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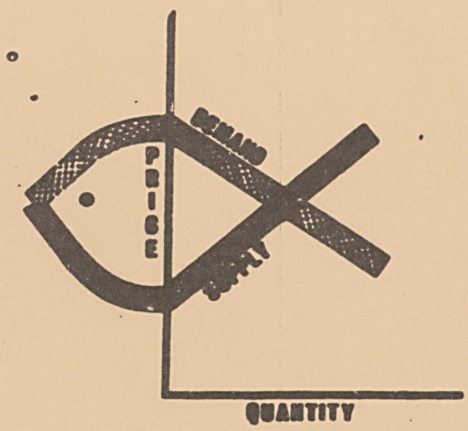

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The King Crab Industry of Alaska: 1953-1969: an Economic Analysis

by

Sybil T. W. Beale

with
assistance
of

James A. Crutchfield

November 1971

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U.S. NATIONAL MARINE FISHERIES SERVICE
ECONOMIC RESEARCH DIVISION

THE KING CRAB INDUSTRY OF ALASKA: 1953 - 1969:*

an economic analysis

by

SYBIL T. W. BEALE

with

assistance

of

JAMES A. CRUTCHFIELD

*This is a report received by the Economic Research Division as part of a contract No. 14-17-0007-1118 (BCF) with the University of Washington. This is only one technical section of the report and a more integrated "final" report is expected in the near future.

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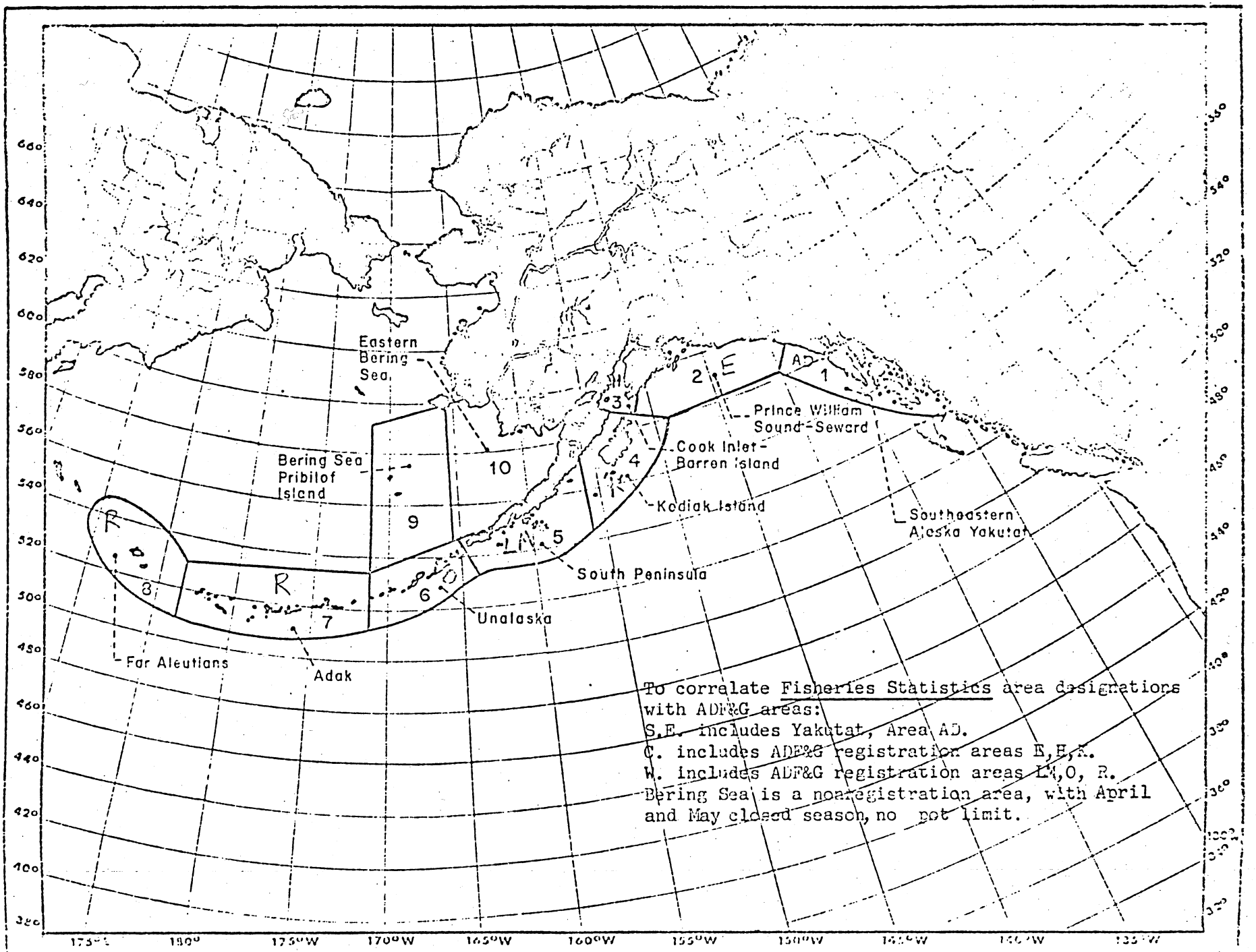

To correlate Fisheries Statistics area designations with ADF&G areas:
S.E. includes Yakutat, Area AD.
C. includes ADF&G registration areas E,H,K.
W. includes ADF&G registration areas L,M,O, R.
Bering Sea is a noaregistration area, with April and May closed season, no pot limit.

BIOLOGY OF THE KING CRAB*

Paralithodes camschatica (Tilesius), the king crab, is a large, slow-growing demersal species found only in the North Pacific Ocean, the Bering Sea, and in Asian waters. Its bathymetric range is wide (it has been found at depths of 1,000-1,200 feet, though most commercial fishing is at depths no greater than 900 feet); its lateral range is narrow (200 miles is the known maximum, with an average of about 25 miles). The species is exploited in several discrete geographic areas, with little apparent intermingling of crabs between areas (e.g., Cook Inlet, Kodiak Island, Bering Sea, the south side of the Alaska Peninsula, and possibly a separate stock about Adak).

The fertilized eggs of the king crab begin developing while still carried by the mother during the approximately eleven months from fertilization to hatching, at the time the adult female molts. Immature crabs live a solitary, pelagic life for about two months, gradually moving lower in the water column. At approximately two years of age they form groups, or pods, living in about thirty to sixty feet of water. The pods disperse at sexual maturity. After that point male and female crabs come together only during the molting-mating season. Adult males tend to segregate according to size; mature and immature crabs are rarely found together.

In late winter or early spring (later in the Bering Sea), adult male crabs move inshore from their feeding grounds, followed by the females, who

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*Grateful acknowledgment is made to Peter Eldridge of the College of Fisheries, whose seminar presentation and personal help have been invaluable in the preparation of this section and parts of the Conclusions.

molt on the breeding grounds prior to mating. After mating, which is only possible for a period of about thirteen days after the female molts, the crabs migrate back to offshore feeding grounds. They are bottom-feeders, preferring muddy to rocky conditions.

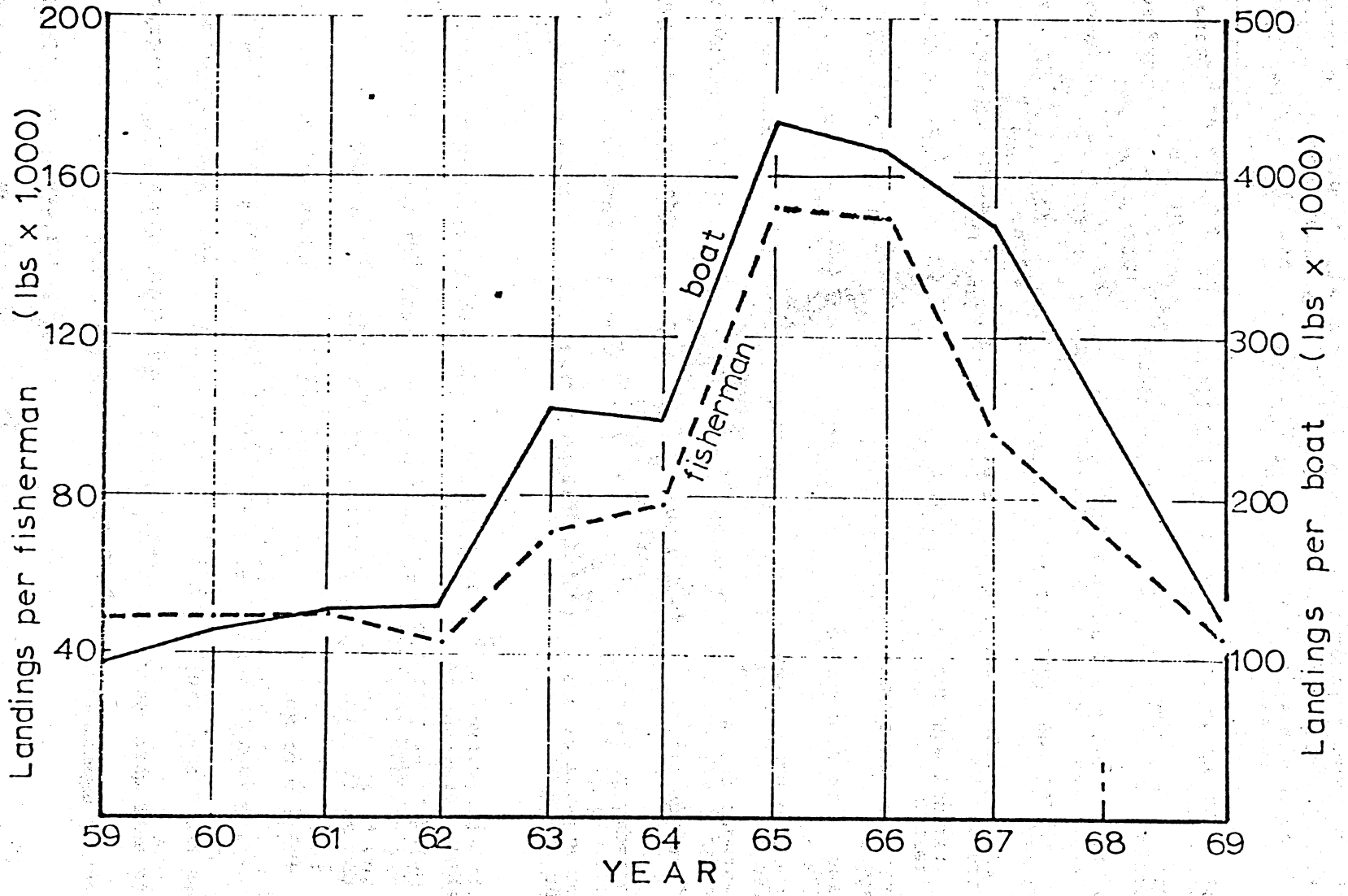
The king crab may live up to sixteen years. It reaches recruitment age, that age at which it is first available for catch by the commercial fishery, at six to eight years. This wide range of estimates illustrates one of the major problems in the study of a species which is of great commercial value and which may or may not have been seriously depleted as a result of fishing effort. It is not yet possible to age the king crab accurately. Mature females molt annually throughout their lives, but males may molt biennially or perhaps every three years after maturity. Estimates of recruitment, growth rates, and natural mortality rates are consequently even more difficult than usual to derive. Knowledge of the natural mortality rate is crucial to an accurate estimate of the weight loss to the biomass from fishing. The king crab appears to have a relatively low natural mortality rate in the middle years of its life. If this is true, it might suggest that a larger legal minimum size is more appropriate. Yield-per-recruit theory suggests that a larger minimum size limit would increase yield; i.e., that the weight increment generated by the delay in catch is less likely to be lost to the fishery due to natural mortality until a greater age/size than is now thought to be the case.

Whatever the theoretical questions, the evidence of declining catches is overwhelming; catches have been falling steadily since 1966, and catch per unit of effort (CPUE) has declined.[1] Average weight per crab has

---

[1] Guy Powell, Alaska Dept. of Fish and Game, Informational Leaflet No. 135; Brian J. Rothschild, et al., ADF&G Informational Leaflet No. 147; Eldridge seminar, March 1971. The sophisticated CPUE measure used by Professor Rothschild has been used only in the Kodiak area. In most cases a much cruder estimate must be used. CPUE has been variously defined in terms of catch per trip, per pot, or per fisherman.

Figure 1



Source: Table I-3(b), Basic Economic Indicators, King and Dungeness Crabs (Bureau of Commercial Fisheries, Division of Economic Research, May 1970), p. 5. 1968 figures are not available; 1969 figures derived from Table 1 herein, and effort data in Ch. 3.

fallen as well, and the catch now contains a far higher percentage of recruits than in earlier years.[2]

Just what real damage has been done to the king crab stocks is hard to determine. The fishery came upon a stock almost untouched, with several year-classes beyond recruit age available for catch. This weight may have been taken without damage to the stock; greater fishing effort, evidenced by smaller average weight per crab, might peel a stock back to a lower level without damaging its reproductive capacity in any way. It is not known whether or not the stock was in a state of biological equilibrium when heavy exploitation began, which makes assessment of possible damage difficult.

