AN ANALYSIS OF PROPOSED EXCLUSIVE REGISTRATION AREAS AND POT LIMITS IN THE ALASKA TANNER CRAB FISHERY

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EXECUTIVE SUMMARY

In this study, we examine allocation in the Tanner crab fishery and possible effects of proposed new exclusive registration areas in the South Peninsula and Southeastern fisheries and a proposed pot limit in the Kodiak Tanner crab fishery. Our analysis focuses on the allocative effects of these proposed regulations--how they would affect the distribution of Tanner crab harvests between small boats and large boats, and between locally-owned boats and nonlocally-owned boats. We argue that allocation is an important aspect of fishery management, and that consideration of allocation is in accordance with the national standards of the Magnuson Act. Regulations invariably have allocative effects, regardless of whether or not they were adopted explicitly for allocative purposes. It is this allocative nature of fisheries management which makes fisheries management so politically sensitive and controversial. Managers of a fishery have the responsibility to consider how their regulations allocate the resources.

In order to examine the effects of the proposed regulations, we first describe vessel characteristics, harvests and management regulations in the Tanner crab fishery, and how they have affected allocation. Nonresident-owned boats in the Tanner crab fishery tend to be much larger than resident-owned boats. In addition, these large boats appear to be substantially more mobile than small boats and are more likely to be affected by regulations which restrict mobility. Local Tanner crab fishermen in South Peninsula and Southeast tend to be highly diversified into other local fisheries and do not fish Tanner crab in other areas. Local Tanner crab fishermen in Kodiak are less diversified and more dependent on king and Tanner crab harvests. Fishing effort by large nonresident-owned boats has been concentrated in the Bering Sea, which accounted for over 75 percent of total Tanner crab harvests in 1981. However, Bering Sea harvests dropped dramatically between 1981 and 1983, while harvests in other areas traditionally fished by smaller, locally-owned boats have remained steady or increased. Fishing effort by larger boats has risen substantially in the South Peninsula and Kodiak areas, while local harvest shares have fallen. The fundamental allocation problem facing managers is the question of which vessels will bear the losses from dramatically lower harvests for the fishery as a whole.

The Prince William Sound and Cook Inlet Tanner crab fisheries have been exclusive registration areas for a number of years. Local harvest shares in these two areas have remained consistently high, suggesting that exclusive registration areas have worked effectively to protect the Prince William Sound and Cook Inlet local fleets. However, they have been effective partly because the Bering Sea has served as a powerful lure for large boats. With the decline in Bering Sea harvests, exclusive registration areas may not be as effective in keeping nonlocal boats from fishing in other areas.

Beginning in 1984, the Southeastern, Kodiak, South Peninsula and Bering Sea Tanner crab seasons were all scheduled to open at the same time. Since opportunities for boats to fish in more than one of these areas are already considerably reduced, exclusive registration areas might not have as significant effects as they would if the seasons in these areas were scheduled at different times. Thus, exclusive registration areas might reduce fishing by nonlocal boats in the Southeastern and South Peninsula Tanner crab fisheries, but these effects might be relatively small. We do not have enough data to estimate reliably the magnitude of these effects.

A pot limit in the Kodiak area might significantly reduce the share of large nonlocal boats in Kodiak Tanner crab harvests, by reducing the catching power of larger boats, and by inducing some larger boats to fish in other areas instead. Ag in, however, we do not have enough data to estimate reliably the magnitude of these effects.

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I. INTRODUCTION

Under the Magnuson Fishery Conservation and Management Act, the Alaska Tanner crab fishery in the Fishery Conservation Zone (FCZ) is managed in accordance with a fishery management plan (FMP) prepared by the North Pacific Fishery Management Council (NPFMC) and approved by the Secretary of Commerce. The State of Alaska, through the Board of Fisheries, manages the Tanner crab fishery within the three-mile limit and the biological contiguous zone for vessels licensed under state laws.

Each spring, the Board of Fisheries and the NPFMC review management regulations in the Tanner crab fishery and may implement new management measures. The Board takes action immediately, and its actions are in effect within 30 days after they are filed in the office of the Lieutenant Governor. Usually, the North Pacific Fishery Management Council subsequently amends the Tanner Crab Fishery Management Plan to conform with the new regulations adopted by the Board of Fisheries, with approval of these amendments by the Secretary of Commerce. This federal process may require as much as 18 months for regulations to become effective.

In March 1983, the Board of Fisheries adopted new regulations providing for exclusive area designations in the South Peninsula/ Chignik and Southeastern Tanner crab fisheries, and a reduction in

the pot limit in the Kodiak Tanner crab fishery from 250 to 200 pots. In September 1983, however, the regional director of the NMFS disapproved the pot limit provision in the package of regulations approved by the NPFMC. At the council meeting, the regional director argued against amending the Tanner Crab Management Plan on the grounds that the amendments had not been adequately justified. The NPFMC then recommended against amending the Tanner crab FMP to conform with regulations adopted by the Board of Fisheries in 1983. Thus, as the start of the Tanner crab fishing seasons approached in February of 1984, the regulations of the State of Alaska differed from those in the Fishery Management Plan. After a U.S. District Court judge issued a temporary restraining order prohibiting the State from enforcing the exclusive registration areas and the pot limits in the FCZ, the Board of Fisheries repealed those state regulations by emergency order.

The North Pacific Fishery Management Council has been asked to reconsider the proposed exclusive registration areas and pot limits in 1984. This paper provides an analysis of these proposed regulations.

Allocation in Fishery Management

The focus of our analysis in this paper differs from the focus of most arguments which have been presented for and against the proposed regulations in the past. Most of the council's past

discussion of these and other regulations have focused on the implications of the regulations for conservation in the fishery. Our analysis does not address conservation. Instead, we focus explicitly on the allocative effects of the proposed regulations.

Many persons involved with fishery management feel that management should be solely concerned with conservation of the fishery resource, and that managers should not attempt to allocate. This sentiment is incorporated in the fifth national standard of the Magnuson Act, which states:

> 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 [emphasis added].

However, fishery management measures invariably have allocative effects--that is, they invariably have differing effects upon different groups of fishermen. Whether or not measures are adopted explicitly for allocative purposes does not change the fact that they still allocate.

The scheduling of fishing seasons offers a classic example of the inherently allocative nature of management measures. If seasons for two areas are scheduled at the same time, all boats will have to choose between fishing in one area or fishing in the other area. If seasons are scheduled at different times, those boats which can travel between areas (for example, larger boats) will be able to

fish in both areas, while those boats which cannot travel between areas (smaller boats) will only be able to fish in one area. Thus, scheduling seasons simultaneously tends to be more beneficial to smaller boats while scheduling seasons at different times tends to be more beneficial to larger boats. When the seasons are scheduled will affect the allocation of the total catch between small and large boats.

To say that season scheduling has an allocative effect does not mean that it does not serve a conservation purpose--obviously, it does. Simultaneous season scheduling may reduce total effort in an individual fishery, making it easier to monitor the rate of catch and prevent overfishing. However, simultaneous season scheduling is not the only way to reduce effort. Reduction of effort could also be achieved using a variety of other regulations such as gear restrictions, exclusive area registration, or limited entry. All of these means of limiting effort affect the allocation of fishery resources in different ways, although some do so more directly than others. Thus, the use of simultaneous season scheduling to reduce effort in a fishery has different allocative effects than do alternative measures, and is in part an allocative decision.

More generally, there are few conservation goals that could only be achieved through the use of one particular set of management measures. Which management measures are actually chosen may significantly affect allocation of the fishery resource. As a

result, the choice of management measures used to achieve conservation goals is in fact often an allocative decision.

It is because of the allocative nature of fisheries management that fisheries management is so politically sensitive and controversial. Almost all groups agree with the basic goals of conserving and enhancing the fishery resource. If all that the North Pacific Fishery Management Council did was to conserve and enhance the resource, there would be much less dispute over its policies. However, the Council's decisions as to how to conserve and enhance the resource inevitably also affect who will benefit from the resource, and as a result many of its decisions are highly controversial.

Since the Council has the responsibility of managing the fishery, it also has the responsibility of allocating the resources of the fishery. That this allocation is often indirect--the fact that the management measures adopted may not directly distinguish between different groups--does not diminish the fact that the management measures do indeed significantly affect who benefits from the resources of the fishery.

Our analysis in this paper is based on the premise that since the Council cannot avoid adopting regulations which have allocative effects, and since these allocative effects are extremely important to the different groups which are affected, the Council should

explicitly consider allocation in their discussion of management measures.

It is important to note that the national standards of the Magnuson Act do not prohibit explicit consideration of allocative effects of regulations. The fourth national standard of the Magnuson Act 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 a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

Thus, the standards acknowledge that the Council may allocate, and they specifically provide guidelines on which to base this allocation. Allocation must be nondiscriminatory and "fair and equitable" and must not provide an "excessive share" of privileges to any particular group. In addition, regulations may not have allocation as their sole purpose. It is up to the Council to interpret these guidelines.

Based on the premise that the Council should explicitly consider the allocative effects of the regulations which it adopts, our analysis in this paper examines the allocative effects of the proposed exclusive registration areas and pot limits: who would

benefit from the proposed new regulations, and who would not. We do not attempt to argue in favor of or against the proposed regulations, but rather to examine their effects. It is up to the Council to determine whether these effects are in accordance with the goals of the Council and the standards of the Magnuson Act.

Organization of this Paper

In Chapter II, we examine recent trends in the Tanner crab fishery including harvests, vessel characteristics, and the residency of vessel owners. We begin by examining total Tanner crab harvests by area and how harvests have changed over time. Next, we examine characteristics of vessels participating in the fishery including the distribution of vessels of different size classes and the mailing addresses of vessel owners.

In Chapter III, we examine allocation in the Tanner crab fishery. We begin by discussing why certain regulations might be expected to have allocative effects. Next, we review regulations which have been used in the fishery which may have important allocative effects; in particular, season scheduling, exclusive area registration, and pot limits. Next, we examine the allocation of catch among vessels by size and owners' residency for different areas. We examine the extent to which regulations such as exclusive registration areas appear to have had allocative effects. Finally, we review the overall problem of allocation in the Tanner crab fishery.

In Chapter IV, we examine the proposed exclusive registration area and pot limit regulations. We discuss the kinds of effects which the proposed regulations might have upon the allocation of catch between local and nonlocal boats, and the significance of these effects for local fleets. We summarize our conclusions in Chapter V.

II. THE ALASKA TANNER CRAB FISHERY

Significant commercial fishing for Tanner crab in Alaska began less than 20 years ago. Although Tanner crab were first harvested commercially in 1951, they were passed by in favor of King crab which are larger and which have more easily removed meat. Fishing efforts by both domestic and foreign fishermen shifted to Tanner crab in the mid-1960s when the sudden decrease in King crab stocks precipitated a diversification of the shellfish industry. An increase in the abundance of Tanner crab accompanied the decrease in King crab stocks and contributed to rapid growth of Tanner crab harvests in the late 1960s and early 1970s. As shown in Table II-1, total U.S. harvests rose from 118 thousand pounds in 1967 to 14 million pounds in 1970 and a peak of 131 million pounds in 1979. Between 1979 and 1983, U.S. harvests have dropped by half, to 65 million pounds.

Foreign fishing of Tanner crab also began as a result of a decline in King crab stocks. The foreign directed catch of Tanner crab significantly exceeded the U.S. catch until 1973. Quotas for the foreign catch of Tanner crab were instituted in 1970, and foreign fishing was gradually phased out. There is currently no foreign directed Tanner crab fishery; however, the incidental catch of foreign trawling operations remains high.

TABLE II-1.
TOTAL CATCH AND VESSEL PARTICIPATION IN THE
ALASKA TANNER CRAB FISHERY, 1967-1983

Year	Total Catch (Thousands of Pounds)	Number Of Vessels
1967	118	-
1968	3,247	-
1969	11,206	-
1970	14,473	-
1971	12,880	-
1972	30,135	-
1973	61,719	-
1974	63,906	-
1975	46,857	275
1976	80,770	345
1977	98,463	390
1978	129,555	535
1979	130,589	639
1980	121,666	635
1981	110,565	582
1982	69,912	658
1983	65,619	654

- Not available.

SOURCE: Number of vessels from Alaska Commercial Fisheries Entry Commission. Total catch from Alaska Department of Fish and Game, Alaska 1980 Catch and Production Statistics (Juneau, February 1982), page 13; 1981-1983 figures from Table II-2.

Tanner Crab Harvests by Area

Table II-2 shows Tanner crab harvests for nine areas corresponding to registration areas and districts in the Alaska Tanner crab fishery.

In the early years of the Tanner crab fishery, the Kodiak area was the most significant area for the U.S. Tanner crab fishery. As late as 1973, the Kodiak area accounted for over half of the U.S. catch. The total Tanner crab catch in the Kodiak area peaked in 1978 at 33 million pounds and dropped to 12 million pounds in 1981. By 1983, however, harvests had risen again to nearly 19 million pounds.

U.S. Tanner crab harvests in the Bering Sea rose rapidly during the mid-1970s, from only 301 thousand pounds in 1973 to a peak of 82 million pounds in 1981. In 1981, the Bering Sea accounted for over 75 percent of U.S. Tanner crab harvests. However, in recent years Bering Sea harvests have dropped sharply to only 30 million pounds in 1983.

Tanner crab harvests have been considerably smaller in the remaining areas. In 1982, for example, harvests in the Southeastern, Prince William Sound, Cook Inlet, Chignik, and South Peninsula regions were all in the two to three million pound range.

TABLE II-2.
ANNUAL ALASKA TANNER CRAB CATCH, BY AREA, 1965-1983

Year[1]	Southeastern	Prince William Sound	Cook Inlet	Kodiak	Chignik[2]	South Peninsula
1967	2,700	-	-	110,961	1,600	3,000
1968	109,300	245,200	165,100	2,560,687	21,500	110,600
1969	267,400	936,500	1,479,700	6,796,477	38,100	606,300
1970	583,300	1,292,400	1,328,700	7,749,859	2,800	2,093,600
1971	251,100	642,300	2,116,800	7,436,414	152,256	2,140,755
1972	790,100	8,550,700	4,807,800	11,898,054	23,343	3,618,883
1973	1,893,000	12,296,800	8,509,100	31,113,459	747,788	5,615,563
1974	3,087,500	9,597,800	7,660,900	25,479,717	4,202,671	9,503,366
1975	3,033,200	5,016,700	4,952,400	17,535,844	3,649,444	5,195,800
1976	4,052,800	6,000,400	5,935,300	23,446,245	6,926,161	11,201,941
1977	3,513,500	2,894,800	5,650,000	20,720,079	5,672,919	6,773,838
1978	2,978,800	4,979,900	5,582,700	33,271,472	4,693,830	7,446,270
1979	3,372,000	6,607,600	5,144,400	29,173,807	2,536,105	8,684,408
1980	4,095,400	5,894,700	4,804,700	18,623,875	3,146,011	6,755,234
1981	2,775,368	2,761,251	2,994,997	11,748,629	3,637,090	3,286,854
1982	2,102,000	3,078,000	2,726,000	13,756,159	2,984,102	3,309,250
1983	170,000	990,000	3,819,000	18,863,000	3,406,000	2,855,000

Year[1]	E. Aleutians	W. Aleutians	Bering Sea	Total U.S.	Total Foreign Harvest
1967	-	-	-	118,261	24,000,000
1968	12,800	-	17,900	3,243,087	30,940,000
1969	21,000	2,200	1,008,900	11,156,577	47,668,000
1970	-	-	1,487,161	14,537,820	47,828,000
1971	-	-	166,100	12,905,725	39,886,000
1972	3,900	-	119,200	29,811,980	31,186,000
1973	62,128	168,354	301,348	60,707,540	27,886,000
1974	498,836	71,887	5,044,197	65,146,874	27,912,000
1975	77,164	3,350	7,028,378	46,492,280	18,456,000
1976	534,295	62,180	22,341,475	80,500,797	19,286,000
1977	1,301,654	-	51,876,235	98,403,025	21,520,173
1978	2,624,016	237,512	67,831,257	129,645,757	33,057,796
1979	1,092,311	197,244	75,705,265	132,513,140	32,914,536
1980	879,807	337,297	76,186,983	120,724,007	15,636,125
1981	654,514	220,716	82,485,120	110,564,539	-
1982	739,694	838,627	40,378,253	69,912,085	-
1983	540,000	425,000	30,012,000	61,080,000	-

[1]Calendar Year.

- Not available or zero.

SOURCE: Kodiak area and westward, 1967-1982, and foreign catch from Alaska Department of Fish and Game, Westward Region Shellfish Report to the Board of Fisheries, March 1983, page 15, except as noted below. All 1983 figures as well as 1981 and 1982 figures for Southeastern, Prince William Sound, and Kodiak areas from preliminary shellfish catch reports published by Alaska Department of Fish and Game. Figures for Southeastern, Prince William Sound, and Cook Inlet prior to 1981 as well as for Chignik and South Peninsula prior to 1971, and Eastern and Western Aleutians prior to 1973, from Alaska Department of Fish and Game, Catch and Production Commercial Fisheries Statistics, various years. Total U.S. harvests based on figures given in Table.

In 1983, Tanner crab harvests declined sharply in the Southeastern and Prince William Sound areas, to less than a million pounds. This decline was due to a shift in the season opening date to after January 1, so that fishing for the 1983 season took place in 1984, whereas fishing for a given management year had previously taken place in the same calendar year.

Characteristics of Vessels and Fleets in the Alaska Tanner Crab Fishery

Fleet Size and Ownership

As shown in Table II-1, the total number of vessels participating in the Alaska Tanner crab fishery increased from 275 in 1975 to 639 in 1979. Subsequently, the number of vessels in the fishery stabilized, increasing only slightly to 654 by 1983.

