or the commissioner. (§ 4 ch 121 SLA 1960; am § 23 ch 206 SLA 1975)

Effect of amendment. — The 1975 amendment deleted "rule or" preceding "regulation" near the middle of the section and substituted "Board of Fisheries" for "board" near the middle and near the end.

Cited in Hjelle v. Brooks, 424 F. Supp. 595 (D. Alas. 1976).

Sec. 16.10.220. Penalties for violation of §§ 200 and 210 of this chapter. A person who violates §§ 200 and 210 of this chapter is guilty of a misdemeanor, and upon conviction is punishable by a fine of not more than $5,000 or by imprisonment for not more than one year, or by both. (§ 5 ch 121 SLA 1960)

Sec. 16.10.230. Exemptions. Sections 180 — 220 of this chapter do not apply to

(1) those species of salmon in international waters of the Pacific Ocean which are regulated by the International Pacific Salmon Fisheries Commission or by laws of the United States or rules or regulations promulgated under those laws:

(2) the use of nets for fishing for or taking salmon for the purposes of scientific investigation authorized by state law; and

(3) existing laws and regulations prohibiting the taking of salmon by means of nets on the high seas. (§ 6 ch 121 SLA 1960)

7.3 National Standards of the Magnuson Fisheries 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.

Sec. 16.10.190. Regulations. The Board of Fisheries may promulgate regulations to carry out the purposes of §§ 180 — 230 of this chapter defining the adjacent high sea areas, migratory fish and migratory shellfish and to make coastal fishery regulations governing the manner, means, conditions and time for the taking of migratory fish and migratory shellfish applicable in designated adjacent high sea areas. (§ 2 ch 121 SLA 1960; am § 21 ch 206 SLA 1975)

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State regulation of certain extraterritorial conduct would pass constitutional muster if its regulations were directed at conserving the crab fishery within Alaska's waters by regulating crabbing in that area and in order to facilitate enforcement, by prohibiting the possession of crab in the state during the closed season, even if that crab were caught outside the state. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

State officials were enjoined from enforcing commercial fishing regulations 5 AAC 07.760 and 5 AAC 36.040, which, respectively, close the king crab fishing season in the Bering Sea Shellfish Area when 23,000,000 pounds of king crab have been taken during the period of June 15 through March 31 and prohibit transportation, possession, etc., of king crab and certain other sealife "taken in violation of the rules and regulations promulgated by the board," if such crab is taken "in any waters seaward of that officially designated as the territorial waters of Alaska." Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974). These regulations were subsequently repealed, and in Hjelle v. Brooks, 424 F. Supp. 595 (D. Alas. 1976), the district court vacated the injunctive order. — Ed. note.

Unlike the judicially approved "landing laws," Alaska's regulations purporting to close the crab fishery in the entire Bering Sea after the quota of 23,000,000 pounds of crab has been reached, and prohibiting the possession, etc., in Alaska only of that crab and sealife "taken seaward" of Alaska's territorial waters, have a direct rather than indirect impact on extraterritorial conduct, and Alaska's justification for this impact, the need to facilitate enforcement of state regulations aimed at conserving the crab fishery within Alaska's waters, simply does not seem to provide a nexus sufficient to withstand constitutional attack. Hjelle v. Brooks, 377 F. Supp. 430 (D. Alas. 1974).

Sec. 16.10.200. Unlawful taking prohibited. It is unlawful for a person taking migratory fish and migratory shellfish in high sea areas designated by the Board of Fisheries or in violation of the regulations promulgated by the Board of Fisheries governing the taking of migratory fish and migratory shellfish in the designated areas to possess, sell, offer to sell, barter, offer to barter, give or transport in the state, including the waters of the state, migratory fish or migratory shellfish. (§ 3 ch 121 SLA 1960; am § 22 ch 206 SLA 1975)

Effect of amendment. — The 1975 amendment near the middle of the section, substituted "Board of Fisheries" for "board" twice and deleted "rules and" preceding "regulations."

This section is a typical "landing law." State v. Sieminski, Sup. Ct. Op. No. 1339 (File No. 2544), 556 P.2d 929 (1976).

Applied in State v. Bundrant, Sup. Ct. Op. No. 1232 (File Nos. 2295, 2435, 2444), 546 P.2d 530 (1976).

Cited in Hjelle v. Brooks, 424 F. Supp. 595 (D. Alas. 1976).

7.4 BIOLOGICAL AND ENVIRONMENTAL CHARACTERISTICS OF THE RESOURCE

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.

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.

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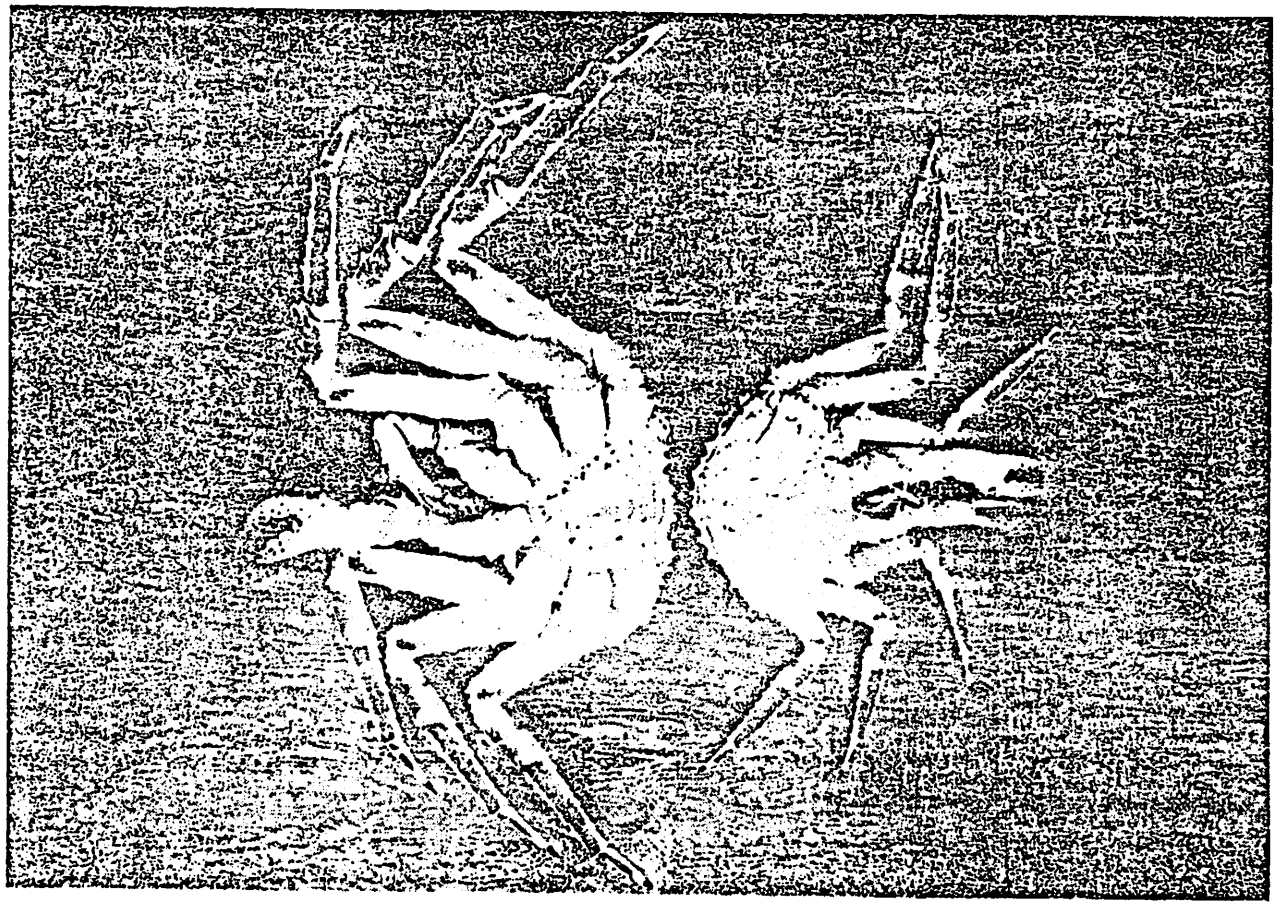

Figure 4. Sexual dimorphism of king crab (male left; female right).

Photo from G. Powell

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 5a and 5b. A similar model for the Kodiak area is presented in Figure 6. Molting frequency schedules for the Bering Sea and Kodiak are presented in Figures 7 and 8.

The time interval between molts progressively increases from a minimum of approximately three weeks for early post-larval juveniles

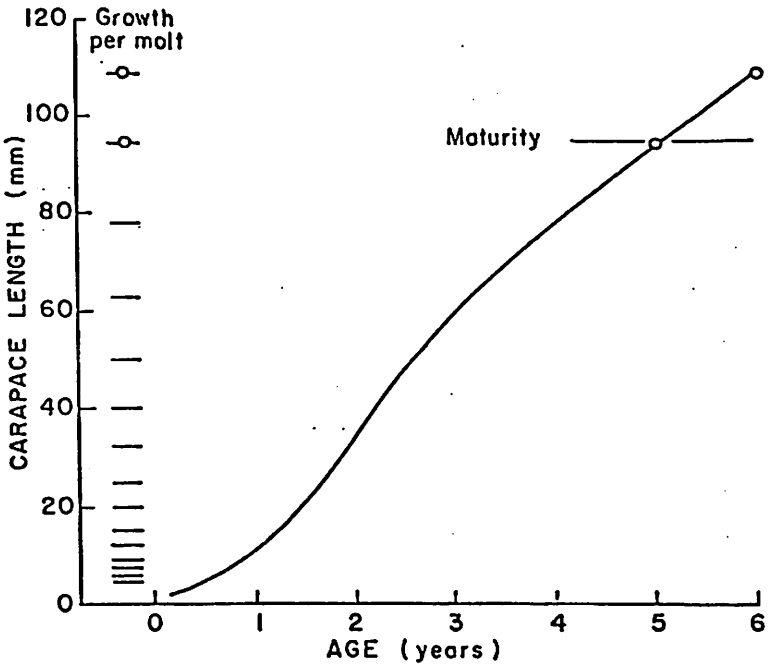

Figure 5a. Growth curve for the southeastern Bering Sea immature king crab. Cumulative growth per molt is shown on the left.

Source: Balsiger (1974)

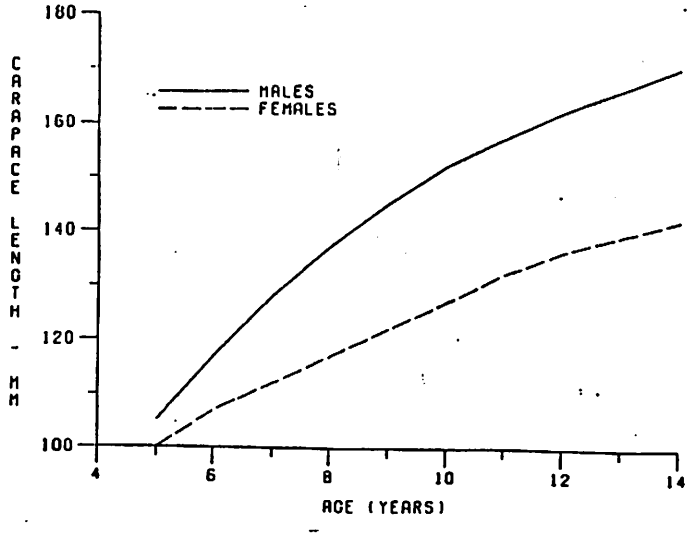

Figure 5b. Growth curve used in simulation for adult male and female red king crab in the southeastern Bering Sea.

Source: Reeves and Marasco (1980)

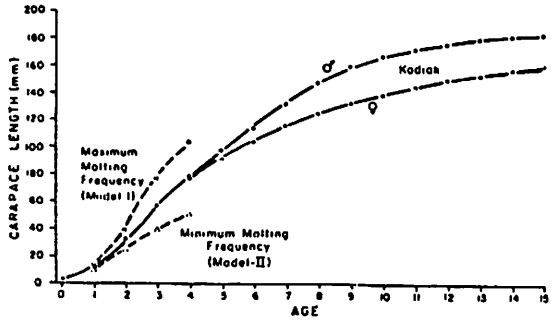

Figure 6. Simulated mean carapace length as a function of age for Kodiak male king crab and simulated mean carapace lengths under maximum and minimum probability of molting for juvenile male king crab.

Source: McCaughran and Powell (1977)

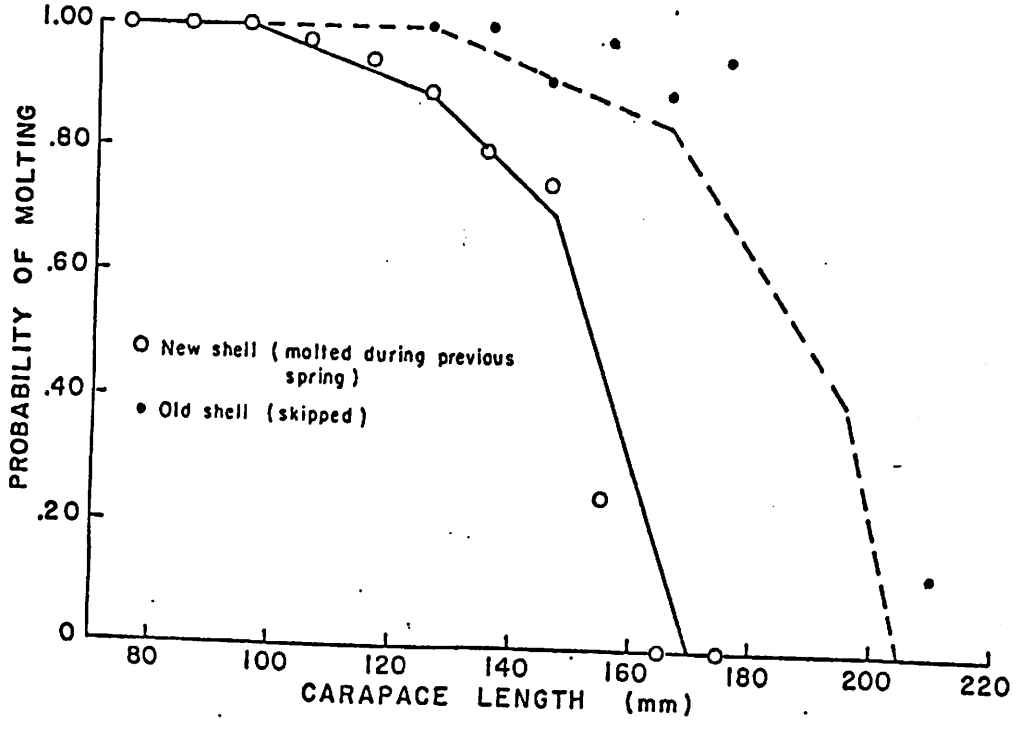

Figure 7. Probability of molting of male king crab from the Bering Sea.

Source: Balsiger (1974)

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 age-length key is presented in Table 1. Molting of adult females is correlated with mating and occurs annually just prior to copulation. 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.

Table 1. Growth simulation of individual king crab carapace lengths taken from the Kodiak Island area, N = 2000. (Carapace length in inches)

Age	Male king crabs			Female king crabs		
	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)

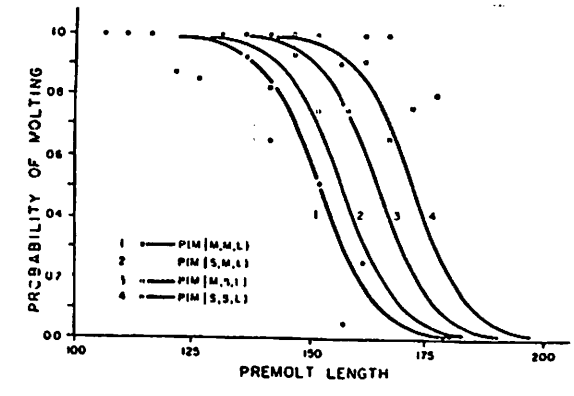

Figure 8. The conditional probability of molting given premolt length and the previous 2 years of molting history for male king crab near Kodiak Island. (Carapace length in inches)

Source: McCaughran and Powell (1977)

Table 2. Age-specific population parameters used in king crab simulations.