What is perhaps a more serious warning signal is the increasing numbers of barren females in some areas, a possible indication of impaired fecundity of the species. Estimates of the number of females which a male can normally service range from three to seven per season; the female-male ratio appears to be much higher than this in some areas. Some biologists have also suggested that smaller males may not be as successful in servicing the larger females, and that old-shelled males (who haven't molted on the way to the breeding grounds) may be more virile than the younger, smaller males debilitated by molting. This may be another reason for the suggestion of an increased minimum legal size--to enable the larger crabs to service the larger females. It has also been proposed that, since adult crabs generally move in single-sex groups, it would not harm the reproductive capacity of the species if barren females were taken by the commercial

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[2]Powell, ADF&G Informational Leaflet No. 135, p. 16. This may be due to changes in fishing effort as well, rather than solely to a change in the character of the stock. The necessity to use the commercial catch as a basis for research may lead to biased findings. See p. 512 for a discussion of some of the differing interpretations which have been made of the same data.

fishery.[3]

Factors which control recruitment are not yet fully understood. The record catch of 1966 has been attributed to an atypically large recruitment from several years earlier. Conversely, the low catches of 1968 and 1969 are said to reflect low recruitment in years prior to the heavier fishing effort of the mid-1960's, and thus may not reflect overfishing.[4]

It is possible that large year-classes of recruits occur in a cyclical pattern, or even randomly. If the pattern is cyclical, the question then is what effect "lopping off" the peak of such a cycle through heavy fishing might have on future recruitment cycles.

Careful analysis of the mix of biological and economic factors that surrounds a valuable commercial species is never easy. In the case of the king crab the analysis concerns a species in apparent disequilibrium and an industry in a similar state of disarray. To an overcapitalized industry faced with steadily declining catches, these problems are more than academic. Until they are much nearer resolution it is extremely difficult - and perhaps dangerously misleading - to assess the merits of alternative regulatory systems.

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[3]It is tempting to suggest that this unfortunate ratio is a severe externality imposed on the crabs by the fishery.

[4]Powell, ADF&G Information Leaflet No. 135, p. 17, and p. 51-12 below.

Economic Theory of the Fishery

The competitive model of textbook microeconomic theory predicts that (1) in equilibrium, factors of production employed in each sector will be used in their least-cost combinations for the given level of output, and that each will earn a rate of return in its given use equal to that which it could earn elsewhere in the economy; (2) in a disequilibrium situation, those factors earning less than the competitive return will shift to sectors where greater than competitive returns are being earned, until the marginal value products of factors in the (formerly) lower-return uses are equal to those in the (formerly) higher-return sector, and equilibrium levels of output and factor return are re-established in all sectors.

The implication of the model--that there exist self-correcting forces which will push toward competitive equilibrium, does not hold in the king crab industry, or indeed in fisheries in general. Two assumptions of the model, one explicit, one usually left implicit, are violated: factor mobility, and property rights in the resource. Factor mobility in a fishery has two facets. Labor is frequently highly immobile, in geographic-social terms, and unskilled in alternative employments. Capital in modern fisheries tends to become increasingly specialized, with few alternative uses other than in another fishery, which is likely to be similarly overcrowded.

Ease of entry combined with difficulty of exit from an industry is not unique to fisheries. In a fishery, however, the asymmetry between entry and exit is encouraged and perpetuated by the common-property characteristic of the resource. Here a scarce resource commands a rent which increases as the value of the resource rises in response to demand. In the absence of ownership rights, the rents cannot be made explicit as a cost of

production. Allocation of optimal amounts of capital and labor to the resource under such conditions is thus made more difficult.

Assume the existence of a fishery, recently developed, where returns to existing units are greater than the competitive level; these inframarginal units are capturing rent from the resource. An individual, viewing access to a common-property resource as costless, enters. The fishery expands, and will continue to expand, so long as individual entrants can cover their costs. Each entrant views only his own immediate costs and his opportunity, as he sees it, to capture as many fish as units already in the fishery. Entry imposes costs on the entire industry not seen by the individual unit, in the form of increasing costs per unit of catch with the greater pressure on the stock of fish.[1] Real production costs to the industry, and real returns to factors, are hidden from the individual entrant. The common-property character of the fishery results in an externality affecting all units (the marginal social cost of additions to the fleet). Inefficient amounts of capital and labor applied to produce the catch impose in turn a cost on the rest of society in the form of foregone alternative production.

Increased fishing pressure on a given stock will result in catching more, but smaller fish; increased production may result in lower prices. A private owner of the resource faced with either of these situations would have the option of foregoing production for a time, investing instead in increased future returns (in the form of the weight increment of fish not caught in the present period), and the expected increase in price as well in the case of low prices, equating the discounted value of expected future returns with those to be gained from present harvest.[2] This option is

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[1]There is also a potential crowding externality in geographically concentrated species as entry continues beyond the efficient level.

[2]It is assumed that level of effort can be varied within and between seasons at relatively small cost.

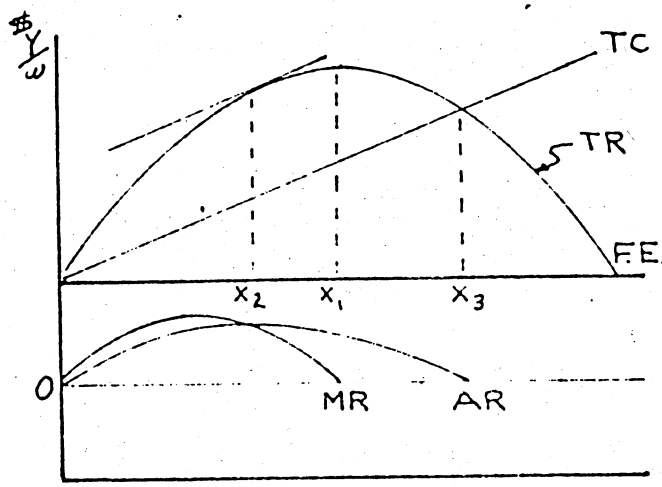
meaningless to units operating on a common-property resource. There is no incentive to invest in future growth or higher prices which the investor cannot capture. There is instead the prospect that when increments to growth do occur--as the result of a conservation program, for example--the increased returns will be dissipated by further entry.[3]

Satisfaction of the criterion of economic efficiency in a fishery is one part of a dual-equilibrium problem. The second part, the biological constraints, must be satisfied as well.[4]

---

[3]The possibility of biological extinction is not treated here; economic extinction is the more likely to occur. Heavy pressure on a species may cut back the basic stock, resulting in lower average weight per fish, after some point in lower numbers of fish--in extreme cases, in damage to the reproductive capacity of the species. However, increasing costs could drive the industry to a point where no price will allow units to cover costs, and the industry is economically extinct while the species survives. The futility of conservation efforts by individual units is analytically the same as the investment case--the rewards aren't capturable by one unit unless all participate.

[4]There is a disparity between economic and biological "ideal" conditions, and between both of these and the likely situation in the real world, which is illustrated below. Assume a yield function of the following form, converted to a total revenue curve by the assumption of perfectly elastic demand at a given price. (This is an idealized curve--the yield curve of the king crab cannot yet be drawn accurately; nor does the assumption of perfectly elastic demand exactly square with my stated assumptions about the demand curve for king crab in particular. It does serve to demonstrate the reasons for overutilization which characterize a common-property resource. The validity of the general conclusions is not impaired .) The ordinate is similarly converted to a dollar basis by multiplying yield by price per pound. A linear total cost function is assumed.



X1, maximum sustainable physical yield (the biological ideal); X2, ideal of the competitive model, where marginal cost per unit of effort and marginal returns per unit of effort are equal; X3, the eventual real-world position, given free entry. At X2, MC = MR, short of X1; beyond X2, MR approaches zero, reaching it at maximum sustained physical yield, while MC is still positive, i.e., at X1. At X3, total

The individual unit in a fishery has no control over the resource, yet it enters as a parameter in his decisionmaking. Utilization of a particular stock of fish is a complex form of stock-flow process, made more so since knowledge of the stock and its reaction to pressure is difficult to obtain and normally inexact. In addition, the stock is subject to biological forces unrelated to the effects of fishing effort.

This analysis applies to the economics of fisheries in general. The American king crab industry is almost a textbook case of the path taken by most of the world's fisheries. Only the speed at which it passed through the stages of development, overexpansion and near collapse is unusual--fewer than twenty years were needed to bring the industry to its present state.

King crab is one of a group of luxury seafoods for which the demand is assumed to be price inelastic--a good consumed by persons whose income level leaves them relatively indifferent to changes in price. The sharp price declines which would have resulted had the increased supply faced a given demand curve were partially offset as demand shifted upward with successful introduction of the product during a period of generally rising incomes; for a time both units in the fishery and their catch increased sharply. When the record catches proved nonsustainable, the industry was left with a greater degree of excess capacity than would have been the case had demand not increased so dramatically, sustaining prices fairly well, given the major increases in supply.

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revenue equals total cost; marginal revenue is negative at this point, and decreased fishing effort would actually increase both physical and economic yield.

Rents are viewed as the difference between total cost and total revenue curves. At X1, rents do accrue to the inframarginal units, though less than at X2, where optimal allocation of factors results in maximum rent to the resource. As more units enter and costs are driven upward, rents erode until they are dissipated entirely at X3, a point of declining physical yield and the onset of negative total revenue. With restricted entry, and real costs made explicit to the remaining units, the regulatory agency could capture the rents through differential license fees, a tax per unit of catch, or--in the case of an auction of fishing rights--in the price bid therefor.

The Industry

The king crab industry had its beginnings as an off-season, inshore fishery conducted in small seniers or salmon-fishing vessels using tangle nets and otter trawls. Before World War II, production was minimal. The modern industry dates from the early postwar period, when a fleet of trawlers and a floating freezer-processor fished successfully in the Bering Sea. Freezing continues to be the dominant method of processing.

Production expanded in the Kodiak Island and Cook Inlet areas as large stocks were discovered and exploited. The catch increased fairly slowly at first, due more to market limitations and technical problems of processing than to lack of crabs. By the late 1950's and early 1960's, the number of entrants into both fishing and processing had expanded rapidly. In 1960, 28,570,016 pounds of crab were caught by 201 vessels and boats and converted by nine[1] processors into 5,034,435 pounds of processed crab. Total wholesale value reached $5,294,866, with an average price of $1.05 per pound. In the peak production year of 1966, 159,201,700 pounds of raw crab, captured by 247 vessels and 135 boats, were converted by twenty-eight processors into 46,168,009 pounds of product valued at $44,367,875, with an average price of $96 per pound.

The catch has dropped every year since 1966, but numbers of vessels and their average size have continued to increase, and there has been little exit of processors.[2] Wholesale prices climbed through 1968, then broke

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[1] This is the figure from Pacific Fisherman Yearbook 1961, which rarely agrees with lists compiled by ADF&G. It probably understates the number of processors.

[2] "Exit" frequently means a switch to processing some other product, not complete cessation of production. A processor may be inactive in king crab processing in one year and return the next. Many of the smaller processors are specialty, custom-processing firms. In either case, there is presently a degree of under-utilized or unutilized capacity that changes from season to season, and which would be difficult to measure solely in terms of king crab processing capacity.

Table 1

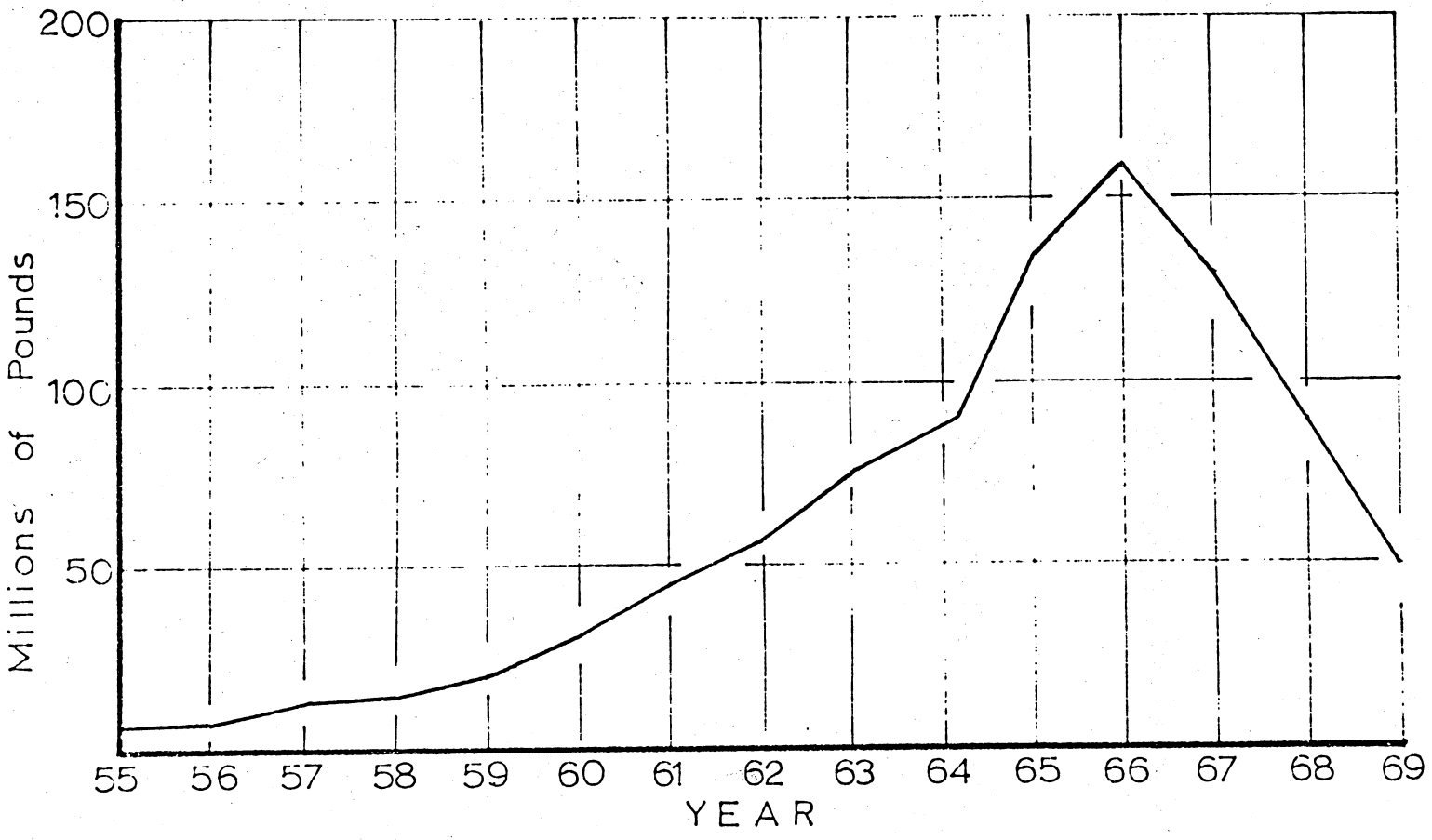
King Crab Landings and Ex-Vessel Value by Area, 1953-1969

