NOAA Technical Memorandum NMFS F/NWC 9

Economic Impacts of the Alaska Shellfish Fishery : An Input-Output Analysis

Walter Butcher, Joanne Buteau,
Kenneth Hassenmiller,
Glenn, Petry, and Samih Staitieh

March 1981

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA FORM 25-13 (1-78)

BIBLIOGRAPHIC DATA SHEET

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

1. NOAA ACCESSION NUMBER NOAA-81122801	2.	3. RECIPIENT'S ACCESSION NUMBER PB82 169723
4. TITLE AND SUBTITLE Economic Impacts of the Alaska Shellfish Fishery: An Input--Output Analysis		5. REPORT DATE March 1981 6. 060035
7. AUTHOR(S) Walter Butcher, Joanne Buteau, Kenneth Hassenmiller, Glenn Petry, and Samih Staitieh (all Washington State Univ.)		8. REPORT NO. NOAA-TM-NMFS F/NWC-9
9. PERFORMING ORGANIZATION NAME AND ADDRESS NOAA, National Marine Fisheries Service, Seattle, WA, 98112 Northwest and Alaska Fisheries Center		10. PROJECT/TASK NO. 11. CONTRACT/GRANT NO. NMFS-03-78-M02-0287
12. SPONSORING ORGANIZATION NAME AND ADDRESS Same		13. TYPE OF REPORT AND PERIOD COVERED 14.

15. PUBLICATION REFERENCE

NOAA Technical Memorandum NMFS F/NWC-9, March 1981. 108 p, 2 fig, 18 tab, 32 ref.

16. ABSTRACT

This study was initiated in 1978 for the purpose of estimating the economic impacts of the Alaska shellfish fishery. Data from an earlier, bio-economic data base survey were augmented by other published and unpublished data to provide economic profiles of the 1976 operations of the principal shellfish harvesting and processing subsectors. An interstate, interindustry input/output model was prepared for the Alaska and Washington economies with detailed treatment of Alaska- and Washington-based shellfish harvesting and processing sectors. The direct plus indirect requirements, value added multipliers, and partitioning of value added show that shellfish harvesting and processing sectors generate from $1.15 to $1.31 in value added for each $1.00 of product delivered to final demand. The input/output model shows that an increase of about one-fourth in shellfish catch would mean $150 million more total economic output in Alaska and $95 million more output in Washington, much of it coming in secondary sectors. Washington, in particular, receives secondary gains from expansion, even by Alaska-based vessels and processing plants. (Author modified)

17. KEY WORDS AND DOCUMENT ANALYSIS

17A. DESCRIPTORS

*Fisheries, *Shellfish, *Economic analysis, Economic models, Industry, Food processing, Harvesting

17B. IDENTIFIERS/OPEN-ENDED TERMS

Alaska, Washington

17C. COSATI FIELD/GROUP

5C, 8A, 6H

18. AVAILABILITY STATEMENT Released for distribution: Elaine S Downs	19. SECURITY CLASS (This report) UNCLASSIFIED	21. NO. OF PAGES
	20. SECURITY CLASS (This report) UNCLASSIFIED	22. PRICE

ECONOMIC IMPACTS OF THE ALASKA
SHELLFISH FISHERY: AN INPUT-OUTPUT
ANALYSIS[1/]

by

Walter Butcher, Joanne Buteau, Kenneth Hassenmiller,
Glenn Petry, and Samih Staitie[2/]

March 1981

1/ From a final report for NOAA NMFS Contract No. 03-78-M02-0287 submitted to Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112.

2/ Department of Agricultural Economics, Washington State University, Pullman, WA 99164.

i.a

ABSTRACT

The Northwest and Alaska Fisheries Center of the National Marine Fisheries Service initiated this study in 1978 for the purpose of estimating the economic impacts of the Alaska shellfish fishery. Data from an earlier, bio-economic data base survey were augmented by other published and unpublished data to provide economic profiles of the 1976 operations of the principal shellfish harvesting and processing subsectors. An interstate, interindustry input/output model was prepared for the Alaska and Washington economies with detailed treatment of Alaska- and Washington-based shellfish harvesting and processing sectors. The direct plus indirect requirements, value added multipliers, and partitioning of value added show that shellfish harvesting and processing sectors generate from $1.15 to $1.31 in value added for each $1.00 of product delivered to final demand. The input/output model shows that an increase of about one-fourth in shellfish catch would mean $150 million more total economic output in Alaska and $95 million more output in Washington, much of it coming in secondary sectors. Washington, in particular, receives secondary gains from expansion, even by Alaska-based vessels and processing plants.

PREFACE

This report was prepared by the Department of Agricultural Economics, College of Agriculture Research Center, Washington State University under contract no. 03-78-M02-0287 with the Northwest and Alaska Fisheries Center, National Oceanic and Atmospheric Administration. The work was conducted under Washington State University, College of Agriculture Research Center research project no. 4436.

The authors of the report are: Dr. Walter Butcher, Professor of Agricultural Economics, Washington State University; Joanne Buteau, Research Associate in Agricultural Economics, Washington State University; Dr. Kenneth Hassenmiller, Consulting Economist, Seattle, Washington; Dr. Glenn Petry, Associate Professor of Business Administration, Washington State University; and Dr. Samih Staitieh, former graduate Research Assistant in Agricultural Economics, Washington State University. Dr. Butcher was project director and principal author of the report.

The statements, findings, and conclusions contained in the report are solely those of the authors of the report and do not necessarily reflect the views of Washington State University or the National Oceanic and Atmospheric Administration.

The authors thank Dr. Lee Blakeslee, Dr. Lewis Queirolo, and Dr. Philip Wandschneider, all of the Department of Agricultural Economics, Washington State University, for their thorough review of a draft of this report, and for their helpful suggestions for improving the report. Dr. Blakeslee also earned special' thanks for his assistance and suggestions for formulation and interpretation of the input/output analysis. Special thanks are also due to Frank Pirnique, Systems and Computer Programmer in Agricultural Economics, for his deft handling of the computer analysis, and to Dianne Reynolds for transforming scribbled notes and manuscripts into a nicely arranged and neatly typed report.

TABLE OF CONTENTS

I. INTRODUCTION

Fish are one of Alaska's most important natural resources. The waters off the coast of Alaska abound in stocks of salmon, halibut, crab, shrimp, and other species of fish. The harvest from these renewable natural resources has been a valuable source of revenue for the Alaskan economy since the earliest days of settlement. Today, the harvesting and processing of these fish provide business opportunities and employment for thousands of Alaskans, as well as for residents of other states who also participate in these fisheries.

Because of the importance of fish in the Alaska economy, there is long standing concern that the fisheries be managed and exploited so as to yield as much benefit as possible for the people of Alaska. This concern has led to considerable discussion of fisheries management policy[1/] Generally policy has been directed toward the attainment of a maximum sustained yield (MSY). To achieve MSY, there must be ideal control of biological factors such as timing-sex-size selectivity in harvest from breeding stocks. Also, in order to attain MSY, the annual harvest must be limited to only the excess numbers above required replacements of breeding stock.

Biologists have given a good deal of emphasis to the determination and attainment of MSY, but fishermen, citizens, and policy-makers are more directly concerned about the economic implications of fisheries exploitation and management. Economists have tried to address that concern with the concept of an economic optimum harvest designed to provide a maximum net value of fish produced minus the cost of harvesting

---

[1/] Tussing, Arlon R., Thomas A. Moorhouse, & James D. Babb, Jr., editors, Alaska Fisheries Policy, Institute of Social, Economic, and Government Research, University of Alaska, Fairbanks, 1972.

and processing. The economic optimum requires the same conditions as MSY with the additional provisions that the least costly harvesting methods be used and that harvesting effort not be expanded to the point where the value of additional catch realized is no longer greater than the marginal cost of the additional fishing effort devoted to the fishery. Economists have been especially concerned that there be no over-investment in excess capacity for harvesting and processing the available catch. Since it always costs something to harvest additional units, and since market limitations cause marginal values to decline as harvests increase, the economic optimum harvest level will almost always be less than the MSY.

The economist's definition of "optimal" fishery management has also not been entirely acceptable to policy-makers and the public. The economic criterion of maximum net value (i.e., maximum revenue minus costs including opportunity cost of labor and capital) appears to be of little concern to the industry and public. Their economic concerns are more apt to center on the number of jobs provided and the amount of income generated for the participants in the industry or the residents of the region. Especially when a basic industry such as fishing is involved, there is a realization that larger harvesting fleets and/or larger harvests create added employment in the fishery and also stimulate growth elsewhere throughout the economy as a result of expansion in the fishery. There is general feeling that growth in local jobs and businesses is good, even if there is less net economic value than could have been realized with less "over-expansion" of the basic industry. Since the public is generally more interested in economic growth than in economic efficiency, it behooves the economists to provide some Indication of the nature and size of the economic effects of various resource policies and developments.

The purpose of this study is to provide estimates of the economic impacts from one part of Alaska's fishing industry, the shellfish fishery. Shellfish harvests in Alaska consist mostly of king, snow (tanner), and Dungenes crab and shrimp. The shellfish fishery has grown from a relatively small and insignificant part of Alaskan fishing and the Alaskan economy to become nearly as large as the venerable Alaskan salmon fishery. From 1960 to 1977, the share of shellfish in the total value of all fish landings in Alaska rose from 8% to 44%. During that time, the value of total shellfish landings grew from $3.1 million in 1960, to $155.6 million in 1977. Processing further increases the value of shellfish so that the wholesale value of the product leaving Alaska is about 70% greater than the value of the harvested shellfish. By 1976, the value of shellfish products from Alaska equaled nearly 2% of the total gross business receipts of all industries in Alaska.

Alaskans consider shellfish to be one of their important natural resources and they would like to see it exploited in a way such that it yields the maximum benefits for the whole state of Alaska. The fact that both state and federal governments are heavily involved in the management and allocation of the fish introduces the possibility that management of the fishery could be adjusted so as to yield maximum benefits for the state. Now that the shellfish sectors are large enough to potentially have a significant impact on other parts of the Alaska economy, there is additional incentive for being concerned about how large those impacts might be and about how various changes to the shell-fish fishery might impact on the economy.

Although there is now considerable attention directed toward the shellfish fishery and its economic impacts, it is still not that easy to determine just how large those impacts might be. Even though the shellfish sector is now a fairly significant part of the Alaska economy, it is not large enough to be an obviously dominant force in the economy. So, it is not possible to gauge the impact of the shellfish fishery by simply correlating the shellfish harvest and the rise and fall of the Alaska economy. There are simply too many other equally or more important sectors that are also changing for various reasons and exerting their impact on the Alaska economy. Furthermore, it is also not possible to guess at the economic impacts of the shellfish fishery by simple adaptation of some rules of thumb derived from analyses of other sectors. The shellfish sector is unique in several important respects and it has grown up quite recently so there is less general background knowledge about the industry as it now exists. We do know that harvesting vessels and processing plants that have recently entered the shellfish industry have tended to be much larger and more commercialized than were the early harvesters and processors. They are also larger than most present participants in salmon, halibut, and other Alaska fisheries or in the Washington, Oregon, and California shellfish fisheries. The recent entrants also have close ties outside the Alaska economy. They often turn to Washington and other states, or even some foreign countries, for financing, managers, skilled operators, equipment, servicing, supplies, etc. Naturally, the economic impacts in Alaska are much less than they would be from a sector that was more closely tied to the Alaska economy.