Data collected by the Commercial Fisheries Entry Commission provides information on the permanent mailing addresses of the owners of these vessels. This permits us to distinguish to some degree between Alaskan-owned vessels and non-Alaskan-owned vessels. While not all vessel owners with permanent mailing addresses in Alaska are necessarily Alaska residents, we believe there is probably a high correlation between mailing addresses and residency. For convenience, we will refer to vessels as either "Alaskan" or "non-Alaskan" and "resident" or "nonresident" based on their owners' mailing addresses. We further divided the home addresses of Alaska resident vessel owners into "residence areas"

corresponding to the registration areas for the Alaska Tanner crab fishery. For convenience, we refer to vessels whose mailing addresses were in the Southeastern area as "Southeastern" vessels, and so forth for other areas.

As shown in Table II-3, 189 non-Alaskan boats fished for Tanner crab in 1982. These boats accounted for 29 percent of the total Tanner crab fleet of 658 vessels. All but 12 of the non-Alaskan boats were from Washington state, and 127 of these boats (19 percent of the entire Tanner crab fleet) were from Seattle.

Of the 457 Alaskan vessels which fished for Tanner crab in 1982, 187 were from the Kodiak area, 85 were from the Southeastern area, 67 were from the Cook Inlet area, 50 were from the South Peninsula area, 39 were from the Prince William Sound area, and 17 were from the Dutch Harbor area. The remainder of Alaska accounted for only 18 boats. With the exception of one vessel from Unalakleet, no boats which fished for Tanner crab were owned by residents of the Bristol Bay/Bering Sea area.

In terms of the number of locally-owned boats participating in the Tanner crab fishery, the most significant Alaskan ports were Kodiak (165), Homer (40), Petersburg (37), Cordova (30), Sand Point (30), Juneau (19), King Cove (14), Seldovia (13), Port Lions (11), and Unalaska (10).

TABLE II-3: NUMBER OF VESSELS PARTICIPATING IN THE ALASKA TANNER CRAB FISHERY, 1980-1982, BY MAILING ADDRESS OF OWNER

Owner's Mailing Address	1980	1981	1982
Total	635	582	658
Non-Alaska: Total	180	180	189
Washington[a]	168	171	177
Seattle	111	119	127
Edmonds	15	14	10
Anacortes	7	11	3
Bellevue	5	4	2
Other	30	23	35
Other Non-Alaska	12	9	12
Alaska: Total	436	397	457
Southeast	56	50	85
Auke Bay	1	2	1
Douglas	1	3	4
Haines	2	1	1
Hoonah	2	2	2
Juneau	6	9	19
Kake	–	–	1
Ketchikan	3	3	4
Mt. Edgecumbe	–	–	1
Pelican	4	3	2
Petersburg	24	20	37
Pleasant Harbor	–	–	1
Port Alexander	–	–	1
Sitka	3	1	2
Tenakee	1	1	1
Ward Cove	4	2	3
Wrangell	4	2	3
Yakutat	5	3	4
Prince William Sound	41	28	34
Cordova	38	27	30
Valdez	3	1	4

TABLE II-3: NUMBER OF VESSELS PARTICIPATING IN THE ALASKA TANNER CRAB FISHERY, 1980-82, BY MAILING ADDRESS OF OWNER (continued)

Owner's Mailing Address	1980	1981	1982
Cook Inlet	64	67	67
Anchor Point	4	5	3
Halibut Cove	1	1	1
Homer	33	39	40
Kasilof	1	2	2
Kenai	3	1	1
Ninilchik	-	-	1
Seldovia	14	11	13
Seward	6	5	4
Soldotna	2	3	2
Kodiak	187	172	187
Kodiak	170	157	165
Larsen Bay	-	1	1
Old Harbor	3	-	6
Ouzinkie	2	4	3
Port Lions	12	10	11
South Peninsula	44	44	50
Chignik	2	4	4
Chignik Lagoon	2	1	2
King Cove	13	13	14
Sand Point	27	26	30
Dutch Harbor	19	22	17
Aleutan	2	1	1
Atka	1	1	1
Dutch Harbor	5	8	5
Unalaska	11	12	10
Bering Sea	1	-	1
Dillingham	1	-	-
Unalakleet	-	-	1
Adak	-	-	-
Other Alaska	24	14	17
Anchorage	18	12	13
Eagle River	1	-	1
Palmer	1	1	2
Sterling	1	1	-
Sutton	1	-	1
Tanana	1	-	-
Kwethluk	1	-	-
Mailing Address Unknown	19	5	12

Boat Size

Table II-4 provides a breakdown by length and owners' residence area of boats fishing for Tanner crab in 1982. Table II-5 shows size and ownership distribution of boats in the fishery in percentage terms.

Of the 658 boats which fished for Tanner crab in 1982, 477, or 70 percent, were less than 80 feet in length. However, there was a dramatic difference in the characteristics of the resident and nonresident fleets. Only 32 percent of nonresident boats were less than 80 feet in length, while more than 64 percent of all nonresident vessels were over 80 feet in length, and 36 percent of nonresident vessels were over 100 feet in length. In contrast, 84 percent of resident vessels were less than 80 feet in length. Less than 16 percent of resident vessels were over 80 feet in length and only 2 percent of nonresident vessels were over 100 feet in length.

Put differently, nonresident vessels accounted for 64 percent of vessels over 80 feet in length and 82 percent of vessels over 100 feet in length, but less than 14 percent of vessels less than 60 feet in length. In sum:

Nonresident-owned vessels in the Alaska tanner crab fishery tend to be significantly larger than resident-owned vessels.

TABLE II-4: NUMBER OF VESSELS PARTICIPATING IN ALASKA TANNER CRAB FISHERY, 1982, BY SIZE, CLASS, AND MAILING ADDRESS OF OWNER

Mailing Address of Vessel Owner	Length in Feet							
	Less than 39'	40-59'	60-79'	80-99'	100-119'	120-139'	Greater than 140'	Total
Total	101	244	102	115	47	24	12	658 [a]
Non-Alaska	4	28	29	59	36	22	10	188
Alaska: Subtotal	97	216	73	56	11	2	2	457
Southeast	19	56	7	3	-	-	-	85
Prince William Sound	8	16	9	1	-	-	-	34
Cook Inlet	28	20	9	8	-	1	-	66
Kodiak	35	69	40	31	8	1	2	186
South Peninsula	1	43	4	1	1	-	-	50
Aleutians	3	4	4	4	2	-	-	17
Bering Sea	1	-	-	-	-	-	-	1
Other Alaska	2	8	-	8	-	-	-	18

NOTES: [a]Total includes 13 vessels for which length and owner's mailing address were unknown.

TABLE II-5: SIZE AND OWNERSHIP DISTRIBUTION OF VESSELS PARTICIPATING IN ALASKA TANNER CRAB FISHERY, 1982
(Percent)

Owners' Mailing Address / Distribution of Size by Ownership	Length in Feet							
	Less than 39'	40-59'	60-79'	80-99'	100-119'	120-139'	Greater than 140'	Total
Total	16	38	16	18	7	4	2	100
Non-Alaska	2	15	15	31	19	12	5	100
Alaska: Subtotal	21	47	16	12	2	-	-	100
Southeast	22	66	8	4	-	-	-	100
Prince William Sound	24	47	26	3	-	-	-	100
Cook Inlet	42	30	14	12	-	2	-	100
Kodiak	19	37	22	17	4	1	1	100
South Peninsula	2	86	8	2	2	-	-	100
Aleutians	18	24	24	24	12	-	-	100
Bering Sea	100	-	-	-	-	-	-	100
Other Alaska	11	44	-	44	-	-	-	100
Distribution of Ownership by Size								
Total	100	100	100	100	100	100	100	100
Non-Alaska	4	12	28	51	77	92	83	29
Alaska: Subtotal	96	88	72	49	23	8	17	71
Southeast	19	23	7	3	-	-	-	13
Prince William Sound	8	7	9	1	-	-	-	5
Cook Inlet	28	8	9	7	-	4	-	10
Kodiak	35	28	39	27	17	4	17	29
South Peninsula	1	18	4	1	2	-	-	8
Aleutians	3	2	4	3	4	-	-	3
Bering Sea	1	-	-	-	-	-	-	-
Other Alaska	2	3	-	7	-	-	-	3

NOTES: - is less than .5 percent.

Totals may not add exactly due to rounding.

Figures do not include 12 vessels for which length and owner's mailing address were unknown.

SOURCE: Commercial Fisheries Entry Commission data; see Table II-4.

Similar differences, although not as dramatic, are apparent between vessels owned by residents of different areas of Alaska. In the Southeastern and South Peninsula resident fleets, 88 percent of boats were less than 60 feet in length. In the Prince William Sound and Cook Inlet fleets, 71 percent of vessels were less than 60 feet in length. Only 56 percent of Kodiak boats were less than 60 feet in length.

III. ALLOCATION IN THE TANNER CRAB FISHERY

In this chapter, we examine how the Tanner crab catch in different areas is distributed between local Alaska vessels, nonlocal Alaskan vessels, and non-Alaskan vessels.* We also examine why this distribution of catch has come about, and, in particular, how management regulations in the Tanner crab fishery may have worked to allocate catch among different vessel classes.

Allocative Regulations in the Tanner Crab Fishery

There is no direct allocation in the Tanner crab fishery. The same regulations apply to all boats, regardless of their ownership. A boat from Seattle is treated no differently than a boat from Cordova or Sand Point.

However, regulations may nevertheless have indirect allocative effects among different kinds of boats by affecting the fishing opportunities open to any boat. For example, exclusive area registration may limit the fishing opportunities for large boats which might otherwise be able to fish in several areas, while not

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*The analysis in this chapter is similar to that developed for the King crab fishery study recently prepared by the Institute of Social and Economic Research for the Alaska Department of Fish and Game. See Gunnar Knapp et al., Institutions and Regulations in the Alaska King Crab Fishery: Effects on Residents and Nonresidents (ISER, December 1983.

limiting opportunities for small boats which could not have traveled to more than one area in any case. In addition, gear restrictions such as pot limits may reduce the catching power of large boats while having no effects upon small boats.

In any given year, when the number of boats participating in the fishery is relatively fixed, regulations tend to allocate primarily through their effects on where vessels choose to fish (and to a lesser extent, by limiting effort). In contrast, in the long run, regulations can affect the entire structure of the fleet--for example, by helping small boats to continue to survive against competition by larger boats. In Appendix A, we use a simple model to illustrate a variety of possible effects of regulations upon allocation in an open-entry fishery.

Since Tanner crab regulations allocate only indirectly, they cannot guarantee a particular allocation of the catch. Other factors besides regulations, such as the biological productivity of the fishery in different areas and trends in crab prices, also affect where boats choose to fish and whether or not boats of different sizes can continue to compete in the fishery over time. The same regulations may result in very different allocations in different years as biological and economic conditions in the fishery change.

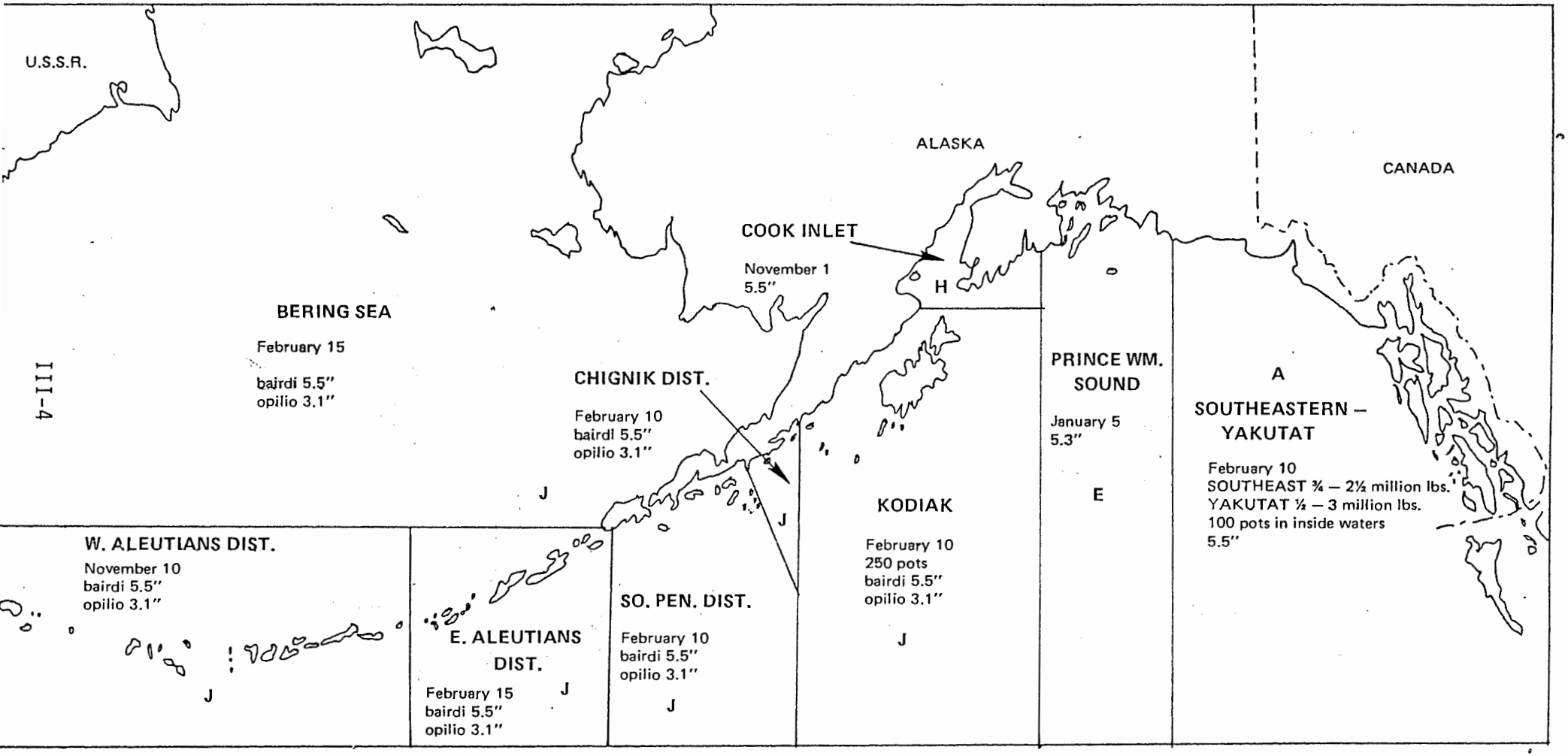
In this section, we document several kinds of regulations which have been used in the Tanner crab fishery which may have significant allocative effects through their effects upon where, how, and when vessels of different types choose to fish. These regulations include exclusive area registration, season scheduling, and gear restrictions. In the following section, we will show how these regulations appear to have affected allocation.

Area Registration

Figure III-1 shows registration areas in the Tanner crab fishery. Table III-1 documents exclusive area registration regulations used in the Tanner crab fishery between 1975 and 1983. Areas were designated either "exclusive" or "non-exclusive." In any given year, if a vessel fished in an exclusive area, it could not fish in any other area. (Prior to 1983, the "exclusive" designation in the Tanner crab fishery was the equivalent of the "superexclusive" designation in the King crab fishery; in 1983, the term "superexclusive" was adopted for the Tanner crab fishery.)

The Prince William Sound and Cook Inlet Tanner crab fisheries have been designated exclsuive since at least 1975. In March 1983, the Alaska Board of Fisheries designated two other areas as exclusive: Southeastern (Area A) and the combined Chignik and South Peninsula districts of Area J. Under these regulations, vessels would have had to choose between fishing in the more productive Kodiak or Bering Sea areas or in one of the four smaller areas which

Figure III-1: Alaska Tanner Crab Fishery Registration Areas, and 1983 Season Opening Dates, Guideline Harvest Levels, Pot Limits, and Minimum Legal Sizes



TANNER CRAB FISHERY

Notations indicate: Opening Dates
Guideline Harvest Levels
Pot Limits, when applicable
Minimum legal size
E.O. = Emergency Order

Source: Alaska Department of Fish and Game, *1983 Commercial Shellfish Regulations.*

TABLE III-1.
SUMMARY OF AREA REGISTRATION REGULATIONS
IN STATE OF ALASKA TANNER CRAB FISHERIES
1975-1983

Year[1]	Registration Areas[2]	Designations[3]
1975	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area K - Kodiak area M - Westward area	Registration areas E and H exclusive. Areas A, K, and M nonexclusive.
1976	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1977	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1978	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1979	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1980	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1981	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.

Table III-1
Summary of Area Registration Regulations
in Alaska Tanner Crab Fisheries 1975-1983 (continued)

1982	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas E and H exclusive. Areas A and J non-exclusive.
1983	A - Southeastern Alaska-Yakutat area E - Prince William Sound area H - Cook Inlet area J - Westward area	Registration areas A, E, H, and the combined South Peninsula and Chignik districts of area J superexclusive.[4] Area J Kodiak, Eastern Aleutian, Western Aleutian, and Bering Sea districts non-exclusive.

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[1]Year refers to management year, which usually begins in August. Actual fishing under these regulations may have occurred partly or completely in the following year (see Table III-2).

[2]Westward area (Area M [1975] and Area J [1976-1983]) includes the Kodiak, Chignik/South Peninsula, Aleutian Islands, and Bering Sea districts.

[3]The "superexclusive" designation introduced in 1983 is the equivalent of the "exclusive" designation used in 1975-1982. Both terms are used to restrict vessels that fish in such an area to only that registration area during a single fishing year (August 1 through July 31). Vessels that fish in nonexclusive registration areas may fish in more than one such area.

[4]On February 9, 1984, the Board of Fisheries adopted emergency regulations repealing the superexclusive designation for Area A and for the Chignik/South Peninsula district of Area J, following the issuance of a temporary restraining order prohibiting state enforcement of these regulations in the FCZ.