Year	Southeast		Central		Western		Total	
	Pounds	Total Value ($)	Pounds	Total Value ($)	Pounds	Total Value ($)	Pounds	Total Value ($)
1953	-----	-----	2,614,277	287,570	1,998,932	291,861	4,613,209	547,431
1954	-----	-----	6,356,827	603,898	2,514,243	276,567	8,871,070	880,465
1955	-----	-----	5,951,120	565,356	2,211,800	243,298	8,162,920	808,654
1956	-----	-----	6,899,795	655,480	1,896,227	208,585	8,796,022	864,065
1957	-----	-----	12,488,131	999,050	588,434	47,075	13,076,565	1,046,125
1958	-----	-----	11,211,554	896,924	-----	-----	11,211,554	896,924
1959	-----	-----	18,839,470	1,477,980	-----	-----	18,839,470	1,477,980
1960	3,424	810	27,878,630	2,230,290	687,962	55,036	28,570,016	2,286,136
1961	429,600	42,960	38,854,800	3,499,290	4,127,200	371,450	43,411,600	3,913,700
1962	1,289,600	128,950	44,653,000	4,465,300	6,839,600	683,960	52,782,200	5,278,210
1963	1,112,200	111,220	50,786,600	5,080,410	26,841,500	2,415,730	78,740,300	7,607,360
1964	820,500	82,050	51,638,600	5,020,600	34,261,600	3,083,540	86,720,700	8,186,190
1965	579,300	57,930	94,505,800	9,375,180	36,585,600	3,296,250	131,670,700	12,729,360
1966	105,900	11,649	117,305,100	11,730,509	41,790,700	3,928,327	159,201,700	15,670,485
1967	599,100	83,871	83,010,700	9,593,163	44,106,100	5,292,734	127,715,900	14,969,768
1968	2,199,772	791,918	37,559,518	10,516,665	42,278,206	10,569,552	82,037,496	21,878,135
1969*	1,675,125	502,538	25,685,246	7,705,574	28,477,121	8,543,136	55,837,492	16,751,248

Source: 1953-1967, Fishery Statistics of the U.S.; 1968, Alaska Department of Fish and Game, Leaflet No. 17; 1969, tentative, communication from Juneau, Alaska office of National Marine Fisheries Service.

Values given are in current dollars.

ALASKA KING CRAB LANDINGS, 1955-1969



Source: Based on Rothschild, et al., ADF&G Informational Leaflet No. 147, p. 4.

Figure 2

Table 2

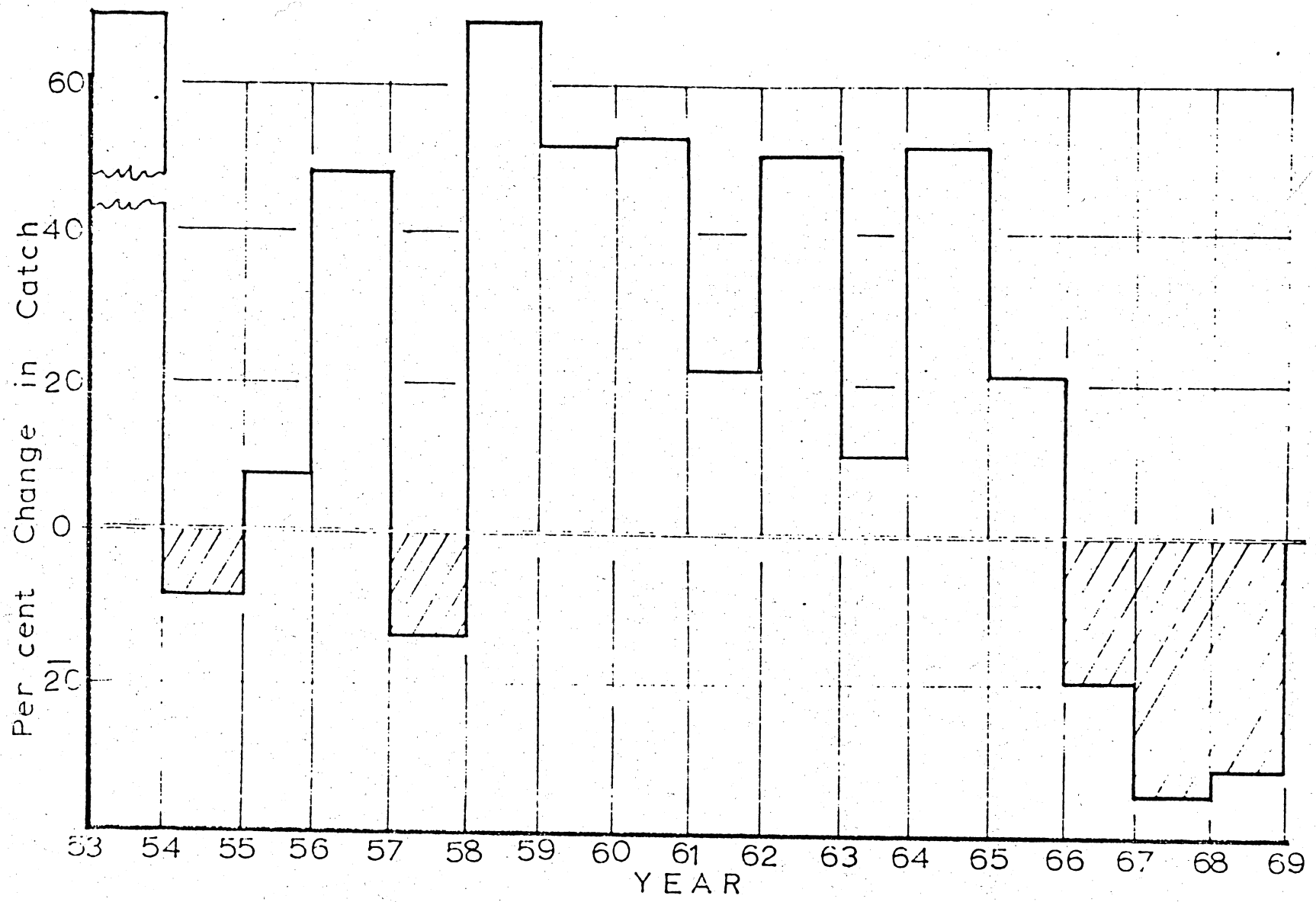
Percentage Changes in King Crab Landings by Area,

1953 - 1969

From	S.E.	C.	W.	Total
53-54	----	132.5	25.7	92.2
54-55	----	-6.3	-12.0	-7.9
55-56	----	15.9	-14.2	7.7
56-57	----	80.9	-68.9	48.6
57-58	----	-10.2	----	-14.2
58-59	----	68.0	----	68.0
59-60	----	47.9	----	51.6
60-61	12446.7	39.3	499.9	51.9
61-62	200.1	14.9	65.7	21.5
62-63	-13.7	13.7	292.4	49.2
63-64	-26.2	1.6	27.6	10.1
64-65	-29.3	83.0	6.0	51.8
65-66	-31.7	24.1	1.4	20.9
66-67	465.7	-29.2	5.5	-19.7
67-68	26.7	-54.7	-4.1	-35.7
68-69	-23.8	-31.6	-32.6	-31.9

Source: Table 1, and sources cited therein.

Figure 3



Source: Table 2.

in early 1969 and fell, though more slowly, through the rest of 1969 and into 1970.[3] Ex-vessel prices have risen steadily since 1966, with wide intraseasonal shifts. The fleet of 247 vessels and 135 boats which caught nearly 160 million pounds of crab in 1966 had increased to 381 vessels and boats in 1970-71, restricted to a preliminary quota of 47.5 million pounds in a much shorter season. (The quota was raised during the season in two areas; the estimated catch is about 50 million pounds, down about 10 percent from the preceding year.)

The balance of this chapter is divided into three parts: the processing sector; the fleet and its changing character; and fishery regulations as they relate both to economic performance of the industry and behavior of the resource on which it rests.

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[3] It has been suggested by Professor Crutchfield that the price break in 1969 was perhaps a "hump" in the demand curve, some price above which demand turns more elastic. A smiliar notion was expressed by one industry representative, who feared the increased prices were just enough to curtail a budding European export market. Evidence for the price break is based on partial data from Chicago and New York for 1969 and 1970, and complete Seattle price data for the two years.

Table 3

Output of Processed King Crab (Frozen)

Year	Area	Meat		Sections		Whole, in Shell	
		Pounds	Value	Pounds	Value	Pounds	Value
1953	S.E.	----	----	----	----	----	----
	C.	49,438	49,438	96,000	49,000	283,435	198,950
	W.	499,733	499,733	----	----	----	----
	Total	549,171	549,171	96,000	49,000	283,435	198,950
1954	S.E.	----	----	----	----	----	----
	C.	556,337	556,945	74,000	41,950	439,805	270,702
	W.	381,479	376,879	----	----	----	----
	Total	937,816	933,824	74,000	41,950	439,805	270,702
1955	S.E.	----	----	----	----	----	----
	C.	572,692	575,986	71,096	31,495	414,410	202,591
	W.	272,888	272,888	42,072	21,036	27,210	13,605
	Total	845,580	848,874	113,168	52,531	441,620	216,196
1956	S.E.	----	----	----	----	----	----
	C.	213,277	193,428	94,747	34,835	267,735	103,168
	W.	285,360	285,412	30,133	9,040	----	----
	Total	498,637	478,840	124,880	43,875	267,735	103,168
1957	S.E.	----	----	----	----	----	----
	C.	1,203,242	1,320,698	300,680	150,340	1,382,200	829,320
	W.	----	----	----	----	----	----
	Total	1,203,242	1,320,698	300,680	150,340	1,382,200	829,320
1958	S.E.	----	----	----	----	----	----
	C.	1,458,823	1,228,795	93,049	41,370	820,899	328,360
	W.	----	----	----	----	----	----
	Total	1,458,823	1,228,795	93,049	41,370	820,899	328,360

Table 3 (continued)

Year	Area	Meat		Sections		Whole, in Shell	
		Pounds	Value	Pounds	Value	Pounds	Value
1959	S.E.	----	----	----	----	----	----
	C.	1,662,597	1,457,039	338,274	145,904	835,222	374,159
	W.	----	----	----	----	----	----
	Total	1,662,597	1,457,039	338,274	145,904	835,222	374,159
1960	S.E.	----	----	----	----	----	----
	C.	1,466,747	1,501,146	585,999	268,545	861,991	430,875
	W.	126,000	126,000	----	----	12,000	6,000
	Total	1,592,747	1,627,146	585,999	268,545	873,991	436,875
1961	S.E.	65,000	71,260	26,500	14,570	3,100	1,180
	C.	4,038,800	3,946,940	646,400	322,740	25,000	13,700
	W.	465,300	465,340	----	----	186,000	102,310
	Total	4,569,100	4,483,540	672,900	337,310	214,100	117,190
1962	S.E.	256,000	342,300	18,100	8,030	7,600	3,820
	C.	4,771,100	5,235,210	1,766,800	946,320	1,700	1,030
	W.	----	----	----	----	----	----
	Total	5,027,100	5,577,510	1,784,900	954,350	9,300	4,350
1963	S.E.	234,400	301,700	----	----	4,200	2,180
	C.	4,215,900	4,409,540	660,600	348,380	3,525,000	1,857,000
	W.	2,566,800	2,754,180	----	----	----	----
	Total	7,017,100	7,465,420	660,600	348,380	3,529,200	1,859,180
1964	S.E.	185,900	216,560	37,000	18,320	87,100	47,300
	C.	4,725,200	4,578,690	5,848,100	3,057,340	401,400	169,500
	W.	6,786,300	7,072,360	9,700	----	----	4,530
	Total	11,697,400	11,867,610	5,894,800	3,080,490	488,500	216,800

Table 3 (continued)