The only practical way to determine the economic impacts from a sector having characteristics such as the Alaska shellfish fishery is to determine the economics of operation within the industry itself, its linkages with other sectors of the economy, and finally the structure and interactions of the entire economy, including the shellfish sectors.

The principal method that is used for conducting "total economy" analyses is called input/output analysis (I/O) or interindustry analysis. The I/O method accounts for all of the economic linkages that exist and provides a method for tracing economic impacts throughout the economy. An I/O model with focus on shellfish sectors would be a useful tool to use in estimating economic impacts from changes such as an increase or decline in the Alaska shellfish fishery or a change in management of the fishery. Since the sectors that are dependent upon the shellfish fishery are also very heavily linked to the Washington economy, it is necessary that the input/output model for analyzing their economic impacts include not only a sector-by-sector accounting of the Alaskan economy, but also a similar accounting for the Washington economy.

The specific objectives of this study are: (1) to determine the economic linkages between harvesters and processors of Alaska shellfish and other sectors of the Alaska and Washington economies; (2) to incorporate the sectors primarily connected to the shellfish fishery into revised Alaska and Washington state economic input/output models; and (3) to estimate economic impacts of potential permanent changes in the Alaska shellfish fishery.

The organization of this report parallels the objectives. First, there is a brief introduction to the history, scope, and nature of the shellfish fishery in Alaska. Next, the shellfish harvesting and processing sectors are described and analyzed in terms of their economic structures and economic linkages with other sectors of the Alaska and Washington economies. An integrated Alaska-Washington input/output model is next developed and the shellfish sectors are integrated into the model. Finally, measures of the economic impacts of various potential changes in developments within the industry are calculated using the input/output model and the results are discussed in terms of their impacts particularly on the most affected segments of the economies.

II. AN INTRODUCTION TO THE ALASKAN SHELLFISH INDUSTRY

Species and Location

The principal species of shellfish caught in Alaska include king, Tanner, and Dungeness crab and shrimp.[2/] The shellfish are harvested in eight principal harvest areas as shown in Figure 1. Those include Southeastern, Prince William Sound, Cook Inlet, Kodiak, Alaska Peninsula, Dutch Harbor, Western Aleutians and Bering Sea.

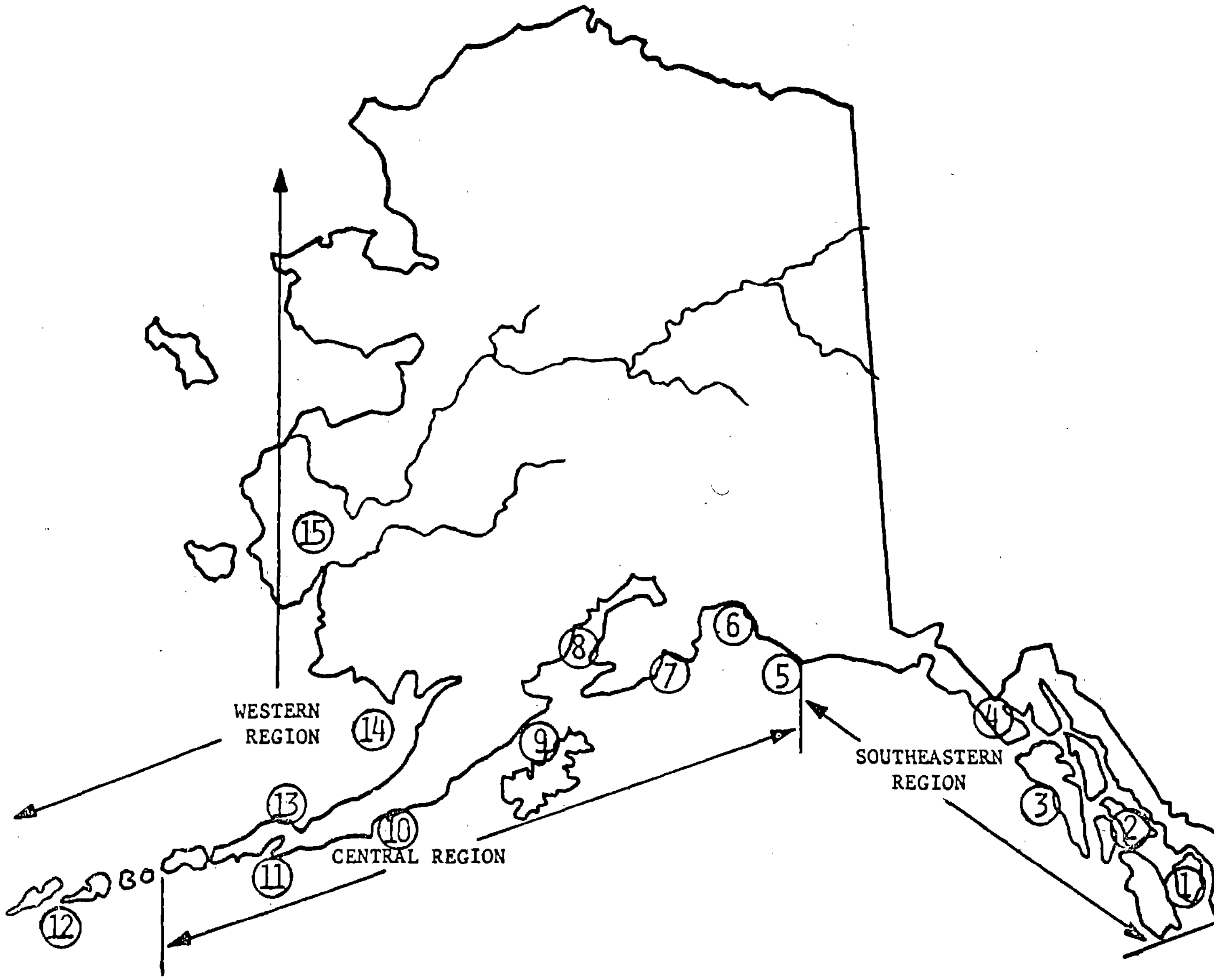
History of Exploitation

The recent history of exploitation of the shellfish stocks is depicted in Table 1 for three selected years (1969, 1972, and 1976). The more sheltered areas of Southeastern Alaska and Prince William Sound, have not been high shellfish producers during this period. In the earlier part of the 11-year period from 1969-79, the principal shellfish fishery was around Kodiak and, to a lesser extent, the Bering Sea and the Western Aleutians. Toward the latter part of the period, while Kodiak maintained some importance, the key fishery shifted to the Bering Sea. This trend is apparent in 1976 and preliminary 1979 figures indicate a continuing growth in importance of the Bering Sea fisheries.

About 70% of total shellfish revenue comes from sale of king crab. The king crab fishery was the first highly successful crab fishery in Alaska. Although there was some commercial exploitation of the species as

---

[2/] There are three subspecies of king crab, two subspecies of Tanner crab (opilio and bairdi) and several subspecies of shrimp. The various subspecies must be specifically managed, individually targeted upon In the harvest and, in some cases, marketed separately at different prices. However, in the interest of simplicity we have treated each species as though its subspecies composition was constant.



REGIONS:

SOUTHEASTERN ALASKA: Dixon Entrance to Cape Suckling

CENTRAL ALASKA: Cape Suckling to Scotch Cap on the southwestern tip of Unimak Island

WESTERN ALASKA: The Aleutian Islands west of Scotch Cap and the Bering Sea north through Kotzebue Sound

AREAS:

1 Ketchikan
2 Petersburg-Wrangell
3 Sitka
4 Juneau-Yakutat
5 Copper-Bering Rivers
6 Prince Wm. Sound
7 Resurrection Bay
8 Cook Inlet
9 Kodiak
10 Chignik
11 South Peninsula
12 Aleutian Islands
13 North Peninsula
14 Bristol Bay
15 Arctic-Yukon-Kuskokwim

Figure 1. Alaska Fishing Harvest Areas

Table 1. Alaskan Shellfish catch Statistics During Three Selected Years (1969, 1972, & 1976) for Eight Geographic Areas (in 1976 dollars)

Area	King Crab			Tanner Crab			Dungeness Crab			Shrimp			
	Gross Revenue ($000)	Pounds (000)	% of Total Gross Revenue	Gross Revenue ($000)	Pounds (000)	% of Total Gross Revenue	Gross Revenue ($000)	Pounds (000)	% of Total Gross Revenue	Gross Revenue ($000)	Pounds (000)	% of Total Gross Revenue	Total Gross Revenue ($000)
Southeastern:													
1969	975	1,895	56	46	268	3	604	2,343	35	112	1,680	6	1,737
1972	588	943	26	163	790	8	1,340	2,593	60	137	919	6	2,228
1976	277	396	16	859	4,070	50	437	1,060	26	129	970	8	1,702
Prince William Sound:													
1969	22	48	5	179	945	43	212	879	51	2	3	1	415
1972	186	296	9	1,580	8,551	72	413	725	19	3	9	0	2,182
1976	11	17	1	1,200	6,000	91	102	290	8	---	---	---	1,313
Cook Inlet:													
1969	561	2,856	64	182	1,455	21	12	50	1	117	1,850	14	872
1972	2,342	4,608	57	1,104	4,779	27	23	39	0	655	5,549	16	4,124
1976	3,518	4,954	62	1,246	5,935	22	63	119	1	852	6,208	15	5,679
Kodiak:													
1969	6,017	12,956	52	1,130	6,862	10	1,505	5,835	13	2,848	41,353	25	11,550
1972	9,058	15,480	53	2,201	11,907	13	1,237	2,060	7	4,700	58,646	27	17,196
1976	12,546	17,522	55	5,019	25,129	22	25	87	0	5,168	51,851	23	22,758
Alaska Peninsula:													
1969	2,294	4,942	79	112	653	4	299	1,158	10	215	3,135	7	2,920
1972	2,004	4,338	50	671	3,968	17	---	---	---	1,291	18,613	33	3,966
1976	564	882	6	3,350	16,752	35	---	---	---	5,613	66,139	59	9,527
Dutch Harbor:													
1969	2,835	7,492	98	5	27	0	69	283	2	---	---	---	2,909
1972	4,523	11,297	100	---	---	---	---	---	---	---	---	---	4,523
1976	7,112	11,471	95	105	551	1	---	---	---	312	3,671	4	7,529
Bering Sea:													
1969	3,791	10,018	93	189	1,103	5	84	353	2	---	---	---	4,064
1972	8,071	20,963	100	17	112	0	---	---	---	---	---	---	8,088
1976	43,631	70,411	91	4,242	22,324	9	---	---	---	---	---	---	47,873
Western Aleutians:													
1969	6,524	18,062	100	---	---	---	---	---	---	---	---	---	6,524
1972	6,499	16,234	100	---	---	---	---	---	---	---	---	---	6,499
1976	236	386	100	---	---	---	---	---	---	---	---	---	236
Total Alaska:													
1969	15,644	57,730	77	1,133	11,207	6	1,620	11,304	8	1,909	47,851	9	20,306
1972	20,519	74,427	67	3,731	30,135	12	1,968	5,448	6	4,493	83,831	15	30,711
1976	68,689	105,899	70	16,166	80,771	17	630	1,546	1	11,572	128,682	12	97,057

far back as the 1920s, the first substantial catches occurred in 1953. The production was rather constant until 1958 when a tremendous expansion started and continued until the peak 1965-66 harvest year of 152 million pounds. From this peak, the harvest level fell and did not recover until 1978 and 1979 when harvests were. 122.9 and 150.1 million pounds, respectively. Despite the drop in production in the late 1960s and early 1970s, king crab maintained its dominance in Alaska shellfish revenue because of its high value per pound.