Age	NATURAL MORATLITY (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 and Marasco (1980)

Table 2a. Age-specific conversion factors for S.E. 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

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 1970-1979. 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. Age-specific values of M for ages 9-14 were adjusted accordingly (Table 2). Estimates for ages 5-8 were left unchanged.

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).

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 spermataphore 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, 3,402 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 sub-legal broodstock was comprised primarily of oldshell crab (70%). This is particularily interesting since the population of sub-legal 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 hard-shell non-molting 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 3 and 4. 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.

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

Table 3. 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	Year	No. of recruits
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		

Table 4. 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

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.

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.

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 sea's 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.

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 5 - 7.

Table 5. Catch and effort statistics for southeast Bering Sea king crab fishery.

Year	Species	No. Vessels	No. Landings	No. Pot Lifts	No. Crab	No. Pounds	No. Crab Per Pot	Ave.Lbs. Per Crab
1966	Red	9	15	2,720	140,554	997,321	51.7	7.1
1967	Red	20	61	10,621	397,307	3,102,443	37.4	7.8
1968	Red	59	261	47,496	1,278,592	8,686,546	26.9	6.8
1969	Red	65	377	98,426	1,749,022	10,403,283	17.8	5.9
1970	Red	51	309	96,658	1,682,591	8,559,178	17.4	5.1
1971	Red	52	394	118,522	2,404,681	12,995,776	20.3	5.4
1972	Red	64	611	205,045	3,994,356	21,744,924	19.5	5.4
1973	Red	-	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	Red	-	605	212,915	7,710,317	42,266,274	36.2	5.5
	Blue	-	101	45,519	908,072	7,107,294	19.9	7.8
1975	Red	102	592	205,096	8,745,294	49,686,776	42.6	5.7
	Blue	20	54	16,297	314,931	2,433,714	19.3	7.7
1976	Red	141	984	321,010	10,603,367	63,044,401	33.0	6.0
	Blue	46	111	69,388	838,730	6,489,884	12.1	7.7
1977	Red	130	1,020	456,073	11,733,101	69,967,868	26.0	5.4
	Blue	34	104	78,271	764,180	6,297,469	10.0	8.0
1978	Red	162	926	406,165	14,745,709	87,273,037	36.0	5.9
	Blue	58	154	101,117	779,213	6,395,512	8.0	8.1
1979	Red	236	889	315,226	16,257,298	104,272,166	52.0	6.4
	Blue	46	115	83,527	738,496	5,710,676	9.0	7.7

Table 6. Catch and effort statistics for the Adak king crab fishery.

Season	No. Pounds	No. Vessels	Landings	No. Pot Lifts
1960-61	2,074,000	4	41	-
1961-62	6,114,000	8	218	-
1962-63	8,006,000	9	248	-
1963-64	17,904,000	11	527	-
1964-65	21,193,000	18	442	-
1965-66	12,915,000	10	431	-
1966-67	5,883,000	10	90	-
1967-68	14,131,000	22	505	-
1968-69	16,100,000	30	NA	-
1969-70	18,016,000	33	435	115,929
1970-71	16,057 000	35	378	124,235
1971-72	15,458,249	40	166	46,011
1972-73	17,991,367	43	283	74,037
1973-74	9,020,393	41	205	60,345
1974-75	2,520,393	36	90	30,051
1975-76	323,031[1/]	9	14	4,903
1976-77	2,285[2/]	2	2	110
1977-78	952,972[3/]	12	19	8,469
1978-79	807,195	13	27	13,948
1979-80[4/]	467,229	18	23	9,757

1/ Includes 25,000 pounds of brown king crab.
2/ Brown king crab.
3/ Includes 47,445 pounds of brown king crab.
4/ Preliminary data.

Table 7. Catch and Effort Statistics for the Dutch Harbor King Crab Fishery.

Season	No. Pounds	No. Vessels	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	32	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

1/ Thousands of pounds

In 1962, a voluntary logbook program was instituted in the Kodiak fishery. The program continued until 1973 when it was essentially discontinued in favor of a vessel captain interview program. The logbook program provided a better estimate of catch per unit effort (CPUE) than the use of only fish ticket reports but also suffered from the problem of effort standardization. An attempt to standardize king crab logbook data was reviewed by Rothschild (1977). This logbook program was discontinued for two reasons: 1) difficulty of getting reliable information on a consistent basis and 2) the introduction of pot limits in the Kodiak area. The logbook program in a pot fishery was a burden to vessel captains and it was difficult to assure good cooperation. Also with the pot limit in place and many vessels fishing with excess units of gear, fishermen were reluctant to accurately report CPUE.

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

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 for the Gulf of Alaska and by NMFS for the Bering Sea. The Department, 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.

Current Status of Stocks

Maximum Sustainable Yield

The maximum sustainable yield (MSY) for the fisheries management unit in this plan is defined as the average of the annual estimates of acceptable biological catch (ABC). Refer to the Management Measures Section for a discussion of procedures for determining ABC.

Future Outlook

The outlook for each of the king crab management areas was recently presented by Powell (1980) at the Alaskan Board of Fisheries meeting April, 1980. A summary of this report follows:

Bering Sea: Healthy stock conditions are indicated by present survey and harvest data (also see Otto et al, 1979). A series of above average recruit classes began entering the fishery in 1976. The recruitment trend indicates high stock levels for the 1980 fishery. A decline in recruitment is forecast starting in the 1981 fishery.

Alaska Peninsula: Depressed stock conditions due to poor recruitment persisted from 1975 through 1976. Recruitment improved in 1978 and appears to be strong for the 1980-81 period.

Dutch Harbor: Depressed stock conditions due to poor recruitment persisted from 1975 through 1977. Recruitment was strong in 1977 and research data suggest good fishing during the 1980-81 period based on strong recruitment. Low utilization in several locations during 1979 should provide additional large crabs for the fishery.

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.

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 addressed later in this plan; and 7) the utility of ecosystem modeling. Sections 5.4, 5.5, and 10.6 discuss these and other research needs.

7.5 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. The United States was successful in eliminating both nations from this fishery by 1975 through diplomatic negotiations. The king crab fishery thus became solely a domestic fishery before passage of the FCMA. The domestic and foreign harvest of king crab from the waters off Alaska between 1950 and 1979 is shown in Figure 9.

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.

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).

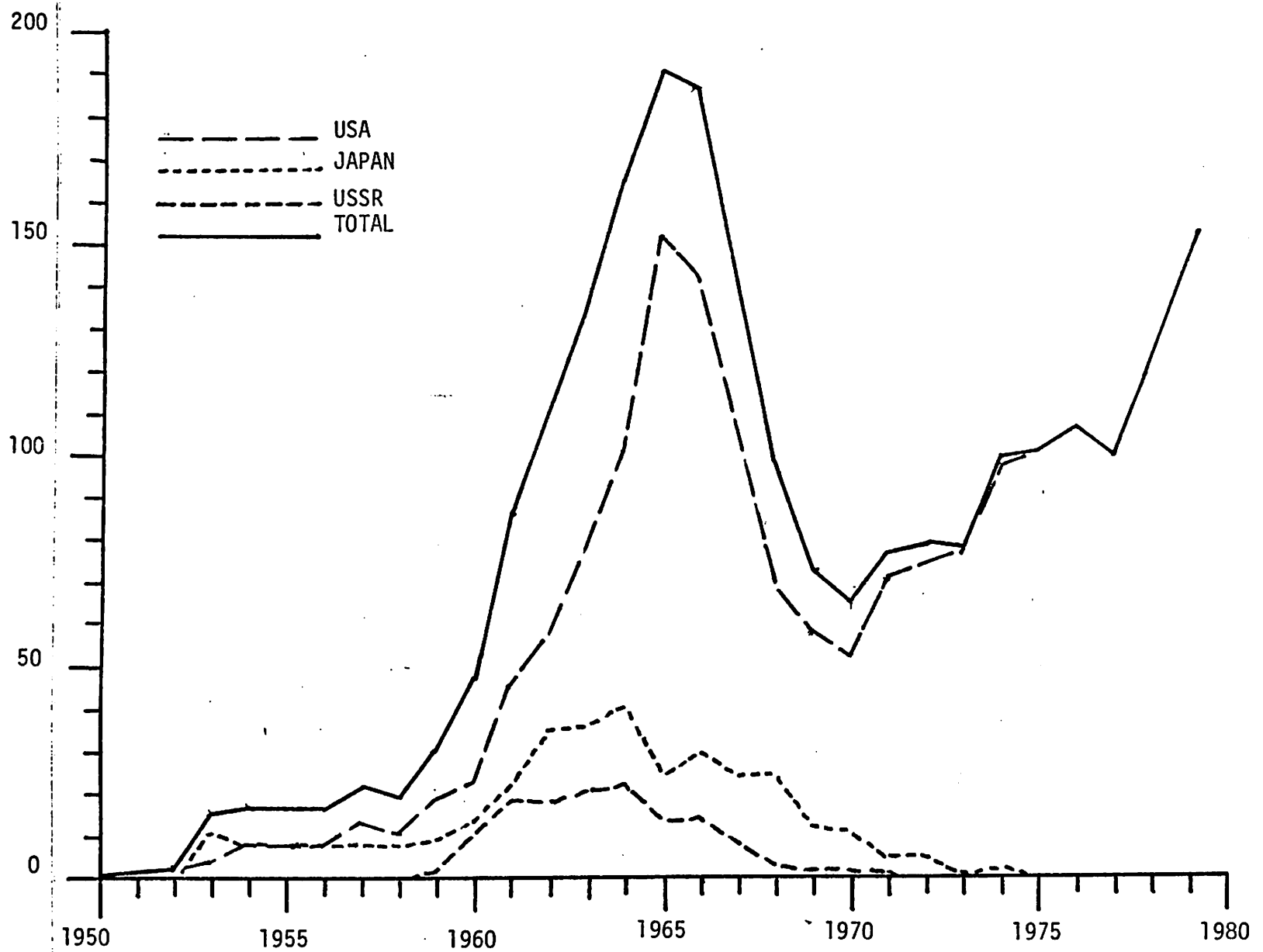

FIG. 9. DOMESTIC AND FOREIGN HARVEST OF KIN CRAB FROM WATERS OFF ALASKA, 1950 - 1979 1/

1/ Westward region only

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 soft-shelled 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 two-thirds of the statewide harvest of king crab (Table 10). 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.

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

The statewide king crab catch reached a peak in 1966 when 159 million pounds were landed. The value of that catch (in 1966 dollars) was $15.6 million. The catch for 1977 was 98 million pounds, but had a value (in 1977 dollars) of $98.5 million. Adjusting these values by the wholesale price index (all commodities, 1967=100) shows that even though the 1977 catch was approximately one-third less in physical terms, its value in 1967 dollars was over twice as great, $15.7 million compared to $56.3 million for 1966 and 1977, respectively. This increase in value is caused by price increases of recent years (Fig. 10).

Table 10. 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 areas.

3 Oregon, Idaho

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

Table 11. Western Alaska king crab catch by fishing year by U.S. 1960-61 through 1979-80.

(millions of pounds)

Fishing year	Kodiak	Alaska Peninsula	Dutch Harbor	Adak	Western Aleutian	Bering Sea	Tota
1960-61	19.1	-	-	-	-	.2	23.
1961-62	30.2	30.2	3.3	.5	-	-	46.
1962-63	35.8	2.3	1.5	8.0	-	.6	58.
1963-64	39.5	7.4	3.9	17.9	-	1.1	77.
1964-65	41.0	16.5	15.1	23.3	-	1.6	102.
1965-66	95.8	18.7	19.2	12.9	-	1.2	152.
1966-67	73.1	24.4	32.9	5.9	-	2.6	141.
1967-68	43.9	12.6	24.7	15.3	.8	6.7	107.
1968-69	18.7	6.6	13.6	16.1	1.9	7.5	69.
1969-70	12.2	4.0	8.9	16.3	1.5	9.0	56.
1970-71	11.7	3.4	9.7	15.6	.5	6.6	
1971-72	10.9	4.1	9.4	15.4	-	17.2	62.
1972-73	15.5	4.1	10.5	18.0	.7	21.9	75.
1973-74	14.4	4.5	12.8	9.0	.8	25.1	71.
1974-75	23.6	4.6	14.0	2.5	.3	46.7	97.
1975-76	24.1	2.6	15.9	.3	.1	55.7	102.
1976-77	18.0	1.0	10.2	.0	-	70.2	103.
1977-78	13.5	.7	3.7	1.0	- 1/	78.9	100.
1978-79 2/	13.3	4.3	10.0	.8	-	98.1	126.
1979-80 2/	14.6	4.5	15.0	.5	-	117.3	151.

1/ Combined with Adak Management Area after 1975-76.

2/ Preliminary catch figures.

Source: ADF&G Statistical Leaflets

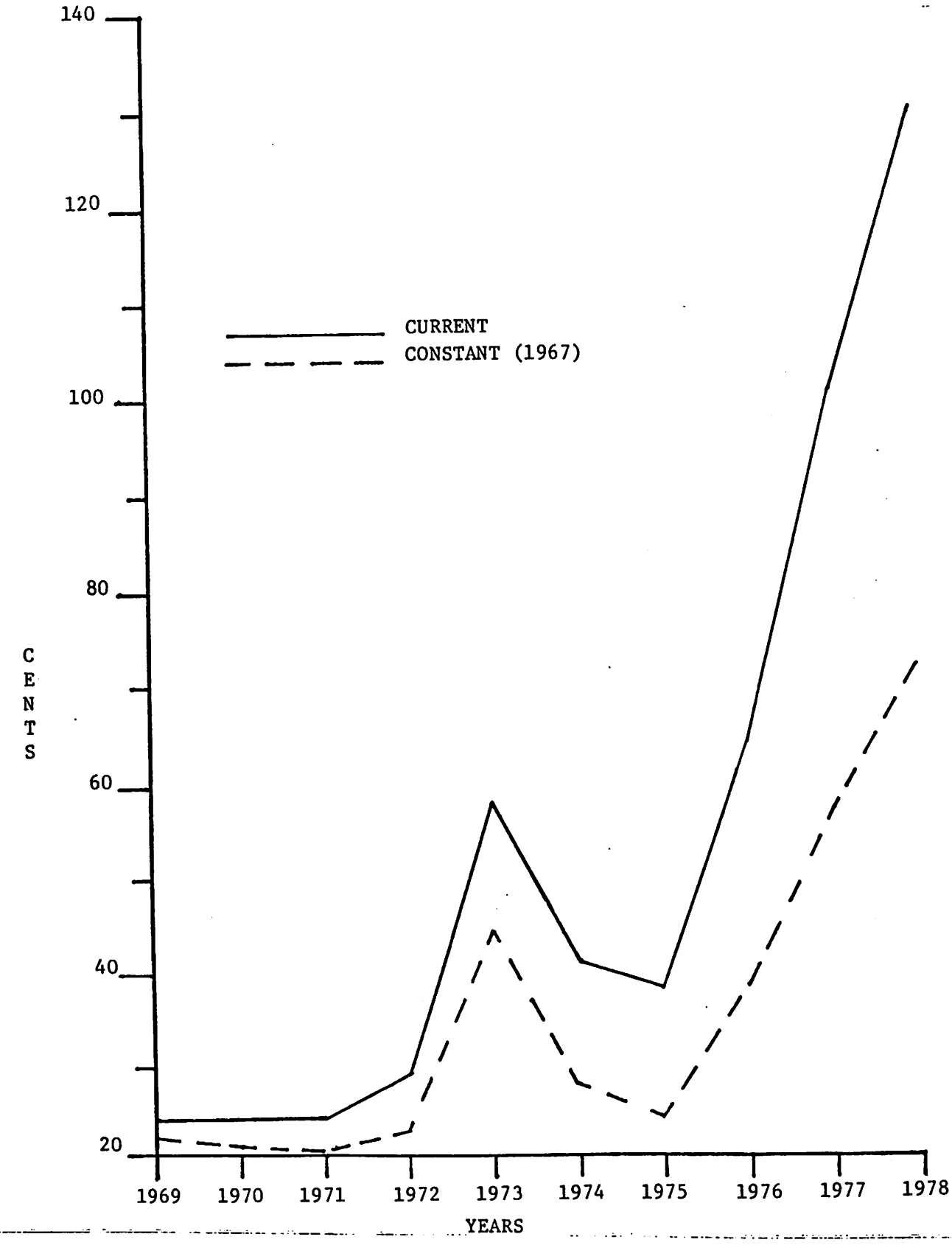

FIG. 10 AVERAGE ANNUAL STATEWIDE EX-VESSEL PRICE PER POUND OF KING CRAB.