Year	Area	Meat		Sections		Whole, in Shell	
		Pounds	Value	Pounds	Value	Pounds	Value
1965	S.E.	112,540	109,347	12,173	5,067	71,006	34,120
	C.	11,845,756	11,189,113	7,622,279	4,079,396	4,775,567	2,398,925
	W.	3,010,670	2,807,773	----	----	----	----
	Total	14,968,966	14,106,233	7,634,457	4,084,463	4,846,573	2,433,045
1966	S.E.	32,360	33,978	----	----	31,225	15,612
	C.	10,325,637	11,023,118	5,649,337	2,752,097	4,693,564	1,544,316
	W.	14,855,782	14,943,179	123,768	92,830	1,160,941	580,020
	Total	25,213,779	26,000,275	5,593,105	2,844,927	5,884,830	2,139,948
1967	S.E.	276,513	414,722	48,748	30,246	----	----
	C.	7,461,448	8,944,336	2,272,772	1,233,493	2,643,926	1,395,122
	W.	9,200,362	11,599,031	117,597	47,038	66,221	45,753
	Total	16,938,323	20,958,089	2,439,117	1,310,777	2,710,147	1,440,875
1968*	S.E.	258,851	592,026	99,700	265,230	652,207	1,464,330
	C.	4,534,082	11,027,598	3,387,729	3,837,484	2,062,370	3,156,263
	W.	3,190,830	9,951,037	157,020	60,508	3,164,864	7,016,236
	Total	7,983,493	21,570,661	3,644,449	4,163,222	5,879,441	11,636,834

Table 3 (continued)

Year	Area	Canned			Cold-Packed		Fresh: Meat		Sections		Whole	
		Pounds*	Cases	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1953	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	----	----	----	----	----	----	----	----	----	129,465	73,524
	W.	----	----	----	80,081**	81,684	----	----	----	----	----	----
	Total	n.a.	n.a.	n.a.								
1954	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	----	28,667	874,753	----	----	----	----	----	----	49,419	26,436
	W.	----	6,350	140,000	2,292	2,429	----	----	----	----		
	Total	----	35,017	1,014,753								
1955	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	272,454	----	376,825	----	----	9,935	6,592	108,996	43,921	137,445	51,351
	W.	78,279	----	106,495	47,628	52,558	----	----	----	----	----	----
	Total	350,733	----	483,320								
1956	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	599,547	----	791,337	----	----	----	----	----	----	37,535	12,338
	W.	100,269	----	137,192	----	----	----	----	----	----	----	----
	Total	699,816	----	928,529								
1957	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	792,383	----	1,060,232	28,180	31,732	20	50	----	----	8,300	2,798
	W.	88,939	----	109,251	----	----	----	----	----	----	----	----
	Total	881,322	----	1,169,483								
1958	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	878,319	45,042	1,079,019	28,509	32,164	----	----	----	----	257	105
	W.	----	----	----	----	----	----	----	----	----	----	----
	Total	878,319	45,042	1,079,019								
1959	S.E.	----	----	----	----	----	----	----	----	----	----	----
	C.	1,078,662	55,316	1,437,890	346,626	415,412	688	725	9,000	3,029	45,694	15,854
	W.	----	----	----	----	----	----	----	----	----	----	----
	Total	1,078,662	55,316	1,437,890								

Table 3 (continued)

		Canned			Cold-Packed		Fresh:**Meat		Sections		Whole	
Year	Area	Pounds*	Cases	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1960	S.E.	----	----	----	----	----	----	----	----	----	3,424	1,333
	C.	1,952,048	100,015	2,950,105	----	----	----	----	----	----	26,226	10,312
	W.	----	----	----	----	----	----	----	----	----	----	----
	Total	1,952,048	100,015	2,950,105	----	----	----	----	----	----	29,650	12,195
1961	S.E.	41,000	2,104	70,210	2,400	3,540	----	----	----	----	----	----
	C.	2,934,200	150,469	4,500,100	66,300	72,900	----	----	----	----	46,200	36,040
	W.	2,800	146	4,670	----	----	----	----	----	----	----	----
	Total	2,978,000	152,719	4,574,980	68,700	76,440	----	----	----	----		
1962	S.E.	13,700	703	29,790	***		5,500	7,590	13,300	7,780	600	380
	C.	3,635,000	186,409	5,177,160			45,100	84,600	21,100	8,220	21,700	9,570
	W.	----	----	----			----	----	----	----	----	----
	Total	3,648,700	187,112	5,206,950			50,600	92,190	34,400	16,000	22,300	9,950
1963	S.E.	239,200	15,950	285,370			----	----	----	----	100	30
	C.	690,000	45,999	762,200			930	700	200,000	80,000	2,200	830
	W.	----	----	----			----	----	----	----	----	----
	Total	929,200	61,949	1,047,570							2,300	860
1964	S.E.	1,500	77	2,950			----	----	----	----	----	----
	C.	4,599,900	235,893	5,938,300			100	70	312,200	156,090	200	30
	W.	----	----	----			----	----	----	----	----	----
	Total	4,601,400	235,970	5,941,250								

Table 3 (continued)

		Canned			Cold-Packed		Fresh:** Meat		Sections		Whole	
Year	Area	Pounds*	Cases	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1965	S.E.	----	----	----			----	----	----	----	----	----
	C.	5,808,777	297,886	9,851,839			190,348	193,734	780	390	1,099	526
	W.	569,809	29,221	994,752			----	----	----	----	----	----
	Total	6,378,586	327,107	10,846,591								
1966	S.E.	----	----	----			----	----	----	----	3,752	1,500
	C.	7,774,241	393,679	11,909,977			----	----	----	----	676,128	
	W.	922,174	47,291	1,130,440			----	----	----	----	(C.)290,803	
	Total	8,696,415	445,970	13,990,417							679,880	
											292,308	
1967	S.E.	----	----	----			****					
	C.	7,155,915	366,970	12,037,534								
	W.	644,728	33,603	1,200,762								
	Total	7,800,643	400,033	13,238,296								
1968	S.E.	----	----	----								
(est.)	C.	1,648,608	85,544	4,727,225								
	W.	188,194	9,651	422,744								
	Total	1,836,802	95,195	5,149,969								

Source: Fishery Statistics of the United States, through 1967; 1968 estimates, ADF&G Statistical Leaflet No. 17.

* Pound equivalents of standard case of 48 1/2 lb. cans, each containing 6 1/2 oz. meat.

** In most years the Central area total was also the state total, so no total figure is given in those years.

***No further production after 1961.

**** After 1966 this production was included in frozen-output statistics.

Summary, Table 3

All-Process Output and Value,
1953-1968

Year	Pounds	*Total Value
1953	1,138,152**	952,009
1954	1,503,332**	2,290,094
1955	2,055,105	1,755,343
1956	1,628,603	1,566,750
1957	3,803,944	3,504,321
1958	3,279,856	2,709,813
1959	3,999,546	3,466,764
1960	5,034,435	5,294,866
1961	8,639,000	9,625,500
1962	10,577,300	11,861,800
1963	12,339,100	10,802,340
1964	22,997,300	21,262,340
1965	34,020,803	31,470,332
1966	46,168,009	44,367,875
1967	29,888,230	36,948,037
1968	19,344,185	42,520,686

Source: Derived from Table 3.
* Figures are in current dollars.
** No figure for pounds or value for canned crab in 1953, none for pounds of canned crab in 1954.

Summary, Table 3

Percentages of Output and Value for
All Types of Processed King Crab
1953 - 1968

	Frozen (all types)		Canned		Cold-Pack		Fresh (all types)	
Year	% Output	% Value	% Output	% Value	% Output	% Value	% Output	% Value
1953	41.5	53.7	n.a.	n.a.	7.0	3.5	11.3	7.6
1954	n.a.	54.4	n.a.	44.3	n.a.	0.1	n.a.	1.1
1955	68.1	63.6	17.0	27.5	2.3	2.9	12.4	5.8
1956	54.7	39.9	42.9	59.2	----	----	2.3	0.7
1957	75.8	65.6	23.1	33.3	0.7	0.9	0.2	0.2
1958	72.3	58.9	26.7	39.8	0.8	1.1	0.2	0.2
1959	70.9	57.0	26.9	41.4	0.7	0.9	1.4	0.5
1960	60.6	44.0	38.7	55.7	----	----	0.5	0.2
1961	64.1	51.3	34.4	47.5	0.7	0.7	0.5	0.3
1962	64.4	43.8	34.4	43.8	----	----	1.0	0.9
1963	90.8	89.5	7.5	9.6	----	----	1.6	0.7
1964	78.6	71.3	20.0	27.9	----	----	1.3	0.7
1965	80.6	65.5	18.7	34.4	----	----	0.5	0.6
1966	79.4	69.8	18.8	29.5	----	----	1.4	0.6
1967	73.9	64.1	26.0	35.8	----	----	----	----
1968	90.5	87.8	9.4	12.1	----	----	----	----

Source: Derived from Table 3.
Totals do not always sum, because of rounding.

Table 4

Wholesale Prices, Real Prices and Percentage Changes, 1953-1968

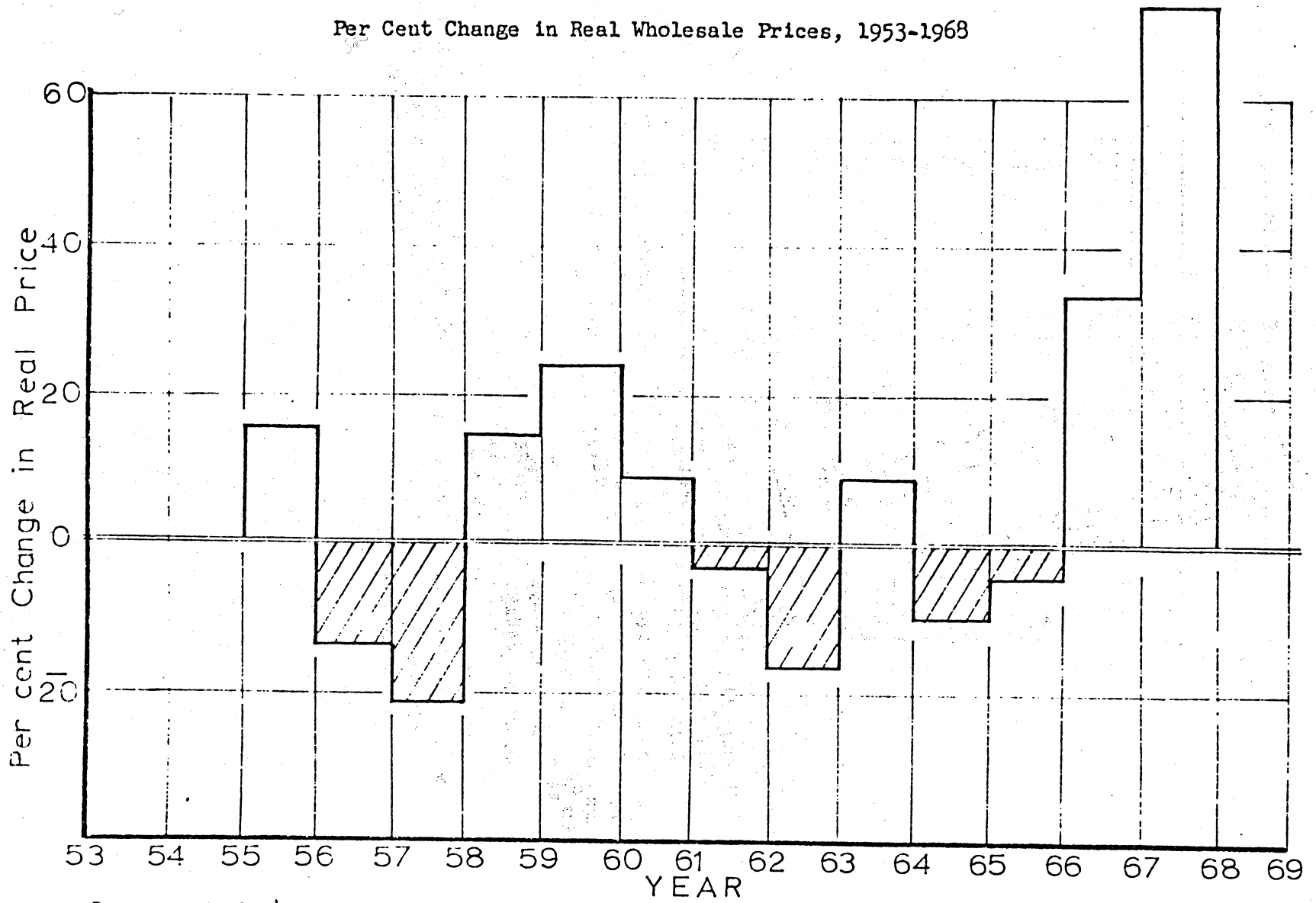
Year	Wholesale Price (in ¢ per lb.)	Real Price (Pkc/WPImpf)	% Change, Real Price	
1953	n.a.	n.a.	1953-54:	n.a.
1954	n.a.	n.a.	1954-55:	n.a.
1955	85.4	99.6	1955-56:	15.9
1956	96.2	115.4	1956-57:	-14.1
1957	92.1	99.1	1957-58:	-22.7
1958	82.6	76.6	1958-59:	14.0
1959	86.6	87.3	1959-60:	23.1
1960	105.1	107.5	1960-61:	8.7
1961	111.4	116.8	1961-62:	-3.2
1962	112.1	113.1	1962-63:	-17.1
1963	87.5	93.8	1963-64:	8.5
1964	92.4	101.8	1964-65:	-10.0
1965	92.5	91.6	1965-66:	-4.8
1966	107.3	87.2	1966-67:	33.8
1967	123.6	117.7	1967-68:	72.4
1968	219.8	202.9		

Source: Derived from Table 3 . Real prices were derived by dividing current wholesale price by the Wholesale Price Index for meats, poultry and fish for the appropriate year, on the base 1957-1959=100.