The Tanner crab fishery is increasing in importance and it appears to be the most under-exploited shellfish in Alaska. Tanner crab was first commercially harvested in Alaska by U.S. fishing vessels in 1961. By 1969 over 11 million pounds were landed, representing 8.8% of the shellfish catch by weight. Tanner crab landings have continued to increase, reaching 15.6% of total shellfish landings in 1972, 25.4% in 1976, and 38.6% in 1979. In addition, foreign vessels harvest a large amount of Tanner crab in Alaskan waters because it has been determined that the U.S. industry cannot harvest and process the potential for the Tanner crab fishery. According to the management plan for Tanner crab, the maximum sustainable yield in the Bering Sea is 539 million pounds, which is 7 times the 1979 harvest in that area by U.S. vessels.

The shrimp fishery in Alaska consists of a trawl fishery for smaller species in the Kodiak and Alaska Peninsula areas and pot fishing for high valued prawn species in the Cook Inlet area. The total shrimp catch in Alaska increased from 16 million pounds in 1961, to a high of 129 million pounds in 1976. Since 1976 the catch has declined to 50 million pounds in 1979.

The ex-vessel price of Alaska shrimp averaged 4¢ per pound for many years. Since 1973 the price has been around 10¢ per pound. Still, shrimp accounted for only 12% of the value of shellfish harvest in 1976 despite constituting 40% of the total pounds harvested.

Acceptable Harvest Levels

Fisheries are notoriously prone to overharvesting due to the tradition of allowing open access to/anyone wishing to harvest from the fish stocks. When combined with the biological dependence on residual (not-harvested) stocks for reproduction, open access and exploitive harvesting can be devastating to future production. Therefore, control of harvest is a most important part of managing the fishery.

A number of different measures of stocks and yields are used to guide fishery management and determine harvest levels., Maximum sustainable yield (MSY) is as the term implies, a yield that can be sustained over time. MSY depends on the size of the resource, reproductive characteristics of the species and selectivity of the harvest method. There is some justification for trying to maintain the fishery near MSY, but, in some cases, there may be high economic costs of pursuing more scattered stocks as harvest approaches MSY. Fish stocks are subject to wide fluctuations from year to year, even when the-fishery is closely managed. Therefore, the acceptable biological catch (ABC) could be above or below MSY in a particular year as recruitment (new members in the fish population) is high or low. Since accurate estimates of recruitment are often not available, ABC is usually based on recent harvest trends. The concept of optimum yield (OY) includes socio-economic considerations, such as a depressed market for the fish or a depressed local economy, in determining how the harvest should deviate from ABC.

MSY, OY, and actual catch for each management area are shown in Table 2. The most striking figure in the crab managementplans is the very high MSY for tanner crab in the Bering Sea. The estimated MSY of 539 million pounds is more than 5 times as large as the 1979 harvest. It reflects the potential for harvesting large amounts of the opilio species of Tanner crab. However, the opilio crab are smaller and less valuable than the bairdi species. Many fishermen feel that it is not profitable to harvest the opilio crab. The much lower “optimum yield” of 58-60 million pounds recognizes this economic consideration.

For the highly profitable king crab, the major fishery management task is prevention of over fishing rather than encouragement of more complete exploitation. Control is accomplished by closing the season as soon as the acceptable yield has been harvested. Guideline- harvest levels are set before each season on the basis of fishery managers’ estimates of recruit-ment-and the general condition of the fishery. When the season is opened, fishery managers keep track of the volume harvested and monitor conditions that might indicate a need for revising the harvest level. When the guide-line harvest level is reached, the season is closed. In 1979, a greatly increased fleet of large, efficient vessels required only 23 days to harvest the ABC for king crab in the Bering Sea.

Harvest Restrictions

In addition to restrictions on the quantity harvested, there are several regulations that are designed to prevent waste or damage to the fishery stocks, provide stability in the fishery, protect local fisheries

Table 2. Maximum Sustainable Yield (MSY), Optimum Yield (OY), and Actual 1976 Catch for Each Management Area* (1,000 pounds)

Area	King Crab MSY	King Crab OY	King Crab 1976 Actual Catch	Tanner Crab MSY	Tanner Crab OY	Tanner Crab 1976 Actual Catch
	---(1,000 lbs)---					
Southeastern	750	602	338	5,500	5,500	3,512
Prince William Sound	300	300	17	7,200	3-7,000	6,000
Cook Inlet	3,930	5,070	4,954	5,300	5,300	5,935
Kodiak	29,090	26,000	17,522	21,500	15-25,000	23,446
Alaska Peninsula	5,000	4,600	882	20,000	20-30,000	
Dutch Harbor	12,000	21,000	11,471	2,000	2,000	17,816
Adak (Western Aleutians)	13,000	1,500	386			
Bering Sea	84,800	139,200	70,411	539,000	58-60,100	22,324
TOTAL	148,870	198,272	105,981	600,500	108-134,900	79,033

*Maximum sustainable and optimum yields for king crab are taken from Fishery Management Plan for Alaska King Crab, North Pacific Fishery Management Council.

Tanner crab is from Fishery Management Plan for the Commercial Tanner Crab Fishery Off the Coast of Alaska, North Pacific Fishery Management Council (Anchorage, Alaska), May 16, 1978.

and encourage the orderly development of unexploited fisheries. The principal restrictions are season limits, exclusive area registration, gear restrictions, size limits, and males only harvest. The regulations often differ from area to area.

The seasons have generally been set in recent years to reduce deadloss of softshell crabs and to curtail fishing during the breeding and egg hatch, season. The opening date is often set to correspond with acceptable meat recovery by the processors. The minimum size limitations have been enacted to allow mature male crab to contribute to stock reproduction for one breeding season before being harvested. The males only restriction is also designed to prevent over-harvesting of the females in the reproducing stocks.

The gear restrictions have been used for a variety of reasons including reducing the fishability of lost pots, limiting competition, making Tanner crab regulations consistent with those for king crab, keeping larger king crab out of the pots, allowing escape of undersized crabs, and reducing sorting and handling problems. Exclusive area registration is designed to protect small locally operating vessels which could not compete with the large mobile fleets..

In the mid-1970s, fishery management began to include the concept of reducing annual fluctuations or risk in the fisheries. This represented a departure from the traditional maximum sustainable yield concept to one that considered both biological and socio-economic management issues. One method of achieving this goal was to set harvest regulations which maintained a range in size of males in the fishery so that each breeding season did not depend largely on new recruits achieving minimum size each year.

Shellfish Harvesting

A total of 540 vessels participated in the 1976 shellfish harvest. They ranged from small boats in the 20 feet-30 feet class up, to multi-million dollar crabbers over 120 feet in length. Many of the smaller vessels are used principally for salmon fishing and enter the shellfish fishery only to fill in the off-season. Most of these vessels operate in local waters along the Alaska coast. The larger vessels, are usually specialized for crab or shrimp. Because of their size and equipment they are able to operate in the Bering Sea and other off-shore waters that would be dangerous and difficult for the smaller vessels. The larger crab boats typically harvest both king crab and Tanner crab, which provides a longer operating season.

Alaska Shellfish Bioeconomic Data Base

The best source of data on specific features of the shellfish harvesting sector is a study conducted in 1977 by the Alaska Commercial Fisheries Entry Commission[3/] under contract to the National Marine Fisheries Service. The study involved summarization and analysis of data from the Alaska Department of Fish and Game's fish ticket files, the Commercial Fisheries Entry Commission's vessel registration records, plus data on costs, vessel characteristics, and fishing operations supplied by 198 fishermen who responded to a survey by the Entry Commission.

As a first step in the development of the bio-economic data base, vessel registration files by species and location and fish ticket. files were collated by the Entry Commission to account for duplicate listings when vessels operated in more than one fishery. Fish ticket files, which

---

[3/] Queirolo, Lewis E. et al., Alaska Shellfish Bioeconomic Data Base, Alaska Commercial Fisheries Entry Commission, Juneau, 1978.

include a record of every delivery of fish to Alaskan buyers or processors, were then scanned to identify and eliminate licensed vessels that actually had no landings of shellfish in 1976. For each of the 540 vessels that were active in the 1976 shellfish fishery, the Entry Commission compiled data on landings of each species in each location. Information on vessel. size was obtained from the Entry Commission's license data which include basic identification of the vessel (which also appears on the fish ticket), its authorization for fishing by species, location, gear type; and a few items of basic vessel characteristics such as length/tonnage displacement, and horsepower.

The collated file of active shellfish vessels provided a-sampling list for the Entry Commission's personal interview survey of 198 shellfish vessel operators. Detailed information was collected from each of the operators on characteristics of the vessel, gear, and crew and on 1976 operations and costs. The survey responses for each vessel were then collated with its fish ticket file and license data to compose a complete account of-the vessel's characteristics, costs and 1976 operations.

The Entry Commission summarized their data by 12 subfleets, identified on the basis of species harvested, areas fished and size of vessel (see Table 3). Selected mean characteristics per vessel are shown in Table 4. A complete discussion of the subfleets appears in the Entry Commission Report.[4/] A comparison, within each subfleet, of catch statistics for the surveyed vessels to the same statistic for all vessels indicates that the samples are good representations of the populations of vessels in the subfleets.

[4/] Queirolo, op cit., Table 3, Table 4, and pp. 53-92.