SOURCE: Alaska Department of Fish and Game. Annual Commercial Shellfish Regulations.

have been designated exclusive. However, in February 1984, the Board of Fisheries repealed the new exclusive designations by emergency order following the issuance of a temporary restraining order prohibiting state enforcement of these regulations in the FCZ.

Season Scheduling

Table III-2 shows Tanner crab season opening dates for the years 1975-1984. Season opening dates for most Tanner crab fisheries are in early or mid-winter, making it possible for boats which fish for king crab to subsequently fish for Tanner crab. Since 1980, the Kodiak Tanner crab season has opened at approximately the same time as the Bering Sea Tanner crab fishery. Thus, although boats could legally fish in more than one of these areas, in practice, fishing in one area considerably reduced opportunities to fish in the other. In 1983, not only Kodiak and the Bering Sea but also the Southeastern, South Peninsula, Chignik, and Eastern Aleutians areas opened on approximately the same dates (either February or February 15). This simultaneous scheduling of seasons, together with exclusive area registration, tended to reduce opportunities for any given vessel to fish in more than one area.

Gear Restrictions

Pot limits are the primary form of gear restrictions in the Tanner crab fishery. Table III-3 summarizes pot limit regulations for the period 1975-1984. The current Tanner crab limit of 100 pots in the Southeastern area parallels a 100-pot limit in the King crab

TABLE III-2
SEASON OPENING DATES IN ALASKA TANNER CRAB FISHERIES
1975-1983

Year[a]	Southeast (A)	Prince William Sound (E)	Cook Inlet (H)	Westward (J)[d]					
				Kodiak	South Penin.	Eastern Aleutians	Western Aleutians	Chignik[e]	Bering Sea
1975	Sep 1	Nov 15	Dec 1	Nov 1[c]	Aug 15	Nov 1	Nov 1	N/A	[f]
1976	Sep 1	Nov 15	Dec 1	Jan 1	Aug 15	Nov 1	Nov 1	N/A	[f]
1977	Sep 1	Nov 15	Dec 1	Jan 1	Nov 1	Nov 1	Nov 1	N/A	Nov 1
1978	Sep 1	Nov 15	Dec 1	Jan 5	Nov 1	Nov 1	Nov 1	N/A	Nov 1
1979	Sep 1	Nov 15	Dec 1	Jan 5	Nov 1	Nov 1	Nov 1	N/A	Nov 1
1980	Sep 15	Nov 15	Dec 1	Jan 22	Dec 1	Jan 15	Jan 15	Nov 1	Jan 15
1981	Feb 1[b]	Nov 15	Dec 1	Feb 10	Dec 15	Feb 15	Jan 15	Dec 15	Feb 15
1982	Feb 1[b]	Nov 15	Dec 1	Feb 10	Feb 10	Feb 15	Nov 1	Feb 10	Feb 15
1983	Feb 10	Jan 5	Nov 1	Feb 10	Feb 10	Feb 15	Nov 10	Feb 10	Feb 15

N/A Not applicable.

[a]Year refers to management year, which usually begins in August. Season openings in January or February occurred in following year.

[b]Yakutat district February 1. Other districts December 1.

[c]In 1975, Kodiak was a separate registration area, designated Area "K."

[d]In 1975, designated as Area "M."

[e]The Chignik and South Peninsula areas were combined in one area designated "South Peninsula" until the 1980 season.

[f]By emergency order, but no earlier than July 1.

SOURCE: Alaska Department of Fish and Game. Annual Commercial Shellfish Regulations.

TABLE III-3.
SUMMARY OF STATE POT LIMIT REGULATIONS IN ALASKA TANNER CRAB FISHERIES, 1975-1983

1975	Area A (Southeast Alaska-Yakutat): 100 pots, except no more than 60 pots during king crab season, in selected areas. Area K (Kodiak): 75 pots during king crab season, from registered king crab vessels. Area M (Westward) South Peninsula district: 75 pots during king crab season, from registered king crab vessel.
1976	Area A (Southeast Alaska-Yakutat): 100 pots, except no more than 60 pots during king crab season, in selected areas. Area J (Westward) Kodiak and South Peninsula districts: 75 pots.
1977	Area A (Southeast Alaska-Yakutat): 100 pots, except no more than 60 pots during king crab season, in selected areas. Area H (Cook Inlet): 75 pots, during king crab season.
1978	Area A: 100 pots during king crab season, in selected areas. Area H (Cook Inlet): 75 pots, during king crab season.
1979	" " " " "
1980	Area A: 100 pots during king crab season, in selected areas. Area H: no pot limit. Area J (Kodiak district): 250 pots.
1981	Area A: 100 pots. Area E (Prince William Sound): 175 pots; 100 pots in Northern district. Area J (Kodiak district): 250 pots.
1982	" " " " "
1983	Area A: 100 pots. Area E (Prince William Sound): 175 pots; 100 pots in Northern district. Area J (Kodiak district): 200 pots.[1]

NOTE: Year refers to management year.

[1] Limit repealed by emergency order of the Board of Fisheries in February 1984.

SOURCE: Alaska Department of Fish and Game. Annual Commercial Shellfish Regulations.

fishery. Pot limits are used in the Prince William Sound Tanner crab fishery although there are no pot limits in the King crab fishery for that area. In contrast, the pot limits in the Kodiak Tanner crab fishery prior to 1983 (250 pots) were less restrictive than the King crab limit of 100 pots.

Summary of Allocative Regulations

We would expect exclusive area registraton, season scheduling, and pot limit regulations in the Tanner crab fishery to have helped small, locally-owned boats in the Southeastern, Prince William Sound, and Kodiak areas by protecting them from competition from larger, nonlocally-owned boats. This is primarily because they have forced larger boats to choose between fishing for Tanner crab in these areas or pursuing more profitable opportunities to fish for Tanner crab or King crab in other areas.

The Bering Sea has been the most productive Tanner crab fishery in recent years. It has offered the highest potential catch to those larger boats which are able to fish in its open, unprotected waters. Given the opportunity, these larger boats might also fish in other areas prior to or after the Bering Sea season, but they have been effectively prevented from fishing some areas by exclusive area registration and season scheduling. Prince William Sound and Cook Inlet have been exclusive registration areas since 1975. Until 1980, the Southeast Tanner crab season was scheduled for approximately the same time as the King crab season in other areas. In 1981, the opening date for the Yakutat district of Southeast was changed to approximately the same time as the opening dates for the Bering Sea and season. We might also expect the restrictive pot

limits in the Southeastern area to have discouraged larger boats from fishing there.

Vessel Mobility in the Tanner Crab Fishery

Table III-4 shows vessel mobility in the Tanner crab fishery for the years 1975-1980 (1980 is the last year for which these data are available). The table provides data for both "small" boats and "large" boats, where "small" boats are defined as those less than 50 feet in length.

As shown in the table, no small boats fished for Tanner crab in more than one area except for five boats which fished in both the Kodiak and South Peninsula areas in 1980. In addition, none of the large boats which fished in the Southeastern, Prince William Sound, or Cook Inlet areas fished in more than one area.

In contrast, there was some mobility of large boats between the Kodiak, South Peninsula, Dutch Harbor, and Bering Sea areas. For example, of the 159 large boats which fished the Bering Sea in 1980, 15 also fished in the Kodiak area, 23 also fished in the South Peninsula area, and 8 fished in the Dutch Harbor (Eastern Aleutians) area. Of the 97 large boats which fished in the Kodiak area, 25 also fished in the South Peninsula area, and (as mentioned above) 15 fished in the Bering Sea area.

TABLE III-4.
NUMBER OF VESSELS FISHING FOR TANNER CRAB, AND NUMBER OF VESSELS WHICH ALSO FISHED FOR TANNER CRAB IN OTHER AREAS, BY AREA SIZE CLASS, AND YEAR

Area and Size Class Area and Size Class[a]	Other Areas in which Boats also Fished for Tanner Crab	1975	1976	1977	1978	1979	1980
Southeastern							
Small Boats	None	23	25	27	37	42	44
Large Boast	None	13	8	11	11	15	20
Prince William Sound							
Small Boats	None	22	24	28	36	41	34
Large Boats	None	11	14	8	11	18	22
Cook Inlet							
Small Boats	None	30	39	53	77	75	42
Large Boats	None	20	25	32	25	25	27
Kodiak							
Small Boats		39	49	57	77	114	110
	South Peninsula	–	–	–	–	–	5
Large Boats[b]		66	58	45	71	102	97
	North Peninsula	11	18	5	21	22	25
	Bering Sea	5	4	6	10	9	15
South Peninsula							
Small Boats		14	19	22	23	26	45
	Kodiak	–	–	–	–	–	5
Large Boats		33	51	29	46	54	66
	Kodiak	11	18	5	21	22	25
	Bering Sea	8	19	8	11	15	23
Dutch Harbor							
Small Boats	None	–	–	–	8	10	10
Large Boats		–	9	14	16	11	12
	Bering Sea	–	8	10	10	8	8
Bering Sea							
Large Boats[b]		27	66	92	126	145	159
	Kodiak	5	4	6	10	9	15
	South Peninsula	8	19	8	11	15	23
	Dutch Harbor	–	8	10	10	8	8
	Adak	–	–	–	6	5	8
Adak							
Large Boats		–	–	–	6	6	10
	Bering Sea				6	5	8

[a]Small boats are defined as boats under 50 feet.

[b]CFEC data indicate that 5 large boats which fished for Tanner crab in the Kodiak area in 1980 also fished for Tanner crab in the southeast area that year; however, the corresponding data for the Southeast area do not indicate that any vessels which fished for Tanner crab in other areas (see pp. 127 and 218 in CFEC data). Similarly, data for large boats fishing for Tanner crab in the Bering Sea indicate that 4 of these boats also fished for Tanner crab in Southeast in 1977, although the data for Southeast do not indicate a corresponding relationship.

SOURCE: Commercial Fisheries Entry Commission, "Alaska's Fishing Fleets: A Compilation of Data on Residence of Gear Operators, Vessel Characteristics, and Fishery Diversification Patterns for Some Major Alaskan Fishing Fleets, 1969-1980" (Juneau, April 1982).

These data suggest that small boats in the Tanner crab fishery are substantially less mobile than larger boats, and are therefore likely to be helped by regulations which restrict vessel mobility and, thus, reduce competition from larger boats which also fish other areas.

The lack of mobility between areas for boats which fished in Cook Inlet and Prince William Sound suggests that exclusive registration area designations have helped to reduce competition in these areas from boats which also fish in other areas.

Allocation of Catch by Vessel Size Class

Table III-5 shows the allocation of catch in the Tanner crab fishery by vessel size class and area for the years 1980-1983. Table III-6 shows the allocation of catch among vessel size classes in percentage terms for each area.

These tables show dramatic contrasts between different areas in the allocation of Tanner crab harvests among boats of different size classes. For example, in 1982, boats greater than 100 feet in length accounted for 33 percent of total Alaska Tanner crab harvests (Table III-6). However, these boats accounted for less than 2 percent of harvests in the Southeastern, Prince William Sound, and Cook Inlet areas. In contrast, boats greater than 100 feet in length accounted for 47 percent of Bering Sea harvests.

TABLE III-5.
VOLUME OF TOTAL TANNER CRAB CATCH,
1980-1983, BY AREA AND VESSEL SIZE CLASS
(Thousands of Pounds)

	South-Eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Less than 39 feet	149	316	162	1,043	237	74	302	—	2,283
40 to 59 feet	1,513	2,443	1,962	5,211	4,491	219	808	—	16,647
60 to 79 feet	402	1,975	1,252	5,062	1,856	307	5,839	—	16,693
80 to 99 feet	794	1,083	1,250	5,684	3,186	270	25,304	183	37,754
100 to 119 feet	611	—	—	789	627	10	19,937	119	22,093
120 to 134 feet	—	66	—	44	503	—	14,671	18	15,302
Greater than 140 feet	189	—	—	314	35	—	6,747	17	7,302
TOTAL	3,658	5,883	4,626	18,147	10,935	880	73,608	337	118,074
1981									
Less than 39 feet	36	134	169	559	—	9	1,174	—	2,081
40 to 59 feet	2,359	1,083	787	3,250	2,780	139	83	—	10,481
60 to 79 feet	445	706	912	3,688	558	88	6,636	—	13,033
80 to 99 feet	155	799	1,076	2,853	2,261	50	23,516	96	30,806
100 to 119 feet	289	—		1,126	487	—	20,113	22	22,037
120 to 134 feet	20	—		23	96	—	14,751	96	14,986
Greater than 140 feet	—	—	1	178	30	—	4,745	6	4,960
TOTAL	3,304	2,722	2,945	11,677	6,212	286	71,018	220	98,384
1982									
Less than 39 feet	146	216	231	368	130	42	408	—	1,541
40 to 59 feet	2,700	1,192	704	2,748	2,717	232	310	—	10,603
60 to 79 feet	627	891	1,017	3,467	901	304	3,433	13	10,653
80 to 99 feet	91	728	694	4,684	1,276	117	16,083	109	23,782
100 to 119 feet	14	28	—	1,802	1,015	36	10,597	324	13,816
120 to 134 feet	—	—	43	163	236	—	6,150	79	6,671
Greater than 140 feet	25	—	—	473	130	—	1,326	534	2,488
TOTAL	3,606	3,055	2,689	13,705	6,405	731	38,307	1,059	69,554
1983									
Less than 39 feet	26	88	197	653	30	30	86	-	1,110
40 to 59 feet	36	401	572	4,458	2,386	58	-	-	7,911
60 to 79 feet	89	334	975	4,503	653	229	2,730	-	9,513
80 to 99 feet	3	170	432	4,877	1,723	183	12,583	170	20,141
100 to 119 feet	-	-	-	2,652	646	38	7,597	45	10,978
120 to 134 feet	-	-	173	855	774	-	5,213	12	7,027
Greater than 140 feet	-	-	-	826	53	-	570	18	1,467
TOTAL	154	993	2,349	18,824	6,265	538	28,779	245	58,147

— Less than 500 pounds.

NOTES: Year refers to calendar year. Catch data do not include catch by vessels for which the length was unknown. (In 1983, catch by these vessels was 1,383 thousand pounds, or approximately 2 percent of total catch.) Data for 1983 are preliminary and are subject to change.

SOURCE: Commercial Fisheries Entry Commission Data.

TABLE III-6.
SHARE OF VESSEL SIZE CLASSES IN TOTAL TANNER CRAB CATCH,
BY AREA, 1980-1983

	South-Eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Less than 60 feet	45	47	46	34	45	33	2	—	16
60 to 79 feet	11	34	27	25	18	35	8	—	14
80 to 99 feet	22	18	27	18	31	31	34	54	32
Greater than 100 feet	22	1	—	6	11	1	56	46	38
TOTAL	100	100	100	100	100	100	100	100	100
1981									
Less than 60 feet	72	45	35	33	45	52	2	—	13
60 to 79 feet	13	26	34	32	9	31	9	—	13
80 to 99 feet	5	29	40	24	36	17	33	44	31
Greater than 100 feet	9	—	—	11	10	—	56	56	43
TOTAL	100	100	100	100	100	100	100	100	100
1982									
Less than 60 feet	51	46	35	23	44	37	2	—	17
60 to 79 feet	17	29	38	25	14	42	9	1	15
80 to 99 feet	3	24	26	34	20	16	42	10	34
Greater than 100 feet	1	1	2	18	22	5	47	88	33
TOTAL	100	100	100	100	100	100	100	100	100
1983									
Less than 60 feet	40	49	33	27	39	16	-	-	16
60 to 79 feet	58	34	42	24	10	43	9	-	16
80 to 99 feet	2	17	18	26	28	34	44	69	35
Greater than 100 feet	-	-	7	23	24	7	46	31	33
TOTAL	100	100	100	100	100	100	100	100	100

— Less than .5 percent.

NOTE: Totals may not add exactly to 100 due to rounding.

SOURCE: Commercial Fisheries Entry Commission Data. See Table III-4 for details.

Boats less than 60 feet in length accounted for only 17 percent of total Alaskan Tanner crab harvests in 1982. However, they accounted for 51 percent, 46 percent, and 33 percent of total harvests in the Southeastern, Prince William Sound, and Cook Inlet areas, compared to only 2 percent of harvests in the Bering Sea.

Large boats account for a greater share of harvests in the Kodiak and South Peninsula areas than in the three eastern areas, but their share is still far smaller than in the Bering Sea. Thus, the composition of the fleets fishing for Tanner crab in these two areas appears to have been intermediate between those of the three eastern areas and that of the Bering Sea.

Table III-7 illustrates the same patterns in terms of the shares of different areas in total harvests for each vessel size class. The Bering Sea accounted for 55 percent of total Tanner crab harvests in 1982. However, it accounted for 79 percent of harvests by boats greater than 100 feet in length, and 68 percent of harvests by boats between 80 and 99 feet in length. In contrast, the Bering Sea accounted for only 32 percent and 6 percent of harvests among the two smaller vessel size classes. Each of the three eastern areas accounted for 4 percent of total statewide Tanner crab harvests, but they accounted for insignificant shares of total harvests by boats greater than 100 feet in length, compared to shares for smaller boats as high as 23 percent (boats less than 60 feet in length in the Southeastern area).