Percentages changes in real price are positive except where otherwise indicated.

Figure 4

Per Cent Change in Real Wholesale Prices, 1953-1968



Source: Table 4.

Table 5

Ex-Vessel Prices, Area and All-Area Averages, 1953 - 1969

(in cents per pound)

Year	S.E.	C.	W.	Average
1953	----	11.0	14.6	11.3
1954	----	9.4	11.0	9.9
1955	----	9.4	11.0	9.9
1956	----	9.4	11.0	9.9
1957	----	7.9	8.0	7.9
1958	----	7.9	----	7.9
1959	----	7.8	----	7.8
1960	20.7	7.9	7.9	8.0**
1961	10.0	9.0	9.0	9.0
1962	9.9	10.0	10.0	9.9
1963	9.9	10.0	8.9	9.6
1964	10.0	9.7	8.9	9.4
1965	10.0	9.9	9.0	9.7
1966	11.0	9.9	9.4	9.8
1967	13.9	11.5	12.0	11.7
1968	36.0	28.1	25.0	26.6
1969*	30.0	30.0	29.9	30.0

These are annual average prices and, particularly for the later years when there were wide intraseasonal price shifts, do not reflect area differences that may have existed as a result of negotiations prior to the beginning of the season.

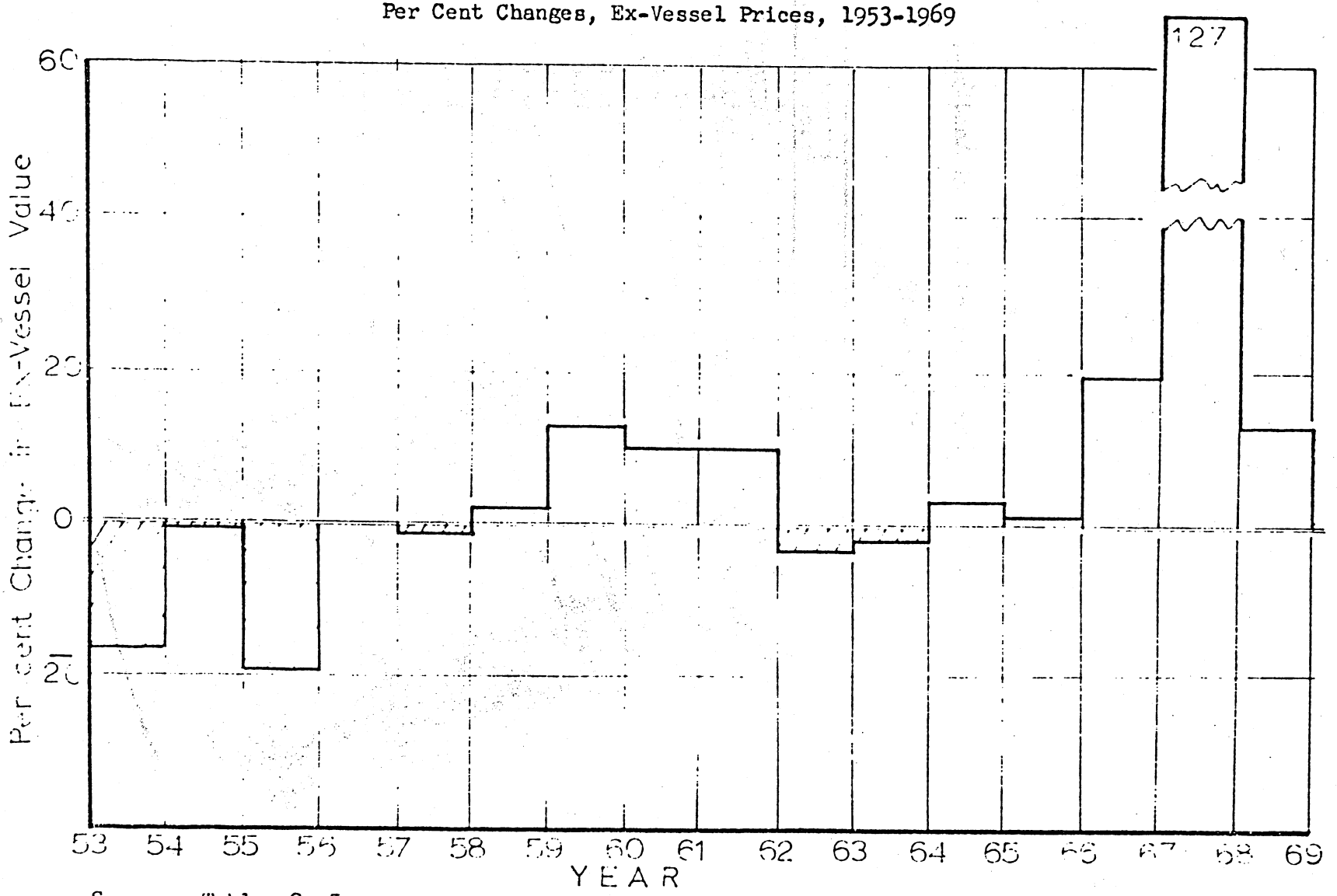
Source: Derived from Table 1.

* Preliminary.

** The wide variation between the S.E. area and average (for all areas) price is due to the fact that in the weighted average the pounds sold at that price were quite insignificant.

Figure 5

Per Cent Changes, Ex-Vessel Prices, 1953-1969



Source: Tables 2, 5.

Table 5a

Percentage Changes in Ex-Vessel Value of Landings,

1953 - 1969

From	% Change, Total Value	% Change, Price per lb.
53-54	00.3	-16.9
54-55	-8.1	-1.0
55-56	6.3	-19.3
56-57	21.0	0.0
57-58	-14.2	-1.2
58-59	64.7	2.5
59-60	54.6	12.5
60-61	71.1	10.0
61-62	34.8	10.0
62-63	44.1	-3.0
63-64	7.6	-2.0
64-65	55.4	3.1
65-66	23.1	1.0
66-67	-4.4	19.3
67-68	46.1	127.3
68-69	-23.4	12.7

The Processing Sector

King crab, both frozen and canned, is sold nationwide, and the demand is apparently devoid of seasonal characteristics. There are strong regional aspects to the demand, however. As of late 1964, about 57 percent of the product was sold on the eastern seaboard. Another 19 percent was sold in the Chicago-Great Lakes area. Of the balance, about 20 percent was sold in the rest of the United States, and 4 percent exported.[4] Slightly over half of the frozen product was sold to instutitions (hotels, restaurants, and airlines) while a much larger proportion (about 90 percent) of canned production was sold for home consumption.

Although developments in the late 1950's and early 1960's led to a considerable increase in technical efficiency of the industry, and a higher minimum level of necessary capital equipment, it remains a relatively labor-intensive process.[5] The initial phases of canning and freezing are the same, both for king crab processing and processing of other shellfish as well.

On the selling side of the market, the present king crab industry is best described as a weak oligopoly. Output in both canned and frozen processing is dominated by a few large firms. Entry, either by new firms or sideways entry by firms already established in production of other seafoods, has been relatively easy, however. If number of firms is a valid criterion, there are no significant barriers to entry.

The firms which were first dominant in both types of processing have

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[4]M. Graham Miller, The Development of the King Crab Industry in Alaska up to 1965, unpublished M.S. thesis, University of Alaska, 1969, p. 115.

[5]Whether or not further labor-saving capital equipment is technically feasible is unknown. Given relative costs of labor and capital, however, the rationality of further capitalization at this time is doubtful.

Table 6

Industry Shares, Canned and Frozen King Crab, 1953-1969

	Canned			Frozen		
Year	No. Processors*	% Output, 1st Three Firms	No. Firms With < 5% of Output	No. Processors*	% Output, 1st Three Firms	No. Firms With < 5% of Output
1953	2	--	--	3	100	1
1954	4	97.4	1	6	93.8	3
1955)						
1956)						
1957)	No data available; king and dungeness production not listed					
1958)	separately for these years.					
1959)						
1960	4	85.9	0	5	92.5	1
1961	9	76.3	5	7	86.7	3
1962	11	64.4	3	n.a.	n.a.	n.a.
1963	11	75.8	5	n.a.	n.a.	n.a.
1964	11	60.1	5	10	84.5	7
1965	12	55.0	4	16	68.4	9
1966	11	55.8	4**	20	51.7	16
1967	10	43.0	2	15	70.6	10
1968	10	56.9	4	25	56.9	21
1969	12	48.3	4	21	57.2	16

Source: Pacific Fisherman Yearbooks (called National Fisherman in 1967, 1968 and Pacific Packers Report, 1970 for 1969 data). Figures for both output and numbers of processors cited there are consistently lower than output shown in Fishery Statistics of the U.S., but they are the only available source of data on production by processor.

ADF&G Statistical leaflets list processors by plant; I have counted the multi-plant firms as one, and their totals still exceed those listed above.

* There is some duplication. There seems a slight tendency for dominant cannery processors to have a higher per cent of frozen output than dominant freezing processors have of canned output.

** "Misc." is credited with 0.2 per cent of the pack in this year.

In a comparison among Yearbook figures, Fishery Statistics figures, and the ADF&G list of processors, the discrepancies in frozen production, for example, are as follows:

	No. Processors		Output		Discrepancy	
	Yearbook	ADF&G	Yearbook	Fish. Stats.	Output (lbs.)	Processors
1964	10	22	11,757,[illegible]27	1[illegible],[illegible]0,700	[illegible]	12
1966	20	28	29,521,672	36,691,714	7,170,042	8
1967	15	28	17,963,333	22,087,587	4,124,254	13
1968	25	35	15,858,281	17,507,383	1,649,102	10
1969	21	28	10,679,236	n.a.	n.a.	7

It is impossible to allot shares of this unaccounted-for production. If this could be done, it is doubtful if relative industry positions, of the major producers at any rate, would be much affected.

declined in importance relative to total industry output. As Table 6 indicates, both the direction and rate of change of the percent of output controlled by the first three firms have shifted markedly over short periods of time in the past few years.

Control of a relatively large share of industry output by a few firms does not imply a high degree of market power on the selling side in the king crab industry. Entry is not difficult, and potential output over time is subject to wide variations outside any processor's control. The leading firms have established some degree of product differentiation through heavy promotional campaigns. When prices fell in 1962, with increasing production and the beginning of heavy price competition by smaller firms seeking an expanded share of the market, the better-known firms suffered relatively less from the price drop than did the smaller firms.[6]

Processors' cost functions vary widely, depending on size of plant, location, and other factors. Firm size varies from small, one-plant operations with minimal capital equipment to multi-plant firms, some of which operate almost as "company" towns, and whose costs include nonproductive services.[7] Processors operating in the Aleutians face generally higher costs than do firms operating in less remote areas.

There are no data available on employment in the processing sector; the statistics list only employment in "shellfish processing"; it seems likely, however, that the labor supply curve to the processing sector is quite elastic.

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[6] Miller, "The Alaska King Crab Industry...", p. 14. Much of the smaller firms' output is sold to wholesalers, and may bear any of a number of retailers' labels. The larger firms may consign output to a wholesaler, but more often sell through their own sales forces.

[7] One industry representative stated that some processors provide some school and medical facilities with their plants in remote areas.

The spectre of idle plant, with fixed costs continuing, has led firms which originally canned or froze only one or two species in a given season to begin processing others as well. The number of processors handling only king crab reflects the changing fortunes of the industry. In 1964, fourteen of twenty-two firms were in that category, and in 1966, twenty-two of twenty-eight confined their activities to king crab. By 1969, only seven of twenty-eight firms processed only king crab.[8] Processing of tanner (snow) crab, scallops, shrimp, dungeness crab, and clams accounts for the change.

On the buying side, the industry can be described as an oligopsony which has been weakened somewhat in the years ince 1966. In the years of ample catch, ex-vessel prices were decided at meetings of the United Fishermen's Marketing Association in Kodiak with a major buyer (one or another of the top three processors). A price for the season, or occasionally for two seasons, was negotiated, and was then accepted by processors throughout the state.[9]

Roughly 90 per cent of the king crab boats have some form of association with a particular processor. These associations range from formal contracts--which seem to be fairly rare--to informal "gentlemen's agreements." The processor agrees to take a boat's catch, the boat to deliver to that processor, at the going price. There is sometimes an additional bonus, calculated on the basis of tonnage and yield. In the earlier years of the fishery, some processors were whole or part-owners of vessels, but

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[8] ADF&G Technical Bulletins, Nos. 12, 14, 16, 18.

[9] The marketing association is a cooperative of boat owners and fishermen, both of whom have voting rights in the negotiations. Apparently it functions in many respects as if it were a union.

this practice has declined. Processors may also advance working capital, or assist with financing purchase of a vessel. Boats affiliated with a particular processor tend naturally to register in an area adjacent to that processor's plant (or in the case of floating processors, the area that plant will be working). This is, generally, the area of residence of the boat skipper and crew (with the obvious exception of the Seattle-based boats and boats operating in the Aleutians and Bering Sea). Loyalty is thus a matter of mutual convenience. Further, since area registration was instituted in 1960, a boat must fish in the area of registration throughout a given season. Differences in the stringency of quality requirements of different processors also tend to tie particular boats to particular buyers.