Table 3. Alaska Shellfish Harvesting Subfleets

Subfleet	Fleet Description	1976 Fleet Size	Sample Size
A1	Vessels under 50 feet whose only shellfish catch in 1976 was shrimp	28	19
A2	Vessels 50 feet and over whose only shellfish catch in 1976 was shrimp	47	21
BC	Vessels reporting landings of both crab and shrimp in 1976	36	14
D1	Vessels under 50 feet reporting shellfish landings of only crab, exclusively in Southeastern in 1976	30	14
D2	Vessels 50 feet and over reporting shellfish landings of only crab, exclusively in Southeastern in 1976	11	
E1	Vessels under 50 feet reporting shellfish landings of only crab, exclusively in Prince William Sound in 1976	24	16
E2	Vessels 50 feet and over reporting shellfish landings of only crab, exclusively in Prince William Sound in 1976	5	
F1	Vessels under 40 feet reporting shellfish landings of only crab, exclusively in Cook Inlet in 1976	41	16
F2	Vessels 40 feet and over reporting shellfish landings of only crab, exclusively in Cook Inlet in 1976	26	13
G1	Vessels under 50 feet reporting shellfish landings of only crab, exclusively in Kodiak in 1976	93	29
G2	Vessels 50 feet and over reporting shellfish landings of only crab, exclusively in Kodiak in 1976	43	12
H	Vessels reporting shellfish landings of only crab, exclusively in the Alaska Peninsula	23	9

Table 3. Continued

Subfleet	Fleet Description	1976 Fleet Size	Sample Size
I2	Vessels from 65-104 feet reporting shellfish landings of only crab in more than one area in 1976	108	28
I3	Vessels over 104 feet reporting shellfish landings of only crab in more than one area in 1976	25	6

SOURCE: Queirolo, Lewis E., et al., Alaska Shellfish Bioeconomic Data Base, Alaska Commercial Fisheries Entry Commission, Juneau, 1978.

Table 4. Selected Mean Characteristics of Alaska Shellfish Harvesting Subfleets

Characteristics	Units	Subfleets											
		A1	A2	BC	D	E	F1	F2	G1	G2	H	I2	I3
<u>Vessels</u>													
Number	no.	28	47	36	41	29	41	26	93	43	23	108	25
Average length	ft.	38	73	61	49	49	35	55	41	72	51	85	109
Engine	hp	203	412	385	242	268	175	259	230	417	260	645	908
Crewmen/vessel	no.	1.3	2.8	2.7	1.8	1.5	1.5	2.4	1.8	3.0	2.2	3.4	3.8
Year built		1962	1955	1967	1952	1959	1962	1946	1967	1953	1955	1962	1966
Market value/vessel:													
Vessel	$1,000	61	338	342	149	125	59	126	119	375	183	747	1,507
Gear	$1,000	5	29	73	38	38	22	29	26	81	35	126	156
<u>Shellfish Harvesting</u>													
Trips	no.	36	49	38	21	30	117	79	23	20	30	19	14
Gross returns	$1,000	17	161	208	49	36	29	55	47	136	80	428	482
Variable costs	$1,000	6	79	78	19	22	14	41	20	60	31	169	195
Fixed costs	$1,000	2	28	52	7	8	4	24	7	58	13	65	110
Skippershare	$1,000	2	24	31	7	5	4	8	7	21	12	64	72
Return to investment	$1,000	7	30	47	15	1	7	-18	13	-3	24	130	104

SOURCE: Queirolo, Lewis E., et al., <u>Alaska Shellfish Bioeconomic Data Base,</u> Alaska Commercial Fisheries Entry Commission, Juneau, 1978.

Similarity between the sample and the entire subfleet indicates that it is reasonably safe to use the means from the surveyed vessels as estimates of the means for the vessels in a subfleet. Therefore, we used the count of vessels actually within the population of each subfleet as weighting factors for expanding the means for the sample into estimates of total investment, cost, employment, etc. for each subfleet.

The Entry Commission's division of the sample into subfleets. helps describe the situation of unique components in this diverse industry;, however, for determination of the economic impacts of the shellfish industry, it is desirable to have a somewhat more aggregated categorization of the. shellfish harvest operations. Therefore, we have further combined the subfleets into three economic classes of shellfish harvesters as follows: (1) large vessels that harvest king and tanner crab in the Bering Sea land other western and central Alaska areas; (2) medium-sized vessels with a moderate capital investment harvesting shrimp or crab, mostly in the Kodiak area; (3) small, relatively low-cost vessels often targeting on non-shellfish species, as well as shrimp or crab, in local waters of central and south-eastern Alaska. The estimated mean characteristics and total for the three size classes and for the entire shellfish fleet, are presented in Table 5.

The estimate of gross earnings derived from the sample survey data is $90.2 million for the entire shellfish fleet. This is 7% below the value reported in fish ticket files. The underestimate must have arisen due to a tendency to get slightly smaller, less active or less productive 'vessels in the survey. If so, statistics other than gross earnings may also be underreported, but there is no sure way to check this.

The vessels in the fleet averaged 61 feet in length and had an average value of $356,000 for the vessel plus $60,000 worth of shellfish gear. The

Table 5. Selected Characteristics of Alaska Shellfish Vessels--Large, Medium, and Small Classes--and Fleet Total, 1976

Item	Units	Averages per Vessel				Totals for Vessel Category			
		Large[a]	Medium[b]	Small[c]	Fleet	Large	Medium	Small	Fleet
Vessels									
Number	no.	1	1	1	1	133	126	281	540
Average length	ft.	90	70	44	61	11,905	8,723	12,345	32,973
Engine	hp	695	405	230	386	92,360	51,156	64,657	208,173
Crewmen/vessel	no.	3.5	2.8	1.8	2.6	462	454	495	1,411
Year built		1963	1958	1960		N/A	N/A	N/A	N/A
Market value/vessel:									
Vessel	$1,000	890	352	106	356	118,377	44,323	29,793	192,493
Gear	$1,000	132	59	27	60	17,097	7,445	7,694	32,236
Shellfish Harvesting									
Trips	no.	18	36	44	36	2,402	4,536	12,419	19,357
Gross returns	$1,000	438	166	44	169	58,248	20,936	12,305	91,489
Variable costs	$1,000	174	72	21	71	23,112	9,124	5,844	38,080
Fixed costs	$1,000	74	45	8	33	9,780	5,679	2,296	17,755
Skippershare	$1,000	66	25	7	23	8,737	3,140	1,810	13,687
Return to investment	$1,000	124	24	8	41	16,619	2,993	2,355	21,967

SOURCE: Queirolo, Lewis E., et al., Alaska Shellfish Bioeconomic Data Base, Alaska Commercial Fisheries Entry Commission, Juneau, 1978.

a/ Subfleets I2 and I3, vessels fishing for crab in multiple areas.

b/ Subfleets A2, BC, and G2, shrimpers, combination shrimp/crab, and Kodiak crabbers, all over 50 feet.

c/ Subfleets A1, D, E, F1, F2, G1, and H.

market value of the shellfish fleet, in 1976, totaled $ 192 million worth of vessels plus $32 million of pots, nets and other shellfish gear.

There were an estimated 2.6 crew members per vessel, making 1,950 crew members and skippers-working on these vessels. The vessels averaged 36. trips each for a total of 19,360 shellfish trips during 1976.

Operating costs (costs that vary with the amount of fishing effort such as fuel, food, crew share, etc.) totaled $38.1 million for the entire shellfish fleet (Table 5) and fixed costs (e.g., insurance, licenses, etc.) totaled $17.8 million. In addition, skipper shares amounted to $13.7 million, leaving about $22 million as return to owners on an investment that totaled $207 million as the shellfish share.

Large Crab Fleet

According to the Entry Commission's analysis of the 1976 Alaska shellfish harvesting operation, there were 133 vessels that were classified as large crab boats operating in multiple areas. These constituted subfleets 12 and 13 in their study.

All vessels assigned to these subfleets were over 65 feet in length. The average length of a vessel was 90 feet. The average market value of the vessel was estimated to be $890,000, and the shellfish gear on these vessels had an estimated value of $132,000.

The vessels in this category had an average gross return from 1976 shellfish operations of $438,000. Virtually all of this revenue was from sale of king and tanner crab, with only incidental amounts of revenue from one or two boats that also landed Dungeness crab or for non-shellfish species. The total value of king and Tanner crab landings reported by this group was $58 million or 72% of the value of king and Tanner crab reported by all vessels. These large vessels are sometimes referred to as the “Bering Sea Fleet” because they operate principally in that highly productive and rapidly expanding fishery. Some. of these vessels also fish other parts of western Alaska, and a few fish in the vicinity of Kodiak Island or other central or southeastern Alaska areas.

The exploitation of the Bering Sea fisheries proved to be very profitable during the 1970s and this has encouraged investors to build vessels specifically designed and equipped to operate in that area. As a result, the vessels in this group are relatively new. The average age for the entire group was 12 years. The newer vessels tended to be larger than the older ones, more powerful, better equipped, and hence more expensive. The total market value of these vessels and gear was $135 million in 1976. A substantial fraction of the total has been invested in very recent times.

Rapidly increasing gross earnings and high profits in this fishery have attracted an accelerating influx of new capital. In response to some questions about their future plans, most of the vessel operators in this category indicated an intention to either. build new vessels or modify their present vessel. At the time they were surveyed in 1977, 50% intended to build new vessels, ranging up to 170 feet in length and costing from $1 million to $3 million per ship. During 1977, 1978 and 1979 new vessels were in fact added to this fleet at a very rapid rate. Shipyards in the Puget Sound area were running at capacity building for the Alaska crab fishermen. In addition, a number of crab vessels were built in Gulf Coast shipyards and on the East Coast. However, when the value of the 1979 king crab harvest fell percipitously, the pace of additions of new vessels in the fishery slowed markedly.

Because of the amount of capital required and the large scale business involved, these vessels are operated more as a business enterprise than would be characteristic of the typical fisherman operating his own vessel with the help of one or two deckhands. Many fishermen cannot finance the $1 million or more that it takes to purchase and outfit one of these vessels. So, they either operate as a hired skipper or share-owner in a vessel owned by outside investors. Outside capital has found these vessels to be a lucrative investment that rapidly increases in market value and provides distinct tax advantages due to large depreciation and interest deductions.

A substantial proportion of the vessels in this class are operated out of Washington home ports. According to the license file data, 53% of the vessels over 100 feet in length that were licensed for king crab fishing in 1976 came from Washington home ports. Although this was only 15% of all licensed boats, the Washington vessels harvested 57% of the king crab in 1976. The Washington vessels operating in the king crab fishery tend to be larger, more modern vessels with relatively larger catch per vessel.

Most of the large king crab boats that are not from Washington ports are based in Kodiak. They also often move out to fish the Bering Sea. Even the Alaska-based boats in this size category have a strong Seattle connect ion. Many were built in Puget Sound shipyards. They are too large for Alaskan yards so it is necessary for them to return yearly to Puget Sound shipyards for hull maintenance. Furthermore, parts, supplies and maintenance services are readily available in Washington at prices that are considerably below those In Alaska. So, the fisherman can save money by going to Seattle for repairs and restocking. Finally, many of the fishermen and their families use the annual maintenance trip as an opportunity for a vacation in the Seattle area. In fact, it is not unusual for Alaska fishermen to establish a second home in the Seattle area and for that to eventually become the residence where they and their families spend most of the year.

On the average, the large crab boats were marginally profitable in 1976. Gross returns averaged $438,000 per vessel. Operating costs other than labor were $141,000 per vessel, leaving a net margin of $297,000 as return to labor, management, and investment. Crew members on these vessels are typically each paid a 7% share of the gross earnings. With an average of almost 3.5 crew members, other than the skipper, the crew share would be about $105,000 per vessel. Cut of the remainder, a skipper share of about 15% of the gross, or $66,000, must be paid, leaving $124,000 to cover the interest and depreciation on a $1 million investment in vessel and gear. Many of the skippers are part owners of the vessel.