Table 12 shows the landings and exvessel value of king crab, all shellfish, and all fish during the period of 1969-78, and also shows the proportion of king crab to all shellfish and all fish landed in Alaska. The 1978 king crab catch of 119 million pounds comprised 37 percent of the statewide shellfish catch and 15 percent of the statewide fish catch for that year. The ex-vessel values of king crab, all shellfish, and all fish in Alaska for 1969-1977 are depicted in Figure 11. In 1977, the ex-vessel values of king crab, all shellfish, and all fish were 98, 152, and 352 million dollars, respectively. King crab represented 65 percent of the value of all shellfish and 28 percent of the value of all fish caught in 1977.

In 1977 the statewide total gross income for all vessels that fished king crab was 138 million dollars. Of this total, 95 million dollars (69 percent) was realized from the harvest of king crab, the balance coming from other fisheries in the State. The tendency for Alaska king crab vessels to rely primarily upon king crab is not uniform across the State, however. Table 14 lists 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. 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 14. The degree of reliance on king crab was greatest in the Bering Sea area where roughly three quarters of the total exvessel value was from king crab. In the Cook Inlet, Kodiak, and Dutch Harbor areas, the ratio was roughly one half. This indicates that the greater the productivity of a region, the more specialization will exist in the king crab fleet in that area.

Table 13 also lists the average value of the king crab catch per vessel for each area for 1977. The catch for the 139 vessels which fished in the Bering Sea averaged $522,000. The vessels that fished in the Dutch Harbor and Kodiak areas averaged $69,000 and $98,000 per vessel respectively, for their king crab catches.

Table 14 contains 1969-77 data on the number of vessels, total landings, total value of the landings in current and constant dollars,

Table 12. Landings and ex-vessel value of king crab, all shellfish, and all fish caught in Alaska. 1969-1978

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) 1/	18,513(74) 1/	384,994(15) 1/	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 2/	118,579	NA	323,358(37)	NA	812,608(15)	NA
1979 2/	154,387	NA	343,747(45)	NA	891,747(17)	NA

1/ Numbers in parenthesis represents the proportion of king crab to all shellfish & all fish respectively.

2/ Preliminary data.

Source: Commercial Fisheries Entry Commission

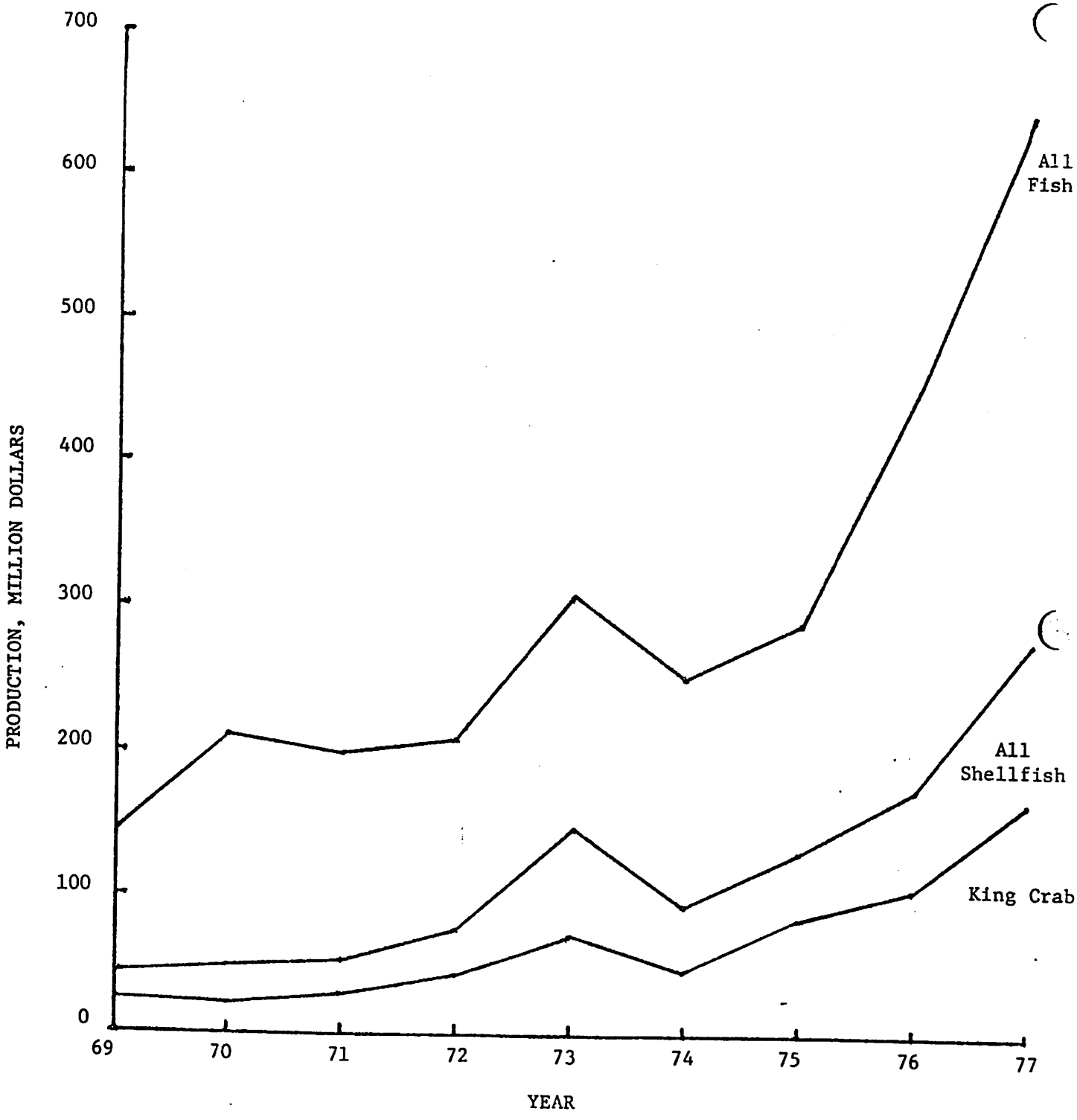

FIG. 11 . VALUE OF KING CRAB PRODUCTION (at processors' level) RELATIVE TO ALL SHELLFISH AND ALL FISH, 1969 - 1977

SOURCE: ADF&G STATISTICAL LEAFLETS.

Table 13. Ex-vessel Value [1] from king crab and all other fisheries for 1977. (Compiled by the Commercial Fisheries Entry Commission)

	For Vessels Fishing King Crab[2] In The Given Management Area			For Vessels Whose Dominant King Crab Catch Was In The Given Management Area[3]					
	Ex-vessel Value of King Crab From The Area (thousand dollars)			Ex-vessel Value of King Crab From The Area (thousand dollars)			Total Ex-vessel Value From All Fisheries[4] (thousand dollars)		
Management Area	Number of Vessels	Total Value	Average Value/Vessel	Number of Vessels	Total Value	Average Value/Vessel	Total Value	Average Value/Vessel	% of Value That Was King Crab
Kodiak	186	18,444	98	172	17,797	103	33,663	196	53
Alaska Peninsula	20	783	39	14	719	51	2,371	169	30
Dutch Harbor	58	4,001	69	29	3,099	107	5,380	186	56
Adak	2	2	1	0	--	--	--	--	--
Bering Sea	139	72,585	522	131	72,056	550	96,815	739	74
		95,515		346					

1 Ex-vessel value was derived from average prices applied to pounds landed - (Prices do not necessarily include all bonuses and payments in kind)

2 Vessels that fished in more than one area are included in each area that they fished.

3 Vessels are placed in the area where their greatest dollar value was caught.

4 Includes king crab from other management areas and salmon, Tanner crab etc.

Table 14. Average 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	331	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	76,824	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

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

2/ Price per pound in current dollars

Source; Commercial Fisheries Entry Commission

and the catch per vessel in pounds, current, and constant dollars. The number of vessels fishing king crab increased each year since 1971 except in 1975.

The average king crab catch per vessel fluctuated from 142,000 pounds in 1969 to 178,000 pounds in 1977. The value of the catch per vessel, both in current and constant dollars, generally increased from 1969 to 1973, decreased in 1974, and increased since then. The value of the catch per vessel in constant dollars was the highest in 1977 (an increase of 57 percent over 1975). The dominating factor in total catch value has been the price per pound received by fishermen.

There is no statewide information on the investments in vessels and gear by the Alaska king crab fishing fleet.

There is no statewide information on the participation in the king crab fishery in terms of standardized vessel days or pot lifts. The best information available is the number of landing per season; however, the additional information which is required to convert the number of landings into a meaningful measure of participation is not available.

Table 15 contains information on the number of vessels, the number of landings, and the harvest by fishing area for 1969-77. Between 1969 and 1977 the total harvest has generally increased while the number of landings has fluctuated greatly without a persistent trend.

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 16). 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 (Fig. 12).

Table 15 Alaska king crab catch, value and participation by area and year (not by season). Compiled by Commercial Fisheries Entry Commission (domestic fishery only)

YEAR	MANAGEMENT AREA	NO. of VESSELS	NO. of LANDINGS	POUNDS (thousands)	METRIC TONS	EX-VESSEL VALUE (thousand dollars)
1969	Southeastern	35	433	1,895	860	567
	Prince William Sound	19	80	48	22	13
	Cook Inlet	40	737	2,778	1,260	722
	Kodiak	142	1,294	12,996	5,895	3,498
	Alaska Peninsula	63	472	4,942	2,242	1,334
	Dutch Harbor	58	376	7,492	3,398	1,648
	Adak	59	409	15,607	7,079	3,277
	Western Aleutians	16	44	2,456	1,114	516
	Bering Sea	69	366	10,018	4,544	2,204
	TOTAL		4,211	58,232	26,414	$13,779
1970	Southeastern	31	228	578	262	158
	Prince William Sound	12	52	94	43	26
	Cook Inlet	53	825	3,888	1,764	1,089
	Kodiak	115	958	12,077	5,478	3,382
	Alaska Peninsula	45	415	3,685	1,672	921
	Dutch Harbor	57	363	10,719	4,862	2,573
	Adak	52	308	11,761	5,335	2,705
	Western Aleutians	7	18	664	301	153
	Bering Sea	57	326	8,594	3,898	1,719
	TOTAL		3,493	52,060	23,615	$12,726
1971	Southeastern	19	180	571	259	200
	Prince William Sound	20	74	144	65	43
	Cook Inlet	54	974	4,158	1,886	1,247
	Kodiak	87	649	11,896	5,395	3,569
	Alaska Peninsula	31	438	4,218	1,913	1,097
	Dutch Harbor	38	307	11,110	5,039	2,777
	Adak	56	447	25,631	11,626	5,639
	Western Aleutians	6	8	219	99	44
	Bering Sea	56	423	12,847	5,827	2,569
	TOTAL		3,500	70,794	32,109	$17,185
1972	Southeastern	19	265	943	428	382
	Prince William Sound	25	196	296	134	121
	Cook Inlet	51	1,089	4,572	2,074	1,509
	Kodiak	88	707	15,480	7,022	5,882
	Alaska Peninsula	33	437	4,338	1,968	1,301
	Dutch Harbor	68	384	11,297	5,124	2,937
	Adak	46	302	16,117	7,311	4,190
	Western Aleutians	4	7	118	54	29
	Bering Sea	74	797	20,963	9,509	5,241
	TOTAL		4,184	74,124	33,624	$21,592
1973	Southeastern	31	263	874	396	629
	Prince William Sound	22	135	208	94	135
	Cook Inlet	66	1,239	4,349	1,973	2,870
	Kodiak	131	869	14,404	6,534	9,507
	Alaska Peninsula	39	511	4,780	2,168	3,107
	Dutch Harbor	59	386	12,723	5,771	7,634
	Adak	52	369	10,631	4,822	5,847
	Western Aleutians	10	50	615	279	314
	Bering Sea	68	573	28,240	12,809	14,685
	TOTAL		4,395	76,824	34,846	$44,728
1974	Southeastern	32	228	583	264	246
	Prince William Sound	21	63	85	39	52
	Cook Inlet	81	1,360	4,602	2,087	2,163
	Kodiak	161	1,266	23,031	10,446	10,134
	Alaska Peninsula	37	504	4,497	2,040	1,799
	Dutch Harbor	87	441	13,069	5,928	5,097
	Adak	24	49	614	279	240
	Western Aleutians	15	35	721	327	281
	Bering Sea	105	940	49,374	22,396	19,256
	TOTAL		4,886	96,576	43,806	$39,268
1975	Southeastern	28	175	436	198	217
	Prince William Sound	10	79	53	24	24
	Cook Inlet	67	673	2,886	1,309	1,183
	Kodiak	170	1,572	24,101	10,932	10,845
	Alaska Peninsula	40	442	2,933	1,330	1,202
	Dutch Harbor	81	398	15,049	6,826	5,719
	Adak	37	145	2,571	1,166	900
	Western Aleutians	5	12	255	116	89
	Bering Sea	104	826	52,112	23,638	18,239
	TOTAL		4,322	100,396	45,539	$38,418
1976	Southeastern	25	181	338	153	251
	Prince William Sound	12	82	17	8	9
	Cook Inlet	79	1,086	4,954	2,247	3,171
	Kodiak	194	1,332	17,522	7,948	12,546
	Alaska Peninsula	28	193	882	400	564
	Dutch Harbor	74	359	11,471	5,203	7,112
	Adak	9	20	272	123	166
	Western Aleutians	11	22	114	52	70
	Bering Sea	142	1,501	70,411	31,938	43,631
	TOTAL		4,776	105,981	48,072	$67,520
1977	Southeastern	27	199	331	150	380
	Prince William Sound	15	77	89	40	98
	Cook Inlet	93	1,340	2,027	920	2,169
	Kodiak	186	1,387	13,214	5,995	18,181
	Alaska Peninsula	20	94	783	355	783
	Dutch Harbor	58	319	4,131	1,874	4,001
	Adak	2	2	2	9	2
	Bering Sea	139	1,515	76,406	34,667	72,585
	TOTAL		4,933	96,983	44,002	98,199

Table 16. 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	12,624	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.