Two factors contributed to the breakdown of the statewide negotiating system. First, the fishery expanded westward to higher-cost fishing areas fished largely by boats from Seattle, whose connection with the Kodiak area is limited. Second, marketing associations in other areas southwest and northeast of Kodiak have developed since 1966, and they now negotiate independently of the Kodiak group. In 1968-1969 the negotiated price system broke down. During that season, ex-vessel prices in Kodiak went from $.13 to $.50 a pound, and processors in other areas tended to follow. Some processors throughout the state were left with large inventories on hand when the wholesale price jumped sharply in response. Others simply ceased processing crab after a time. In 1970-1971, prices were again negotiated by the leading processors and the Kodiak association, and were accepted with some reluctance by the western area processors. Kodiak prices began to climb from the original level of $.25 1/4 ($.25 in the western areas), and reached $.39 a pound by the end of the season. Most major buyers ceased buying at $.30 a pound (a 20 per cent increase over beginning prices), and

the "Kodiak effect" did not operate to the same degree as it had in earlier seasons.[10]

While the ability of a few major central Alaska processors to negotiate ex-vessel prices for the state for an entire season or even two has been diminished, a good deal of market power clearly still exists. In the more remote areas in particular, boats face fewer alternative buyers, even if a skipper were tempted to break his agreement with a processor for the chance of a higher price elsewhere.[11] There is no legal restriction against selling one area's catch in another, but increased running costs, the increased risk of dead loss, and loss of time on the fishing grounds--weighed against the possibility of a higher price--work against the practice. (Some boats may sell the season's last load to a conveniently located processing plant along the route home. In mid-season, however, a boat would be required to return to its area of registration to continue fishing.) Thus a single processor or small group of co-operating processors could maintain a price, isolated in the more remote areas from the influence of competing offers.[12]

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[10]This effect occurs when small processors, perhaps for one or two loads, bid higher than agreed prices, which are then met by larger processors. These firms, as good oligopsonists, should let the smaller firms pay the higher price for that small share of the market they can absorb and maintain a lower price for the balance--in short, let the small fry have their share without reacting.

[11]To what degree affiliated boats honor their commitments, and for what reasons other than personal integrity, is not known. One firm uses the bonus as an end-of-season reward for staying out the season. There may be costs in the form of greater difficulty of making future agreements, but this is unknown.

[12]During the 1970-71 season, the initial Adak price held through the season, as did the Seldovia price. Prices in some other areas besides Kodiak did rise from 20% to 40% over initial prices.
The factual material on price-setting policy was gathered through personal interviews and correspondence with officials of Kinnear & Wendt, Vita Seafoods, and Wakefield Fisheries.

The Boats and Gear

Beginning with a fleet composed largely of small vessels designed for other fisheries, the king crab fleet expanded and underwent substantial change as demand grew.

The fishery remained an inshore operation until the development of shipboard live tanks, since the crab must be kept alive until it reaches the processor. Most of the earlier vessels equipped with such tanks were conversions from other uses. Later, newly constructed vessels especially designed for crabbing were added to the fleet. Some were combination crabber-seiners, but many of the larger ones are purely crab-fishing vessels.

Types of gear employed during the initial phases of the fishery were either tangle nets or otter trawls. Both were inefficient; they snagged on debris on the bottom, damaged some of the crabs, and were indiscriminate in catch. Large converted dungeness crab pots were the next technical improvement, followed, in the late 1950's, by the rectangular pot especially designed for king crab fishing. Its size has increased over the years (from 6 x 6 x 2 1/2 feet, still in use by smaller vessels, to pots either 7 x 7 x 3 or 8 x 8 x 3 feet), and it is the standard unit of catching gear for the fleet. Better pot-hauling devices were developed as well. As the larger vessels ranged farther out along the Aleutians and into the Bering Sea, they were equipped with sophisticated navigational aids and depth finding gear.

The degree to which the industry expanded in the late 1950's and 1960's can be seen in the statistics on numbers of vessels and boats, fishermen, and pots for those years.

Table 7

Numbers of Fishermen in the King Crab Industry, 1959-1969

Year	On Vessels	On Boats	Total
1959	329	54	383
1960	486	94	580
1961	750	106	856
1962	1,023	190	1,213
1963	1,020	88	1,108
1964	941	171	1,112
1965	607	257	864
1966	780	285	1,065
1967	1,249	76	1,325
1968	n.a.	n.a.	n.a.
1969	n.a.	n.a.	1,226*
1970	n.a.	n.a.	1,067*

Source: To 1967, Fishery Statistics of the U. S.; estimates for numbers of fishermen in 1969 and 1970 derived by multiplying known total numbers of vessels and boats by 2.8, the average number of fishermen per vessel in 1966.

Table 8

Numbers of Pots in the King Crab Industry, 1959-1967

Year	Total No. Pots
1959	5,655
1960	8,375
1961	10,076
1962	13,700
1963	16,000
1964	22,000
1965	24,350
1966	41,340
1967	28,771

Source: Compiled from data published in Fishery Statistics of the U.S.

Table 9

Numbers, Total and Average Gross Tonnages of

Vessels and Boats in the King Crab Industry, 1960 - 1970

Year	Area	No. Vessels	Total Gross Tonnage	Average Tonnage	No. Boats
1960	S.E.	1	155	55.0	---
	C.	198	5,125	26.6	47
	W.	2	37	18.5	---
	Total*	201	5,247	26.1	47
1961	S.E.	14	430	30.7	---
	C.	272	7,424	27.3	53
	W.	9	617	68.5	---
	Total*	285	8,461	29.34	53
1962	S.E.	27	922	34.15	5
	C.	256	10,274	40.13	90
	W.	32	2,281	71.24	---
	Total*	315	13,477	42.78	95
1963	S.E.	9	291	32.3	10
	C.	256	13,352	52.16	27
	W.	25	2,702	108.08	7
	Total*	265	16,345	61.68	44
1964	S.E.	14	618	44.14	4
	C.	223	12,770	57.26	73
	W.	37	4,001	168.14	5
	Total*	268	17,389	64.81	82
1965	S.E.	6	200	33.3	7
	C.	176	11,233	63.82	107
	W.	44	4,927	111.98	19
	Total*	184	16,360	88.91	119
1966	S.E.	12	489	40.75	3
	C.	235	14,474	61.59	120
	W.	45	5,145	114.33	12
	Total*	247	20,108	81.41	135
1967	S.E.	13	520	40.0	---
	C.	275	20,803	72.0	20
	W.	57	7,913	138.8	12
	Total	345	29,236	84.74	32
1968		n.a.	n.a.	n.a.	n.a.
1969	Total	438**	n.a.	n.a.	n.a.
1970	Total	381**	n.a.	n.a.	n.a.

Source: Fishery Statistics of the U.S.; averages derived therefrom.

* Totals exclusive of duplication.

** Totals obtained from 1969, 1970 ADF&G registration lists, and include boats as well as vessels.

Simple figures on numbers of boats, gear, and fishermen give little indication of changing real capacity. Given the fragmentary data available, only the roughest estimates are possible. For example, composition of the Kodiak area fleet changed markedly in the direction of larger vessels over the period from 1960 to 1970 as indicated in Table 10 below.

Table 10

Length Frequency of Kodiak Area Vessels, 1960-1970

	Length Frequency (in Feet)			
Year	25-[illegible]	[illegible]-[illegible]	[illegible]-[illegible]	100-107
1960	90.3%	3.4%	0.7%	0.0%
1961	92.5	6.76	0.68	0.0
1962	81.5	15.4	2.05	1.03
1963	68.0	20.4	7.8	3.9
1964	66.4	22.1	7.4	4.2
1970	52.8	25.0	18.0	4.16

Source: Pacific Fisherman, June 1965, p. 41; 1970 figure from 1970-71 Alaska registration list. The Kodiak area fleet as per cent of total registrations is as follows: 1960, 56.2%; 1961, 49.6%; 1962, 56.0%; 1963, 60.7%; 1964, 63.5%;...1970, 37.7%. Boats in the Kodiak area average smaller than in other areas, except perhaps the boats in the southeastern area.

In the fleet at large, there was a marked increase from 1960 to 1970 in the percentage of vessels over sixty feet in length.

Year	Year	Number Vessels Over 60 Ft.	
		Number of Vessels Over 60 Feet	Per Cent of Fleet
1960		13	2.93
1964		64	23.88
1970		167*	43.83

Source: Fisherman's News, May 1966, 2d issue, p. 2; 1970 figure from Alaska registration list.
*This does not count any vessels in this category which might be registered in southeastern area, Prince William Sound, and Cook Inlet, which were not given. The percentage of boats over 60 feet is probably understated.

Of the thirteen vessels known to have been added to the fleet in 1969, the average length was 91.38 feet. (Fisherman's News, February 1970.)

A better indication of real capacity is cubic carrying capacity: the number of live crabs per trip a given vessel is capable of carrying. One estimate made on this basis suggests that increased capacity from conversions, 1965-1970, was about 400,000 cubic feet of carrying capacity. At two and one-half seven-pound crabs per cubic foot, conversions added 7,000,000 pounds-per-trip capacity to the fleet. Assuming two seven and one-half-pound crabs per cubic foot, conversions added 6,000,000 pounds of per-trip capacity. New vessels constructed in the same period added about 267,000 cubic feet per trip carrying capacity. On the two sets of assumptions used above, new construction added from 4,672,500 to 4,005,000 pounds of per-trip capacity to the fleet.[13]

As usual, the ability to assess the economic performance of the king crab industry is severely hampered by the lack of complete, easily accessible data on which to base an estimate of real costs of and returns to resources in the industry. Fragments are all that have yet been accumulated.

One estimate gives costs and returns per season for the years 1966, 1967, and 1968 for a sample of 21, 28, and 35 vessels respectively. After fixed charges (interest, insurance, taxes, depreciation), trip expenditures, boat and gear maintenance, and all share expenses were deducted, average net returns before taxes were $11,013, $6,619, and $10,183 for the given

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[13]Mr. Allen W. Engle, Marine Construction and Design Co., Seattle, furnished the conversion and new construction estimates, which he states are by no means exact. They do suggest a more accurate method of measuring real capacity than by tonnage or vessel length, should the data ever become available. It should be noted that this is in no sense an estimate of net additions to capacity.

years.[14] Per-man shares for the three years are given as well, and are contrasted with average wages in U.S. manufacturing.[15] Any attempt to apply the opportunity cost doctrine fails for lack of data, however. No information is given in either case on total money incomes, i.e., income from other sources such as employment in other fisheries, or from transfer payments; nor are such factors as differing costs of living included. For these reasons, no comparisons of real returns to participants in the fishery relative to returns in other employments can yet be made.

Costs per unit of output for the same three years are given, and are separated into their component parts. For each year the figures are (in cents per pound): 1966, 8.5¢; 1967, 10.74¢; 1968, 27.25¢. The rising trend of these costs is evident, even, apart from the element of labor cost, which, under the shore system, is a function catch size and price per pound.

Costs and returns for a small sample of existing units in the fleet can be contrasted with the costs of new entry and the required level of returns implied by these costs. On the basis of current assumptions about construction costs, interest rate, and depreciation rate, it is estimated that a vessel costing $350,000 in 1969 (86-94 feet average length, 5,000 cu. ft. carrying capacity) would earn a net return of about $1,300 with a seasonal catch of 900,000 pounds of crab.

Hypothetical Costs, 86-94-foot Vessel, Built in 1969

	Investment: $350,000	
Fixed Charges:	Interest (10%)	35,000
	Depreciation (10 years)	35,000
	Insurance (5%)	17,500
	Gear Replacement (1.25%)	4,375
	Repairs, Maintenance (3.75%)	13,125
		$105,000

[14] Basic Economic Indicators, p. 2. The sample covered boats from Seattle and Kodiak, averaging 81-87 feet in length. Average returns are said to be representative of vessels in the size range 80-85 feet. No data were available for length of trips, numbers of trips, or time at sea.

[15] Ibid.

Gross:	900,000 lbs. at $.25/lb.	$225,000
	Boat Share (60% of gross)	135,000
	Crew Share (40% of gross)	90,000
	Captain's share (10% of boat share)	13,500
	Fuel & Bait (paid from boat share)	15,000
	Net Boat Share	$106,500
	Fixed Charges	105,200
	Net Returns	$ 1,300

Note on sources: The gross boat share, crew share, and captain's share are quite standard. In some cases, the boat furnishes food and charges a set fee per man; in others, crew members pay directly for food. The "Fuel & Bait" figure is suspect; it obviously depends on length of trip, time spent to catch a given amount, etc., but it is the only one available at the moment.

A catch of 900,000 pounds would represent 1.8 per cent of the total allowable catch set in 1970.[15]

That part of the increasing cost of a vessel which results from general increases in the price level and from rising interest rates is exogenously determined, and not part of the increased fishing costs which result from the pressure of an expanded fleet on the stock (except perhaps as differential interest rates may reflect the cost of capital to more risky ventures). It is assumed that the increasing construction costs are a result of general economic conditions, not that increasing demand for fishing vessels has introduced a scarcity factor into the costs of construction. It might be argued, however, that the greater cost of a larger, more seaworthy and efficient vessel (even with constant unit construction costs) is one of the increased search costs of a unit forced to range farther and fish harder for a given catch.

In 1966 a registered American fleet of 247 vessels and 135 boats caught 159,201,700 pounds of king crab for a total ex-vessel value of $15,670,485

[15]Construction costs are estimated to have risen at an annual rate of 6 to 8 per cent over the past five years. Conversion costs ranged widely, from $35,000 to $100,000, depending both on size and type of vessel and date. None of the costs given includes gear for the vessels.