Medium-Size Shellfish Harvest Vessels

The Bioeconomic Data Base includes three subfleets with 126 shellfish harvesting vessels that are greater than 50 feet in length, but not generally as large as the specialized crab vessels in their subfleets I2 and I3. Subfleet A2 includes the 49 larger shrimp boats which generally operate in the Kodiak area, plus Cook Inlet and the Alaska Peninsula. These were fairly specialized shrimp vessels with relatively small, incidental landings of other species. Subfleet BC included 36 vessels that landed both shrimp and crab in 1976. Two-thirds of their gross earnings in 1976 came from crab, and one-third from shrimp. The vessels in this subfleet operate in the Alaska Peninsula, Kodiak, and Bering Sea areas. Subfleet G2 consisted of 43 crab boats, all greater than 50 feet in length, that operated only in the Kodiak area. A few vessels in the l00-foot category operated in the

Kodiak area and hence were included in subfleet G2; however, most vessels in the 90-foot or above class fish the Bering Sea and were included in the subfleet I2 or I3 along with the other large vessels from the Seattle fleet.

Vessels in the medium-size category averaged 70 feet in length. They tended to be older than the large crab vessels, with an average construction date of 1958. It was particularly likely for the specialized shrimp boats and the crabbers who operated only in the Kodiak area to be older, whereas the combination shrimp-crab fleet were typically somewhat newer. The average market value of the vessel and gear was $404,000, or less than half of the average value of the large "Bering Sea" crab boats. The average crew on these vessels was 2.8, in addition to the skipper, which means that the average investment per crew member was considerably less than on the larger boats.

Vessels in the medium size category are much more likely to be Alaska based, have an Alaska home port, and stay in Alaska for repairs, maintenance, and outfitting. According to the evaluation of shrimp harvest by home port of vessel, only 25% of the vessels and 25% of the harvest were taken by Washington or Oregon vessels. However, some of the larger Alaska-based shrimpers and crabbers do travel to the Puget Sound area each year for their repairs and maintenance.

Local and Small Subfleets

The Entry Commission study identified 9 shellfish subfleets that operate exclusively in one of the local areas of Alaska. Many of the 281 vessels in these local subfleets are relatively small--the average length was 44 feet and they averaged less than two crewmen (in addition to the skipper) per vessel. They also tend to be older than the larger shellfish fishing vessels. The average in 1976 was 16 years of age. Most of these vessels are harvesting crab--only 19 were shrimpers. Most also operate in other fisheries such as salmon or halibut. In fact, for many of them crabbing is an off-season sideline to supplement income from their principal fishery. This may explain why they have only limited livetank capacity.

Because of small size, age. and limited shellfish equipment, the capital investment in these boats is relatively small. The average value of vessel and shellfish gear in 1976 was only $133,000, which is only slightly more than one-tenth of the value of the large vessels. As a result, the average investment per worker is only about 20% as large as it is on the large specialized crab boats. The gross returns from shellfish fishing by these vessels averaged only $44,000 in 1976. Fortunately, the variable and fixed costs of operating these vessels are relatively small, and a substantial portion of the fixed costs are covered by salmon, halibut or other non-shellfish species. The average skippershare plus net returns above operating cost totaled $15,000 per vessel.

The 281 vessels in this class made up more than half of all the vessels operating in the Alaska shellfish fishery in 1976. However, their gross returns from shellfish total only $12.3 million, which is approximately 14% of the total shellfish harvest. Diversification into other fisheries, low overhead, and a typical do-it-yourself operation made it possible for some of these fishermen to make a reasonably good return on their capital investment and their own labor and management input.

Vessels in the smaller class are more typically Alaskan fishing operations. The operators and the crew are usually Alaskan residents, and the vessel is kept in Alaska where it is serviced, repaired, and stacked for fishing operations. Involvement in other fisheries tends to keep the vessel in Alaska, and many of these boats are small enough so that it is feasible to do all the repairs on the boat in Alaskan facilities. An annual trip to the South is neither comfortable, safe, nor as advantageous in cost savings as it is for the larger Alaskan-based boats.

Shellfish Processing

Virtually all shellfish that are commercially harvested in Alaska are delivered to processing plants, located reasonably close to fishing grounds, where they are cleaned, cooked, and prepared for shipment to U.S. and international markets. The amount that moves directly from fishermen to consumers in Alaska is quite small.

The processing plants clean and cook the shellfish as soon as it is received. After the initial processing, some of the crab and shrimp are processed further toward final product forms which are principally crab sections, claws, and meat, and shrimp meat. The rest is simply frozen in bulk and shipped out to reprocessing plants in the Puget Sound region or in the Far East. Even products that are in a retailable form are generally shipped to reprocessors for repackaging, labeling, cold storage, and marketing.

The volume of Alaska shellfish processing by product type is presented in Table 6.[5/] These data are based on reports submitted by all fish processors in Alaska. It should be noted that other sources report somewhat different weights of processed product.[6/] A recent, detailed study of

---

[5/] Alaska Dept. of Fish & Game, Alaska 1976 Catch and Production, Statistical-Leaflet No. 29, Division of Commercial Fisheries, Juneau, July 1979.

[6/] National Marine Fisheries Service, Current Fishery Production, Annual Summary, U.S. Dept. of Commerce, 1976.

Table 6. Processed Shellfish Production and Value by Product Type, Alaska, 1976

Product	Production 1,000 pounds	Wholesale Value $1,000	Average Value $/pound
King Crab			
Whole or sections	32,141	63,810	1.98
Fresh meat	6,772	36,040	5.32
Canned meat	974	4,418	4.54
Total King Crab	39,887	104,267	
Tanner Crab			
Whole	26,617	20,081	.75
Sections	591	1,537	2.60
Fresh meat	3,071	9,322	5.04
Canned meat	1,822	5,805	3.19
Total Tanner Crab	32,101	36,672	
Dungeness Crab			
Whole and sections	1,089	1,627	1.49
Total All Crab	73,077	142,566	1.95
Shrimp			
Fresh	15,007	21,047	1.40
Canned	6,445	13,944	2.16
Total Shrimp	21,452	34,991	
Total Shellfish	94,529	177,557	1.88

Source: Alaska Dept. of Fish & Game, Alaska 1976 Catch and Production.

shellfish processing[7/] documented several potential problems with these data. However, errors in the official estimates seem likely to be small with the exception of possible underestimate in processed shrimp output. Orth's calculations indicate that the volume of shrimp catch should yield somewhat more product output, given normal assumptions about rates of conversion from raw to processed product.

Shellfish processing plants are widely distributed throughout Alaskan fishing regions. Processing plants must be reasonably accessible to the fishing grounds. Crab must be delivered live and shrimp need to be delivered to processors as soon as possible after they are caught. Fishermen want to minimize the running time required for traveling from the grounds to the processor and back.

Orth reported, in 1973-75, 88 plants producing crab products in Alaska. The largest plants are in the Western region which produces nearly three-fourths of all Alaskan king and tanner crab. This is also the area of most rapid growth in capacity, in many cases by bringing floating plants. By January, 1978, Orth estimated that there were 25 crab processing plants in the Western, region. The total capacity of these plants was 2.6 million pounds per day of king crab or 2.0 million pounds per day of tanner crab. This amounted to more than one-half of the total capacity in Alaska.

Shrimp processing is concentrated in the Kodiak area, which had 8 of 16 shrimp plants and two-thirds of the state's capacity in 1977-78. As with crab, the center of production has been moving to the West and processing has been following. Capacity is being added in the West, but

---

[7/] Orth, F.L., J.A. Richardson, and S.M. Piddle, Market Structure of the Alaska Seafood Processing Industry, U. of Alaska Sea Grant Report No. 78-10, Dec. 1979, p. 157.

it still was not adequate to handle the area's 1977 production. On' the other hand, Kodiak had substantially more processing capacity than would be needed to handle the catch in that area in recent years.

Shellfish processing operations vary substantially from small plants operating far below-capacity to one plant that produced more than 3 million pounds of crab meat products during the season.[8/] Differences in shellfish output per plant are more a result of variations in availability of raw product than of differences in size of the plant itself. Several of the larger plants also handled a large volume of salmon or other species which increased the overall utilization of their facilities.

In most Alaska regions there is considerable overcapacity in shellfish processing. Thisarises because of the cycles in shellfish harvests and the freedom for more and more vessels to enter and speed up the harvest. As new fishing grounds are discovered or harvestable stocks increase, 'there is a great demand for more processing capacity to handle the catch. If more vessels and fishermen are allowed 'to enter, the harvests will be completed more quickly. This creates demand for more processing capacity to handle the higher rate of catch per day. However, the plants will only be used for a few days out of their total annual capacity; If the resource dwindles and the catch falls, as has often happened, the added processing capacity will be even further underutilized. A large exodus of harvesting capacity from a no-longer lucrative fishery may actually result in a longer season for a smaller harvest and daily landings that are far below the processing plants' daily capacity.

[8/] Orth, et al., op. cit., pp. 56-59.

The most extreme overcapacity problems are in Southeast Alaska. Crab plants in that region have very low output per plant, but their capacity per day averages almost the same as the much more productive plants in Kodiak and Western Alaska areas. In fact, the six plants in Southeastern Alaska could have processed the region's entire 1976 crab catch in only eight days if they could have operated at capacity for only that short a time. Actually, the harvesting and processing of king, tanner and Dungeness crab in that area is spread over most of the year and the plants simply operate at a small fraction of their capacity during a relatively long season. The capacity is utilized for other species, but still there is substantial underutilization of capacity.

Overcapacity is a problem in both crab and shrimp processing for all areas. According to Orth,[9/] the Western Alaska region had enough capacity to process the 1977 king and tanner crab harvests in about 32 days for each. By 1979, the king crab season in the Bering Sea was down to only 23 days and the total catch was above the 1977 level. Even though more capacity had been added, there were serious bottlenecks during the short season and pressure to add still more capacity. But the extremely short season means that the plants stand idle for much of the year.

[9/] Orth, et. al., op., cit., pp. 110-120.

III. STRUCTURE OF THE ALASKA AND WASHINGTON ECONOMIES: AN INPUT/OUTPUT ANALYSIS

Shellfish and the Alaska Economy

The shellfish harvesting and processing sectors are important components of the Alaska economy. The value of the shellfish catch has grown at a rate of more than 20% per year since 1960. The landed value of all shellfish harvested in 1976 totaled $96 million. An additional $81 million of value was added during processing to yield a total wholesale value of $177 million worth of processed shellfish products. This amounts to almost 2% of total 1976 gross receipts by all sectors in the Alaska economy and ranks the combined shellfish sectors above several highly respected economic sectors. For example, the shellfish harvesting sector had earnings nearly 5 times as large as earnings in mining (excluding petroleum) and more than 10 times as large as Alaska agriculture's gross receipts. Several major sectors such as finance and insurance, communications and utilities, and medical services each had 1976 gross earnings in Alaska that were approximately the same as the gross earnings of the shellfish harvesting sector.