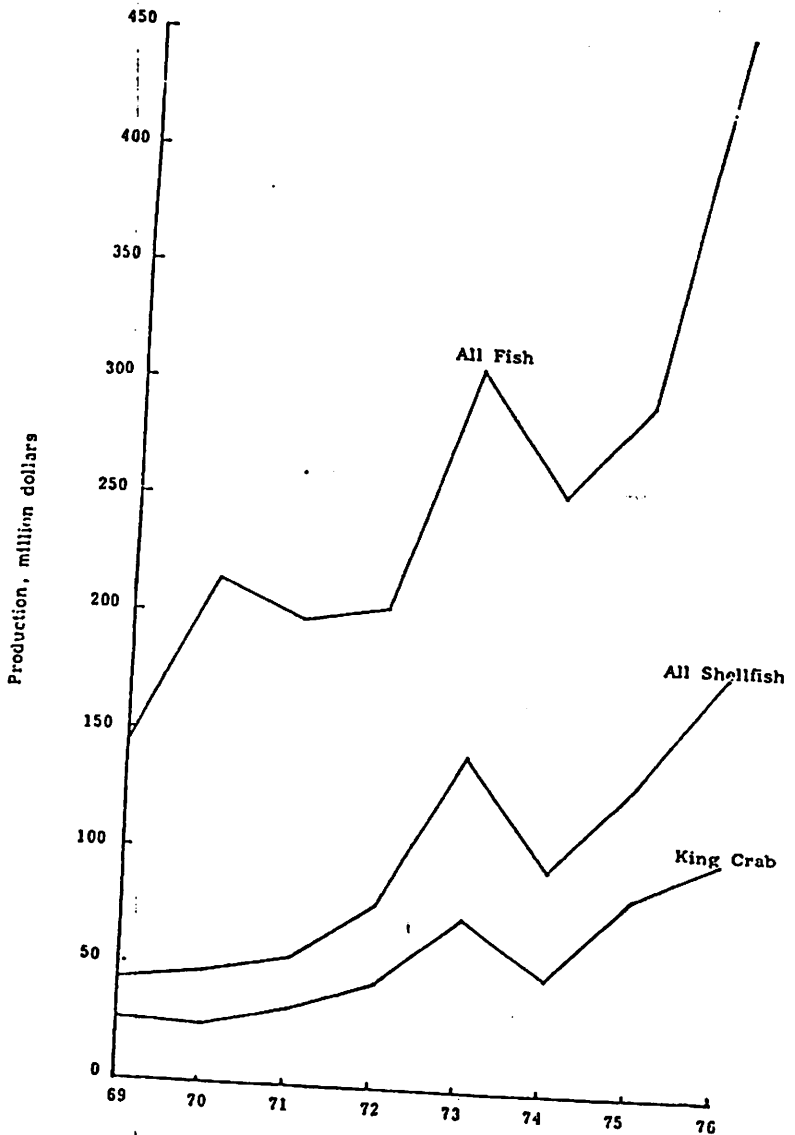

Figure 12. Value of king crab production (at processors' level) relative to all shellfish and all fish, 1969-76. Source: ADFG Statistical Leaflets

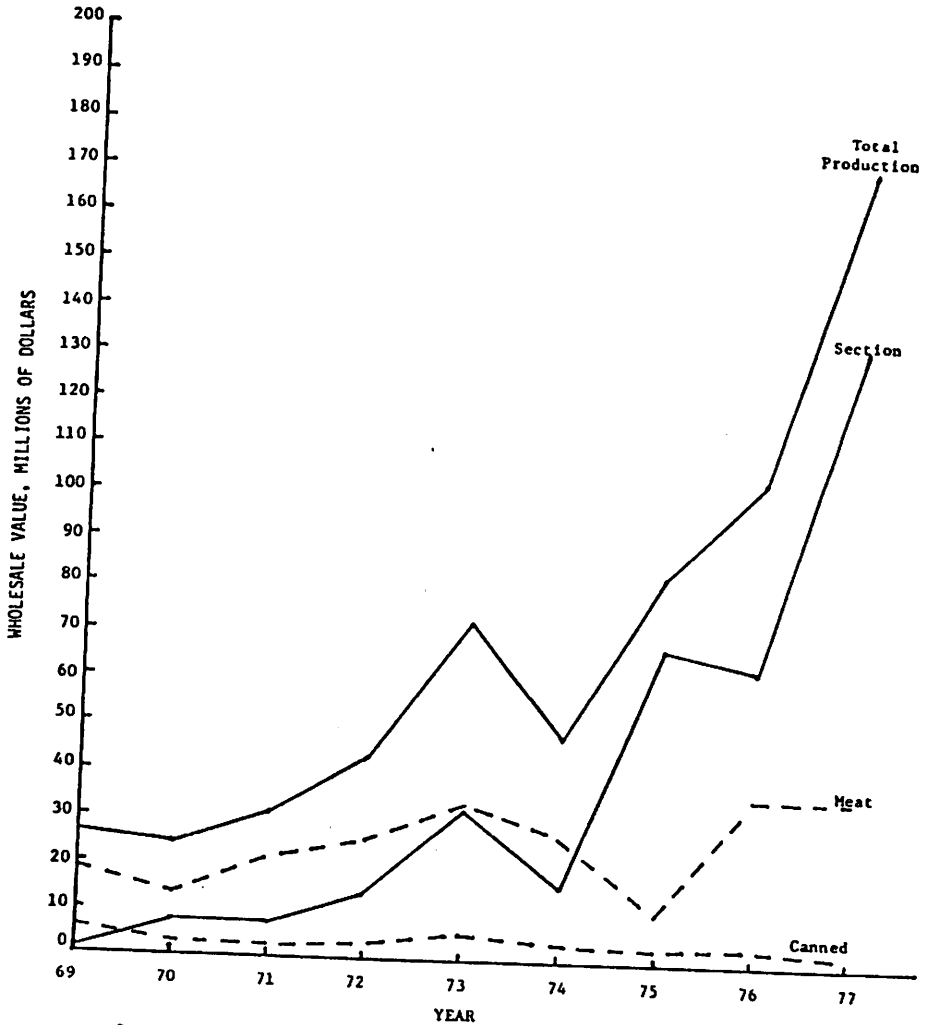

FIG. 13. WHOLESALE VALUE OF KING CRAB BY PRODUCT FORM, 1969-77.
SOURCE: ADF&G STATISTICAL LEAFLETS

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, representing 64 and 33 percent of total production value in 1976 (Fig. 13). 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. 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.

King crab production is distributed unevenly throughout the state. Table 17 shows 1976 production and value by product form for each fishing area. The port of Dutch Harbor produced the most crab in the section and meat forms and is now the State's leading processor. Kodiak and Alaska Peninsula are the only areas that produce canned king crab.

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

Table 17. Volume and wholesale value of king crab production by product for each management area, 1976.

Area	Number of processors	Sections Thousand pounds	Sections Thousand dollars	Meat Thousand pounds	Meat Thousand dollars	Canned Thousand pounds	Canned Thousand dollars	Total king crab value thousand dollars
Kodiak	14	10,862	17,990	249	1,249	799	3,899	23,138
Alaska Peninsula	4	3,196	6,914	680	4,193	174	519	11,626
Dutch Harbor 1/	15	15,831	34,386	4,742	24,624	0	0	59,010
Totals	33	29,889	59,290	5,671	30,066	973	4,418	93,774

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

Source: ADF&G Catch & Production Statistics. 1976. Juneau.

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

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).

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 (Fig. 14). 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 and frozen, by country of destination for 1976 and 1977. Figure 15 depicts king crab exports by product form. Japanese imports have been almost entirely in 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.

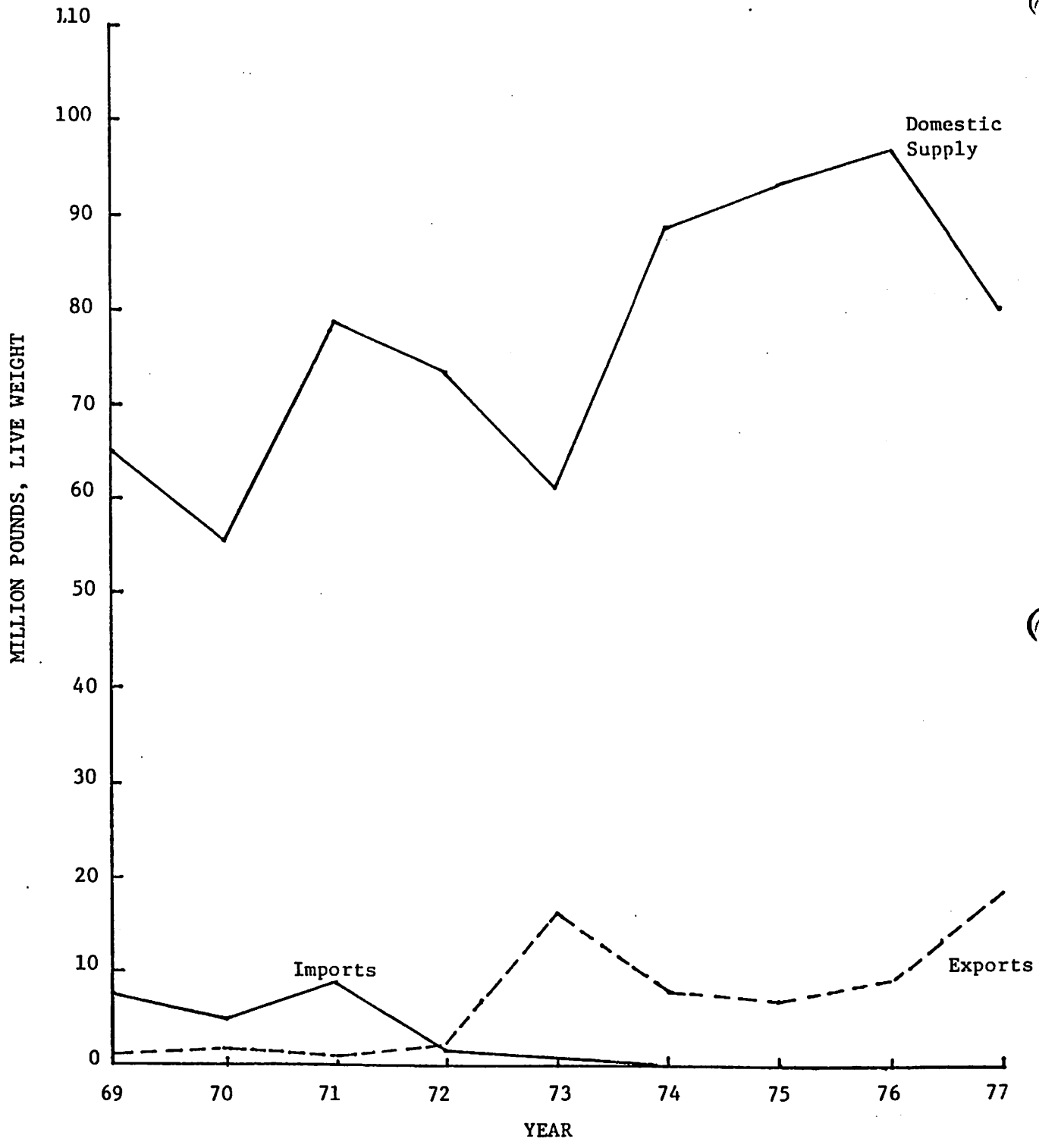

FIG. 14 U.S. KING CRAB SUPPLY, 1969-77

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 king crab, frozen, 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	
Japan	1,730	7,499	433.5	42.2	73.6
Canada	630	951	151.0	15.4	9.3
Belgium	410	495	120.7	10.0	4.9
Netherlands	577	401	69.5	14.1	3.9
Australia	176	210	119.3	4.3	2.1
France	70	131	187.1	1.7	1.3
Denmark	85	100	117.6	2.1	1.0
Switzerland	17	98	576.5	.4	1.0
Sweden	105	71	67.6	2.6	.7
Other	299	226	75.6	7.6	2.2
Total	4,099	10,182	248.4	100.0	100.0

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

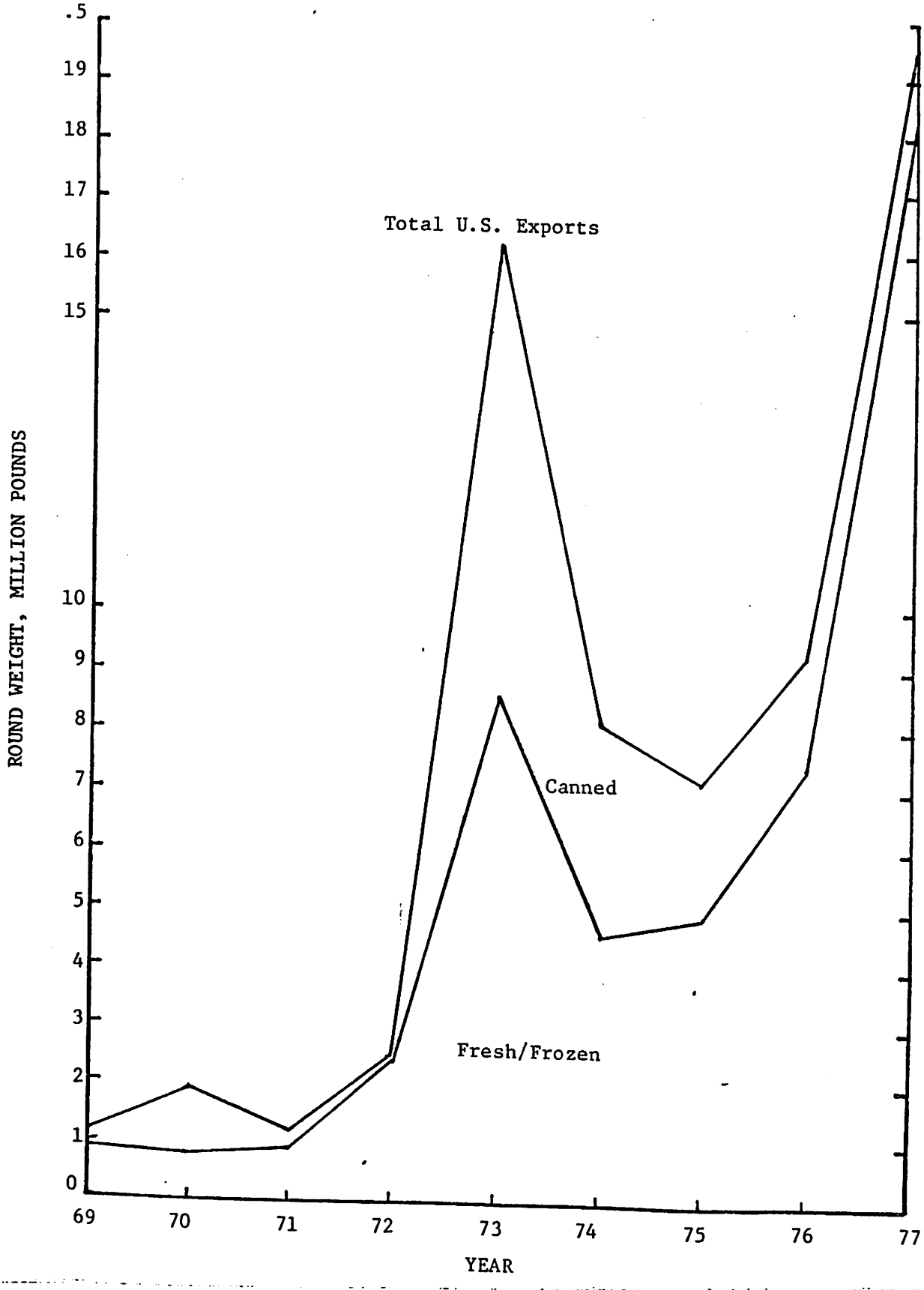

FIG.15.U.S. KING CRAB EXPORTS BY PRODUCT FORM.