TABLE III-7.
SHARE OF AREAS IN TOTAL TANNER CRAB CATCH,
BY VESSEL SIZE CLASS, 1980-1983

	South-Eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Less than 60 feet	9	15	11	33	25	2	6	—	100
60 to 79 feet	2	12	8	30	11	2	35	—	100
80 to 99 feet	2	3	3	15	8	1	67	1	100
Greater than 100 feet	2	—	—	3	3	—	93	—	100
All size classes	3	5	4	13	9	1	62	—	100
1981									
Less than 60 feet	19	10	8	26	22	1	10	—	100
60 to 79 feet	3	5	7	28	4	1	51	—	100
80 to 99 feet	1	3	3	9	7	—	76	—	100
Greater than 100 feet	1	—	—	3	1	—	94	—	100
All size classes	3	3	3	12	6	—	72	—	100
1982									
Less than 60 feet	23	12	8	26	23	2	6	—	100
60 to 79 feet	6	8	10	33	8	3	32	—	100
80 to 99 feet	—	3	3	20	5	1	68	1	100
Greater than 100 feet	—	—	—	11	6	—	79	4	100
All size classes	5	4	4	20	9	1	55	2	100
1983									
Less than 60 feet	1	6	10	65	31	1	1	-	100
60 to 79 feet	1	4	10	47	7	2	29	-	100
80 to 99 feet	-	1	2	24	9	1	62	1	100
Greater than 100 feet	-	-	1	22	8	-	69	-	100
All size classes	-	2	4	32	11	1	49	-	100

— Less than .5 percent.

NOTE: Totals may not add exactly to 100 due to rounding.

SOURCE: Commercial Fisheries Entry Commission Data. See Table III-4 for details.

Obviously, many factors besides management regulations have influenced these patterns of allocation among vessel size classes. For instance, weather conditions would probably have kept the small-boat share of Bering Sea harvests small no matter what regulations had been used in the fishery. Nevertheless, patterns of allocation in the fishery suggest that regulations have worked to deter fishing by large boats in some areas.

The low shares of large boats in Tanner crab harvests in the Prince William Sound and Cook Inlet areas, compared with other areas, suggest that exclusive registration area designations have worked to reduce large-boat fishing effort in these areas. Similarly, restrictive pot limits in the Southeastern area as well as the scheduling of the Southeastern season at the same time as King crab or Tanner crab seasons in other areas may have contributed to the very low share of large boats in the Southeastern Tanner crab harvest.

Changes in the relative productivity of different areas during the period 1981-1983 appear to have affected the allocation of Tanner crab catch among vessels of different size classes in several areas. Total harvests in the Bering Sea fell dramatically between 1981 and 1983, while harvests in the Kodiak area rose, and harvests in other areas remained relatively unchanged. We might therefore expect some larger boats to have shifted part of their fishing effort away from the Bering Sea to other areas. This appears to have occurred.

As shown in Table III-6, the share of boats greater than 100 feet in length in South Peninsula harvests increased from

10 percent in 1981 to 24 percent in 1983; their share in the Kodiak harvest increased from 11 percent to 23 percent over the same period, and their share in the Cook Inlet harvest increased from zero to 7 percent.

Tanner crab fishing effort by larger vessels appears to be shifting away from the Bering Sea area to other areas as harvests have declined dramatically in the Bering Sea. This is likely to alter traditional patterns of allocation between small and large vessels in these areas.

Allocation of Catch by Residency of Vessel Owners

Table III-8 shows the allocation of catch in the Tanner crab fishery between locally-owned vessels, nonlocal Alaskan-owned vessels, and non-Alaskan owned vessels, for each area, for the years 1980-1983. Table III-9 shows the allocation of catch among local and nonlocal vessels in percentage terms, and Table III-10 shows, in percentage terms, where vessels from each area actually harvested Tanner crab.

As shown in Table III-9, non-Alaskan-owned boats accounted for almost all Bering Sea Tanner crab harvests. The share of out-of-state boats in Bering Sea harvests rose from 84 percent in 1980 to 93 percent in 1983. In contrast, locally-owned boats accounted for very high shares of Tanner crab harvests in the Prince William Sound and Cook Inlet areas--over 80 percent since 1981. The shares of local boats in the Southeastern and Kodiak areas were also over 80 percent in 1981 and 1982. However, the share of local boats

TABLE III-8.
VOLUME OF TOTAL TANNER CRAB CATCH, 1980-1983,
BY AREA AND MAILING ADDRESS OF OWNER
(thousands of pounds)

Year and Owner's Mailing Address	South-eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Local	1,980	4,220	4,112	15,171	4,707	268	67	-	30,525
Nonlocal									
Southeastern	-	66	90	204	6	-	-	-	366
Prince William Sd.	-	-	-	-	-	-	-	-	
Cook Inlet	-	254	-	124	70	14	1,143	-	1,605
Kodiak	160	4	62	-	3,216	-	5,539	11	8,992
South Peninsula	-	-	-	-	-	14	-	-	14
Aleutians	75	18	-	37	292	-	3,810	6	4,238
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	393	274	51	393	320	63	1,482	-	2,976
Out of State	1,052	1,047	316	2,530	2,522	522	63,415	320	71,724
TOTAL	3,660	5,883	4,631	18,459	11,133	881	75,456	337	120,440
1981									
Local	2,700	2,213	2,512	9,669	2,767	132	-	-	19,993
Nonlocal									
Southeastern	-		238	-	43	2	-	-	283
Prince William Sd.	40	-	-	-	-	-	-	-	40
Cook Inlet	13	13	-	22	-	2	949	-	999
Kodiak	55	-	147	-	2,217	10	4,686	-	7,115
South Peninsula	-	-	-	25	-	-	120	-	145
Aleutians	-	-	4	25	-	-	2,991		3,020
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	81	30	34	76	-	-	526	-	747
Out of State	415	467	10	1,877	1,191	146	62,218	221	66,545
TOTAL	3,304	2,723	2,945	11,694	6,218	292	71,490	221	98,887
1982									
Local	3,038	2,459	2,116	11,247	2,962	346	-	-	21,822
Nonlocal									
Southeastern	-	159	267	35	77	-	408	-	946
Prince William Sd.	29	-	-	-	-	13	-	-	42
Cook Inlet	25	-	-	161	56	-	653	13	908
Kodiak	44	57	169	-	1,149	3	481	1	1,904
South Peninsula	-	-	-	111	-	-	193	-	304
Aleutians	133	-	-	14	-	-	2,413	2	2,908
Bering Sea	-	10	-	-	-	-	-	-	10
Other Alaska	25	123	79	111	7	6	-	-	351
Out of State	344	247	60	2,025	2,154	367	35,034	1,051	41,282
TOTAL	3,638	3,055	2,691	13,704	6,405	735	39,182	1,067	70,477
1983									
Local	101	791	1,874	11,046	2,246	145	-	-	16,203
Nonlocal									
Southeastern	-	3	102	122	-	-	-	-	227
Prince William Sd.	-	-		125	-	22	-	-	147
Cook Inlet	-	-	-	394	-	4	396	-	794
Kodiak	-	-	212	-	302	-	894	-	1,408
South Peninsula	-	-	-	190	-	-	242	-	432
Aleutians	-	-	-	292	121	-	345	-	758
Bering Sea	-	-	-	21	-	-	-	-	21
Other Alaska	3	121	42	398	210	-	113	-	887
Out of State	50	78	121	6,237	3,387	366	27,818	245	38,302
TOTAL	154	993	2,351	18,825	6,266	537	29,808	245	59,179

See Notes on Following Page.

Table III-8.
Volume of Total Tanner Crab Catch, 1980-83
By Area and Mailing Address of Owner
(Continued)

- Less than 500 pounds

NOTES: "Local" catch refers to catch caught by local boats; i.e., Southeastern boats in the Southeastern area, Cook Inlet boats in the Cook Inlet area. Year refers to calendar year. Catch data do not include catch of vessels for which the owner's mailing address was not known. (In 1983, catch by these vessels was 352 thousand pounds, or approximately 1 percent of total catch.) The 1983 data are preliminary and subject to change.

SOURCE: Commercial Fisheries Entry Commission data.

TABLE III-9.
SHARE OF LOCAL ALASKA, NONLOCAL ALASKA, AND NON-ALASKA FLEETS IN TOTAL TANNER CRAB CATCH, 1980-1983, BY REGISTRATION AREA

Year and Owner's Mailing Address	South-eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Local	54	72	89	82	42	30	-	-	25
Nonlocal									
Southeastern	-	1	2	1	-	-	-	-	-
Prince William Sd.	-	-	-	-	-	-	-	-	-
Cook Inlet	-	4	-	1	1	2	2	-	1
Kodiak	4	-	1	-	29	-	7	3	7
South Peninsula	-	-	-	-	-	2	-	-	-
Aleutians	2	-	-	-	3	-	5	2	4
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	11	5	1	2	3	7	2	-	2
Out of State	29	18	7	14	23	59	84	95	60
TOTAL	100	100	100	100	100	100	100	100	100
1981									
Local	82	81	85	83	44	45	-	-	20
Nonlocal									
Southeastern	-	-	8	-	1	1	-	-	-
Prince William Sd.	1	-	-	-	-	-	-	-	-
Cook Inlet	-	1	-	-	-	1	1	-	1
Kodiak	2	-	1	-	36	3	7	-	7
South Peninsula	-	-	-	-	-	-	-	-	-
Aleutians	-	-	-	-	-	-	4	-	3
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	2	1	1	1	-	-	1	-	1
Out of State	13	17	-	16	19	50	87	100	67
TOTAL	100	100	100	100	100	100	100	100	100
1982									
Local	84	80	79	82	46	-	-	-	31
Nonlocal									
Southeastern	-	5	10	-	1	-	1	-	1
Prince William Sd.	1	-	-	-	-	2	-	-	-
Cook Inlet	1	-	-	1	1	-	2	1	1
Kodiak	1	2	6	-	18	-	1	-	3
South Peninsula	-	-	-	1	-	-	1	-	-
Aleutians	4	-	-	-	-	-	6	-	4
Bering Sea	-	-	-	-	-	47	-	-	-
Other Alaska	1	4	3	1	-	1	-	-	1
Out of State	9	8	2	15	34	50	89	99	59
TOTAL	100	100	100	100	100	100	100	100	100
1983									
Local	66	80	80	59	36	27	-	-	27
Nonlocal									
Southeastern	-	-	4	1	-	-	-	-	-
Prince William Sd.	-	-	-	1	-	4	-	-	-
Cook Inlet	-	-	-	2	-	1	1	-	1
Kodiak	-	-	9	-	5	-	3	-	2
South Peninsula	-	-	-	1	-	-	1	-	1
Aleutians	-	-	-	2	2	-	1	-	1
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	2	12	2	2	3	-	-	-	1
Out of State	32	8	5	33	54	68	93	100	65
TOTAL	100	100	100	100	100	100	100	100	100

See Notes on Following Page.

Table III-9.
Share of Local Alaska, Nonlocal Alaska, and
Non-Alaska Fleets in Total Tanner Crab Catch,
1980-1983, by Registration Area (Continued)

- Less than .5 percent.

NOTES: Totals may not add exactly to 100 due to rounding. For other notes, see Table III-8.

SOURCE: Commercial Fisheries Entry Commission data, shown in Table III-8.

TABLE III-10.
DISTRIBUTION OF CATCH BY REGISTRATION AREAS, FOR ALASKAN AND NON-ALASKAN FLEETS, 1980-1983

Year and Owner's Mailing Address	South-eastern	Prince William Sound	Cook Inlet	Kodiak	South Peninsula	Dutch Harbor	Bering Sea	Adak	Total
1980									
Alaska									
Southeastern	84	3	4	9	-	-	-	-	100
Prince William Sd.	-	100	-	-	-	-	-	-	100
Cook Inlet	-	4	72	2	1	-	20	-	100
Kodiak	1	-	-	63	13	-	23	-	100
South Peninsula	-	-	-	-	100	-	-	-	100
Aleutians	2	-	-	1	6	6	85	-	
Bering Sea	-	-	-	-	-	-	100	-	100
Other Alaska	13	9	2	13	11	2	50	-	100
Non-Alaska									
Total	3	5	4	15	9	1	63	-	100
1981									
Alaska									
Southeastern	90	-	8	-	1	-	-	-	100
Prince William Sd.	2	98	-	-	-	-	-	-	100
Cook Inlet	-	-	72	1	-	-	27	-	100
Kodiak	-	-	1	58	13	-	28	-	100
South Peninsula	-	-	-	1	95	-	4	-	100
Aleutians	-	-	-	1	-	4	95	-	100
Bering Sea	-	-	-	-	-	-	-	-	-
Other Alaska	11	4	5	10	-	-	70	-	100
Non-Alaska									
Total	1	1	-	3	2	-	93	-	100
1982									
Alaska									
Southeastern	76	4	7	1	2	-	10	-	100
Prince William Sd.	1	98	-	-	-	1	-	-	100
Cook Inlet	1	-	70	5	2	-	22	-	100
Kodiak	-	-	1	86	9	-	4	-	100
South Peninsula	-	-	-	3	91	-	6	-	100
Aleutians	5	-	-	-	-	12	83	-	100
Bering Sea	-	100	-	-	-	-	-	-	100
Other Alaska	7	36	23	32	2	-	-	-	100
Non-Alaska	1	1	-	5	5	1	85	3	100
Total	5	4	4	19	9	1	56	2	100
1983									
Alaska									
Southeastern	76	4	7	1	2	-	10	-	100
Prince William Sd.	1	98	-	-	-	1	-	-	100
Cook Inlet	1	-	70	5	2	-	22	-	100
Kodiak	-	-	1	86	9	-	4	-	100
South Peninsula	-	-	-	3	91	-	6	-	100
Aleutians	5	-	-	1	-	12	83	-	100
Bering Sea	-	100	-	-	-	-	-	-	-
Other Alaska	7	36	23	32	2	-	-	-	100
Non-Alaska	-	-	-	16	9	1	73	1	100
Total	-	2	4	32	11	1	50	-	100

- Less than .5 percent.

NOTES: Totals may not add exactly to 100 due to rounding. For other notes, see Table III-7.

SOURCE: Commercial Fisheries Entry Commission data, shown in Table III-7.

in the Kodiak area declined substantially in 1983, when out-of-state boats caught one-third of the total Tanner crab harvest. In the South Peninsula area, the share of out-of-state boats in total harvests rose from 19 percent in 1981 to 54 percent in 1983, while the local share fell from 44 percent to 36 percent and the nonlocal Alaskan share (mostly Kodiak boats) fell from 37 percent to 10 percent.

These patterns and trends in the allocation of catch by residency of boat owners parallel those in the allocation of catch by vessel size class. This is to be expected since vessel size class and residency of boat owners are highly correlated, as we showed in Chapter II. In sum,

> Locally-owned boats account for very high shares of total Tanner crab harvests in the Prince William Sound and Cook Inlet areas, which are exclusive registration areas. In the Southeastern, Kodiak, and South Peninsula areas, the shares of locally-owned boats in total harvests fell sharply betweeen 1982 and 1983, while the shares of out-of-state boats rose. Apparently, out-of-state boats have shifted part of their fishing effort to these areas as Bering Sea harvests have fallen.

The Allocation Problem in the Tanner Crab Fishery

If harvests are increasing in an open-entry fishery, allocation is not usually a problem. Harvests of small and large boats or local and non-local boats can all rise, although harvests may rise more rapidly for some classes of boats than for others.

If harvests are stable in an open-entry fishery, allocation becomes more important. As new vessels continue to enter the fishery, competition for limited resources increases. Harvests by some vessel classes may rise at the expense of harvests by other vessel classes. However, regulations may benefit vessel classes which might otherwise face declining harvest shares through their effects on the fishing opportunities available to boats--in partcular, by forcing boats to choose between fishing areas rather than permitting them to fish sequentially in multiple areas. Regulations such as exclusive registration areas in Prince William Sound and Cook Inlet appear to have effectively protected the local harvest share of small boats in these areas during the period of rising or stable statewide Tanner crab harvests through 1981.

Since 1981, however, statewide Tanner crab harvests have fallen dramatically, from 110 million pounds to 61 million pounds in 1983. As harvests have decreased, the allocation of harvests has become more important.

The fundamental allocation problem facing the managers of the Tanner crab fishery is the question of which vessels will bear the losses from dramatically lower harvests for the fishery as a whole. This problem is complicated by the fact that the bulk of the decline in harvests has occurred in the Bering Sea, which has traditionally been fished by large out-of-state boats, while harvests in other areas traditionally fished by smaller locally-owned boats have remained steady or actually increased.

Fishery managers cannot avoid addressing this problem since whatever they do will affect the way in which vessels of different classes share in the overall decline of Tanner crab harvests. The decisions about whether or not to change management regulations will affect patterns of fishing effort throughout the fishery. This will affect whether or not the burden of declining Bering Sea harvests is borne primarily by larger vessels which have previously fished primarily in the Bering Sea or by smaller vessels in other areas, due to increased competition from former Bering Sea boats.

The question of how fishery management measures should attempt to influence who bears the burden of declining harvests is a political question. There is no technical "right" answer. There is no solution which can make everyone happy. Nevertheless, the question cannot be avoided.

This does not mean that the Board of Fisheries and the North Pacific Fishery Management Council can choose whatever pattern of allocation they desire for the Tanner crab fishery. In addition to the legal standards of the Magnuson Act, they are constrained by the fact that the Tanner crab fishery is an open-entry fishery so that there is only a limited range within which regulations can affect allocation. For example, an exclusive registration area will not be effective in protecting a local fishery such as that in Cook Inlet if the area should become more attractive to nonlocal vessels than other areas. If large boats leave the Bering Sea to fish elsewhere, measures designed to divert them from one area (such as the South Peninsula) may end up only diverting them to other areas (such as Kodiak).

In Chapter IV, we will examine the implications of the proposed exclusive registration areas and pot limit regulations for allocation in the Tanner crab fishery. We will examine how these regulations might affect the allocation of catch in these and other areas between small and large boats and between local and nonlocal boats. However, we will not attempt to suggest whether or not these effects are desirable since this is a political question which can be decided only by the appropriate political institutions.