The shellfish sector is more important to the Alaska economy than would be indicated by comparing its size to the rest of the economy. The reason for its importance is that the shellfish industry is one of the "basic" industries in the Alaska economy. Basic industries use the region's basic natural or human resources to produce a product that is exported and sold outside of the region. The sale of the exported shellfish products brings in the funds which the basic industry uses to buy inputs, pay workers, and yield a net return to resource and company owners.

The non-basic sector makes sales to the basic industries, the resident population, and the other industries in the non-basic sector. Size of the non-basic sector depends upon the size of the basic sector and the "maturity" of the local economy. "Maturity" or "depth" of an economy is reflected in a wide variety of goods and services available locally and in a high proportion of business inputs and consumer goods produced locally rather than being imported from outside.

The basic sector is the independent or autonomous part of the economy. A basic industry, such as the shellfish industry, may move up or down for various reasons such as new discoveries, depletion of a resource base, or changes in the export market for its product. The non-basic portion of the economy, and other local industries that produce for local markets, is carried along by its sales to the basic sector and its workers. Furthermore, as local businesses expand to serve the basic sector, they buy more inputs for their own operation and bring in more employees of their own who also need local services. The extent of this cumulative building of growth on growth depends on the self-sufficiency of the region's economy. If most things are locally supplied rather than being imported from outside, the total growth that follows from an initial autonomous change will be much larger. However, without a base of some sort, growth cannot happen unless the region is completely self-sufficient in everything that is consumed.

The Alaska economy has several important basic industries which, like the shellfish industries, rely on the state's abundant and unique natural resources to produce commodities that are exported to national or international markets. Other important basic industries in Alaska are salmon and other fishing, petroleum, and forest products. The

Alaska tourism and recreation sector also makes substantial "export" sales to non-residents, and there are substantial federal government operations that use Alaska's geography with at least some purchases made locally using "outside" money (i.e., federal funds).

Despite its rich endowment of natural resources, the Alaskan economy is small in comparison to many other states that have much less of a natural resource base. One reason for the difference is that Alaska lacks 'manufacturing or specialized service industries other than those, like shellfish processing, that are an integral part of natural resource extraction. It has nothing in its economy comparable to Washington's aerospace industry, or Oregon's electronics industry. So, Alaska has nothing to export other than its natural resource products.

A second factor in the lack of size of the Alaska economy is the limited local availability of supplies and services. Alaska businesses and consumers often turn to outside suppliers and import things that they need or want from more mature economies. As a result, expansion of a basic sector in Alaska, such as the shellfish industries, does not induce as much growth in the local supporting sectors as it would had it occurred in a more mature economy. What actually happens is that much of the supporting sector growth occurs in the regions that supply those services, rather than in Alaska. Money brought into Alaska by exports from the basic natural resource industries quickly leaks out to other regions.

The Alaska economy's closest external ties are with the state of Washington. Washington's location is an advantage, and it has a well developed waterborne transportation System. Furthermore, Washington businesses are well prepared to serve Alaska consumers, businesses, and major industries, such as fishing, forestry, construction, and transportation. In many respects, it is cheaper and easier for Alaskans to rely on Washington suppliers rather than to patronize their own manufacturers, services, and trades. So, there is a long-standing and widespread trade between Alaska and Washington. The Alaska shellfish industry shares these strong external ties with the Washington economy.

Regional Economic Models

A general understanding of the local economic structure gives some indication of the economic impacts that might arise from changes in the Alaska shellfish industry. However, it would be preferable to be more specific and quantitative about how basic resource and economic changes impact the entire economy.

Early attempts at quantifying these relationships centered on regional economic base analysis, which was developed in the late 1950s by Tiebout[10/] and others Economic base analysis focuses on the different functions of the basic or export sector and the non-basic or local sector. The ratio of sales, employment, or income in the non-basic sector to that of the basic sector is used as a multiplier, indicating the rate at which the non-basic sector will expand as there is a growth, for some independent reason, in the basic sector. One weakness of this approach is that all the industries in the basic sector are assumed to have the same effect upon the non-basic sector. If individual industries actually have very different relationships to the non-basic sector, economic impacts may be quite different from that which would be predicted by a simple export base multiplier.

[10/] Tiebout, Charles, "The Urban Economic Base Reconsidered," Land Economics, Vol. 32(l), 1956.

A more elaborate type of economic base study with several basic subsectors can allow for different rates of impact by different basic industries. However, it is difficult to determine the rates at which different subsectors affect the overall economy when all are interacting at the same time. For example, in Alaska it would be very difficult to tell how much local non-basic economic activity was attributable to the shellfish industry since its effects are intermixed with impacts attributable to salmon or other fisheries, logging; tourism, and other industries that are all located in the same region. As one moves upward towards larger aggregate economies, such as an entire state, the difficulties of separating out the impacts of a particular sector become even more insurmountable. So, most analysts have turned in recent years to the technique of regional input/output analysis which. gives more detailed treatment to the unique nature of each sector's role in the interdependent economy.

Structure of an Input/Output Model for Analyzing Shellfish Impacts

Input/output is a method for analyzing the structure of an economy based on an accounting of the flows among sectors within an economy, between the economy and the outside world, and between the economy and the residents (households) of the area.. The method was developed in the 1940s by Leontief.[11/] The first applications were to the U.S. national economy. In recent years, input/output has been widely used for analyzing the structure and responsiveness of state and regional economies.

[11/] Leontief, Wasily W The Structure of the American Economy, 1919-1939, International Arts & Sciences Press, Inc., White Plains, N.Y., 1951.

An input/output model is based on a system of accounts that encompass all transactions within the economy. There is one account for each economic sector and one entry for each transaction between sectors. For example, an Alaska I/O model might have an account for shrimp processing and within that account, entries for the purchases by shrimp processors from shrimp fishermen, fuel suppliers, workers, etc. Most of the sectors are "industries" such as shrimp processing, shrimp harvesting, wholesale and retail trade, etc. However, there are also special accounts for external trade with sectors outside of the regional economy--represented by import purchases and export sales, the households or residents of the region--reflected in purchases of labor. and other personal services from households and sales of consumption goods to households, and the capital resources of the region--represented by rent, interest, and dividend payments made to purchase the services of capital, by capital consumption allowances, and by the sales- of goods and services for the net capital investments.

The I/O accounts are arranged in a matrix format with a column for each economic sector. Within the sector's column, each element shows the total value of that sector's purchases from each of the other sectors within the economy.

The I/O model designed to analyze the impacts of the Alaska shellfish fishery includes both the Alaska and Washington economies to take into account the close ties that exist between the Alaska and Washington economies. As was mentioned earlier; a significant portion of the shellfish harvest fleet is based in Washington. These and many of the Alaska-based vessels as well rely upon purchases from Washington to supply and maintain their equipment. Processing plants are also often owned and managed by Washington firms, obtain significant portions of their supplies from Washington, and ship most of their product to Washington for reprocessing or storage and transshipment. In addition, other sectors within the Alaska economy are also closely linked to the Washington economy, and Alaska consumers spend a substantial amount of their income on Washington-supplied goods and services.

The Alaska-Washington I/O model includes full sets of sector accounts for Alaska and for Washington. Each sector's account includes purchase and sales transactions with sectors in the other state, as well as within the same state. A simple block diagram of this system of accounts is shown in Figure 2. The general approach has been labeled multi-regional input/output analysis (MRIO).[12/] Purchases by Alaska industries and households from other Alaska sectors are entered in Block A, the upper left-hand portion of the matrix. Purchases that these same Alaska industries and households make from Washington economic sectors are entered in Block B. Comparable Washington from Washington purchases are entered in Block E, and Washington from Alaska purchases are entered in Block D. Thus, the two economies are integrated, but trade between them is explicitly identified rather than being lost in aggregated import and export accounts. Purchases from exogenous sectors, such as imports from other regions or direct resource use, appear in marginal Blocks C, F, and J. Purchases by exogenous sectors, such as exports, federal government or capital investments, are in Blocks G, H, and J.

[12/] MRIO was developed in formal detail by Polenske in a monumental MRIO for the entire U.S. economy. Each state represents a block component and all interstate transactions are accounted for. For example, the accounts would theoretically show purchases by the Washington aerospace manufacturing sector from the electronics manufacturing sector in California, as well as the plethora of purchases from other sectors in other states. In a recent application, Wilkins developed a 3-state MRIO for the Washington-Oregon-Idaho Pacific Northwest region.

			PURCHASING SECTORS				
			Located in AK		Located in WA		Exports & Other Final Demands
			Industries	HH	Industries	HH	
SELLING SECTORS	Located in AK	Industries	Purchases by AK sectors from other AK sectors A		Purchases by WA sectors from AK sectors D		Exogenous purchases from AK sectors G
		HH					
	Located in WA	Industries	Purchases by AK sectors from WA sectors B		Purchases by WA sectors from other WA sectors E		Exogenous purchases from WA sectors H
		HH					
	Imports & Other Value Added		Purchases by AK sectors from exogenous sectors C		Purchases by WA sectors from exogenous sectors F		J

Figure 2. Structure of the Alaska-Washington Input/Output Model, Households Endogenous

Within the I/O, there must be an accounting for all the economy's inputs and outputs, and each sector's total inputs and outputs must be divided into transactions with each of the other sectors. There is, considerable latitude in the way that the economy is divided into sectors if the necessary data on purchase and sales transactions are available. In constructing the Alaska-Washington I/O for analyzing the economic impacts of the shellfish fishery in Alaska, we have followed the practice of defining the shellfish harvesting and processing sectors in considerable detail. However, in the rest of the economy, there is a rather high degree of aggregation since we are concerned primarily with the quantity but not the details of impacts in that portion of the economy. A list of the sectors and their definitions is given in Table 7.

Alaska and Washington Input/Output Models

Most of the important elements in the multi-regional input/output analysis of the Alaska and Washington economies are in the state input/output models. Because of the heavy expense in time and resources necessary to construct I/O models from the ground up, it was decided early on to make use of existing models. To select the models, two criteria in addition to acceptable overall quality were used as general guides. First, the models should be recent so they can be updated to the analysis year 1976 with minimum distortion. Second, the models should permit a fairly easy recombination of sectors to the desired sector breakdowns. Specifically, it should be possible to break out Alaska fishing, Alaska fish processing, and Washington fishing as independent sectors. The other sectors to be used are sufficiently aggregated that they can be fairly easily developed in most models.