SOURCE: U.S. BUREAU OF CENSUS, 1973b - 1977, U.S. EXPORTS/SCHEDULE B COMMODITY BY COUNTRY, FT 410, VARIOUS ISSUES

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Sweden	15	7	46.7	4.1	2.6
Norway	-	5	-	-	1.9
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Switzerland	17	98	576.5	.4	1.0
Sweden	105	71	67.6	2.6	.7
Other	299	226	75.6	7.6	2.2
Total	4,099	10,182	248.4	100.0	100.0

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

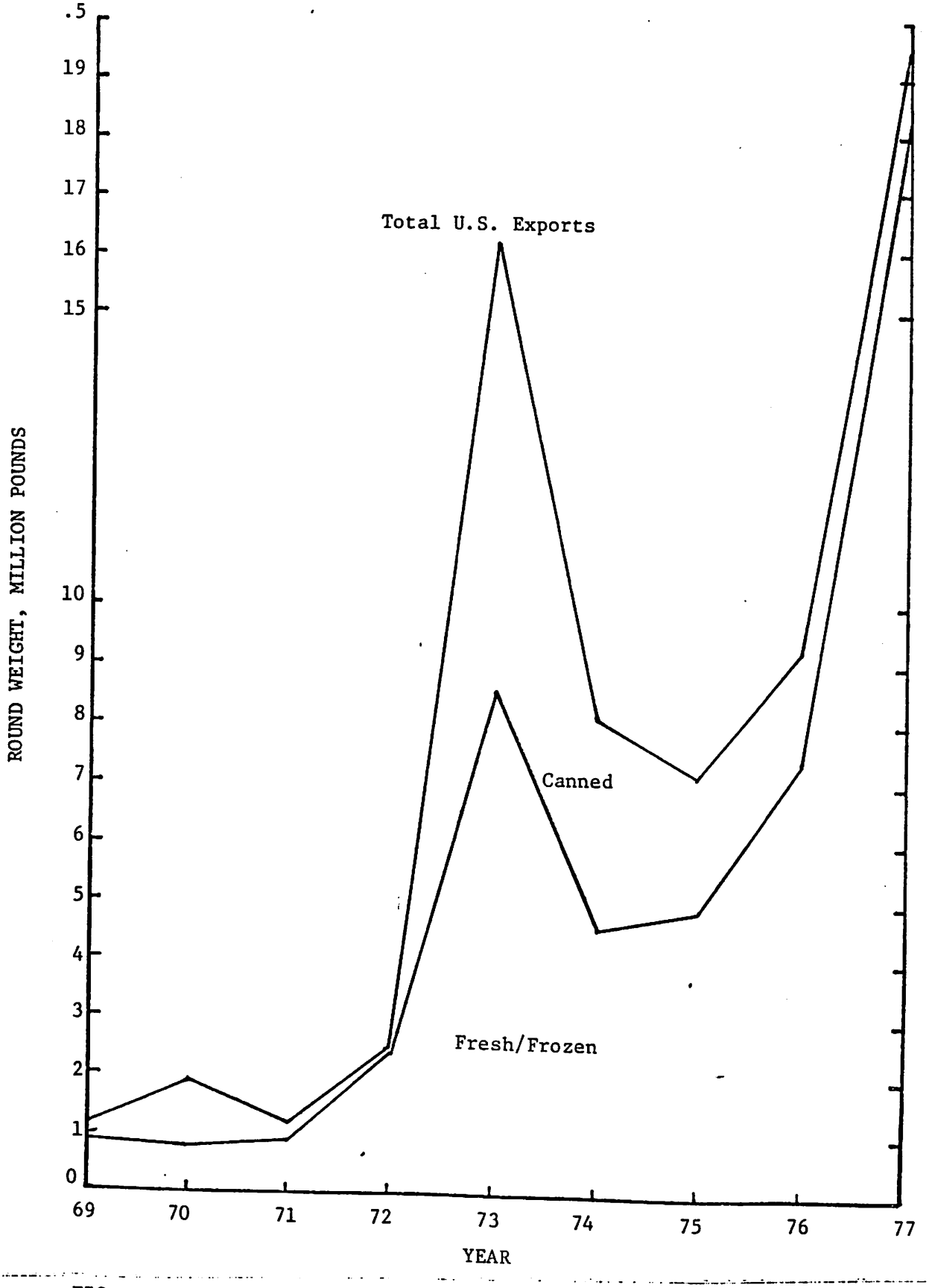


FIG.15.U.S. KING CRAB EXPORTS BY PRODUCT FORM.

SOURCE: U.S. BUREAU OF CENSUS, 1973b - 1977, U.S. EXPORTS/SCHEDULE B COMMODITY BY COUNTRY, FT 410, VARIOUS ISSUES

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.

The market for king crab was strong during 1978, a continuation of the trend over recent years. Meat prices in New York climbed to $10.78 by August which was a 42 percent increase since the first of the year. Prices for claws and sections were stable at $4.15 per pound. The relatively large harvest during the second half of 1978 could act to dampen wholesale prices, particularly if demand were to weaken. However, current forecasts indicate that this is unlikely (Shellfish Market Review, Nov. 1978).

Other 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, 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.

Table 22. 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.

7.6 LITERATURE CITED

Alaska Department of Fish and Game
Catch and Production Leaflets, 1960-1976, Juneau, Alaska.

ALVERSON, D.L. and W.T. Pereyra. 1969. Demersal fish explorations in the northeastern Pacific Ocean - an evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. J. Fish. Res. Bd. Can. 26:1985-2001.

BALSIGER, J.W. 1974. A computer simulation model for the Bering Sea king crab population. Ph.D. Thesis. University of Washington. 198 pp.

BEVAN, D.E. and D.L. Alverson. 1980. The Function of Optimum Yield Under the Fishery Conservation and Management Act of 1976. University of Washington, Seattle, Washington. Unpublished M.S. 14 pp.

BRIGHT, D.B., F.E. Durham and J.W. Knudsen. 1960. King crab investigations of Cook Inlet, Alaska. Dept. Biol., Allan Hancock Foundation, University of Southern California, 180 pp. (Processed Report).

COCHRAN, W.G. 1963. Sampling Techniques. John Wiley and Sons, New York. pp. 87-152.

ELDRIDGE, P.J. 1975. An analysis of the Kodiak stocks of the Alaska king crab, Paralithodes camtschatica. Ph.D. Dissertation. University of Washington, Seattle, Washington. 270 pp.

ELDRIDGE, P.J., G.C. Powell, and D. Chapman. 1980. A method to estimate the proportion of sublegal male king crab, paralithodes camtschatica, that participate in mating in the Kodiak Island, Alaska fishery. Submitted for publication.

GRAY, G.W. 1964. Halibut preying on large crustacea. Copeia 1964. (3): 590.

GRAY, G.W., R.S. Roys, and R.J. Simon. 1965. Development of the king crab fishery off Kodiak Island. Alaska Dept. of Fish & Game Info. Leaflet 52, Juneau.

GRAY, G.W. and G.C. Powell. 1966. Sex ratios and distribution of spawning king crab in Alitak Bay, Kodiak Island, Alaska. Crustaceana 10:303-309.

GREENOUGH, J.W. 1972. Equilibrium sustained yield model for the southeastern Bering Sea king crab fishery. Natl. Mar. Fish. Serv., NOAA, Auke Bay Fish. Lab., Auke Bay, Alaska. Unpublished Manuscript. 46 pp. (Submitted to INPFC by U.S. National Section. INPFC Doc. 1509).

HAYES, M.L., and D.T. Montgomery. 1963. Movements of king crabs tagged and released in Shumagin Islands area 1957-62. U.S. Fish and Wildlife Service. Spec. Sci. Rept.--Fish. 458: 7 pp.

HOOD, P.W. and E.X. Kelley (Eds). 1974. Oceanography of the Bering Sea. Institute of Marine Science. University of Alaska. Occasional Publications 2. 450 pp.

HOOPES, D.T. and J.W. Greenough. 1970. King crab research, INPFC Annual Report 1968:116-124.

MARUKAWA, H. 1933. Biological and fishery research on Japanese king crab Paralithodes camtschatica (Tilesius). (In Japanese, English abstract.) J. Imp. Fish. Exptl. Sta. (Tokyo) Pap. 37, No. 4, 152 pp.

MC CAUGHRAN, D.A. and G.C. Powell. 1977. Growth model for Alaska king crab (Paralithodes camtschatica). J. Fish. Res. Bd. Can. 34:989-995.

MC LAIN, D.R. and F. Favorite. 1976. Anomalously cold winters in the southeastern Bering Sea. 1971-1975. Section 7 in. Goulet, J.R. (Ed) 1976. The environment of the United States Living Marine Resource, Natl. Mr. Fish. Serv., Washington, D.C.

MIYAHARA, T. and H.H. Shippen. 1965. Preliminary report of the effect of varying levels of fishing on eastern Bering Sea king crab, Paralithodes camtschatica (Tilesius). Conseil Permanent International pour L'Exploration de la Mer. Rapp. et Proc.-Verb. Vol. 159, 1965: 51-58.

MOSIEEV, P.A. 1964 (Ed). Soviet fisheries investigations in the northeast Pacific. (Israel Program for Scientific Translations, 1968). 3 volumes. Available from U.S. Dept. of Commerce. Natl. Tech. Info. Serv., Springfield, VA 22151.

ORTH, F.L., J.A. Richardson, and S.M. Piddle. 1979. Market structure of the Alaska seafood processing industry. Volume I Shellfish. University of Alaska, Sea Grant Report 78-10. 284 pp.

OTTO, R.S., R.A. MacIntosh, A.K. Fukuyama, T.M. Armetta, and C.I. Pace. 1979. Report to industry on 1979 eastern Bering Sea survey king and Tanner crab. Northwest and Alaska Fisheries Center (NMFS/NOAA). Processed Report. 53 pp.

PEREYRA, W.T., J.E. Reeves, and R.G. Bakkala. 1976. Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975. Northwest Fish. Cent. Processed Report. 2 volumes. Northwest and Alaska Fisheries Center, 2725 Montlake Blvd. E., Seattle, Washington.

POWELL, G.C. 1974. Gregarious King Crabs. Sea Frontiers, Vol. 20 (4) pp. 206-211.

POWELL, G.C. 1967. Growth of king crabs in the vicinity of Kodiak Island, Alaska. Alaska Dept. of Fish Game Info. Leaflet 92, Juneau.

POWELL, G.C., K.E. James, and C.L. Hurd. 1974. Ability of male king crab, Paralithodes camtschatica, to mate repeatedly, Kodiak, Alaska, 1973. Natl. Mar. Fish. Service. Fish Bull. 72 (1): 171-179.

POWELL, G.C. and R.B. Nickerson. 1965. Reproduction of king crab, Paralithodes camtschatica (Tilesius). J. Fish. Res. Bd. Canada 22: 101-111.

POWELL, G.C. and R.E. Reynolds. 1965. Movements of tagged king crabs, Paralithodes camtschatica (Tilesius), in the Kodiak Island-Lower Cook Inlet region of Alaska, 1954-1963. Alaska Dept. Fish Game Info. Leaflet 55, Juneau.

POWELL, G.C., B.J. Rothschild, and J. Buss. 1974. A study of king crab Paralithodes camtschatica, (Tilesius) brood stocks, Kodiak Island, Alaska, 1963-1971. Unpublished manuscript. 30 pp.

POWELL, G.C. 1980. King crab research. In: Westward region shellfish report to the Alaska Board of Fisheries March, 1980. Alaska Department of Fish and Game, Kodiak. 290 pp.

REEVES, J. E. 1981 A proposed method for determining ABC and OY for the eastern Bering Sea King crab fishery. NWAFC MS, 16 pp.

REEVES, J.E. and R. Marasco. 1980. An evaluation of alternative management options for the southeastern Bering Sea king crab fishery. Northwest and Alaska Fisheries Center (NMFS/NOAA). Processed Report, 80-6, 85 pp.

RICKER, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Bd. Can. Bull. 191. 382 pp.

RIVARD, D. and L.J. Bledsoe. 1978. Parameter estimation for the Pella-Tominson stock production model under non equilibrium conditions. Fish. Bull. Vol.76, pp. 523-534.

SIMPSON, R.R. and H.H. Shippen. 1968. Movement and recovery of tagged king crabs in the eastern Bering Sea, 1955-63. Bull. Int. North Pac. Fish. Comm. 24: 111-123.

STINSON, J.E. 1975. The effect of ocean currents, bottom temperatures, and other biological considerations in regard to the location and abundance of mature southeastern Bering Sea king crab (Paralithodes camtschatica). University of Washington, Seattle. Unpublished M.S. 20 pp.

THOMPSON, W.F. and R. Van Cleve. 1936. Life history of the Pacific halibut: (2) Distribution and early life history. Int. Fish. Comm. Rept. 9, Seattle. 184 pp.

TRASKY, L.L., L.B. Flagg, and D.C. Burbank. (Eds) 1977. Environmental studies of Kachemak Bay and Lower Cook Inlet. Marine/Coastal habitat management, Alaska Dept. of Fish and Game, Anchorage, Alaska, 10 volumes.

WALLACE, M.M., C.J. Pertuit and A.R. Hvatum. 1949. Contribution to the biology of the king crab (Paralithodes camtschatica Tilesius). U.S. Dept. of Interior. Fish. Leaflet. 340:50 pp.

WEBER, D.D. 1965. Growth of the immature king crab Paralithodes camtschatica (Tilesius). Unpublished Masters Thesis., University of Washington. 100 pp.

WEBER, D.D. 1967. Growth of the immature king crab, Paralithodes camtschatica (Tilesius). Bull. Int. North Pac. Fish. Comm. 21: 21-53.

WEBER, D.D. and Takashi Miyahara. 1962. Growth of the adult male king crab Paralithodes camtschatica (Tilesius). U.S. Fish and Wildlife Service, Fish. Bull. 62: 53-75.

WOLOTIRA, R.J. JR., T.M. Sample and M. Morin, Jr. 1977. Demersal fish and shellfish resources of Norton Sound, the southeastern Chukchi Sea, and adjacent waters in the baseline year 1976. Natl. Mar. Fish. Serv. Northwest and Alaska Fish. Cent. (Seattle) Processed Rept. 292 p.

PROJECTED 1981 GUIDELINE HARVEST LEVEL

FOR

RED KING CRABS IN BRISTOL BAY

J.E. REEVES

KING CRAB TEAM

MARCH 1981

PROJECTED 1981 GUIDELINE HARVEST LEVEL FOR RED KING CRAB IN BRISTOL BAY

This report describes the procedures used to establish the guideline harvest level for the 1981 red king crab fishery in Bristol Bay (Area T). A guideline harvest range is established from projections of abundance of crabs based on the 1980 NMFS trawl survey. The most probable catch level within this range is based on current knowledge of the spawning stock and how fishing may impact it. Final verification of the projected guideline harvest level will await results of the 1981 survey.

GUIDELINE HARVEST RANGE FOR 1981

Projected abundance of legal males for 1981

Abundance of king crabs in 1981 has been projected from knowledge of the 1980 survey abundance estimates, the 1980 catch, and king crab growth and natural mortality rates. A projected fishable stock of 21 million males is indicated for 1981 by the information given in Table 1. This figure is the sum of 1981 projected age groups which will be available to the fishery under a 6.5" size limit. Each projected age group is calculated by subtracting catches and natural mortality from it when it was a year younger, as estimated by the 1980 trawl survey. The projection formula is given in Appendix 1. Size intervals for each age group, as well as natural mortality, and the percent of each age group available to the fishery under a 6.5" size limit, were derived from information given by Balsiger (1974) and Reeves and Marasco (1980).

Accuracy of the 1981 projection

When the projection method described above is applied to the data from past surveys, and the results of the projections compared with the next year's actual survey estimates, some idea of the accuracy of the projection is

obtained. Figure 1 shows the results of such comparisons for surveys from 1974 through 1980. If the projection method was entirely accurate in predicting the next survey's abundance estimate, the point for each year would be on the solid line. Most of the observed points are near the solid line, but there is a tendency for the projection method to underestimate next year's survey abundance, especially in 1974 and 1976. Whether this tendency to underestimate is associated with lower stocks, or with other factors prevailing during the earlier years, cannot be determined at present. The dashed line represents a statistical fit to the observed points (see Appendix 2) and in the next section, is used to correct the results of the projection method.