IV. ALLOCATIVE EFFECTS OF THE PROPOSED NEW EXCLUSIVE REGISTRATION AREAS AND POT LIMITS IN THE ALASKA TANNER CRAB FISHERY

In this chapter, we examine potential allocative effects of the proposed new exclusive registration areas in the South Peninsula and Southeastern Tanner crab fisheries and the proposed new pot limit for the Kodiak area.

The primary effects of all three of the proposed regulations would occur as a result of shifts in patterns of vessel participation throughout the Tanner crab fishery. More boats would fish in some areas and fewer boats would fish in other areas. While it is possible to predict the general patterns of changes which might occur, it is very difficult to quantify these changes since so many difficult factors affect patterns of vessel participation.

Allocative Effects of an Exclusive Registration Area in the South Peninsula Tanner Crab Fishery

Patterns of Allocation in Recent Years

As we discussed in Chapter III, the allocation of the South Peninsula Tanner crab catch shifted dramatically between 1981 and 1983. Total harvests stayed relatively constant over this period, between 6.2 and 6.4 million pounds. However, the share of locally owned boats in total harvests fell from 44 percent to 36 percent. The share of nonlocal Alaskan boats fell from 37 percent to 10 percent, while the share of non-Alaskan-owned boats rose from 19 percent to 54 percent (Table III-9). Paralleling these trends was an increase in the share of boats greater than 100 feet in length from 10 percent to 24 percent.

Table IV-1 shows the shifts in vessel participation which have underlain these shifts in allocation. Since 1981, the total number of boats fishing for Tanner crab in the South Peninsula area increased from 77 to 114. The number of locally owned boats increased from 42 to 57, and the number of nonlocal Alaskan owned boats increased from 19 to 47. While the numbers of both locally owned boats and nonlocally owned boats increased, the new nonlocally owned boats were considerably larger. Most of the increase in locally owned boats was in boats between 40 and 59 feet in length, while most of the increase in nonlocally owned boats was in boats between 50 and 99 feet in length.

Of the boats which fished for Tanner crab in the South Peninsula area, the overall fishing activities of locally owned boats varied strikingly from those of nonlocally owned boats. As shown in Table IV-2, Tanner crab accounted for between 17 and 29 percent of the value of total catch for locally owned boats. During the years 1980-1982, almost all of these Tanner crab were caught in the South Peninsula area. King crab accounted for between 24 and 27 percent of the value of total catch of locally owned boats. However, salmon was the most important fishery for locally owned boats, accounting for between 42 and 56 percent of the value of their total catch.

In contrast, nonlocal boats derived almost all of their income from Tanner crab and King crab. In addition, their Tanner crab catch from other areas generally exceeded their South Peninsula Tanner crab catch.

TABLE IV-1.
NUMBER OF BOATS PARTICIPATING IN THE SOUTH PENINSULA TANNER CRAB FISHERY, 1980 - 1983, BY LENGTH AND OWNER'S MAILING ADDRESS

Year and Owners' Mailing Address	Less than 39'	40 to 59'	60 to 79'	80 to 99'	100 to 119'	120 to 139'	Greater than 140'	TOTAL
1980								
South Peninsula	4	32	6	2	-	-	-	44
Other Alaska	2	8	11	13	1	3	-	39
Out-of-State	2	6	4	13	4	1	1	31
TOTAL	8	46	21	28	5	4	1	116
1981								
South Peninsula	-	35	5	2	-	-	-	42
Other Alaska	-	4	3	7	-	1	1	16
Out-of-State	-	3	1	9	3	2	-	19
TOTAL	-	42	9	18	3	3	1	77
1982								
South Peninsula	1	41	4	1	1	-	-	48
Other Alaska	2	2	6	9	1	-	1	21
Out-of-State	-	4	7	14	7	4	1	37
TOTAL	3	47	17	24	9	4	2	107
1983								
South Peninsula	2	49	5	1	-	-	-	57
Other Alaska	-	1	3	4	-	1	-	9
Out-of-State	-	6	5	21	-	6	1	47
TOTAL	2	56	13	26	8	7	1	114

- No vessels.

SOURCE: Commercial Fisheries Entry Commission.

NOTE: Totals include three vessels for which length or residency was unknown for 1980 and one for the years 1981-1983.

TABLE IV-2.
SHARE OF SPECIES IN VALUE OF TOTAL CATCH
FOR VESSELS PARTICIPATING IN THE SOUTH PENINSULA
TANNER CRAB FISHERY, BY MAILING ADDRESS
OF VESSEL OWNER, 1980 - 1982

	Mailing Address of Vessel Owner		
	South Peninsula	Other Alaska	Non-Alaska
1980			
South Peninsula Tanner	29	16	14
Other Tanner Crab	0	24	18
King Crab	27	50	60
Halibut	0	0	0
Salmon	42	1	4
Other Species	2	9	4
Total	100	100	100
1981			
South Peninsula Tanner	17	25	11
Other Tanner Crab	0	8	26
King Crab	26	62	56
Halibut	0	0	0
Salmon	56	1	6
Other Species	0	4	2
Total	100	100	100
1982			
South Peninsula Tanner	28	16	16
Other Tanner Crab	2	34	36
King Crab	24	45	44
Halibut	1	3	1
Salmon	43	1	2
Other Species	1	1	0
Total	100	100	100

SOURCE: Commercial Fisheries Entry Commission.

In sum, the South Peninsula Tanner crab fishery is fished by two quite different types of boats: small, locally owned boats which only fish the South Peninsula area and which derive the largest share of their income from salmon, and larger, nonlocally owned boats which fish almost exclusively for Tanner crab and King crab and which catch more Tanner crab in other areas than in the South Peninsula area.

Table IV-3 illustrates the range of possible benefits or costs to local and nonlocal boats which could result from changes in the allocation of the South Peninsula Tanner crab harvest, based on 1982 data. In 1982, local boats harvested 46 percent of the South Peninsula Tanner crab catch, which accounted for 28 percent of their income. If their share of the Tanner crab catch had fallen to zero, their total income would have fallen by 28 percent. If local boats had harvested the entire South Peninsula Tanner crab catch, their income would have risen by 32 percent.

The relative effects of changes in the South Peninsula harvest allocation upon nonlocal boats would have been smaller. This is partly because South Peninsula Tanner crab accounted for a smaller share of the total income of these boats. In addition, they might make up part of their losses by harvesting more Tanner crab in other areas. For example, if nonlocal boats had been excluded entirely from the South Peninsula Tanner crab fishery in 1982, their aggregate income would have fallen by a maximum of 16 percent. However, if they had made up 50 percent of their losses through increased harvests in other areas, their aggregate income would have

TABLE IV-3.
HYPOTHETICAL PERCENT CHANGE IN TOTAL 1982 INCOME FOR LOCAL AND NONLOCAL BOATS IN THE SOUTH PENINSULA TANNER CRAB FISHERY, AS A FUNCTION OF LOCAL SHARE OF TANNER CRAB CATCH

Local Boat Share in South Peninsula Tanner Crab Harvest (Percent)	Percent Change in 1982 Income of Local Boats	Percent Change in 1982 Income of Nonlocal Boats, Assuming 0%, 25%, 50%, 75%, and 100% Replacement of South Peninsula Tanner Crab Losses by Increased Harvests in Other Areas[a]				
		0	25	50	75	100
100	32	-16	-12	-8	-4	0
80	20	-10	-8	-5	-3	0
60	8	-4	-3	-2	-1	0
46[b]	0	0	0	0	0	0
40	-4	+2	+1	+1	0	0
20	-16	+8	+6	+4	+2	0
0	-28	+14	+10	+7	+3	0

[a]Where nonlocal catch increases, percentages reflect extent to which increases merely offset reduced catches in other areas.

[b]Actual 1982 local share.

NOTES: Calculations based on the following 1982 harvest values, provided by the Commercial Fisheries Entry Commission. (Thousands of Dollars)

	South Peninsula Tanner Crab	Other Harvests	Total
Local Boats	3,785	9,921	13,706
Nonlocal Boats	4,447	23,357	27,804
TOTAL	8,232	33,278	41,510

fallen by only 8 percent. In effect, they could have shifted some of their losses onto local boats in other areas.

Effects of an Exclusive Registration Area

If the South Peninsula area were made an exclusive registration area, boats would have to choose between fishing for Tanner crab there or in other areas. Locally owned boats would fish in the South Peninsula area since almost all of their catch is from that area in any case. Some nonlocally owned boats might choose to fish exclusively in the South Peninsula area, while other boats might choose to fish in other areas. Whether or not the local fleet would benefit would depend upon whether or not the reduction in catch from those boats which chose to fish in other areas exceeded the potential increase in catch from nonlocal boats which chose to fish exclusively in the South Peninsula area.

In 1982, nonlocally owned boats which fished in the South Peninsula area caught more than twice as much Tanner crab in other areas as in the South Peninsula area (Table IV-2). However, the 1982 harvest was conducted under regulations for the 1981 management year, when the South Peninsula Tanner crab season opened two months prior to the Kodiak and Bering Sea seasons (Table III-2). Thus, it was possible for boats to fish in the South Peninsula area before fishing in the Kodiak or Bering Sea areas. Since the 1982 management year (the 1983 calendar year), the South Peninsula season has been scheduled at the same time as the Kodiak and Bering Sea

seasons, which may have already considerably reduced opportunities for boats to fish in more than one area. This may help to account for the dramatic drop in the 1983 share of nonlocal Alaskan boats in the South Peninsula harvest.

In 1983, according to data from the Commercial Fisheries Entry Commission, non-Alaskan owned boats which fished for Tanner crab in the South Peninsula area caught 42 percent of their total Tanner crab harvests in the South Peninsula area and 58 percent in other areas. This suggests that the pattern of fishing may be changing for these boats: with the decline of Bering Sea harvests and the opening of the South Peninsula area at the same time as other areas, the South Peninsula area may be becoming the primary Tanner crab area for many of the nonlocal boats which fish there. If this is the case, many nonlocal boats might continue to fish the South Peninsula area if it were made an exclusive registration area. Moreover, those nonlocal boats which currently catch the most Tanner crab in the South Peninsula area are those which are most likely to remain if it should become an exclusive registration area.

The fact that nonlocally owned boats which fished in the South Peninsula area caught more Tanner crab in other areas suggests that more of these boats would choose to fish in other areas than in the South Peninsula area. Thus, it is likely that the locally owned fleet would benefit to some extent from an exclusive registration area.

Thus, while an exclusive registration area might keep some nonlocal boats from fishing in the South Peninsula area, it might have only a relatively small effect on total fishing effort by nonlocal boats since these boats are already foregoing other fishing opportunities in order to fish in the South Peninsula area.

Allocative Effects of an Exclusive Registration Area in the Southeastern Tanner Crab Fishery

Patterns of Allocation in Recent Years

Our most recent reliable data for the Southeastern Tanner crab fishery are for the 1982 calendear year, when locally-owned boats accounted for 84 percent of total Southeastern harvests (Table III-9). As shown in Table IV-4, most nonlocal boats as well as most local boats were between 40 and 59 feet in length. However, 5 of the 6 boats over 80 feet in length were nonlocal boats.

Locally-owned boats in the Southeastern Tanner crab fishery were highly diversified with King crab, Halibut, Salmon, and other species all accounting for significant shares of their total harvest value (Table IV-5). In 1982 (but not in 1980 or 1981), nonlocal boats were also highly diversified. However, in contrast to local boats, nonlocal boats harvested approximately the same value of Tanner crab in other areas as in the Southeastern area.

Table IV-6 illustrates the range of possible benefits or costs to local and nonlocal boats which could result from changes in the allocation of the Southeastern Tanner crab harvest, based on 1982 data. If the share of local vessels in Tanner crab harvests in 1982 had been zero, their income would have been 29 percent lower. If the local share had been 100 percent, the aggregate income of nonlocal boats would have been as much as 12 percent lower.

TABLE IV-4.
NUMBER OF BOATS PARTICIPATING IN THE SOUTHEASTERN TANNER CRAB FISHERY, 1980 - 1983, BY LENGTH AND OWNER'S MAILING ADDRESS

Year and Owners' Mailing Address	Less than 39'	40 to 59'	60 to 79'	80 to 99'	100 to 119'	120 to 139'	Greater than 140'	TOTAL
1980								
Southeastern	9	36	6	1	-	-	-	52
Other Alaska	1	0	1	2	3	-	-	7
Out-of-State	0	3	0	2	2	-	1	8
TOTAL	10	39	7	5	5	-	1	68
1981								
Southeastern	4	36	6	1	-	-	-	47
Other Alaska	-	3	-	2	-	1	-	6
Out-of-State	-	1	1	-	2	-	-	4
TOTAL	4	40	7	3	2	1	-	59
1982								
Southeastern	17	55	7	1	-	-	-	80
Other Alaska	1	1	3	2	1	-	-	8
Out-of-State	2	15	4	1	-	-	1	23
TOTAL	20	71	14	4	1	-	1	114
1983								
Southeastern	5	1	1	-	-	-	-	7
Other Alaska	-	-	-	1	-	-	-	1
Out-of-State	-	1	1	-	-	-	-	2
TOTAL	5	2	2	1	-	-	-	10

- No vessels.

SOURCE: Commercial Fisheries Entry Commission.

NOTE: Totals include the following numbers of vessels for which length or residency was unknown: one in 1980, two in 1981, and three in 1982. Figures are for calendar year catches. The 1983 figures are for the end of the 1982 management year.

TABLE IV-5.
SHARE OF SPECIES IN VALUE OF TOTAL CATCH
FOR VESSELS PARTICIPATING IN THE SOUTHEAST
TANNER CRAB FISHERY, BY MAILING ADDRESS
OF VESSEL OWNER, 1980 - 1982

	Mailing Address of Vessel Owner		
	South-East	Other Alaska	Non-Alaska
1980			
Southeast Tanner	19	7	15
Other Tanner Crab	2	17	11
King Crab	22	69	72
Halibut	14	0	0
Salmon	34	3	2
Other Species	8	4	0
Total	100	100	100
1981			
Southeast Tanner	23	17	14
Other Tanner Crab	0	1	16
King Crab	21	35	63
Halibut	14	2	3
Salmon	32	22	4
Other Species	10	23	0
Total	100	100	100
1982			
Southeast Tanner	30	14	12
Other Tanner Crab	0	27	13
King Crab	29	24	18
Halibut	9	6	6
Salmon	18	7	27
Other Species	14	21	25
Total	100	100	100

SOURCE: Commercial Fisheries Entry Commission.

TABLE IV-6.
HYPOTHETICAL PERCENT CHANGE IN TOTAL 1982 INCOME FOR LOCAL AND NONLOCAL BOATS IN THE SOUTHEASTERN TANNER CRAB FISHERY, AS A FUNCTION OF LOCAL SHARE OF TANNER CRAB CATCH

Local Boat Share in Southeastern Tanner Crab Harvest (%)	Percent Change in 1982 Income of Local Boats	Percent Change in 1982 Income of Nonlocal Boats, Assuming 0%, 25%, 50%, 75%, and 100% Replacement of Southeastern Tanner Crab Losses by Increased Harvests in Other Areas[a]				
		0	25	50	75	100
100	+5	-12	-9	-6	-3	0
84[b]	0	0	0	0	0	0
80	-2	+3	+3	+2	+1	0
60	-8	+19	+14	+9	+5	0
40	-15	+34	+25	+17	+8	0
20	-22	+49	+37	+24	+12	0
0	-29	+64	+48	+32	+16	0

[a]Where nonlocal catch increases, percentages reflect extent to which increases merely offset reduced catches in other areas.

[b]Actual 1982 local share.

NOTES: Calculations based on the following 1982 harvest values, provided by the Commercial Fisheries Entry Commission. (Thousands of Dollars)

	Southeastern Tanner Crab	Other Harvests	Total
Local Boats	4,045	9,763	13,808
Nonlocal Boats	745	5,564	6,309
TOTAL	4,790	15,327	20,117

Effects of an Exclusive Registration Area

As of 1983, the Southeastern Tanner crab season is scheduled at the same time as the Kodiak, South Peninsula and Bering Sea seasons. Therefore an exclusive registration areas might have relatively little effect upon fishing effort of nonlocal boats, since these boats are already foregoing opportunities to fish elsewhere.

In order to project the allocative effects of an exclusive registration area in the Southeastern area reliably, we would need data on the extent to which nonlocal boats which currently fish in the Southeastern area also fish in other areas. To the extent that some of these boats harvest more Tanner crab in other areas, an exclusive registration area might deter them from fishing in the Southeastern area, and thus might benefit local boats. But as in the South Peninsula area, those nonlocal boats which would stop fishing in the Southeastern area if it became an exclusive registration area are probably less significant for nonlocal harvests than those nonlocal boats which would remain.

Allocative Effects of a 200-Pot Limit in the Kodiak Area

Patterns of Allocation in Recent Years

The share of local boats in Kodiak Tanner crab harvests fell from 82 percent in 1982 to 59 percent in 1983, while the share of out-of-state boats increased from 15 percent to 33 percent (Table III-9). As shown in Table IV-7, the number of local boats fishing the Kodiak area increased from 178 in 1982 to 226 in 1983, while the number of nonlocal boats increased from 41 to 128. While

TABLE IV-7.
NUMBER OF BOATS PARTICIPATING IN THE KODIAK TANNER CRAB FISHERY, 1980 - 1983, BY LENGTH AND OWNER'S MAILING ADDRESS

Year and Owners' Mailing Address	Less than 39'	40 to 59'	60 to 79'	80 to 99'	100 to 119'	120 to 139'	Greater than 140'	TOTAL
1980								
Kodiak	42	62	39	22	5	1	2	175
Other Alaska	3	3	2	5	-	-	-	13
Out-of-State	2	6	6	6	1	-	1	23
TOTAL	47	71	47	33	6	1	3	216
1981								
Kodiak	32	62	37	19	6	1	-	157
Other Alaska	5	4	-	-	-	-	-	9
Out-of-State	2	4	6	5	1	-	1	20
TOTAL	39	70	43	24	7	1	1	188
1982								
Kodiak	34	67	37	30	8	1	2	179
Other Alaska	2	9	-	3	-	-	-	14
Out-of-State	-	5	8	8	3	2	1	27
TOTAL	36	81	45	41	11	3	3	221
1983								
Kodiak	67	84	37	27	9	-	2	226
Other Alaska	1	13	5	7	1	1	-	28
Out-of-State	5	18	19	25	13	8	5	93
TOTAL	73	115	61	59	23	9	7	348

- No vessels.