Table 7. Definitions of Sectors in the Alaska-Washington Input/Output Model

Abbreviated Name	Definition
Alaska Sectors	
AGRI.	All agricultural production, crops and livestock
SHP.FISH	Fishing for shrimp by Alaskan vessels
CRB.FISH	Fishing for crab by Alaskan vessels
OTR.FISH	Fishing for non-shellfish species in Alaska
FORESTRY	Forestry
MIN.PETR	Mining and petroleum production
LUMB.PCP	Lumber, wood products, pulp and paper
SHP.PROC	Processing shrimp in Alaska
CRB.PROC	Processing erab in Alaska
OTR.PROC	Processing other fish
OTRMANUF	All other manufacturing
CONST.	Construction
TRANSP.	Transportation services
COMMyUT.	Communication and utilities
F.I.R.E.	Finance, insurance, and real estate
TRADE	Wholesale and retail trade
SERVICES	All privately supplied services
STATELOC	State and local government
Washington Sectors	
AGRI.	All agricultural production, crops and livestock
SHP.FISH	Fishing for shrimp by Washington vessels
CRB.FISH	Fishing for crab by Washington vessels
OTR.FISH	Fishing for non-shellfish species in Washington
FISHPROC	Fish processing
MIN.OILG	Mining and petroleum production
LUMB.P.P.	Lumber, wood products, pulp and paper
OTRMANUF	All other manufacturing
CONST.	Construction
TRANSP.S	Transportation services
COMM-UT.	Communication and utilities

Table 7. Continued

Abbreviated Name	Definition
F.I.R.E.	Finance, insurance, and real estate
TRADE	Wholesale and retail trade
SERVICES	All privately supplied services
FORESTRY	Forestry
<u>Value Added</u>	
AK.H.H.	Wage and salary payments to Alaska households
WA.H.H.	Wage and salary payments to Washington households
V.A.OTR.	Other value added including rents, interest, profits, capital consumption, & taxes other than to Alaska state & local gov't
IMPORTS	Purchases from outside Alaska or Washington
<u>Final Demands</u>	
AK.H.H.	Consumption purchases by Alaska households
WA.H.H.	Consumption purchases by Washington households
FED.GOVT	Federal government expenditures in Alaska and Washington
ST-LOCAL	State and local government expenditures in Washington
INVEST	Net private capital investment
EXPORTS	Sales outside of Alaska or Washington

Philip J. Bourque and Richard S. Conway, Jr. in 1977 published the most important, recent input/output study of the Washington State economy.[13/] The model applied to 1972; earlier input/output studies of the state economy in 1963 and 1967 also have been published by Bourque and others. The 1972 model included 51 sectors including a separate fishing sector. It was developed principally from primary sales and purchases data collected through a sample survey of Washington industries and firms. Published secondary data were used to provide "control totals" of the overall level of economic activity and to fill in gaps in the survey data. Because of its recent publication, reliance on primary data, and detail, the Bourque-Conway model was chosen as the basis for estimating the 1976 Washington model used in this study.

Two relatively recent input/output models of the Alaska economy were reviewed for adaptation for this study; one was prepared by Charles L. Logsdon and Kenneth L. Casavant, and the second by Mathematical Sciences Northwest, Inc. and Human Resources Planning Institute, Inc.[14/] These two models are very similar. First, both are constructed for 1972. Second, they contain approximately the same number of sectors exclusive of final demands, 16 for the Logsdon-Casavant model, and 14

---

[13]Bourque, Philip J., and Richard S. Conway, Jr., The 1972 Washington Input/Output Study, Graduate School of Business Administration, University of Washington, June 1977. In addition to using the Bourque-Conway model directly, some use was made of it as aggregated by John Wilkins, "Construction of a Multi-Regional Input/Output Model for the Pacific Northwest," Northwest Energy Policy Project, Portland, 1977.

[14]/Logsdon, Charles L., and Kenneth L. Casavant, "Alaska-Washington Trade: An Applied Input/Output Study," Bulletin 848, College of Agriculture Research Center, Washington State University, June 1977; Mathematical Sciences Northwest, Inc. and Human Resources Planning Institute, Inc., "A Social and Economic Study of Off-Shore Petroleum and Natural Gas Development in Alaska," report to the Bureau of Land Management, Department of the Interior, October 1976.

for the Mathematical Sciences-Human Resources model. Third, each model is derived from earlier models with revisions based onsecondary data. The Logsdon-Casavant model has some advantages for this study. It breaks out the fishing and fish processing industries as separate sectors. The Logsdon-Casavant model also pays particular attention to the nature of Washington-Alaska trade which is a concern of this study. For these reasons, the logsdon-Casavant model was chosen for use in this study.

The first step in constructing new 1976 transaction tables involved updating estimates of sector output in the original tables. For many sectors, output data were not readily available or were not consistent with the tables 1972 estimates. Hence, the updating of sector outputs was generally based on indices calculated from published output proxies such as value added, payroll, or sales.[15/] Thus, to estimate a sector's 1976 output, value added in 1976, was divided by value added in 1972 and this ratio then multiplied by 1972 sector output. The result is an estimate of the sector's 1976 total output.

In the second step, updated 1976 transaction matrices were prepared, assuming that input purchases per dollar of output remain constant in each sector. All inter-industry purchases, imports, and value added of each sector were increased in the same proportion as the 1972 to 1976 increase in total output.. Given the relatively short updating period of only four years and the aggregated character of most sectors, this proportional procedure is quite. acceptable.

[15/] Value added estimates were taken from U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1976; payroll data from U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1976, and State of Alaska, The Alaska Economy, 1977; and sales data again from the latter source.

Completion of the estimated inter-industry purchases by every sector also fills in the state's entire transaction matrix. These estimates appear in the Alaska-to-Alaska and Washington-to-Washington portions of Table 8, which is the transactions matrix for the Alaska-Washington I/O model. The total inter-industry sales of every sector were then calculated by adding across columns of industry purchasing sectors. The difference between a sector's total output or sales and inter-industry sales is an estimate of the sector's sales to final demand.

The third step in constructing the transactions matrices involved dividing the total residual sales allocated to final demands among the final demand sectors--household consumption, investment, government, purchases, and exports. The demands were estimated from each residual based on-their proportions of total final-demand in 1972. As a check on this estimation procedure, the ratios of final demand sales to total sales in 1976 and 1972 were compared and in most cases found to be reasonably close.

In the fourth step of the analysis, the matrices were aggregated to correspond to the chosen sector breakdowns. In all cases, this only involved combining sectors; no subdivision was required.

In the fifth step of constructing new transactions matrices, the value added and imports rows and the exports column of each matrix were subdivided. Value added was divided into one row representing wages, salaries, and income to proprietorships and partnerships and a second row representing income to corporations and all other value added. The division for each sector was based on data in <u>County Business Patterns</u> and <u>The Alaska Economy, 1977</u> showing wages and salaries by industry and

Table 8. Transactions Matrix for the Alaska-Washington Input/Output Model, 1976 ($ million)

Selling Sectors	Alaska Purchasing Sectors																	
	AGRI.	SHP.FISH	CAB.FISH	OTR.FISH	FORESTRY	MIN.PETR	LUMB.PUP	SHP.PROC	CAB.PROC	OTR.PROC	OTRMANUF	CONST.	TRANSP.	COMM-UT.	F.I.R.E.	TRADE	SERVICES	STATELOC
Alaska:																		
AGRI.	0.100	0.020	0.310	0.0	0.0	0.0	0.0	0.0	0.120	0.0	7.900	0.100	0.0	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.140	1.660	3.220	0.0	0.0	0.0	0.0	0.0	124.510	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.100	0.0	4.500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIN.PETR	0.0	0.0	0.0	1.010	0.0	0.0	0.0	0.070	1.040	2.800	10.100	24.900	0.0	0.0	0.0	0.0	0.0	6.000
LUMB.PUP	0.0	0.0	0.0	0.0	0.0	0.0	7.200	0.0	0.0	0.0	0.903	27.200	2.100	0.630	0.300	2.200	0.500	2.633
SHP.PROC	0.0	0.030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAB.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.PROC	0.0	0.0	0.0	1.970	0.0	0.0	0.0	0.0	0.0	0.630	0.0	0.0	0.0	0.0	0.0	0.0	0.333	1.430
OTRMANUF	0.100	0.235	1.345	6.280	0.0	0.500	0.100	0.150	1.040	0.160	5.703	88.200	2.100	10.600	0.0	0.303	0.403	3.733
CONST.	3.100	0.0	0.0	0.0	0.0	1.000	0.200	0.0	0.0	0.790	0.200	0.300	15.600	2.930	0.930	0.533	0.933	115.333
TRANSP.	0.100	0.0	0.0	2.000	0.300	2.400	3.700	0.340	3.210	26.370	6.400	74.200	65.200	1.430	0.830	63.530	0.333	4.430
COMM-UT.	3.230	0.310	0.070	0.933	0.0	4.700	2.700	0.590	0.090	7.910	5.900	24.200	18.400	25.530	2.103	13.103	12.833	33.433
F.I.R.E.	0.100	0.460	1.910	3.480	0.0	6.000	0.400	0.200	0.470	4.020	0.600	12.930	19.000	1.533	5.100	7.003	2.633	2.603
TRADE	0.230	0.220	-0.050	1.470	0.0	1.200	1.200	0.050	0.690	18.180	0.900	57.200	7.300	3.530	1.100	3.703	1.333	4.933
SERVICES	0.200	0.690	2.610	6.003	0.100	23.700	0.390	0.0	0.533	9.570	1.700	34.800	10.700	5.500	3.100	13.103	7.630	3.133
STATELOC	0.0	0.020	0.090	-0.440	0.0	83.000	0.600	0.200	2.380	2.250	0.900	181.200	11.100	11.000	1.200	2.100	1.330	9.633
Washington:																		
AGRI.	2.450	0.080	0.300	1.350	0.0	0.0	0.0	0.0	1.180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.520	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.480	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.810	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FISHPROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIN.OILG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMB.PUP	0.0	0.0	0.0	0.0	0.0	0.0	11.310	0.030	0.0	0.020	0.0	5.200	0.0	0.0	3.250	2.780	0.0	0.0
OTRMANUF	2.780	1.750	6.733	20.630	1.500	10.070	2.470	3.210	6.330	2.130	10.460	70.280	12.530	7.760	3.250	30.353	15.550	11.343
CONST.	0.0	0.0	0.0	0.0	0.0	4.000	0.090	0.0	[illegible]	0.0	0.0	46.860	0.0	0.0	0.0	0.0	2.560	0.0
TRANSP.S	0.0	0.0	0.0	0.0	0.0	3.200	0.0	0.540	3.530	0.350	0.110	0.0	38.150	0.0	0.330	9.080	16.453	12.833
COMM-UT.	0.0	0.0	0.0	0.0	0.0	0.0	0.220	0.0	0.0	0.0	0.0	0.0	0.0	3.340	0.330	6.523	10.713	0.0
F.I.R.E.	0.0	0.290	1.310	4.910	0.0	0.0	0.470	0.0	1.100	0.0	0.0	26.030	0.0	0.0	14.040	12.523	8.263	31.180
TRADE	1.270	0.560	2.640	9.480	0.200	4.730	2.680	0.060	0.950	0.040	12.540	0.0	1.960	6.200	0.430	10.120	20.820	0.0
SERVICES	0.0	0.333	1.640	5.600	0.0	0.0	0.0	0.670	0.530	0.440	0.220	7.810	9.540	1.940	0.0	27.825	14.323	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Value Added:																		
EMPL.C.	8.200	1.480	9.810	34.870	1.900	128.700	60.000	3.700	18.410	58.330	37.300	1466.000	257.800	121.340	102.100	360.100	394.530	548.033
[illegible]	0.0	0.0	0.0	5.380	0.500	0.0	2.060	5.260	3.830	3.750	12.670	34.620	2.530	0.0	0.0	0.0	0.0	0.0
[illegible]	0.500	0.680	6.020	17.430	0.600	352.400	20.400	1.920	3.080	12.290	32.000	181.300	207.700	79.900	186.400	336.003	112.830	300.003
IMPORTS	0.0	0.560	3.120	7.760	0.0	72.000	26.600	6.630	6.950	3.800	16.200	572.300	0.0	12.500	4.760	26.103	171.940	153.679