Projected guideline harvest range for 1981

Based on the correction equation given in Figure 1, the projected estimate of 21 million legal crabs in 1981 is modified to 29 million crabs. This adjustment to the original projection for possible inaccuracies is used to establish the guideline harvest range. The uncorrected and corrected projections are converted, in Table 2, to catch levels based on three different average size figures, and exploitation rates of 0.4 and 0.6. The average size in the 1980 fishery was 6.2 lbs; a 6.0 lb average might be expected in 1981 if the declining trend in size continues; 5.7 lbs is the lowest average size observed since 1975 (Appendix 3). Based on the 1980 survey and catch information, last season's exploitation rate approached 60%; in earlier years this rate has been in the 35 to 40% range. Using these variations in average size and exploitation rate, a guideline harvest range of 40-100 million pounds is established for 1981.

GUIDELINE HARVEST LEVEL FOR 1981

The final guideline harvest level for 1981 will be determined by the abundance of the female spawning stock as well as abundance of legal males. The biological goal of management is to maintain the spawning stock as close as possible to the level where the catch of recruits per spawning female is maximized. The achievement of this goal requires knowledge of the spawner-recruit relationship. At present, our knowledge of this relationship for king crabs is sketchy, and this leads to uncertainty in determining the level of female spawning stock that maximizes the catch.

Spawner-recruit relationship

Theoretically, the spawner-recruit relationship can take many forms, but from a practical management standpoint, two basic forms can be distinguished: (1) where recruitment drops off at high spawning stock densities (Figure 2A), and (2) where recruitment is independent of spawning stock density above a certain level (Figure 2B). Within these two basic forms the spawner-recruit relationship can still theoretically take on a variety of shapes, but again for practical management considerations, the most probable curves can be limited to a few (numbered 1, 2, and 3 in Figure 2). The vertical dashed lines represent spawning stock levels which will, on the average, produce the highest catches; i.e., the spawning level to be maintained, as far as possible, by management. The solid straight replacement line represents the abundance of recruits that will maintain (or replace in the future) the current level of spawning stock.

The spawner-recruit data at hand for red king crab in Bristol Bay (Figure 3) suggests that we are dealing with a curve similar to form A1 of Figure 2. However, at this early stage of knowledge, other forms cannot be

ruled out. Based on a consideration of these possible forms, Reeves (1980) selected a "threshhold" female spawner abundance of 60 million females, which at the time was considerably less than the estimated abundance of mature females in the population. Unless the actual curve is of the form A2 for A3, this is a conservative choice which represents a compromise among likely forms of the spawner-recruit relationship. Since that time, a new data point from the 1980 survey has been added to the series (labeled "74" in Figure 3) and fits well with form A1, which indicates an optimum of 20 million spawning females. Continuing a cautious approach, however, a revised "threshhold" level of 40 million spawning females seems prudent. Below this level, fishing on males should be restricted to insure that all mature females are mated. Above this level, fishing can be less restricted.

Projected abundance of mature females for 1981

The projected abundance of mature females is calculated in much the same ways as for males, except that no catch removal is considered and only two groups need be dealt with--mature females and immediate pre-recruits to the mature stock. The projected abundance using the equation in Appendix 1, with growth and mortality rates derived from the same sources as for males, is 51 million mature females. An historical check on the accuracy of this projection (Figure 4) reveals a consistent tendency for underestimating the next year's abundance estimate for mature females. Correcting the projection for this tendency gives an estimate of 82 million mature females. Thus, the probable range for abundance of the mature female stock in 1981 is 51-82 million crabs.

Effect of catches on the spawning stock

During times of lower spawning stock abundance, the question of how the catch of males effects the extent of female copulation becomes increasingly important to management of the stocks. Reeves and Marasco (1980) have framed this question in the form of a hypothetical model expressed in Table 3, which shows the percent copulation of females dropping off as the exploitation of males is increased, or the size limit is reduced. This hypothesis can be checked by observation if the exploitation rate and size limit are allowed to vary. For example, since the 1980 exploitation rate approached 60%, 89% copulation of females (circled value on Table 3) would be expected from the 1981 survey, rather than 96% copulation associated with an exploitation rate of 40%.

The application of the values in Table 3 to the projected spawning stock provides a first approximation regarding the effect of fishing on spawning stock. Table 4 shows the result of applying the hypothetical percent copulation data to the lower end of the projected range of abundance of mature females, 51 million crabs. The line passing through this table separates what are currently considered adequate spanwing stocks (above) from those which may produce lower future recruitments (below). From this it is concluded that an exploitation rate of 60% for 1981 is biologically safe.

Projected guideline harvest level for 1981

Referring back to Table 2, current knowledge of the spawning stock points to the row of possible 1981 catches associated with an exploitation rate of 0.6. These catches are in the upper half of the guideline harvest range. However, there is uncertainty regarding how well the correction procedure used for the 1981 projected male stock applies to the current situation. If the

large differences between projected and observed male stock (Figure 1) is associated with factors more related to the years sampled (e.g., environmental conditions during the 1974-76 period) rather than with stock abundance, then more weight should be given to the uncorrected projection. In order to take the above possibility into account, the lower projected abundance of 21 million crabs has been chosen. This choice leads to a guideline harvest level of 75 million pounds for 1981.

Final guideline harvest level

Final evaluation of this number will await the results of the 1981 NMFS trawl survey of the Bristol Bay red king crab stock. When the results of that survey pertaining to abundance of legal males, abundance of mature females, and the percent copulation of females are available, a final guideline harvest level can be set based on the most current information. Unexpectedly lower or higher abundances of legal males or egg-bearing females determined from the 1981 survey will lead to downward or upward adjustment of the 75 million pound level.

REFERENCES

Balsiger, J.W., 1974. A computer simulation model for the eastern Bering Sea crab population. Ph.d. Dissertation, Univ. Wash., 160 pp.

Reeves, J.E., 1980. A proposed method for determining ABC and OY for the eastern Bering Sea king crab fishery, NWAFC Ms, 16 p.

Reeves, J.E. and R. Marasco, 1980. An evaluation of alternative management-options for the southestern Bering Sea king crab fishery. NWAFC Proc. Rpt. 80-6. 85p.

Table 1.--Projected stock of male red king crab for 1981 by age.

Millions of male crabs

Age	carapace length group (mm)	1980 survey estimate	1980 catch	1980 estimated natural mortality	1981 projected stock	1981 % available at 6.5" size limit	1981 projected fishable stock
7	120-129	9.6	0	1.0	7.4	0	0
8	130-139	12.1	2.3	1.0	8.6	50	4.3
9	140-149	13.6	7.7	.9	8.8	100	8.8
10	150-154	5.8	3.8	.6	5.0	100	5.0
11	155-159	4.3	2.9	.9	1.4	100	1.4
12	160-164	2.9	2.1	.6	.5	100	.5
13	165-169	1.7	1.3	.1	.2	100	.2
14+	>169	1.6	.8		.3	100	.3
Total							20.5

Table 2.--Estimated catches of red king crabs in 1981 used to establish the range of possible harvests (6.5" size limit)

	Estimated catch (millions of pounds) at 6.5" size limit					
	21 million crab projection			29 million crab projection		
Rate of exploitation \ Average weight (lb)	5.7	6.0	6.2	5.7	6.0	6.2
.4	48	50	52	66	70	72
.6	72	76	78	99	104	108

Table 3.--Simulated copulation rates for female king crabs, by minimum size limit and exploitation rate.

Simulated percent copulated females							
Size limit	Exploitation rate .3	.4	.5	.6	.7	.8	.9
7.00"	100	100	100	100	98	97	95
6.75"	100	98	97	95	92	90	87
6.50"	100	96	93	89	86	82	79
6.25"	93	89	85	81	78	74	72
6.00"	86	82	77	73	70	66	64
5.75"	81	77	72	68	65	62	60
5.50"	77	73	68	64	61	57	55
5.25"	72	68	63	59	56	53	51

* * * * * *

Table 4.--Estimated female spawning stock for 1982, by minimum size limit and exploitation rate.

1982 female spawning stock (millions of crabs)							
Size limit	Exploitation rate .3	.4	.5	.6	.7	.8	.9
7.00"	51	51	51	51	50	50	49
6.75"	51	50	50	49	47	46	45
6.50"	51	49	48	46	44	42	41
6.25"	48	46	44	42	40	38	37
6.00"	44	42	40	38	36	34	33
5.75"	42	40	37	35	33	32	31
5.50"	40	38	35	33	31	29	28
5.25"	37	35	32	30	29	27	26

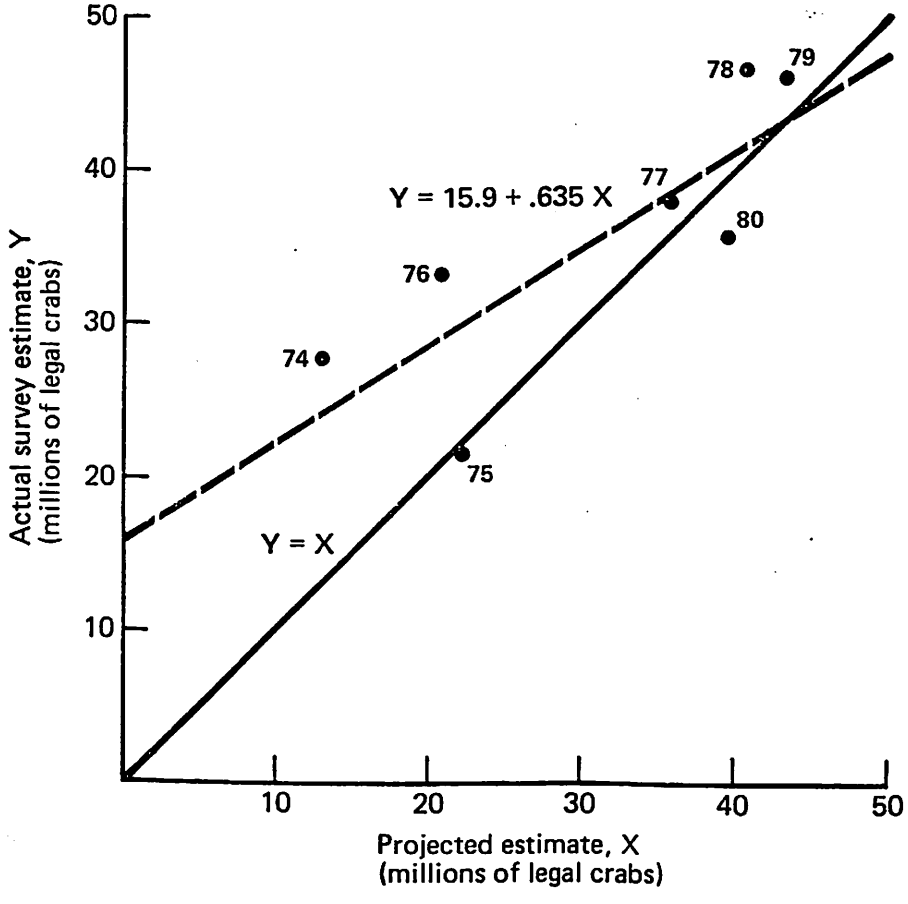


Figure 1.--Relation of actual survey estimates to model projections for Bristol Bay legal male red king crabs.

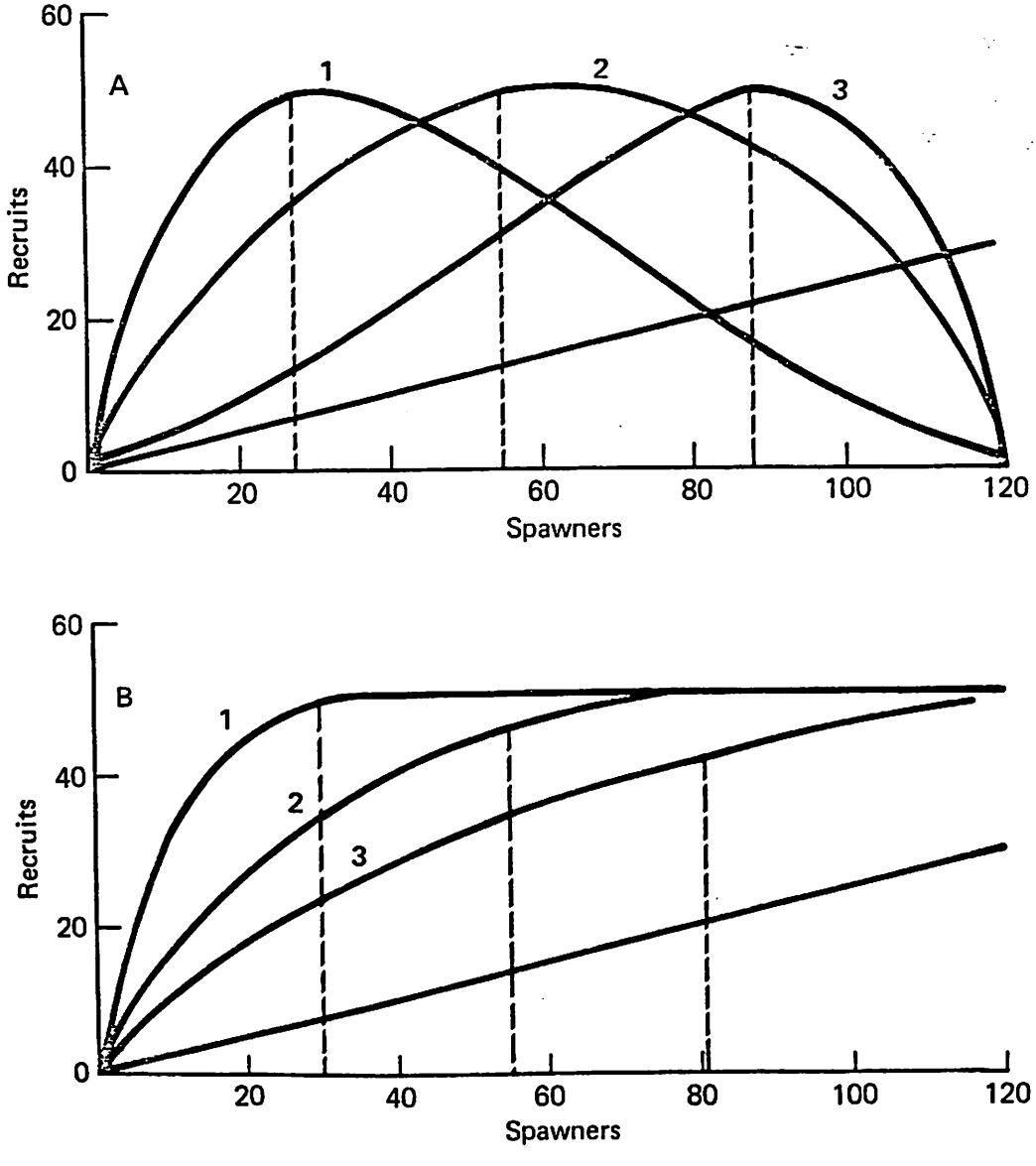


Figure 2.--Examples of possible spawner-recruit curves: A, dome-shaped and B, asymptotic.