SOURCE: Commercial Fisheries Entry Commission.

NOTE: Totals include the following numbers of vessels for which length or residency was unknown: eight in 1980, three in 1981, one in 1982, and one in 1983.

all but one of the new local boats were less than 60 feet in length, most of the new nonlocal boats were greater than 60 feet in length, including 22 new boats greater than 100 feet in length. Thus, there has been a dramatic increase in the effort by nonlocal boats in the Kodiak Tanner crab fishery, which is reflected in a significant drop in the share of locally owned boats in Tanner crab harvests.

As shown in Table IV-8, local and nonlocal boats in the Kodiak Tanner crab fishery exhibited fairly similar patterns in the aggregate composition of their total catch. Both local and nonlocal boats derived most of their income from Tanner crab and King crab harvests.

Table IV-9 illustrates the range of potential benefits or costs to local and nonlocal boats which could result from changes in the allocation of the Kodiak Tanner crab harvest, based on 1982 data. If the share of local boats in Tanner crab harvests had been zero in 1982, their income would have been 38 percent lower. On the other hand, if the local share had been 100 percent, the aggregate income of nonlocal boats would have been as much as 35 percent lower. The figures in Table IV-9 suggest that the drop in the local share of Tanner crab harvests to 59 percent in 1983 may have reduced the income of local boats by as much as 10 percent.

TABLE IV-8.
SHARE OF SPECIES IN VALUE OF TOTAL CATCH
FOR VESSELS PARTICIPATING IN THE KODIAK
TANNER CRAB FISHERY, BY MAILING ADDRESS
OF VESSEL OWNER, 1980 - 1982
(Percent)

	Mailing Address of Vessel Owner		
	Kodiak	Other Alaska	Non-Alaska
1980			
Kodiak Tanner	22	49	22
Other Tanner Crab	6	7	7
King Crab	55	25	46
Halibut	0	4	0
Salmon	9	10	5
Other Species	9	4	20
Total	100	100	100
1981			
Kodiak Tanner	16	10	25
Other Tanner Crab	3	6	2
King Crab	62	14	57
Halibut	1	1	1
Salmon	11	68	4
Other Species	7	1	10
Total	100	100	100
1982			
Kodiak Tanner	38	28	37
Other Tanner Crab	4	13	14
King Crab	46	43	39
Halibut	2	3	2
Salmon	5	11	2
Other Species	5	2	6
Total	100	100	100

SOURCE: Commercial Fisheries Entry Commission.

TABLE IV-9.
HYPOTHETICAL PERCENT CHANGE IN TOTAL 1982 INCOME FOR LOCAL AND NONLOCAL BOATS IN THE KODIAK TANNER CRAB FISHERY, AS A FUNCTION OF LOCAL SHARE OF TANNER CRAB CATCH

Local Boat Share in Kodiak Tanner Crab Harvest (%)	Percent Change in 1982 Income of Local Boats	Percent Change in 1982 Income of Nonlocal Boats, Assuming 0%, 25%, 50%, 75%, and 100% Replacement of Kodiak Tanner Crab Losses by Increased Harvests in Other Areas[a]				
		0	25	50	75	100
100	+8	-35	-26	-17	-9	0
82[b]	0	0	0	0	0	0
80	-1	+4	+3	+2	+1	0
60	-10	+43	+32	+21	+11	0
40	-19	+81	+61	+41	+20	0
20	-29	+120	+90	+60	+30	0
0	-38	+159	+119	+79	+40	0

[a]Where nonlocal catch increases, percentages reflect extent to which increases merely offset reduced catches in other areas.

[b]Actual 1982 local share.

NOTES: Calculations based on the following 1982 harvest values, provided by the Commercial Fisheries Entry Commission. (Thousands of Dollars)

	Kodiak Tanner Crab	Other Harvests	Total
Local Boats	20,931	34,242	55,173
Nonlocal Boats	4,573	8,614	13,187
TOTAL	25,504	42,856	68,360

Effects of a 200-Pot Limit

A 200-pot limit could affect allocation in the Kodiak Tanner crab fishery in two ways. First, it could reduce the catching power of some boats. Secondly, it could cause some boats to fish in other areas rather than fish with only 200 pots. We will examine each of these effects in turn.

A 200-pot limit would only reduce the catching power of those boats which would ordinarily fish more than 200 pots. Of the 219 boats which fished in the Kodiak area in 1982, 47 fished more than 200 pots (North Pacific Fishery Management Council, Regulatory Issues Paper for Amendment #10 in the Fishery Management Plan, September 1983, page 10). As shown in Table IV-7, 57 of the boats which fished the Kodiak area in 1982 were greater than 80 feet in length. Therefore, it appears reasonable to assume that only boats greater than 80 feet in length would be affected by a limit of 200 pots.

The effect of a 200-pot limit in the Kodiak fishery must be compared with the alternative case of no-pot limit, since the 250-pot limit which was in effect through the 1983 calendar year is now no longer in effect. We can examine the potential effect of the 200-pot limit in 1983 by first examining what patterns of allocation might have prevailed in 1983 in the absence of pot limits, and then comparing them with the patterns of allocation which might have occurred had there been a limit of 200 pots instead of 250 pots.

In order to project allocation under different pot limits, we must first make assumptions about the extent to which pot limits would reduce boats' catching power. We have already assumed that boats less than 80 feet in length would not be affected by pot limits. We do not have any reliable information on which to base assumptions about the effects of pot limits on the catching power of boats larger than 80 feet in length. A boat's catching power is not necessarily proportional to the number of pots which it fishes since if a boat fishes fewer pots it may be able to fish them more intensively. However, it seems reasonable to assume that without pot limits, the total catching power of boats greater than 80 feet in length in the 1983 Kodiak fishery might have increased by between zero and 30 percent. Similarly, if a 250-pot limit had been in effect instead of a 200-pot limit, the catching power of these boats might have decreased by between zero and 20 percent.

In Table IV-10, we illustrate the patterns of allocation that would have occurred in the 1983 Kodiak Tanner crab fishery under a variety of assumptions within these ranges. In the most extreme

TABLE IV-10.
HYPOTHETICAL 1983 KODIAK TANNER CRAB HARVEST SHARES IN THE ABSENCE OF A POT LIMIT AND WITH A 200-POT LIMIT, UNDER DIFFERENT ASSUMED PERCENT REDUCTIONS IN THE RATE OF HARVEST BY LARGE BOATS DUE TO POT LIMITS

	Share of Kodiak Tanner Crab Harvest			
	Small[1] Boats	Large Boats	Local Boats	Nonlocal Boats
Actual 1983 Shares[2]	51	49	59	41
Hypothetical Shares in the Absence of 250-Pot Limit, Assuming that without the Limit, the Rate of Harvest by Large Boats Would Increase from 1983 Levels by the following:[3,4]				
30 percent	44.5	55.5	55.3	44.7
20 percent	46.4	53.6	56.4	43.6
10 percent	48.6	51.4	57.7	42.3
5 percent	49.8	50.2	58.3	41.7
0 percent	51.0	49.0	59.0	41.0
Hypothetical Shares with a 200-Pot Limit, Assuming that the Limit would Reduce the 1983 Rate of Harvests for Large Boats by the following:[5,4]				
20 percent	56.5	43.5	62.1	37.9
15 percent	55.0	45.0	60.5	39.5
10 percent	53.6	46.4	59.1	40.9
5 percent	52.3	47.7	59.8	40.2
0 percent	51.0	49.0	59.0	41.0

[1]Small boats are defined as those less than 80 feet in length.

[2]Based on data in Tables III-6 and III-9.

[3]Large boat share calculated as

$$\frac{49 \times (1 + \text{percent increase}/100)}{51 + 49 \times (1 + \text{percent increase}/100)}$$

[4]Nonlocal and local shares calculations based on assumption that nonlocal boats accounted for 70 percent of large boat harvests and 13.1 percent of small boat harvests.

[5]Large boat share calculated as

$$\frac{49 \times (1 - \text{percent reduction}/100)}{51 + 49 \times (1 - \text{percent reduction}/100)}$$

case, the catching power of "large" boats--those greater than 80 feet in length--might have been 30 percent greater in the absence of a 250-pot limit. As a result, the ratio of the total catching power of large boats to the total catching power of small boats would have risen, causing the harvest share of large boats to rise from 49 percent to 56 percent. Similarly, in the most extreme case, the catching power of "large" boats might have been 20 percent lower with a 200-pot limit instead of a 250-pot limit, which would have caused the harvest share of large boats to fall from 49 percent to 44 percent. Thus, in the extreme, a 200-pot limit in the 1983 Kodiak Tanner crab fishery might have affected the allocation between small and large boats of as much as 12 percent of the total catch by reducing the catching power of large boats. Similarly, a 200-pot limit might have affected allocation between local and nonlocal boats of as much as 7 percent of the total catch. However, these is an extreme case, and it is likely that the actual effects of pot limits due to reductions in catching power would be much smaller.

A pot limit could also affect allocation in the Kodiak area by affecting where boats choose to fish. Boats which are capable of fishing substantially more than 200 pots might choose to fish in other areas, such as the Bering Sea, if faced with a 200-pot limit in the Kodiak area. Conversely, without a pot limit, large boats which have previously fished the Bering Sea may choose to fish the

Kodiak area instead. We do not have enough data to estimate the potential importance of pot limits in affecting where boats fish, but it is possible that these effects are more important for allocation than actual reductions in boats' catching power.

In sum, a 200-pot limit in the Kodiak area might significantly reduce the share of larger boats in Kodiak Tanner crab harvests by reducing the catching power of some boats and by inducing other boats to fish elsewhere. However, we do not have sufficient data to quantify these potential effects of a pot limit.

V. CONCLUSIONS

Our analysis in Chapter III suggested that the fundamental allocation problem facing the managers of the Tanner crab fishery is the question of who will bear the losses resulting from dramatically lower Tanner crab harvests in the Bering Sea. To the extent that large, non-Alaskan owned vessels shift their effort from the Bering Sea to other areas, smaller locally-owned boats in these areas may face reduced harvests due to increased competition. The proposed exclusive registration areas in the South Peninsula and Southeastern areas and the proposed pot limit in the Kodiak area represent, in part, attempts to maintain local harvest shares in these areas.

Exclusive registration areas appear to have been effective in reducing fishing by large nonlocal boats in the Prince William Sound and Cook Inlet areas. However, they have been effective partly because the Bering Sea has served as a powerful lure for large boats. With the decline in Bering Sea harvests, exclusive registration areas may not be as effective in protecting other areas. In addition, since the Southeastern, Kodiak, South Peninsula and Bering Sea seasons are now scheduled to open at the same time, opportunities for boats to fish in more than one area have already been greatly reduced. Thus, while exclusive registration areas in the South Peninsula and Southeastern areas might somewhat reduce

fishing by nonlocal boats in these areas, these effects may be fairly small. We do not have enough data to estimate reliably the magnitude of these effects--while we cannot demonstrate that they would have significant effects, we also cannot demonstrate that they would not.

A pot limit in the Kodiak area might significantly reduce the share of large nonlocal boats in Kodiak Tanner crab harvests, by reducing the catching power of some boats and by inducing some boats to fish in other areas instead. Again, however, we do not have enough data to estimate reliably the magnitude of these effects.

If the managers of the Tanner crab fishery should decide to attempt to preserve local harvest shares in these areas, no measures will work perfectly in an open entry fishery. The proposed exclusive registration areas and pot limits might be effective to some extent, but it is difficult to project their effects reliably. In the end, the question may be whether the regulations should be adopted because they might work, or rejected because they might not.

APPENDIX A.
A MODEL OF INDIRECT ALLOCATION IN OPEN-ENTRY FISHERIES

Introduction

In this appendix, we use a simple model to examine the allocative effects of regulations in an open-entry fishery. We examine the effects of three kinds of regulations--gear restrictions, exclusive area registration, and season scheduling. Our model suggests that all three of these regulations may tend to favor one kind of boat over another in an open-entry fishery--that is, they may have indirect allocative effects.

The examples with which we illustrate our model are purely hypothetical. They do not necessarily depict the actual effects of regulations in any particular Alaska fishery. Real world fisheries are much more complex than those of our simple model, and many different factors affect fisheries participation. However, the model helps to illustrate how allocation may occur.

Fisheries regulations may have allocative effects upon processors as well as fishermen. We discuss these effects briefly at the end of this appendix.

Short-Run and Long-Run Effects of Regulations

Fisheries regulations may have both short-run and long-run effects. These effects may be very different. In the short run--one or two years--the number of boats which may participate in a fishery is more or less fixed. Fisheries regulations may have allocative effects by changing the way in which the total catch is divided up among different kinds of boats.

In the long run--more than one or two years--the number of boats participating in a fishery may change considerably as more boats arrive from other areas and as new boats are built. Fisheries regulations may have allocative effects not only by affecting the division of the catch among different kinds of boats, but also by affecting the number and kinds of boats participating in the fishery.

We will use our model to examine both short-run and long-run allocative effects of fisheries regulations. In examining short-run allocative effects, we will assume that the number of boats of each type participating in the fishery is fixed. In examining long-run allocative effects, we will assume that the number and type of boats participating in the fishery adjusts to that pattern of participation which would prevail if fisheries regulation (and other

conditions) were held fixed over a long period of time. In the real world, the actual effects of fisheries regulations are likely to be a combination of both the short-run and the long-run effects illustrated by our model.

Short-Run Allocative Effects of Fisheries Regulations

We may begin by describing the basic assumptions of our short-run model. We assume at first that there is only one fishery with a fixed number of boats. The fishery managers decide how many fish may be caught, based on a biological assessment. They open the season on a specified date and close the season once the specified number of fish have been caught. For simplicity, we assume that the managers have set the total catch at 1,000 fish.

At first, we will assume that all fishermen are the same, and that they have identical boats. All of these boats are "small." With a small boat, a fisherman can catch 10 fish per day. After covering the variable costs of fishing, his net earnings are $1 per fish.

Suppose there are 20 small boats in the fishery. If each boat catches 10 fish per day, together they will catch 200 fish per day. The quota of 1,000 fish will be caught after five days. During this five-day season, each boat will catch 10 x 5 = 50 fish, and will earn $50.

Now suppose that, in addition to the 20 small boats, there are also ten "large" boats in the fishery. Each large boat can catch 25 fish per day. Together, the small boats catch 200 fish per day and the large boats catch 250 fish per day, resulting in a total catch of 450 fish per day. As a result, the fishing season is 1,000/450, or 2.22 days long. During this season, each small boat earns $10 x 2.22 = $22.20, and each large boat earns $25 x 2.22 = $55.50.

With the large boats participating in the fishery, the small boats are not as well off, with each boat earning only $22.20 instead of $50.00. This is because the large boats add to the total catch per day, or fishing effort, resulting in a shorter season.

This illustrates a fundamental point:

> In the short run, in a fishery with a fixed quota, the earnings of individual boats are determined by the total fishing effort, which is determined by the number of boats of each type participating in the fishery. The higher the level of effort, the lower will be the earnings of each boat.

Short-Run Allocative Effects of Gear Restrictions

One way in which the small boats could increase their earnings would be to exclude the large boats from the fishery altogether. This would cause their earnings to increase from $22.50 to $50.00 per boat.

Suppose, however, that it is unconstitutional or otherwise impossible to exclude the large boats from the fishery. An alternative way in which the small boats could increase their earnings would be to reduce the catch per day of the large boats through the use of gear restrictions.

One example of a gear restriction is a limit on the number of pots which a boat may fish. Suppose a pot limit has no effect on small boats which, in any case, would fish a smaller number of pots than that permitted by the law. However, suppose that the pot limit reduces the catch per day of the large boats from 25 to 16. Now together the small boats will still catch 200 fish per day, while the large boats will only catch 160 fish per day, resulting in a total catch of 360 fish per day. The fishing season will last 1,000/360 = 2.78 days. During the season, each small boat will earn $10 x 2.78 = $27.80, and each large boat will earn $16 x 2.78 = $44.48.

The effect of the gear restriction will be to increase the season earnings of each small boat from $22.50 to $27.80, and to reduce the season earnings of each large boat from $55.50 to $44.48. Thus we may conclude that

> In the short run, gear restrictions may increase the earnings of small boats by reducing the catching power of large boats, resulting in a longer fishing season and a greater share of the total catch for small boats.

Short-Run Allocative Effects of Exclusive Area Registration

Suppose next that there are two fisheries, which we will refer to as Fishery A and Fishery B. We will examine the short-run allocative effects of permitting individual boats to fish in only one of the two fisheries--that is, exclusive area registration. To simplify our analysis, we will assume that in the absence of exclusive area registration, seasons in the two fisheries are scheduled consecutively so that all vessels may participate for an equal amount of time in both fisheries. (We will consider the effects of simultaneous season scheduling in the next section.)