(annual average price per pound was 9.8¢). Had a fleet of efficient vessels of the 86-94-foot class existed in that year, how many such vessels could have taken the catch (assuming good fishing and no seasonal limitations), and what would their returns have looked like compared to those of such a vessel entering the fishery today?

A vessel of 5,000 cubic feet carrying capacity, hauling two crabs of 7.5 pounds each per cubic foot, could carry 75,000 pounds of crab per vessel-trip. Assuming thirty trips per year at ten days per trip, such a vessel could have caught 2,250,000 pounds of crab annually. Dividing the total 1966 catch by this estimate gives a fleet size of seventy-one vessels.

Alternatively, with the same carrying capacity, a vessel carrying more but smaller crabs (2.5 crabs per cubic foot at 7 pounds per crab) would have had an annual catch of 2,625,000 pounds of crab, at thirty trips per year and 87,500 pounds per vessel-trip. Again dividing total 1966 catch by catch per vessel, there results a fleet size of sixty-one vessels, assuming that each vessel fished to capacity.

Note on sources: Time per trip was estimated by owners of Seattle-based boats of the 86-94-foot range, who traditionally fish the western areas. However, slightly more than 73 per cent of the total 1966 catch was taken in the central area of Alaska, so the estimate may be biased upward. Round trip is defined as time to catch a load, deliver it, and return to the fishing grounds.

I have attempted to keep the catch-per-trip estimate fairly conservative. Vessel owners in Seattle claim to have hauled in loads of from 100,000 to 200,000 pounds per trip in a 5,000 cubic-foot tank with no more than 1-2 per cent dead loss. These estimates would of course imply a still smaller fleet capable of taking the record catch.

The figure for number of crabs per cubic foot was furnished by a shipbuilding firm and confirmed by vessel owners as a conservative estimate.

Construction cost of an efficient vessel in the above size range in 1965, so that it was ready to fish in 1966, is estimated at $300,000. Fixed charges are estimated as follows:

Fixed Charges:	
Interest (7%)	$21,000
Depreciation (10 years)	30,000
Insurance (5%)	15,000
Gear Replacement (1.25%)	3,750
Repairs & Maintenance (3.75%)	11,250
Total Fixed Charges	$81,000

A discount of approximately 7% per year has been applied to construction costs; interest rate quoted was that charged by a commercial bank which makes this sort of loan; gear replacement and repair charges are the same percentage of total original investment as in the estimates given for present construction. Since it is here assumed that such a vessel would fish under 1966 conditions--plentiful supply of crabs, no seasonal restrictions--these estimates may understate the repair and maintenance charges which heavier fishing would make necessary.

Average returns to a vessel in the seventy-one-vessel fleet would be as follows:

Gross (2,250,000 lbs., at 9.8¢ per pound)	$220,711
Boat Share (60% of Gross)	132,426*
Captain's Share (10% of Boat Share)	13,242*
Crew Share (40% of Gross)	88,284*
Fuel and Bait	11,720**
Net Boat Share	107,464
Less Fixed Charges	81,000
Net Return (about 8.3%)	26,464

*Figures do not sum due to rounding.

**The same discount figure as described above was applied to the figure for fuel and bait. It should be treated with caution.

If the fleet in 1966 had been composed of sixty-one vessels, each with an annual catch of 2,625,000 pounds, for the same fixed charges its returns would have been:

Gross (2,625,000 lbs., at 9.8¢ per pound)	$256,893
Boat Share (60% of Gross)	154,135*
Captain's Share (10% of Boat Share)	15,413*
Crew Share (40% of Gross)	102,757*
Fuel and Bait	11,720**
Net Boat Share	127,000
Less Fixed Charges	81,000
Net Return (about 15.3%)	46,000

*Figures do not sum, due to rounding.

**Again, the fuel and bait estimate should be treated cautiously.

It would be foolish to interpret the above estimates as other than rough approximations. They contain some restrictive assumptions, and are based on meager data. What they do demonstrate is that there is a staggering degree of overcapacity in the king crab industry, and has been for some time. They further demonstrate the futility of attempts to assess real returns to resources in the fishery in the absence of the sort of coherent, comparable cost and accounting data which more mature fisheries seem to have accumulated.

Regulation of the Fishery by the State of Alaska

Very little was known about the biology of the king crab at the time the industry began to expand. Knowledge accumulated only slowly, and was far from complete when the catch first declined in 1967, although some biologists had been concerned in the early 1960's that, given the lack of information, the industry might well be overfishing without realizing it. If regulations prior to 1967 were made in ignorance of impending trouble, the post-1967 regulations are attempts at remedial action based on a somewhat lower level of ignorance, amidst politically-based quarrels.

Other than outlawing the tangle net in 1955 and otter trawl in 1960 (both were uneconomical as well as damaging to females and undersized males returned to the sea), the industry was subject to few restrictions until after 1966. Minimum legal size, which was raised to 165 mm. carapace width (about 6 1/2 inches) in 1949, remained at that level until 1969, when it was raised to 175 mm. (about 7 inches).

Area registration was instituted in 1960, though numbers of registrants were, of course, not controlled. Some limited movement between areas was permitted.

The industry began as an off-season, fall-winter fishery. As demand expanded and larger catches taken, there was some fishing almost year-round, except for the molting-mating period (which occurs at slightly different times, depending on the particular area). In 1967 the first official closed season, corresponding roughly with this period, was instituted.[17] In 1969 a more extensive closed season was defined: fishing was limited to a period of roughly five months, beginning in late summer. Area seasons were redefined in 1970, with staggered opening and closing dates.[18]

A maximum allowable catch level was established for the first time in 1970, with the quota divided into separate area subquotas, with provision for intraseasonal adjustments. Two such adjustments were made, at Dutch Harbor and Adak. The original overall quota was 47.5 million pounds. Regulations governing the 1971-72 season provide for lowering the Kodiak Island area (Area K) quota to 10.2 million pounds from 14.0 million pounds, with other area quotas unchanged.[19]

Pot limits, which had been instituted in certain areas in the late 1950's and early 1960's and abandoned in 1964, were reinstituted in 1969. The regulations for 1971-72 provide for further changes: Area O pot limit has been raised to 90 pots; in all other areas the limit has been raised to 75

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[17] The closure was partly illusory, as crabs close to the breeding grounds eat less and are less subject to capture. Their meat is less flavorful, and their weight drops during this time.

[18] Since a vessel could fish only in its area of registration, it was prevented from moving to another area which might still be open. This frustration of a normal sequence of fishing operations was regarded as a restraint on efficient operation of the larger vessels in particular.

[19] Alaska Commercial Fishing Regulations. King Crab Supplement, 1971-71, p. 5; verbal account of 1971-72 regulations given by Mr. A. Hudson prior to their availability in published form.

pots per vessel.[20] A difficult regulation to enforce at best, the pot limit is claimed to have adverse efficiency effects on the larger vessels.[21]

Perhaps the most controversial of the 1970 emergency regulations was the increase in minimum legal size for Bering Sea crabs from 5 3/4 inches to 7 inches across the carapace for the period from September 1 through the end of February. For the rest of the year it was to remain at the lower limit, the same as that imposed by international agreement on the Japanese and Soviet fisheries. The regulation was challenged in the Federal courts on the grounds that (1) it was in conflict with Federal law, and (2) it ignored the biological peculiarity that Bering Sea king crabs are characteristically smaller at maturity than those found in other Alaskan Waters. It was further claimed that the regulation made fishing uneconomical for the larger vessels, whose normal fishing sequence had been to operate in the Bering Sea prior to the opening of the western areas south of the Aleutian Islands and Alaska Peninsula. (Since the Bering Sea was a nonregistration, nonquota area, this sort of interarea movement was permissible.) They claimed that the greater minimum size limit from September 1 until the opening of Areas O and R from six weeks to two months later worked an undue hardship on their operations. The regulations for 1971-72 have removed the basis for the quarrel, however. Minimum legal size for

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[20] Ibid.

[21] There is some feeling that the pot limit does hamper efforts of the larger vessels in the western areas, where they may [illegible] 100-120 pots at times. Some of the vessels use "extra" pots for exploratory fishing.

If the pot limit does hamper the larger vessels' efficiency, the regulation would operate to reduce industry efficiency toward the level of the smaller units. Given both pot limit and time-restricted quotas, vessels are more likely to fish harder and faster, pushing men and equipment past the point of optimal utilization. There is a fairly narrow range of efficient soak time for the pots; attempts to get maximum use out of a smaller number of pots may violate this efficiency consideration. For a study of catch per unit of effort based on differing soak times and other factors, see Rothschild, et al., A.E.&G. Informational Leaflet No. 147.

Bering Sea king crabs for the ensuing year is set at 6 1/4 inches from June 1 to October 31; from November 1 to March 31 it will be 6 1/2 inches, and the months of April and May have been declared a closed season. Minimum legal size in Areas O and R has been lowered to 6 1/2 inches as well. It remains at 7 inches in the rest of the Alaska fishery.[22]

International Regulations

American participation in the king crab fishery prior to the early 1950's was minimal. Both Japan and the Soviet Union had exploited the species since the early 1930's, with the exception of the period of World War II and the early postwar period, both in Asian waters and in the eastern Bering Sea.

As the American fishery expanded into the Bering Sea, it became apparent that some sort of international regulation was required, both for reasons of biological conservation and as a basis for settlement of disputes over access to the fishing grounds and occasional quarrels over reputed trespass and wrecked or damaged gear.

The Soviet Union is a signatory of the United Nations Convention on the Continental Shelf (1958), under which the king crab is defined as a resource of the continental shelf over which the coastal nation has sovereign rights for exploitation and exploration. Japan, which is not one of the signatories to the U.N. Convention, continues to claim that the king crab is a high seas fishery resource, and that its nationals may continue to exercise their "historic fishing rights" in the eastern Bering Sea.

In 1964 the first U.S.- Soviet Union and U.S.-Japanese agreements, were signed governing access to the eastern Bering Sea and setting quotas for both nations, for the years 1965 and 1966. With slight modifications,

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[22] Interviews with attorney for plaintiff vessel owners, and A. Madsen.

the agreements have been renewed biennially; the latest renewals were negotiated in late 1970 and early 1971. In summary, they include the following provisions:

Size Limits: Until the latest agreements, minimum legal size limit was 14.5 cms. (about 5 3/4 inches); for the years 1971 and 1972 it has been raised to 15.8 cms. (about 6 1/4 inches) for the Japanese fishery. The lower limit will continue for the Soviet fishery during 1971 and 1972, during which time that fishery is expected to shift gradually from the use of tangle nets to pots. No female crabs, soft-shelled, or undersized male crabs are to be taken.

Gear: Only tangle nets or pots may be employed. There is no suggestion in the U.S.-Japanese agreement that the latter fishery will not continue to use tangle nets (of mesh size not less than 50 cms.), but the U. S. is apparently planning to push for the gradual discontinuance of this form of gear on the grounds that it is destructive of crabs.[23]

Quotas: The quotas for both Japanese and Soviet fisheries have been steadily lowered since 1964. The quotas (in numbers of cases, each containing 48 1/2-pound cans) are:

King Crab	Japan	U.S.S.R.	Tanner Crab	Japan	U.S.S.R.
1965, 1966	135,000	113,000	---	---	---
1967, 1968	163,000	100,000	---	---	---
1969, 1970	85,000	52,000	1969, 1970	---	40,000
1971, 1972	37,500	12,300**	1971, 1972	14,600,000*	35,000

*Numbers of crabs, not cases.
**The original agreement listed a Soviet quota of 23,000 cases of king crab; it was changed to the lower figure in a letter attached to and made part of the agreement.

Restricted Areas: The most recent U.S.-Soviet agreement defines the

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[23] U.S.-Soviet and U.S.-Japanese agreements for the stated years. The statement about U.S. plans to push for outlawing the tangle net, on the basis of evidence of its destructiveness, was made by Dr. Larkins, National Marine Fisheries Service, Seattle.

allowable area for Soviet king crab fishing as "that portion of the southeastern Bering Sea lying seaward of the nine-mile zone contiguous to the territorial sea of the United States west of 160° W. longitude." The agreement with Japan states that: "The fisheries for king and tanner crab by nationals and vessels of Japan in the eastern Bering Sea will continue in and near the waters which have been fished historically by Japan;..." Although the wording of the agreement with Japan is vague, it is understood that Japanese vessels will not fish on the continental shelf adjacent to the Aleutians on the northern side. Neither Japan nor the Soviet Union may fish for king crabs south of the Alaska Peninsula or the Aleutians.[24]

Restricted Areas (Pot Sanctuary): Both U.S.-Japanese and U.S.-Soviet agreements contain a provision restricting an area north and west of Unimak Island and the western Alaska Peninsula as an area where only pots may be used in king crab fishing. (See map, p. 50.)

In 1966, with strong encouragement from the U.S., and with that country acting as intermediary, a bilateral agreement was concluded between the Japanese and Soviet governments on the allocation of king crab fishing rights between the two countries in the areas of the eastern Bering Sea to which both countries have access. Allocation was made through a series of alternating latitudinal corridors, beginning at the northern boundary of the pot sanctuary. The Japanese corridors are twelve miles in width, the Soviet corridors ten, with two-mile-wide buffer zones between them. In the 1969 agreement, the corridors were in effect slid northward slightly when the pot sanctuary was enlarged.