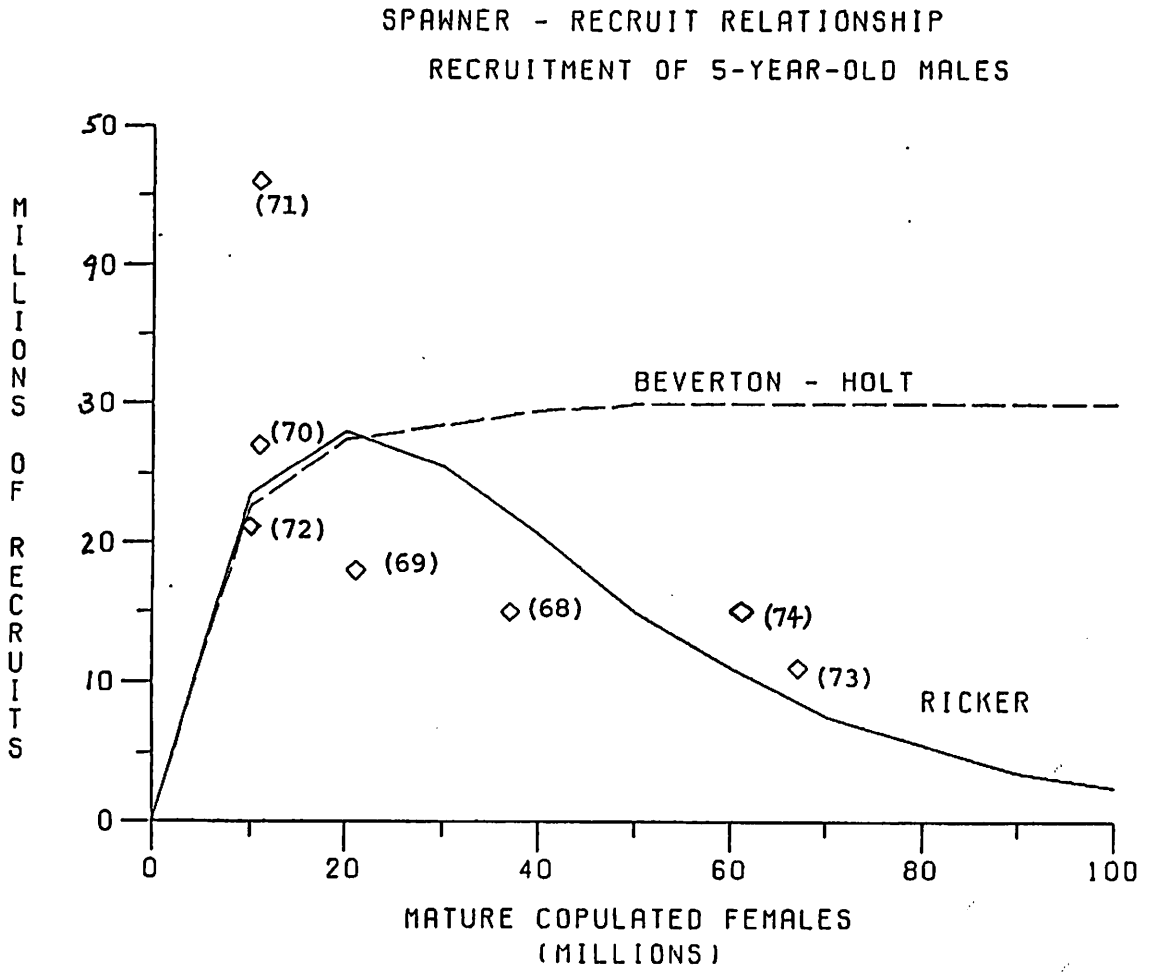


Figure 3.--Spawner-Recruit data and fitted curves for the southeastern Bering Sea red king crab stock. (Year of estimate of mature copulated females in parentheses)

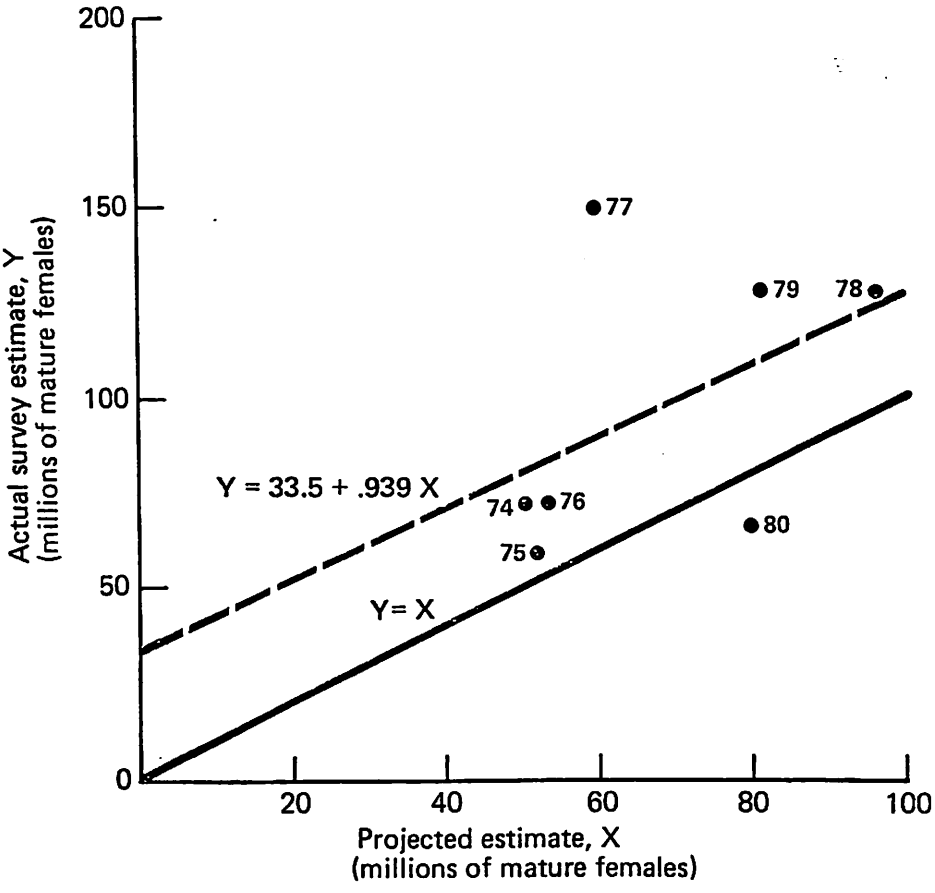


Figure 4.--Relation of actual survey estimates to model projections for Bristol Bay mature female red king crabs.

Appendix 1

Projection equations for red king crab abundance

Legal males

$$XM_{i+1,\,j+1} = XM_{ij}e^{-(F_{ij}+15M_j)}$$

where F_{ij} is determined iteratively from

$$u_{ij} = \frac{F_{ij}}{F_{ij}+M_j}\left(1 - e^{-(F_{ij}+M_j)}\right) \text{ where}$$

$$u_{ij} = \frac{C_{ij}}{XM_{ij}e^{-3Mj}}$$

$$TM_{i+1} = \sum_j s_j XM_{i+1,j}$$

XM_{ij} = estimated abundance of males, age j, at the time of the survey in year i

$XM_{i+1,j+1}$ = projected abundance of males, age j+1, in year i+1 at the beginning of the fishing season

C_{ij} = catch during the season in year i of age j crabs

F_{ij} = instantaneous seasonal fishing mortality in year i on age j crabs

M_j = instantaneous monthly natural mortality on age j crabs

s_j = percent availability of age j crabs to the fishing gear

Mature females

$$XF_{i+1,j+1} = (XF_{i,j} + XF_{i,j+1})\, e^{-M}$$

$XF_{i,j}$ = estimated abundance of immature females at the time of the survey in year i

$XF_{i,j+1}$ = estimated abundance of mature females at the time of the survey in year i

$XF_{i+1,j+1}$ = projected abundance of mature females at the time of the survey in year i+1

M = instantaneous annual natural mortality

j = 1, immature females (75-89 mm)

j = 2, mature females (>89 mm)

Appendix 2

Regression parameters for accuracy of projections

	MALES		FEMALES	
	Fishable population (millions of crabs)		Mature population (millions of crabs)	
Year	Projected (x)	Actual (y)	Projected (x)	Actual (y)
1974	12.9	27.6	50.2	72.1
1975	22.2	21.6	51.7	58.9
1976	20.7	33.0	53.9	71.8
1977	36.3	37.7	58.6	150.1
1978	40.8	47.1	96.1	128.3
1979	43.8	46.3	81.2	128.7
1980	39.9	36.0	80.2	67.6

Regression equation:

$y = 15.9 + .635\ x$

$R^2 = 68\%$

SD/Y = 5.710

Regression equation:

$y = 33.5 + .939\ x$

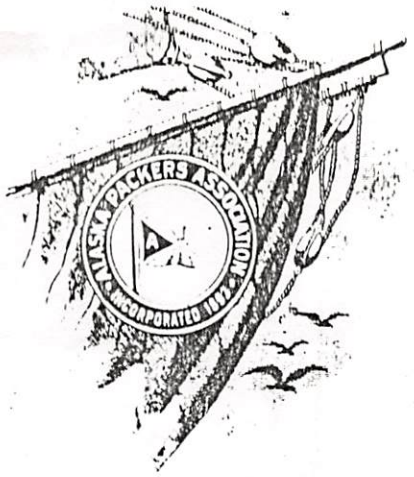
$R^2 = 21\%$

SD/Y = 36.41

Appendix 3

Average weight of red king crab in the catch, Bristol Bay fishery

Year	Average lb/crab
1975	5.7
1976	6.0
1977	5.9
1978	5.8
1979	6.4
1980	6.2



Alaska Packers Association, Inc.

A Subsidiary of Del Monte Corporation

The Commons Suite C-115 • 1200 112th Ave. N.E.
(206) 455-1745 • P.O. Box 3326, Bellevue, WA 98009

March 10, 1981

Rep Ray Lewis
He packed out

State of Alaska
Board of Fisheries
Subport Building
Juneau, AK 99801

Members of the Board:

We understand that the Alaska Board of Fisheries will consider shellfish regulatory proposals at its Spring meeting commencing March 23, 1981 at Anchorage, Alaska.

The Industry experienced a significant problem with light meat content in King Crab taken during the early part of both seasons this year which has caused problems of acceptance in both the domestic and export markets. We, therefore, recommend the 1981 season for Red King Crab in Statistical Area T (Bristol Bay) be delayed until November 1, 1981 and that the start of fishing in Statistical Area O (Dutch Harbor) be delayed until December 1, 1981.

We also recommend that the minimum carapace width in both Statistical Area T (Bristol Bay) and O (Dutch Harbor) not be changed from the present 6.5 inches. A size reduction in the carapace width, we feel, would significantly affect the market acceptance of our product now being merchandised in the shell.

Many thanks for this opportunity to present our recommendations to the Board.

Sincerely,

W. H. Nichols

WHN:pj

Draft

Alaska Board of Fisheries

~~DRAFT~~

BERING SEA/ALEUTIAN ISLAND

KING CRAB

FISHERY MANAGEMENT PLAN

March ~~18~~ 24, 1981

3.0 AREAS AND FISHERIES

This management plan presently applies only to the king crab (family Lithodidae) fisheries in the Bering Sea and Aleutian Islands (Fig. 2). These fisheries are described in the Alaska Shellfish regulations as the Bering Sea, Bristol Bay, Adak, and Dutch Harbor "statistical areas" (Areas Q, T, R, and O, see Fig. 2).

These areas describe geographically segregated stocks capable of being managed as independent units. Within each statistical area manageable portions of the stocks are further divided into fishing districts and sections. For a complete description of the statistical areas, fishing districts, and sections refer to the commercial section of the Alaska Shellfish Regulations.

4.0 MANAGEMENT OBJECTIVES

The management regime for the king crab fisheries is intended to achieve the following objectives. It is noted that these objectives are not in rank order nor mutually exclusive and that management measures may be designed to accomplish several objectives (i.e., achievement of one objective may be constrained by the need to also achieve another objective).

1. ACHIEVE REPRODUCTIVE REQUIREMENTS FOR INDIVIDUAL KING CRAB STOCKS.

The cornerstone of king crab fishery management is optimization of the reproductive potential of individual king crab stocks. At low population levels or in situations when there is insufficient knowledge of spawner-recruitment relationships to define spawning requirements it is prudent to strive for the maximum reproductive potential by assuring that enough males of the appropriate sizes remain in the population so as to guarantee full egg clutch development of all females. At high abundance levels full egg clutch development in all female crab is unnecessary. Additional harvest of male crab or allowing a harvest of female crab is under these circumstances consistent with the goal of achieving the reproductive requirement of individual

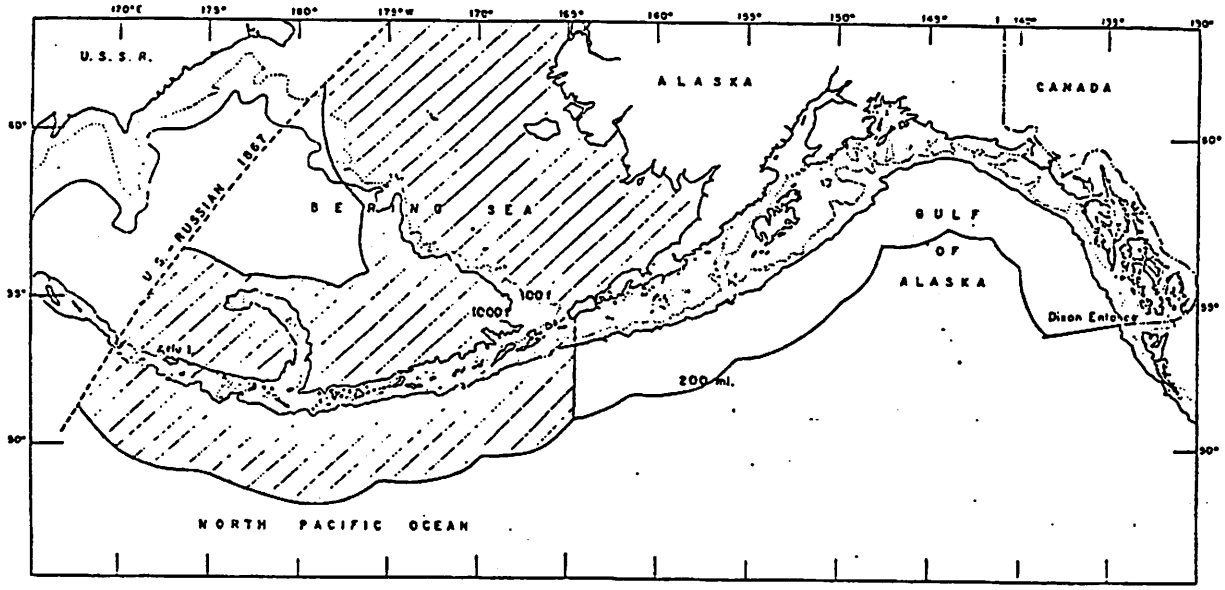


Figure 1. Area (diagonal lines) over which this fishery management plan applies.