Suppose first that there is no exclusive area registration. Table A-1 illustrates the determination of the total season earnings for each type of boat in each fishery. We assume that the fisheries are identical except in one respect: the catch per day of

TABLE A-1.
SHORT-RUN EFFECTS OF EXCLUSIVE AREA REGISTRATION ON SEASON LENGTH AND SEASON EARNINGS: AN EXAMPLE

	Without Exclusive Area Registration[a]			With Exclusive Area Registration		
	Small Boats	Large Boats	Total	Small Boats	Large Boats	Total
FISHERY A						
Total catch	–	–	1000	–	–	1000
Number of boats	20	10	–	0	10	–
Catch per boat per day	10	25	–	(10)	25	–
Total catch per day	200	250	450	0	250	250
Season length	2.22	2.22	2.22	(4)	4	4
Earnings per boat ($)	22.20	55.50	–	(40)	(100)	–
FISHERY B						
Total catch	–	–	1000	–	–	1000
Number of boats	20	10	–	20	0	–
Catch per boat per day	10	18	–	10	(18)	–
Total catch per day	200	180	380	200	0	200
Season length	2.63	2.63	2.63	5	(5)	5
Earnings per boat ($)	26.30	47.34	–	50	(90)	–
COMBINED FISHERIES						
Total earnings per boat ($)	48.50	102.84	–	50	100	–

– Not applicable

() Hypothetical, since no boats participate in fishery.

[a]Assumes consecutive season scheduling.

large boats is lower in Fishery A (18) than in Fishery B (25), although it is still larger than for small boats. The catch per day is the same in each fishery for small boats (10).

There are a number of reasons why the catch per day might differ between fisheries for large boats but not for small boats. For example, Fishery A might have a greater abundance of crab than Fishery B, but might also be farther from a port at which the crab can be delivered. These two factors might exactly balance each other for small boats, resulting in the same average catch per day.

However, large boats might have a greater storage capacity relative to catching power than smaller boats. As a result, for large boats the greater abundance of crab in Fishery A is not offset by greater travel time, resulting in a higher average catch per day than in Fishery B.

As shown in Table A-1, the total catch per day in Fishery A is 450 fish, resulting in a fishing season of 2.22 days and earnings of $22.20 for small boats and $55.50 for large boats. This is identical to the one-fishery case which we discussed above. Now, however, we assume that after the season in Fishery A, all boats proceed to Fishery B. Here, the small boats catch 200 fish per day and the large boats catch 180 fish per day. The total catch is 380 fish per day, resulting in a season of 2.63 days. During this Fishery B season, each small boat earns $26.30 and each large boat earns $47.34.

Combining their earnings from the two fisheries, small boats earn a total of $48.50 and large boats earn a total of $102.84.

We may next examine the effect of exclusive area registration upon the earnings of small and large boats. With exclusive area registration, each boat must choose between participating in Fishery A or participating in Fishery B.

What kind of distribution of boats between fisheries might we expect? We would expect that each boat will choose the fishery in which it can earn the most money. Boats of the same type will not fish in both fisheries unless they can earn the same amount in each fishery. Therefore, there are three kinds of distributions of boats between fisheries which might arise:

- All small boats will participate in one fishery and all large boats will participate in the other fishery. The fishing seasons will be such that no boat could increase its earnings by switching to the other fishery.

- All of one type of boat will participate in one fishery, and the fishing seasons will be such that no boat of this type could increase its earnings by switching to the other fishery. Boats of the other type will participate in both fisheries, earning the same amount in each fishery.

- Boats of both types will participate in both fisheries, with earnings for each type of boat equalized between fisheries.

Given the catches per boat per day assumed in Table A-1, the third kind of distribution is impossible since there is no combination of fishing seasons which would equalize earnings for both types of boats in both fisheries. Moreover, trial and error reveals that the first kind of distribution would, in fact, arise. This distribution is shown on the right-hand side of Table A-1.

With exclusive area registration, all large boats choose to fish in Fishery A and all small boats choose to fish in Fishery B. Larger boats have total earnings of $100 in Fishery A, compared with the earnings of $90 which would be possible if they were to switch to Fishery B. Small boats have earnings of $50 in Fishery B, compared with the earnings of $40 which would be possible if they were to switch to Fishery A. Thus, neither type of boat has an incentive to switch to the other fishery.

With exclusive area registration, small boats have earnings of $50, compared with earnings of $48.50 without exclusive area registration. In contrast, large boats have earnings of $100, compared with earnings of $102.89 without exclusive area registration. Thus, in this example, exclusive area registration would increase the earnings of small boats and lower the earnings of large boats.

How has exclusive area registration helped the small boats? It has reduced their earnings in Fishery A where they can no longer fish. However, it has increased their earnings in Fishery B by reducing the effort of large boats in this fishery. For the small boats, the loss of earnings from Fishery A is more than offset by the increase in earnings from Fishery B. In contrast, the large boats have lost their earnings from Fishery B. Although large boats do better in Fishery A than in Fishery B, the increase in large boat earnings in Fishery A (due to the reduction of effort of small boats) does not offset the large boats' loss in earnings from Fishery B.

Exclusive area registration does not necessarily help small boats in all cases. Which type of boat is helped depends upon the number of boats of each type, or more precisely, the total catching power of boats of each type. If large boats had represented a

smaller share of total catching power, they, rather than the small boats, would have been helped by the institution of exclusive area registration.

Table A-2 provides an example of such a situation. In this example without exclusive area registration, there are now only five large boats; total fishing effort is reduced in each fishery compared to our earlier example, and total earnings per boat are $65.30 for small boats and $139.10 for large boats.

If we now institute exclusive area registration, all large boats will once again find it most profitable to participate in Fishery A. However, not all small boats will choose to fish in Fishery B. This is because, given the lower catching power of large boats (compared to our earlier example), the season in Fishery A would be longer than that in Fishery B if all small boats participated in Fishery B. As a result, 3.75 small boats will participate in Fishery A, which shortens the season in A and lengthens the season in B until the seasons are equalized (at 6.15 days). With these seasons, small boats earn $61.50 per season (in either fishery), while large boats earn $153.75 in Fishery A. Large boats have benefited from exclusive area registration, while small boats have been harmed.

Based on these two examples, we may make several conclusions about the short-term allocative effects of exclusive area registration.

1. In the short run, exclusive area registration may have allocative effects by changing the distribution of fishing effort by boats of different types between different fisheries. Whether a boat of a given type will benefit from exclusive area registration depends upon whether the loss in earnings from being restricted to just one fishery is offset by the increase in earnings due to reduction of total effort in that fishery.

2. In the short run, exclusive area registration will cause boats to concentrate in the areas in which they have a comparative advantage (where the ratio of their catch per day to that of other types of boats is highest). However, the more boats there are of a given type, the more likely some boats of this type are to fish in other areas as well, where a less favorable catch-per-day ratio may be offset by a lower total fishing effort.

TABLE A-2.
SHORT-RUN EFFECTS OF EXCLUSIVE AREA REGISTRATION ON SEASON LENGTH AND SEASON EARNINGS: ANOTHER EXAMPLE

	Without Exclusive Area Registration[a]			With Exclusive Area Registration		
	Small Boats	Large Boats	Total	Small Boats	Large Boats	Total
FISHERY A						
Total catch	-	-	1000	-	-	1000
Number of boats	20	5	-	3.75	5	-
Catch per boat per day	10	25	-	10	25	-
Total catch per day	200	125	325	37.5	125	162.5
Season length	3.08	3.08	3.08	6.15	6.15	6.15
Earnings per boat ($)	30.80	77.00	-	61.50	153.75	-
FISHERY B						
Total catch	-	-	1000	-	-	1000
Number of boats	20	5	-	16.25	0	-
Catch per boat per day	10	18	-	10	(18)	-
Total catch per day	200	90	290	162.5	0	162.5
Season length	3.45	3.45	3.45	6.15	(6.15)	6.15
Earnings per boat ($)	34.50	62.10	-	61.50	(110.70)	-
COMBINED FISHERIES						
Total earnings per boat ($)	65.30	139.10	-	61.50	153.75	-

- Not applicable

() Hypothetical, since no boats participate in fishery.

[a]Assumes consecutive season scheduling.

3. In the short run, the smaller the share of a given type of boat in total catch without exclusive area registration, the more likely boats of this type are to benefit from exclusive area registration. In particular, the fewer the number of boats of a given type relative to other types of boats, the more likely they are to benefit from exclusive area registration.

We may explain our third conclusion intuitively as follows. Exclusive area registration tends to cause boats of different types to fish in different areas, depending upon where they are relatively best at catching fish. An individual boat faces less aggregate catching power as competition, but may compete for a smaller total catch. The more boats there are of the same type, the less likely any individual boat of this type is to benefit from exclusive area registration, since other boats of this type are likely to choose the same area in which to fish.

In our examples thus far, we have assumed that without exclusive area registration, both types of boats would participate in both types of fisheries. Under this assumption, it is not immediately obvious which type of boat would benefit from exclusive area registration. Suppose, however, that some boats can only fish in one fishery whether or not there is exclusive area registration. For instance, small boats might not be able to participate in some fisheries due to rough weather conditions. These boats will always benefit from exclusive registration because it will lower total fishing effort in their home fishery, while they lose nothing from the fact that the other fishery is now legally closed to them.

In the short run, for boats that would fish in only one area in any case, exclusive area registration will always be beneficial since it reduces total fishing effort in that area.

Short-Run Allocative Effects of Season Scheduling

The short-run allocative effects of simultaneous season scheduling are similar to those of exclusive area registration.

If two fisheries' seasons are scheduled simultaneously, vessels cannot participate in each, except to the extent that one season is longer than the other. Thus, simultaneous season scheduling reduces total effort in both fisheries while also reducing fishing opportunities for any given boat. Whether or not boats of a particular type would benefit from simultaneous season scheduling depends upon whether their gains from the reduced total effort in the fishery they choose offset their losses from the lack of opportunity to fish in the other fishery.

Another possible allocative effect of season scheduling results from different effects of weather conditions upon different kinds of boats. For example, rough weather may hinder fishing for small boats more than for large boats. As a result, scheduling a fishing season at a time when the weather is likely to be rough will increase the catch of large boats and lower that of small boats.

Long-Run Allocative Effects of Fisheries Regulations

For our short-run model, we assumed that the number of boats participating in a fishery is fixed. With a fixed number of boats, regulations affecting where boats may fish or how much gear they may use affect total fishing effort by different kinds of boats in different areas and, thus, the distribution of total catch and earnings between different kinds of boats.

In an open entry fishery, in the long run (a period of several years) the number of boats participating in a fishery is not fixed. We would expect boats to leave fisheries which are unprofitable, and we would expect new boats to be built (or come from other areas) to participate in fisheries where profits are to be made. This change in the total number of boats and, thus, total fishing effort tends to offset some of the short-run allocative effects of regulations which we discussed above. Thus, the long-run allocative effects of regulations may differ considerably from their short-run effects. In the following sections, we examine these long-run allocative effects.

Long-Run Model Assumptions

As with our short-run model, we will begin by assuming that there is only one fishery. There is open or unlimited entry to this fishery. Anyone may enter the fishery, and the same regulations apply to anyone who enters the fishery.

As we assumed before, the fishery managers decide how many fish may be caught each year based on a biological assessment. They open the season each year on a scheduled date and close the season once the specified number of fish have been caught. Again, we assume that the managers have set the total annual catch at 1,000 fish.

Suppose first that all fishermen have "small" boats. With a small boat, a fisherman can catch 10 fish per day. After covering the variable costs of fishing, his net earnings are $1 per fish. He also has fixed costs of $50 per year, which includes costs such as payments on his boat. Thus, the fisherman needs to clear $50 per season above the variable costs of fishing in order to "break even." This income is just enough to keep him satisfied with fishing, given the other opportunities open to him. If a fisherman

can clear more than $50 per season, new boats will enter the fishery. If a fisherman can clear less than $50 per season, boats will begin to leave the fishery.[2]

Any amount earned by a fisherman in excess of $50 is what economists refer to as "economic rent"--income in excess of a normal market return, or what is required to keep a business in operation. Economic rent is the "gravy" of a business or an industry--extra income which is not needed to keep the industry going, but which could be enjoyed by the participants in the industry, or taxed to provide benefits for the public at large.[3]

Long-Run Characteristics of an Open-Entry Fishery

Using the assumptions of our simple model, we can now examine certain long-run characteristics of an open-entry fishery. Table A-3 illustrates the effects of fleet size on season length, catch per boat, and economic rent. The higher the number of boats in the fleet, the greater will be the total catch per day. The higher the total catch per day, the shorter will be the length of the season since managers close the season once the biologically-determined season catch has been reached. The shorter the season, the lower will be the season catch, earnings, and economic rent per boat. In addition, total economic rent in the fishery will also be lower.

We may use Table A-3 to examine changes in fleet size, earnings per boat, and economic rent which would occur over time in a new fishery. Suppose there is only one boat in the fishery to begin with. The season will last 100 days and the boat will earn $1,000, resulting in economic rent of $950. The next season, more boats will enter the fishery in response to the opportunity to earn high economic rents. If the fleet size increases to five, the fishing season will decline to 20 days, earnings per boat will decline to $200, and economic rent per boat will decline to $150. In addition, total economic rent will decline from $950 to $750.

Since there is still the opportunity to earn economic rent, boats will continue to enter the fishery. The fleet size will expand until there are 20 boats in the fishery. With this fleet size, the fishing season will be only five days long, the total earnings per boat will be only $50, and the economic rent per boat will be zero. In addition, total economic rent in the fishery will be reduced to zero. Only when the fleet has expanded to this size will the earnings per boat be reduced to a level at which there is no more incentive for new boats to enter the fishery.

A similar process would take place if there had originally been more than 20 boats in the fishery. With more than 20 boats, the fishing season would have been less than five days. Individual

TABLE A-3.
EFFECTS OF FLEET SIZE ON SEASON LENGTH,
CATCH PER BOAT, AND ECONOMIC RENT

Assumptions:

The season closes after 1,000 fish have been caught.
Each boat catches 10 fish per day.
Each fish has a net value of 1 dollar.
Each boat must cover fixed costs of 50 dollars per season.

A. Fleet Size	1	2	5	10	15	20	30
B. Total catch per day (10xA)	10	20	50	100	150	200	300
C. Season Length (1000/B)	100	50	20	10	6.7	5	3.3
D. Season catch per boat (10xC)	1000	500	200	100	67	50	33
E. Season net earnings per boat (before fixed costs) (0x1)	1000	500	200	100	67	50	33
F. Economic rent per boat (net earnings after fixed costs) (E-50)	950	450	150	50	17	0	-17
G. Total economic rent (AxF)	950	900	750	500	255	0	-510

boats would have caught less than 50 fish per season and would not have earned enough to cover their fixed costs and break even. As a result, some boats would leave the fishery. Over time, the fleet size would decline until only 20 boats remained in the fishery.

When the fleet size is 20, the fishery will be in "equilibrium." We use this term to refer to a stable situation in which no additional boats enter or leave the fishery.

Our example illustrates a fundamental characteristic of open-access fisheries:

> In an open-access fishery, over time the number of boats tends to increase and the season length tends to decrease until total economic rents are reduced to zero, and the average vessel is just able to break even.

In an open-access fishery like that of our sample model, the equilibrium fishing season length is given by the formula:

$$\text{Fishing Season} = \frac{\text{Fixed Costs}}{\text{Net Earnings Per Day}}$$

That is, the pressure of more vessels entering the fishery will shorten the season to a length at which each vessel has only enough fishing time to earn the minimum amount needed to break even by just covering fixed costs. This suggests a second fundamental characteristic of open-access fisheries:

> The lower the ratio of fixed costs to net earnings per day, the shorter will be the equilibrium fishing season.[4]

In our example of Table A-3, this formula gives a fishing season length of 50/10=5 days.

Suppose now that we introduce a second kind of boat, which we will call a "large" boat, into our model. Large boats can catch 25 fish per day, with net earnings of $25 per day. However, they need to earn a minimum of $100 per season in order to cover their fixed costs.

Using the formula presented above, we see that a large boat could break even with a fishing season of only 100/25=4 days. If the fishery were initially in equilibrium for small boats, the fishing season would be five days. With this season length, large boats could earn 25x5=$125 in a season, which would provide an economic rent of $25 per boat. This would provide an incentive for large boats to enter the fishery, driving the season down to only four days. With the shorter fishing season, small boats would only be able to earn $40 in a season, and would leave the fishery. Eventually, the small boats would be replaced by large boats, and the fishing season would be shortened from five days to four days.

We can see this result directly from Table A-4, which compares the equilibrium fisheries for small and large boats. The equilibrium season length is shorter for large boats. Thus, if both kinds of boats are permitted to enter the fishery, the 20 small boats would be replaced by 10 large boats, which would catch the total of 1,000 fish in four days instead of five days.[5]

This leads us to a third fundamental characteristic of open-access fisheries.

> In an open-access fishery, over time those vessels which can get by with the shortest fishing season tend to displace other vessels by driving the season length down below the minimum length at which other vessels can break even.

Long-Run Allocative Effects of Gear Restrictions

We may next use our model to examine the long-run allocative effects of gear restrictions. In our example of the previous section, we showed that if the fishery were opened to large boats, they would drive out the smaller boats by driving the fishing season down below the minimum length at which the smaller boats could break even. Assume now that we introduce gear restrictions, such as a limit on the number of pots which a boat may fish. As shown in Table A-5, this has no effect on the daily catch of a small boat. However, it reduces the daily catch of a large boat from 25 to 16, since the large boat can no longer fully utilize its capacity. As a result, the number of days which a large boat must fish in order to earn enough to stay in business is increased from 4 days to 6.25 days. Large boats no longer have an advantage over small boats which need only a 5-day season. The effect of the gear restriction is to protect the small boat fishery. Eventually, the total catch of 1,000 fish will be harvested by 20 small boats instead of 10 large boats.

> Thus, gear restrictions may have indirect long-run allocative effects in open-access fisheries by modifying the relative minimum fishing seasons which vessels of different characteristics require to break even.