How well these arrangements have worked in practice is not known. There have been claims of violations of American fishing waters by both Soviet and

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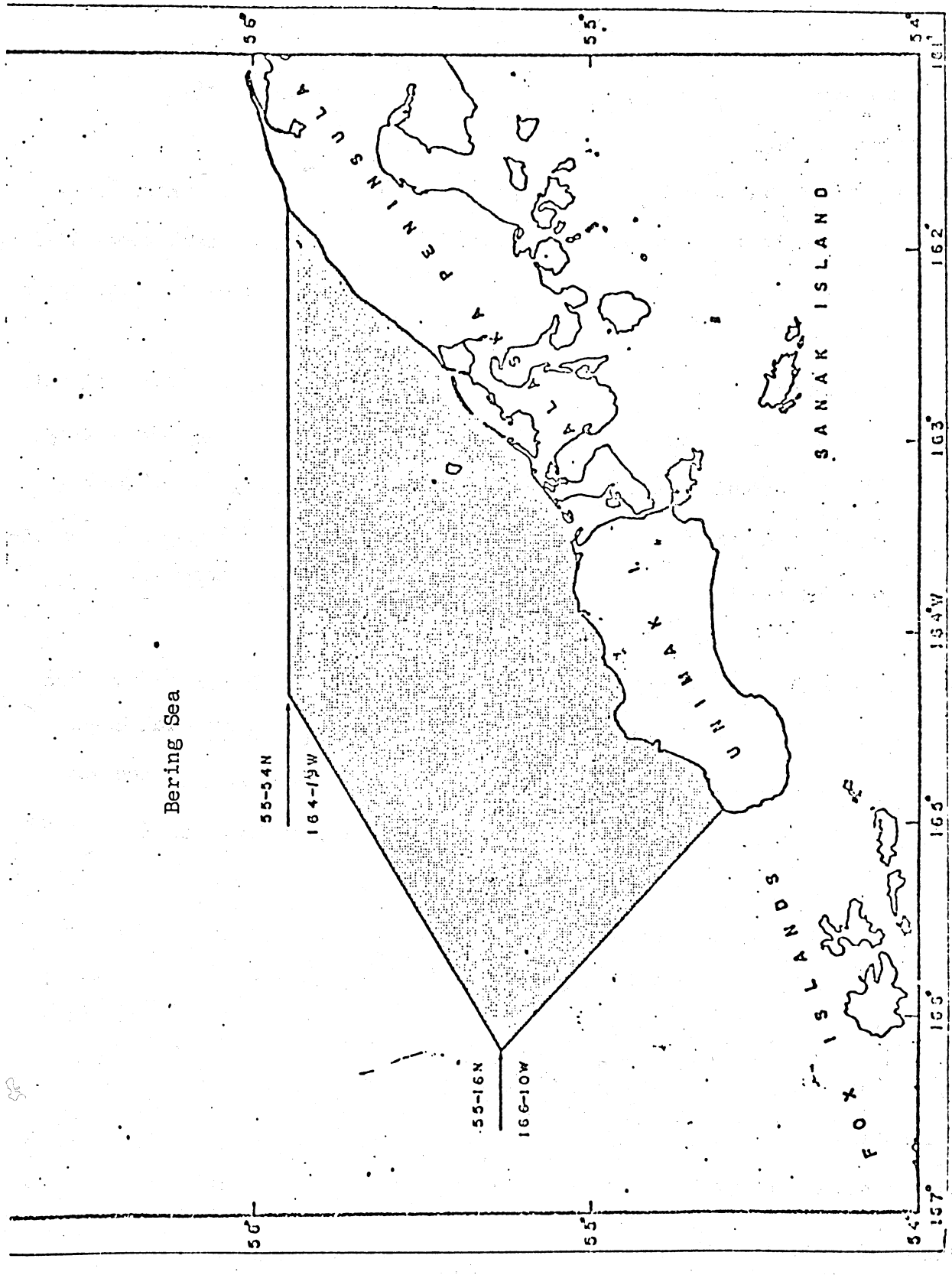
[24] Statement by Mr. Donald Mabb, Enforcement Office, National Marine Fisheries Service, Juneau, Alaska.

Japanese vessels, but their number and degree relative to total fishing effort can only be guessed at.

Clearly, the level of Soviet fishing effort is declining sharply, relative both to its own former level and to the level of Japanese fishing. Quotas for both countries have been continuously reduced since 1964. In contrast, the American king crab fishery in the Bering Sea is under no quota restriction. The one-year experiment with a 7-inch minimum size limit has been abandoned; the larger vessels plan to move increasingly into the Bering Sea. There may be long-run effects from these changes--in terms of increasing pressure on the Bering Sea stocks and in the changing relative strengths of the three national fleets operating in the area.

Eastern Bering Sea King Crab Pot Sanctuary



Source: Map prepared 1969, Bureau of Commercial Fisheries, Juneau, Alaska.

Conclusions

The king crab industry at present is in the anomalous condition of decrepit adolesence. From meager beginnings, it rose in about a decade to a position second only to the salmon fishery in commercial value in the Northwest. It is now overcapitalized for any sustainable level of catch that seems likely, and some biologists feel that present regulatory measures may drive the catch to even lower levels.

Ideally, economists and regulatory bodies attempting to formulate policies for a fishery work from a foundation of accepted biological information. Intelligent policies are difficult to achieve even when there is agreement, function relating yield to effort and the reaction of a given stock to exploitation. There is at present apparently no such consensus among biologists studying the king crab.

Support for any hypothesis about the effects of fishing effort on the population necessarily rests on evidence drawn from the commercial catch. Depending on how the evidence has been interpreted and what evidence was considered, widely varying conclusions have been reached. The large catches of the mid-1960's have been attributed to unusually good recruitment (as evidenced by large numbers of small crabs in the catch and by increasing CPUE). Alternatively, increased fishing effort in terms of both numbers, size, and efficiency of vessels, and the shift in both locational and seasonal patterns of fishing have been cited as causes.

Failure to consider and weigh all the variables could lead to some skewed results. Suppose, for example, a fleet selectively fished for larger crabs. This was actually the case in the early 1960's, when a fleet composed largely of vessels incapable of fishing deeper waters in the winter months concentrated on groups of larger males migrating inshore to breed.

Apparent recruitment, as judged by the resulting commercial catch, would be lower than if the fleet had worked the areas where smaller crabs appear to have concentrated at that time. Conversely, a high level of recruitment could be inferred from a catch with a high proportion of small crabs, when fishing patterns had shifted to areas where the smaller crabs predominated as the concentrations of larger crabs were depleted. (The crabs tend naturally to segregate by both sex and size.) In both of these cases unweighted evidence from the commercial catch would incorrectly reflect the real level of recruitment.

There are other unsettled questions. One is the issue of whether a single year-class of recruits (now defined to include crabs 145-163 mm. carapace length) may actually include crabs from several different year-classes because of the crabs' variable molting rate. It has been suggested that use of this definition may result in overestimates of the size of an entering year-class. Another issue centers about the lowered minimum legal size for the Bering Sea and western areas and the possibility of lowering the biomass through adverse effects on the breeding population, as well as the prospect of significantly lower yield per recruit at the lower size limit.

So long as questions of such importance remain unsettled, further biological research is a first requirement. The issues can only be resolved by biologists, but until some agreement is reached both economists and regulatory agencies must work on shifting ground.[1]

The options available to a decisionmaker operating in the real world of a fishing industry are limited at best. Biological conservation regulations that are successful often achieve their goal at the cost of economic efficiency. These latter criteria are rarely considered, or even clearly

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[1]See citations on pp. 3-4 above, and Minutes, Second Annual Shellfish Conference. Mr. Peter Eldridge, Fisheries Research Institute, was helpful in supplying information as well.

understood, by most regulatory bodies. Part of the reason is that questions of economic efficiency are not viewed in relation to the social welfare problem of an immobile labor force that is endemic to overcrowded fisheries.[2] Another reason for the rejection of economic efficiency as one of the criteria of a fishery's performance is that the concept of a fishery as a common-property resource is so deeply imbedded, in custom if not in law.

The theory of a common-property resource predicts that, in the absence of property rights or some other method of making explicit the costs of access to a natural resource, no self-correcting forces exist to push an industry based thereon in the direction of equilibrium with efficient use of capital and labor. Declining catches in the king crab industry may temporarily divert vessels to other fisheries; some obsolete or destroyed vessels may not be replaced or repaired. Stable or increasing catches, however, would again induce entry, again driving down returns to participants in the fishery. So long as entry to the fishery is unrestricted, this pattern is unlikely to change.

Any plan to place the king crab fishery on an efficient footing (in the static microeconomic sense) must also deal with welfare aspects which are inextricably linked to the economic problems. Such a plan, then, must at least attempt to satisfy the following criteria:

(1) It should provide for the reduction of effort (vessels, gear, men) to that level at which the marginal value product of a resource in the fishery equals its marginal value product in other uses.

Proposals for reducing effort in a fishery where many of the units (particularly the smaller, less efficient ones) participate only on a part-time basis, turning to other fisheries in the off-seasons or when catches drop, are a form of partial equilibrium analysis. To the extent that vessels

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[2]This is complicated in Alaska by being in part an ethnic problem as well

leave one fishery only to enter another, efficiency may be achieved in one at the expense of (possible) more costly disequilibrium elsewhere.[3]

(2) There should be no uncompensated "losers" as a result of the reduction of effort. This is perhaps the most difficult of the economic-social questions, since the "losers" are often the immobile, relatively untrained participants in the fishery who have few alternative employment opportunities.

(3) Since normal catches may vary widely over time, quite apart from the effects of fishing effort, optimal fleet size is more probably a range of capacity rather than a single level. A fleet large enough to take a so-called normal catch might be inadequate for a larger yield. Marginal costs of generating information about size and location of potential catch are very high, however. There is a point at which the incremental returns from additional catch are outweighed by the increasing marginal costs of information--at which the gain foregone from fish uncaught would be less than the avoided costs of an inefficiently large fleet.

Two solutions for rationalizing the fishery might apply to the king crab industry. One, originated in another context by Professor J. A. Crutchfield, involves direct limitation of fleet size through restrictive licensing. Briefly, it would provide that an optimum number of vessels be licensed to operate in the fishery, with the licenses transferrable as a right. Provision would be made for retiring inactive and obsolete vessels, with compensation to their owners. Differential license fees or a tax per unit of catch would operate to encourage efficient operation, and to make

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[3] An area-wide solution, in the form of simultaneous rationalization of a number of fleets, merits investigation. It would involve the constraints of providing for simultaneous and/or sequential harvesting of various species, and some loss of efficiency implied by a fleet of multi-purpose vessels. However, the series of good "second-best" solutions likely to emerge would be preferable to the present conditions, or a piecemeal approach.

explicit to units in the fishery the real costs of catch. The rent on the scarce resource would then be captured by the regulatory agency rather than being dissipated through increasing marginal costs to all participants, as unrestricted entry implies. The losers would be compensated from fees so collected.

A second proposal is based on the concept of an auction of rights to fish.[4] Assuming the establishment of an overall quota and area subquotas based on accurate biological data, rights to fish for part of the quota (in units of, say, several thousand pounds), would then be sold at auction. Fishing rights so purchased would be transferrable within the period covered by the right. At the end of that time, whatever its length, all rights would revert to the regulatory authority to be auctioned off again.

It has been claimed that part of the problem of an immobile, underemployed labor force in a fishery is overstated--that such persons derive a utility from their way of life which renders alternative employments less desirable. The auction system could provide a test of the real utility of their "way of life"--the amount they would accept to give it up. All or part of an area quota of fishing rights could be reserved to this element of the fishery, with the holders of these reserved rights having the option to sell or retain and use them.

Auctions held annually would discourage exit, and would make the acquisition of appropriate gear and financing more difficult and costly. On the other hand, too long an interval between auctions could make necessary changes in size and area composition of allowable catch more difficult to implement.

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[4]Professor Arlon Tussing, University of Alaska, is the originator of this proposed solution. Since there has been no opportunity to discuss it with him, what follows are my views of how such a proposal might work. Any sins of omission or commission in the analysis are mine alone.

Under certain conditions, fishing-right owners (and license-holders as well) could capture increasing rents during the periods between auctions or renewal periods for licenses. For example, the holder of either sort of right acquired before increased demand raised ex-vessel prices would capture the increased rents accruing during the remaining period of his right. Were he to sell his rights, this increased value would be reflected in the purchase price as the capitalized value of the rents expected to accrue over time. Alternatively, the increased value of the right would be reflected in higher bids at a subsequent auction, and the returns to the next purchaser, cet. par., would be no more than competitive. Obviously, the reverse process would decrease the value of fishing right or license.

A rational bidder would offer an amount equal to his estimate of the value of access to the resource (i.e., a bid such that expected catch times expected price per pound minus fixed and variable costs ≥ 0). Real costs of access to the resource can thus be made explicit to the units in the fishery. Efficiency would be encouraged since, for given ex-vessel prices and fixed costs, net returns will be the greater as costs per unit of catch are lowered.

This brief discussion must obviously leave out of consideration a number of technical and procedural problems which would occur in the implementation of such a plan.[5] It is presented as a proposal worth further investigation and analysis, not as a complete outline.

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[5]For example, there are the questions of how the rents captured by the regulatory agency might be allocated--to regulatory costs, research, retirement of inactive or obsolete vessels, etc., and how inter-auction changes could be accomplished.

No mention is made of possible effects on the processing side of the industry. It is possible that marginal processors might be at a disadvantage were the more efficient processors to underwrite bids by the larger vessels in order to secure ample supplies of crab.

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