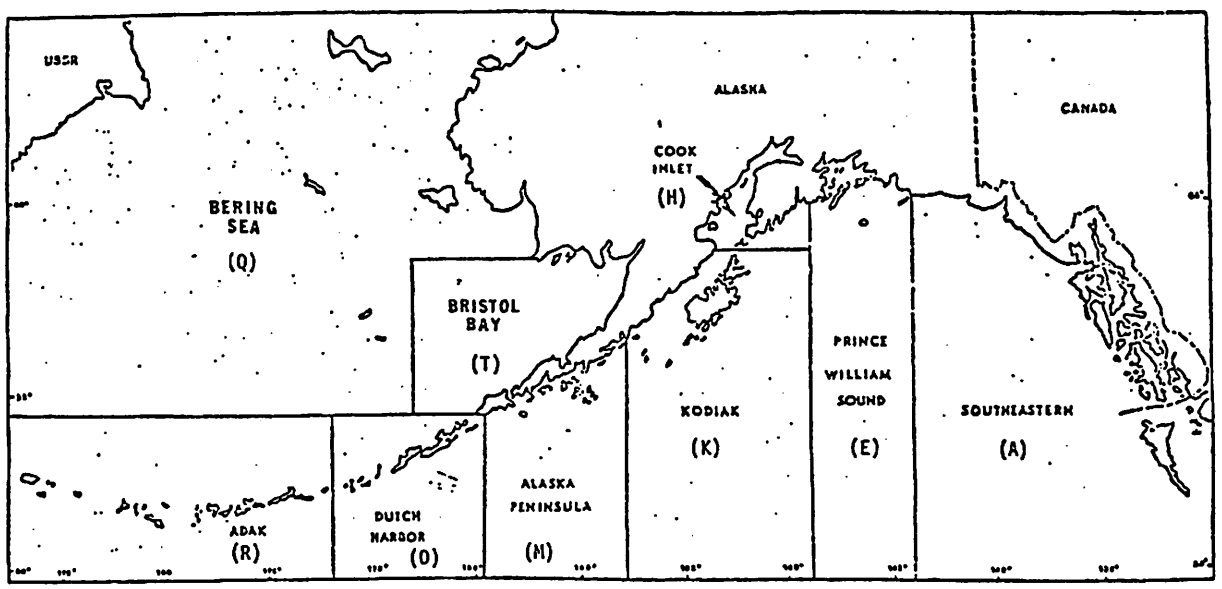


Figure 2. Alaska king crab statistical areas.

stocks.

2. OPTIMIZE THE NET VALUE OF THE FISHERY

The optimal harvestable surplus for the Bering Sea/Aleutian Island king crab fishery is not necessarily the maximum physical yield. Social, economic or ecological factors may change the yield. In particular, annual harvests that are relatively stable between years (i.e., where extreme fluctuations in annual harvests do not occur) are a goal because adverse socioeconomic consequences are associated with "boom and bust" crab fisheries. Management strategies should attempt to moderate peaks and troughs (which are a function of year class strength) with due regard for cost/benefit considerations.

Unless consideration is necessary for conservation or social objectives, management measures should not impose additional burdens on industry; cost effective harvesting and processing techniques should not be restricted; and production/marketing standards should be accommodated.

As an example, management strategies should avoid unnecessary vessel use, thus reducing operating costs associated with fuel consumption. As another example, since crab recovery rates (the ratio of recoverable meat to total body weight) increase dramatically during the period of rapid growth following molting, a delayed season opening can act to increase both the volume and value of the catch and final product, benefiting both fishermen and processors.

3. MINIMIZE ADVERSE SOCIOECONOMIC IMPACTS BY PROTECTING COMMUNITY AND INDUSTRIAL INVESTMENTS.

Because the Bering Sea/Aleutian Island king crab fishery is an existing, historic fishery with an established industrial system (harvesting and processing) and community infrastructures are dependent on the fishery, mechanisms may be necessary to protect investments that have been made.

These considerations are not solely economic but also social in nature. Changes made in the management of the fishery need to be evaluated in light of these previously made investments.

Examples of management measures that have been used to accomplish this objective are exclusive registration, "fair starts", and the setting of seasons in relation to other fisheries.

4. MINIMIZE ADVERSE INTERACTIONS AMONG FISHERIES

Modern management practices dictate that the management of a particular fishery consider the interaction with other fisheries. For example, crab trawls and tangle nets should not be used because they cause excessive mortalities of nontargeted species.

5. OPTIMIZE THE COST EFFECTIVENESS OF MANAGEMENT AND ENFORCEMENT

Fishery management should seek a reasonable balance between the enforcement and management costs borne by the public and by the impacts on industry and should seek to bring all costs within reasonable limits relative to the value of the fishery.

5.0 MANAGEMENT MEASURES

This section establishes a multiyear management regine for the Bering Sea/ Aleutian Islands king crab fisheries described in Section 3.0.

5.1 Determination of Optimum Yield

Two numerical values are addressed in this section. One is the Acceptable Biological Catch (ABC), which is based on the biological status of the stocks. The other is the Optimum Yield (OY), which represents a modification of the ABC for social, economic, or ecological factors. The ABC and OY for Bering Sea/Aleutian Island king crab stocks are determined annually.

ABC

The ABC will be based on the following estimates:

1) Stock abundance and distribution by sex and size class;

2) Natural mortality rates by sex and size class;

3) Fishing mortality rates from previous years by size class;

4) Growth rates by sex and size class;

5) Recruitment into the fishery;

6) Critical size necessary for reproductive needs;

7) Reproductive success given a specific population size, sex ratio, and distribution of spawning stocks; and

8) Environmental and ecological effects.

The ABC should maintain recruitment to the fishable stock at the highest possible level. Maintenance of this level of recruitment for king crab is achieved by perpetuating a minimum required spawning stock of fertilized females. When the stock is below the minimum, the fishery should be restricted to maintain full female fertilization. When the stock is above this minimum, higher exploitation or lower size limits on males may be permitted.

The procedure for determining ABC for king crab is as follows:

1. Establish the minimum required female spawning stock.

This is done by an analysis of the stock-recruitment relationship, based on abundance estimates from resource assessment surveys. This is an ongoing analysis which builds on the use of additional data as each survey is completed.

Information is not complete for all the king crab fisheries in Bering Sea/ Aleutian Islands. The Bering Sea area presently has the best data base and is experiencing high stock levels. A study by Reeves and Marasco (1980) which simulated the spawner-recruitment relationship, the copulation coefficient and the size of the Bering Sea fishery indicates that because of high stock levels

there is currently an excess reproductive potential. Further, Reeves (1981) has indicated that 40 million copulated females is a reasonable estimate of the minimum number necessary to sustain the population based on spawner-recruit information. Therefore, at the high population levels now apparent in the Bering Sea, a greater portion of males is surplus to reproduction and is available as ABC for the fishery. The ABC is estimated using this information combined with current survey estimates of abundance. A detailed example is provided by Reeves (1981).

2. ABC is set equal to the maximum catch (i.e., a given minimum size limit/exploitation rate combination applied to survey estimates of abundance) which still maintains the minimum required spawning stock.

Expected catches are calculated from survey abundance estimates by minimum size limit and exploitation rate. Acceptable catches are those which do not lower the expected spawning population of females below a minimum required. Such a reduction in spawning population operates through a presumed reduction in percent copulation. The highest of these catches is selected as the ABC.

3. For those stocks at a low level, or where data are insufficient for determining the minimum required spawning stock, ABC will be set at the maximum catch which still maintains full female fertilization.

For example, this catch currently corresponds to an exploitation rate of approximately .4 and a minimum size limit of 6.5 inches in the Dutch Harbor area. Fisheries where these parameters are in effect or where the exploitation rate is less than .4 (eq. Norton Sound) have not impacted on full female fertilization. Thus, until additional information indicates otherwise, and for stocks that are at a low level or whose abundance is unknown, management will be conservative and attempt to achieve maximum fecundity in the female population.

OY

The Optimum Yield for the Bering Sea/Aleutian Island king crab fishery is the preseason indication of the allowable harvest. The realized harvest may differ from the earlier specification of OY due to information gained during the season (see Section 5.9, In-season Adjustment of Time and Area).

The OY for the Bering Sea/Aleutian Island king crab fishery is a result of a management strategy which attempts to maintain stable annual harvest levels (i.e., to avoid extreme fluctuation). The acheivement of this policy necessitates flexible harvest strategies which are a function of population size and structure.

The procedure for determining the OY is:

1. Categorize the fishery

   Describe the fishery's current population abundance (compared to historical levels) and population structure (i.e., levels of perecruits, recruit and post-recruit crabs). For example, a fishery may be categorized as having an average population size with declining recruitment and a high level of post-recruits.

2. Determine the exploitation rate

   Each category of population abundance and structure requires an appropriate exploitation rate to achieve management objectives (e.g., reproduction and stability):

*For a low or depressed population exhibiting declining

recruitment and a moderate level of post-recruits, the exploitation rate is .25.

*For average population levels characterized by stable or slightly declining recruitment and comprised of mostly recruit crab, the exploitation rate is .40.

*For average population levels with increasing recruitment or comprised of mostly post-recruit crab, the exploitation rate is .50.

*For high population levels with increasing recruitment or mostly post-recruit crab, the exploitation rate is .60.

3. Determination of OY

The optimum yield is determined by applying the exploitation rate to the amount of legal crab, unless there is further social, economic, or ecological rationale for harvesting more or less crab.

Additional information and details of this procedure are provided in Table 1.

The Optimum Yield for the Bering Sea/Aleutian Island king crab fishery is the preseason indication of the allowable harvest. The realized harvest may differ from the earlier specification of OY due to information gained during the season (see Section 5.9, In-season Adjustment of Time and Area).

The OY will equal the ABC unless there is social, economic or ecological rationale for harvesting more or less than the ABC. Agency reports, public comments, analyses of impacts on markets, the processing and harvesting sectors and the community infrastructures, etc. will serve as the basis of modifying ABC into OY.

5.2 Fishing 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. Because harvest levels are usually taken in two months or less there is opportunity to look beyond biological considerations in setting the date of the season opening.

In determining an appropriate data, several factors will be weighed. One factor to be considered 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.

A second factor to be weighed is weather conditionss. 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 operators of smaller vessels.

A third 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 lengthly period of time between the two fisheries will force vessels and processors to lie idle and may create additional startup costs.

A fourth 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 season opening should reflect a balance of attitudes within the industry with respect to the several factors described above.

5.3 Sex Restrictions

Common to nearly all crab fisheries is the restriction of taking only male crab. This restriction is assumed to contribute to maximium reproductive potential. The data base to support or reject an intensive harvest of female king crab is poor. Reeves and Marasco (1980) and Reeves (1981) indicate that there are probably surplus female crab which can be taken from the high stock levels now present in the Bering Sea. However, the accumulative effects of female harvests and the subsequent environmental impacts are not demonstrable at this time and may never be without actually harvesting the female population.

The potential harvest of female crab has not been an issue. Management philosophies endorse a limited fishery for females in years of high abundance; however, industry has shown little interest. Females are considerably smaller than males of the same age and the proportion of recoverable meat is much less than that of males.

At the request of industry, the feasibility of providing a limited harvest of female crab will be determined.

5.4 Exclusive Registration Areas

The designation of registration areas as exclusive or non-exclusive has been debated for years. Exclusive registration areas encompass generally well developed historical fisheries. Non-exclusive registration areas are generally areas where king crab fisheries are relatively unexplored, unstable or marginal. The socio-economic impact upon local communities within an area has been a major consideration as to whether a registration area warrants exclusive or non-exclusive status.

In determining the need for designating a registration area as exclusive or non-exclusive consideration will be given to:

1) The desire by the public to protect industrial and community investments;
2) The ability to properly manage the fishery;
3) Providing fleets a reasonable opportunity to participate in the fishery;
4) Promoting the most efficient utilization of vessels and gear; and
5) Availability of similiar management measures which would limit overall fishing effort.

king crab statistical areas Q, T, O, and R but not in any other king crab statistical area of the State.

5.5 Gear Placement

Determination of the need for regulations affecting gear placement or staging, (i.e., allowing fishing gear to be placed on the grounds prior to fishing and/or remain on the grounds after the season closure) will result from examining:

1) The biological impacts on target and nontarget species;

2) Enforcement problems and costs borne by the public versus by the industry;

3) Possible gear conflicts; and

4) The desire by the public to protect industrial and community investments.

5.6 Gear Storage

Between fishing seasons, king crab gear can be stored on land or at sea. The expense of storage on land is of course greater than at sea, however loss of gear is significantly reduced with on land storage. Under current State regulations, gear must be removed from the fishing grounds after the fishing season is over and stored on land, in shallow waters (less than 25 fathoms), or in specific high seas areas when there is insufficient shallow water storage. These designated storage areas have historically been areas of low crab abundance. Gear must be stored in a nonfishing condition; bait and bait containers removed and doors locked open.

Regulations which describe the means by which king crab fishing gear may be stored during the closed fishing season will continue to be developed. These regulations may range from random (at sea) storage to limited designated (at sea) storage areas, or complete removal of gear from the sea and will be based on analyses of the following information:

1) The biological impacts of storing gear at sea;

2) The enforcement costs of determining whether fishing gear stored at sea is in a nonfishing condition;

3) The costs borne by the fleet to store gear; and

4) Availability of on land or at sea storage areas.

5.7 Vessel Tank Inspection

Vessel tank (e.g., live hold) inspections are required under State regulations to meet the legal requirements for the State's "landing laws" (see Appendix 7.2). In order to pass inspection, the vessel must have no crab aboard. Generally, the tank inspection is performed by Department personnel during the 24-hour period preceding the season opening.

In determining the need for vessel tank inspection regulations consideration will be given to:

1) Enforcement requirements;

2) Documentation of commercial harvest location;

3) The fleet's ability to move freely from the fishing grounds to processing locations;

4) The time necessary to transport gear from the storage areas to the fishing grounds;

5) The increase fuel useage required by the fleet to effect this regulation; and

6) The desire by the fleet to insure a fair and equitable season start among the various participants.

5.8 Limited Entry

There is no present need to implement a limited entry program for vessels fishing the king crab fishery in the Bering Sea/Aleutian Island area.

5.9 In-season Adjustment of Time and Area

Optimum yields are based upon projections of the status of the stocks, economic and other conditions several months in advance of the actual conduct of the fishery and may be found to be mis-specified in light of unpredicted and unanticipated adverse or favorable stock conditions which are revealed in-season. Under such circumstances it is appropriate to take immediate action by issuing emergency orders adjusting time and/or area restrictions. Therefore, this plan provides that seasons and area shall be subject to in-season adjustment based upon one or more of the following factors:

1. Distribution of fishing effort by time and area;
2. Catch per unit effort and rate of harvest:
3. Relative abundance of age classes of king crab within the area in comparison with preseason prediction;
4. The proportion of immature or soft shell king crab being handled; and
5. Any other factors relevant to the conservation and management of king crab.

6.0 ENFORCEMENT AND REPORTING REQUIREMENTS

Enforcement procedures are necessary for:

a. surveillance of fishing vessels to assure compliance with the registration and permitting regulations as well as area and season openings and closures.

b. surveillance of landings to assure compliance with size, sex, and species regulations;

c. surveillance of fishing gear to assure compliance with gear restrictions and gear storage areas.

Catch reporting by the fishermen and the buyers is necessary for proper management. When a king crab fisherman lands his catch, a report in the form of a "fish ticket" must be completed. The information required provides a statistical data base on the fishery and shall include information on: type and quantity of fishing gear used, catch by species in numbers of crab or weight thereof, areas in which fishing was engaged in, time of fishing, and number of hauls. Any fishing vessel which processes its own catch or the catch of other vessels must comply with this catch reporting requirement.

Fish buyers, processors, etc., who purchase, transport, and/or process king crab shall provide the following data:

1. The amount or tonnage of crab purchased, transported, and/or processed, by species.

2. Locations at which crab are received and/or processed, by species.

3. Limitations as to seasons, quantities, or quality standards of crab which apply to crab received and/or processed, by species.

4. Disposition of the crab received or processed, by species.

5. Prices paid for crab received, by species.

6. The amount or tonnage which the processor expects to purchase, transport, and/or process, by species, by year.

Table 1. Comparison of exploitation rates of legal crab given relative population size and recruitment and post-recruitment abundance levels.

Population size	Recruitment abundance	Exploitation rates of legal crab at given levels of post-recruits		
		Low*	Moderate**	High***
Depressed	Declining	20	25	25
	Stable	30	30	35
	Increasing	30	30	35
Average	Declining	40	40	40
	Stable	40	45	45
	Increasing	40	50	50
Peak	Declining	40	45	50
	Stable	50	55	60
	Increasing	60	60	60

* Low = less than 1/3 of total population (lbs.)
** Moderate = 1/3 - 2/3 of total population
*** High = over 2/3 of total population