Long-Run Allocative Effects of Exclusive Area Registration

We may next consider allocative effects of exclusive area registration. Suppose now that there are two fisheries, which we will refer to as Fishery A and Fishery B. We will examine the composition of the fleet in each fishery over time with and without exclusive area registration. To simplify our analysis, we will assume that in the absence of exclusive area registration, seasons in the two fisheries are scheduled consecutively, so that all vessels may participate for an equal amount of time in both

TABLE A-4.
COMPARISON OF EQUILIBRIUM FISHERIES
FOR SMALL AND LARGE BOATS

	Small Boats	Large Boats
Total catch	1000	1000
Catch per boat per day	10	25
Net value per fish	1	1
Season fixed costs = minimum net earnings required to stay in business	50	100
Equilibrium net earnings per boat (before fixed costs)	50	100
Equilibrium season catch per boat	50	100
Equilibrium season length	5	4
Equilibrium number of boats	20	10
Equilibrium economic rent per boat	0	0
Equilibrium total economic rent	0	0

TABLE A-5.
EFFECTS OF GEAR RESTRICTIONS ON EQUILIBRIUM FISHERIES FOR SMALL AND LARGE BOATS

	Without Gear Restrictions		With Gear Restrictions	
	Small Boats	Large Boats	Small Boats	Large Boats
Total catch	1000	1000	1000	1000
Catch per boat per day	10	25	10	16
Net value per fish	1	1	1	1
Season fixed costs = minimum net earnings required to stay in business	50	100	50	100
Equilibrium net earnings per boat (before fixed costs)	50	100	50	100
Equilibrium season catch per boat	50	100	50	100
Equilibrium season length	5	4	5	6.25
Equilibrium number of boats	20	10	20	10
Equilibrium economic rent per boat	0	0	0	0
Equilibrium total economic rent	0	0	0	0

fisheries. In the next section, we will consider the effects of simultaneous season scheduling.

If there is exclusive area registration, so that boats are restricted to fishing in only one fishery, our analysis for each fishery is the same as our earlier analysis for an individual fishery. Over time, each fishery will be dominated by the kind of boat which can break even (meet fixed costs) with the shortest fishing season. The season in each fishery will be this minimum length, and the number of boats participating in the fishery will be that which is required to harvest the total catch at the minimum season length.

If there is not exclusive area registration, so that boats may participate in each fishery, the analysis of the composition of the fishery is somewhat more complicated. Below, we discuss general factors affecting equilibrium fleet composition, using an example. As before, we use the term "equilibrium" to refer to a stable situation in which no additional boats enter or leave the fishery. In general, after a new regulation is imposed, over time the composition of the fleet will gradually approach the equilibrium composition.

Several factors combine to determine the equilibrium composition of the fleet if boats may participate in each fishery. We can state the effects of these factors in terms of two conditions which must hold in equilibrium:

(1) All boats must be just breaking even (no boats earn economic rent).

(2) All boats participate for the full season in each fishery.

The first condition must hold because if boats of either size were earning economic rent, new boats of that size would have an incentive to enter the fishery, causing the season length to decline in both fisheries, and causing economic rents to decline for boats of each size. Thus, in an equilibrium situation, no boats can be earning economic rents. The second condition must hold in our simple model because no boat would have any reason to fish less than the full season in each fishery.

Keeping these two conditions in mind, we can now use Tables A-6 and A-7 to illustrate one possible effect of removing exclusive area registration. Table A-6 illustrates the determination of fleet composition. Table A-7 summarizes the equilibrium fleet composition and season length.

TABLE A-6
DETERMINATION OF SEASON LENGTH AND FLEET COMPOSITION
IN EXCLUSIVE AND NON-EXCLUSIVE FISHERIES: AN EXAMPLE

	Exclusive Fisheries		Non-Exclusive Consecutive Fisheries		
	Fishery A	Fishery B	Fishery A	Combined A & B	Fishery B
Small Boats					
A. Total catch	1000	1000	1000		1000
B. Catch per boat per day = Net earnings per boat per day	10	10	10		10
C. Fixed cost per boat per season	50	50		50	
D. Equilibrium net earnings per boat = C	50	50		50	
E. Number of boats = A/D	20	20		40	
F. Total catch per day = ExB	200	200	400		400
G. Season length = A/F	5	5	2.5		2.5
H. Net earnings per boat in equilibrium season for large boats	4x10 =40	5.56x10 =55.60		2x10 2.78x10 =47.80	
I. Dominant boat? (yes if H C)	no	yes		no	
Large Boats					
A. Total catch	1000	1000	1000		1000
B. Catch per boat per day = Net earnings per boat per day	25	18	25		18
C. Fixed cost per boat per season	100	100		100	
D. Equilibrium net earnings per boat = C	100	100		100	
E. Number of boats = A/D	10	10		20	
F. Total catch per day = ExB	250	180	500		360
G. Season length = A/F	4	5.56	2		2.78
H. Net earnings per boat in equilibrium season for small boats	5x25 =125	5x18 =90		2.5x25 +2.5x18 =107.50	
I. Dominant boat? (yes if H C)	yes	no		yes	

TABLE A-7.
COMPARISON OF EQUILIBRIUM
SEASON LENGTH AND FLEET COMPOSITION
WITH AND WITHOUT EXCLUSIVE AREA REGISTRATION

Assumptions:

Total catch is 1000 for both Fishery A and Fishery B.
Fixed costs per season are $50 for small boats and $100 for large boats.
Catch per day = net earnings per day = 10 for small boats and 25 for large boats in Fishery A; = 20 for small boats and 25 for large boats in Fishery B.

	Equilibrium Fleet Composition	Equilibrium Season Length
Exclusive Area Registration		
Fishery A	10 large boats	4 days
Fishery B	20 small boats	5 days
Total	10 large boats	4 days Fishery A
	20 small boats	2.5 days Fishery B
Non-Exclusive Area Registration[a]		
Fishery A	20 large boats	2 days
Fishery B	20 large boats	2.78 days
Total	20 large boats	4.78 days

[a]Assumes consecutive fishing seasons.

SOURCE: Table A-6.

The analysis in Table A-6 proceeds by determining the equilibrium fishing seasons which would occur if both fisheries were fished exclusively by small boats, and those which would occur if both fisheries were fished exclusively by large boats, for separate fisheries and for combined fisheries. We examine whether small boats could earn economic rent under the fishing seasons which would prevail in a large-boat fishery, and similarly, whether large boats could earn economic rent under the fishing seasons which would prevail in a small-boat fishery. This determines, for each fishery, whether small boats or large boats would "win out" if the fishery were open to each, by driving the season length down below that at which the other type of vessel could break even.

As shown in Table IV-6, if the fleets for fisheries A and B were separated by exclusive area registration, fishery A would be fished exclusively by large boats and fishery B would be fished exclusively by small boats. This is because large boats could break even with a season length of 4 days in fishery A, while small boats would require 5 days. In contrast, large boats would require a season of 5.6 days to break even in fishery B, while small boats would still require 5 days. The difference is due to the fact that we have assumed a smaller relative advantage for large boats in fishery B. Small boats can catch the same amount per day in each fishery, whereas large boats can catch less per day in fishery B than in fishery A (although still more than small boats).

We may now examine the small-boat fishery which would result if we removed the exclusive area registration regulation, so that the same boats could fish in both fisheries (refer to the first page of Table IV-6). Since small boats must meet a fixed cost of $50 per season (Row C), and in equilibrium economic rent must be zero, we know that equilibrium net earnings per boat must be $50 (Row D). There are 2,000 fish to be caught in the combined fishery (Row A). If, in equilibrium, each boat earns $50, there must be a total of 40 boats in the fleet (Row E). For each day of fishing in fishery A, these 40 boats would catch 400 fish; for each day of fishing in fishery B, they would also catch 400 fish (Row G). This would result in fishing seasons of 2.5 days in both fisheries (Row H).

A similar analysis for large boats shows that a combined fishery for large boats would result in a fleet of 20, with season lengths of 2 days in Fishery A and 2.78 days in Fishery B.

Given the fishing seasons that would prevail in a small boat fishery, if a small boat entered the fishery, it could earn $107.50 per season (Row H). This would enable it to more than break even. In contrast, under the seasons that would prevail in a large-boat fishery, a small boat could earn only $47.80 per season, and could not break even. Thus, large boats would have an incentive to enter a small-boat fishery, and would tend to drive small boats out by

shortening the fishing seasons below those at which the small boats could break even. If the combined fishery were open to both types of boats, eventually only large boats would be able to survive.

Thus, as shown in Table IV-7, the effect of removing exclusive area registration in this example would be to drive out all small boats, so that there would be 20 large boats instead of 20 small boats and 10 large boats. Even though small boats would control fishery A if it were an exclusive fishery, they could not compete against large boats in a combined fishery. Thus, in this example, exclusive area registration has the effect of protecting the small boats in fishery A.[6]

Our simple example has illustrated how exclusive area registration can protect one type of vessel which may be able to compete in a separate fishery, but which could not compete in a combined fishery. We may state the effects of exclusive area registration more generally as follows:

> Exclusive area registration may have indirect long-run allocative effects in open-access fisheries, since vessels which have a comparative advantage in a combined fishery (in terms of the minimum combined fishing seasons required to cover fixed costs) may not have a comparative advantage in an exclusive fishery (in terms of the minimum fishing season required to cover fixed costs from one fishery alone).

Long-Run Allocative Effects of Simultaneous Season Schedulings

The allocative effects of simultaneous season schedulings work similarly to those of exclusive area registration. If two fisheries seasons are scheduled simultaneously, vessels cannot participate in each, except to the extent that one season is longer than the other. Thus, separate fleets tend to develop for each fishery, instead of the combined fleet which would develop with consecutive season scheduling. The types of vessels which have an advantage in separate fleets may differ from those which have an advantage in a combined fleet.

Extension to the Long-Run Model

Changes in Price. Thus far, we have assumed that the price of fish remained constant. This assumption resulted in total earnings per boat being inversely related to the length of the fishing season. As the number of boats in the fishery increased, the fishing season declined, until economic rents were driven to zero, and those boats which required a longer fishing season were no longer able to compete.

If we drop our assumption of fixed prices, then earnings are no longer directly related to the total catch per boat or the length of the fishing season. As long as prices continue to rise, then boats can continue to enter the fishery, even though the catch per boat declines. What boats lose from reduced catch theymake up for with higher prices.

Changes in Total Catch. We have assumed that the total catch or quota remains constant. If the total catch instead fluctuates, the equilibrium size of the fleet which could be supported by the fishery will also fluctuate.

In general, we might expect the effects of changes in total catch to be partially offset by changes in price. When total catch declines, the supply of fish to the market declines, putting upward pressure on prices. Thus, in a fishery where total catch is declining, the number of boats participating in the fishery may not fall, and may even rise, as long as the decline in catch per boat is being offset by the increase in prices.

Participation in Other Fisheries. We have assumed in our long-run model that fishermen participate in only one or two fisheres, from which they must earn enough to cover their fixed costs. To the extent that fishermen participate in other fisheries as well, the fixed costs which must be recovered from any given fishery are reduced. Thus, boats which are diversified will tend to be able to survive with shorter fishing seasons than boats that are not diversified.

Differences Among Fishermen. In our model, we have assumed that all boats of a given type catch equal amounts of fish and have identical costs. In reality, some fishermen will be much more skilled than others, catching far more fish with the same boats and equipment. In addition, fishermen differ greatly with respect to the costs that they face, including the minimum return which they will accept for their own labor and on their invested capital. As a result, the effects of regulations may differ for boats of the same type. For example, some small boats are likely to always be able to compete with large boats. In addition, some boats may always earn substantial economic rents due to superior fishing skills, even though economic rents might be zero for marginal boats in the fishery, discouraging new entrants.

Allowing for these extensions of the model does not substantially affect the fundamental conclusions of our model as to the allocative effects of regulations.

Over time, even with changing prices and catches, differences in fisheries participation and differences in fishing skills, those boats which can break even with the shortest fishing season or combination of seasons will still tend to predominate.

Allocative Effects of Regulations Upon Processors

Fisheries regulations may have a variety of allocative effects upon processors as well as fishermen. In this section, we briefly discuss some of these effects.

Among processors, we may distinguish between mobile floating processors and land-based processors (including permanently moored floating processors). We may further distinguish among processors with respect to capacity and the kinds of fish which are processed. Still another distinction is with respect to associations with fishing vessels. Some processors may own the fishing vessels which supply them, others may have long-standing business relationships with traditional supplying vessels, and others may purchase from all boats within a fishery without having ties to particular boats.

If a processor has special ties to some boats within a fishery, the processor will be affected by regulations in the same way that these boats are. For example, if a processor owns or is traditionally supplied by small boats from a local fleet, then the processor will benefit from gear restrictions, area registration, or season schedules which benefit these boats.

Land-based processors will benefit from regulations which reduce competition from mobile processors for limited fish supplies. For example, simultaneous season scheduling may work to the advantage of land-based processors to the extent that mobile processors choose to work in other areas. Exclusive area registration may also benefit land-based processors by eliminating competition from catcher processors that are restricted to fishing in only one area.

Processors with limited capacity will benefit from regulations which lengthen the fishing season, increasing the quantity of fish which they can process. Regulations which reduce the total catching power of the fleet fishing locally, such as exclusive area registration, simultaneous season scheduling, and gear restrictions, will all have this effect. Processors with greater capacity will be harmed by these regulations to the extent that they reduce the total catch available to be harvested daily and increase the share of total catch which is processed by smaller, competing processors. However, all those processors which are already established will benefit to the extent that regulations ensure a season long enough so that the catch can be handled with existing capacity, which might discourage the establishment of new processors within the area.

Summary: Allocative Effects of Regulations in Open-Entry Fisheries

In this appendix, we have discussed and illustrated a variety of ways in which regulations in open-entry fisheries may have allocative effects. We have based our discussion upon simple short-run and long-run models. The real world is, of course, far

more complicated than that of our simple models, with many fisheries, many types of boats, many types of fishermen and processors, and widely fluctuating fishing conditions as well as market conditions. In addition, regulations governing fishing activity may change dramatically over time. The allocative effects of any given regulation may thus be quite complicated and difficult to trace. Nevertheless, we may draw several general conclusions about the allocative effects of certain kinds of regulations.

Gear restrictions will tend to favor small boats in the short run by reducing the catch of larger competing boats. Over time, gear restrictions are also likely to limit the entry of larger vessels into a fishery, compared with smaller vessels, by reducing the profitability of these boats.

Exclusive area registration separates boats, forcing them to choose between fisheries. These regulations will always benefit those vessels and processors which are limited in any case to working in only one area, since competition from more mobile vessels and processors is reduced to the extent that they choose to work in other areas. Among boats which are mobile and which could fish in several areas in the absence of exclusive area registration, the allocative effects of these restrictions are uncertain, depending upon the relative catching power and costs of different fleets. In general, in the short-run, the advantages of reduced competition will outweigh the reduced fishing opportunities for some boats--usually those boats with the lowest catching power. In the longer run, some types of boats may be able to compete in individual exclusive fisheries which would not be able to compete across combined fisheries against a larger total fleet.

Simultaneous season scheduling separates fleets, with similar effects to those of exclusive area registration.

It is instructive to briefly consider the effects of these regulations upon the efficiency of the fishing industry.

In theory, in the long run, in an open-entry fishery, all types of regulations are equally inefficient.

This is because all economic rent will ultimately be dissipated by the entry of new boats. Increased fishing effort, whether by small or large boats, will reduce the catch of those boats already in the fishery until there is no longer any incentive for new entry. The efficiency of all boats will be reduced by shortened fishing seasons and lowered catches per boat.

In the real world, regulations do affect efficiency; for example, gear restrictions reduce the efficiency of larger boats. Although the powerful forces of increased fishing effort will tend to reduce efficiency in any case, some regulations may hasten this process.

NOTES

[1]In order to keep our model simple, we assume that the number of fish caught per day by each boat and the variable costs (labor and fuel) of catching the fish are unaffected by the number of boats in the fishery or the length of the season. Relaxing these assumptions would complicate the model without altering its conclusions.

[2]In order to keep our model simple, we assume that the minimum amount which a fisherman must earn per season to cover fixed costs is unrelated to the length of the season. In the real world, a fisherman will tend to require more earnings for a longer season, to the extent that there are other uses for his boat (we include his time as a variable cost). However, as long as the increase in fixed costs is less than proportional to the increase in fishing time, the conclusions of the model still hold.

[3]That share of a fisherman's earnings which is normal returns as opposed to economic rent depends upon a great many things, including the rate of return on investments other than fishing boats, wages in other occupations, and how much he enjoys fishing. The fact that fishing is more than just a job, but rather a way of life for many fishermen, may tend to make the required return--the minimum income from their capital and labor before they leave the business--lower for fishermen than for people in many other occupations.

[4]Perhaps one reason for the extremely short openings in some fisheries, such as some herring roe fisheries in Alaska, is a very low ratio of fixed costs to net earnings per day. Fixed costs, such as annual payments on boats, are covered in large parts by income from other fisheries. Since there is no large increase in fixed costs with entry in the fishery (other than the costs of the herring gear) and since the net earnings per day can be very high, it is worthwhile to enter the fishery even if it is for only a very short period of time.

[5]This does not mean that "larger" boats always have an advantage over small boats. Which boat has an advantage depends upon the ratio of fixed costs to net earnings per day. If we had assumed that large boats had fixed costs of $150, then large boats would have required six fishing days to stay in business, and they would not have been able to compete with small boats.

[6]Exclusive area registration will not necessarily always work to the advantage of smaller boats. Which size boat will benefit depends upon the catch per day of each type in each fishery as well as the fixed costs of each type of boat.