Table 8. Continued

Selling Sectors	Washington Purchasing Sectors														
	AGRI.	SHP.FISH	CRB.FISH	OTR.FISH	FISHPROC	MIN.OILG	LUMB.P.P	OTRMANUF	CONST.	TRANSP.S	COMM-UT.	F.I.R.E.	TRADE	SERVICES	FORESTRY
Alaska:															
AGRI.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.028	0.798	6.860	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIN.PETR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMB.POP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHP.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.PROC	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTRMANUF	0.0	0.230	1.610	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRANSP.	0.0	0.0	0.0	0.0	0.0	0.0	10.300	25.760	10.300	5.150	0.0	5.150	20.640	10.303	0.0
COMM-UT.	0.0	0.0	0.0	0.0	0.0	0.0	0.800	2.000	0.800	0.400	2.600	0.400	1.530	0.100	0.0
F.I.R.E.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRADE.	0.0	0.030	0.260	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SERVICES	0.0	0.040	0.230	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STATELOC	0.0	0.010	0.060	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Washington:															
AGRI.	197.600	0.030	0.190	1.050	1.200	0.850	0.0	585.060	3.000	0.300	0.200	0.0	0.0	0.143	0.710
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.030
FIS-PROC	0.0	0.0	0.0	0.180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.180
MIN.OILG	0.900	0.0	0.0	0.0	0.0	1.630	0.600	32.490	39.400	0.330	31.800	0.0	0.0	0.200	0.110
LUMB.P.P	5.103	0.0	0.0	0.0	1.000	0.800	942.700	118.870	189.600	1.400	6.900	10.200	38.830	5.400	3.730
OTRMANUF	122.933	0.510	4.789	10.350	3.300	4.930	87.800	977.420	592.400	76.000	24.300	52.100	163.933	136.400	8.700
CONST.	18.503	0.0	0.0	0.0	3.000	0.630	12.409	16.630	0.900	9.500	6.400	30.700	26.230	15.700	0.070
TRANSP.S	23.100	0.0	0.0	2.280	4.300	0.800	125.700	120.290	71.600	152.500	10.100	14.700	50.430	29.903	5.110
COMM-UT.	28.200	0.0	0.010	0.180	1.503	2.700	19.600	230.220	25.000	29.900	448.700	77.000	174.430	222.233	2.389
F.I.R.E.	12.900	0.400	2.940	0.560	0.700	1.200	24.000	43.460	27.700	25.100	12.300	165.100	84.100	70.300	0.949
TRADE	75.700	0.220	2.220	5.600	5.300	1.630	117.200	164.380	212.400	23.900	8.700	20.500	67.230	76.930	6.320
SERVICES	54.700	0.400	2.160	2.250	1.800	2.730	87.000	236.420	137.200	46.300	62.800	174.703	344.430	218.209	3.780
FORESTRY	0.0	0.0	0.0	0.0	14.000	0.0	351.500	0.0	0.0	0.0	0.200	0.0	0.0	0.0	0.0
Value Added:															
HH.HH.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH.HH.	252.300	0.450	11.720	14.140	10.300	36.700	960.700	2692.700	989.300	1049.000	300.500	730.400	2637.700	1790.100	21.603
V.A.OTH.	925.000	0.780	12.410	21.210	334.200	39.900	1036.300	2291.750	840.800	416.000	1233.100	860.500	3242.330	1747.400	44.590
IMPORTS	242.900	0.290	3.690	11.790	6.700	29.500	740.600	4167.340	1069.400	222.850	244.000	110.030	327.160	322.500	10.808

Table 8. Continued

Selling Sectors	Final Demands					
	AK.H.H.	WA.H.H.	FED.GOVT	ST-LOCAL	INVEST	EXPORTS
Alaska:						
AGRI.	7.850	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.490	0.0	0.0	0.0	0.0	0.0
OTR.FISH	3.700	0.0	0.0	0.0	0.0	0.0
FORESTRY	0.700	0.0	0.0	0.0	0.0	0.300
MIN.PETR	1.100	0.0	0.400	0.0	0.0	635.380
LUMB.POP	8.100	0.0	0.700	0.0	1.500	54.500
SHP.PROC	0.0	0.0	0.0	0.0	0.0	35.150
CRB.PROC	5.000	0.0	0.0	0.0	0.0	140.640
OTR.PROC	15.000	0.0	0.0	0.0	0.0	257.850
OTRMANUF	70.900	0.0	10.600	0.0	1.400	0.0
CONST.	20.100	0.0	382.900	0.0	2394.410	0.0
TRANSP.	60.100	29.200	36.400	0.0	13.500	200.200
COMM-UT.	122.400	0.0	9.600	0.0	0.0	13.500
F.I.R.E.	261.950	0.0	0.300	0.0	0.700	0.0
TRADE.	781.440	0.0	2.700	0.0	53.600	0.0
SERVICES	672.360	0.0	6.000	0.0	0.0	0.0
STATELOC	403.640	32.300	352.900	0.0	109.700	33.600
Washington:						
AGRI.	0.0	225.700	2.400	5.900	7.100	923.560
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	7.290	0.0	0.0	0.0	6.350
FISHPROC	0.0	9.000	0.0	0.0	0.0	157.120
MIN.OILG	0.0	1.200	1.400	1.200	0.0	11.800
LUMB.P.P	0.0	44.900	16.100	6.400	44.900	3057.810
OTRMANUF	3.150	1492.200	1665.900	77.500	135.700	5904.640
CONST.	3.788	88.400	414.000	1117.400	2399.520	0.0
TRANSP.S	0.668	317.800	111.800	31.900	16.000	887.220
COMM-UT.	0.668	869.700	11.800	79.200	1.100	87.490
F.I.R.E.	0.0	1186.700	1.800	37.600	0.0	463.580
TRADE	0.0	4388.300	32.200	12.900	135.300	1747.160
SERVICES	0.0	2988.600	127.800	68.800	0.0	15.190
FORESTRY	0.0	1.100	0.0	0.0	0.0	20.100
Value Added:						
AK.H.F.	0.0	0.0	0.0	0.0	0.0	0.0
WA.H.F.	0.0	0.0	0.0	568.000	0.0	0.0
V.A.OTR.	0.0	0.0	0.0	0.0	0.0	0.0
IMPORTS	213.800	5575.398	482.500	148.200	161.600	0.0

general knowledge of the importance of proprietorships and partnerships in that industry.

Alaska-Washington Interstate Trade

The Alaska-Washington I/0 model is in the MRIO format which requires detailed figures on transactions between Alaska and Washington economic sectors. Data on trade flows are not normally collected and summarized in this much detail. In fact, it is often difficult to determine even the state from which an import is purchased or to which an export is sold. However, Alaska's external trade moves almost entirely by water, and water trade statistics by origin and destination are compiled by the U.S. Army Corps of Engineers.[16/] Furthermore, Alaska interstate trade takes place exclusively with Washington for several important goods and services.

The Logsdon-Casavant analysis made use of this information to divide each Alaska sector's imports into imports from Washington and those originating elsewhere. Similarly, they divided exports from Washingtonsectors into exports to Alaska and exports to other destinations. However, they made no estimates of trade flowing from Alaska to Washington.

We used the Logsdon-Casavant estimates for 1972 as the beginning point for our estimates of Alaska imports from Washington and Washington exports from Alaska. Waterborne commerce data (U.S. Army Corps of Engineers) and more recent economic production data were used to update these to 1976. Those more recent data were also used to prepare estimates

---

[16/] U.S. Army Corps of Engineers, Waterborne Commerce Statistics of the United States, Washington, D.C., annual.

of Alaska exports to Washington and Washington imports from Alaska, both of which were omitted in the Logsdon-Casavant study.

The final step in constructing the trade portion of the Alaska-Washington I/O model is to fill in, sector by sector, the distribution of each sector's imports among the other state's exporting sectors. As a first approximation, it was assumed that Alaska's general sectors, such as trades and services, would have a pattern of total purchases similar to that of the corresponding Washington sectors. However, the Alaskan business would have to turn to Washington suppliers for some inputs that are not adequately available in Alaska. Therefore, the imports from Washington sectors were estimated to equal the difference between what the Alaska businesses buy in Alaska and what comparable, Washington businesses buy within Washington. In the case of the shellfish sectors, other information; which will be described later, was used to estimate those sectors' imports from Washington sectors.

Purchases by Washington industries from the Alaskan 'economy are much less widespread. They are concentrated mostly in a few sectors where Alaska has a comparative advantage in supplying some special items such as petroleum and tourist services, or where Alaskan industries provide an intermediate service to Washington firms operating in Alaska. Alaska transportation services and utilities supplied to Washington were distributed among Washington purchasing industries in proportion to the volume of their sales to Alaska industries.

Input/Output Transactions of the Alaska Shellfish Harvesting Sector

Since the principal purpose of this study is to measure the economic impacts of the Alaska shellfish fishery, it is necessary to give special attention to the definition and description of the shellfish harvesting and processing sectors. The subsectors selected were:

Crab harvesting by Alaska-based vessels

Shrimp harvesting by Alaska-based vessels

Crab processing in Alaska

Shrimp processing in Alaska

Crab harvesting by Washington-based vessels

Shrimp harvesting by Washington-based vessels

The first four sectors are nominally Alaska economic sectors, and the last two, Washington-based vessels[17/] harvesting shellfish in Alaska, are nominally part of the Washington economy. However, all of these sectors have economic connections to both states' economies. Alaska-based vessels make significant purchases from Washington businesses, as do also the processing plants. Washington-based vessels, on the other hand, buy some of their inputs in Alaska and sell all of their catch to processors in Alaska. In the Alaska-Washington I/O, this interstate interdependency is reflected in significant transactions-across the state lines, with sectors in the other state's economy.

The basic source of information for the purchases by the shellfish harvesting sectors was the Entry Commission's survey of vessel operators in the industry. The vessel operators' estimates of costs by category were apportioned between shellfish harvesting activities and harvesting of other species. The Entry Commission prepared a special tabulation of the individual cost items (fuel, bait, food, etc.) for each of the subfleets These costs were apportioned among the shellfish species

---

[17/]A very small number of non-Alaska, non-Washington vessels are included in this category.

[18/]Roger Kolden, letters with tables attached to Richard Marasco, Northwest & Alaska Fisheries Center, April 12, 1979, and January 3, 1980.

on the basis of the number of days a vessel fished for each species. When there was no report of a cost item which could confidently be presumed to be incurred by every vessel, we used the average per vessel reporting the cost as an estimate of the cost for the vessels that failed to report. For example, in fleet 12, only 21 out of 28 vessels in the sample reported any fuel costs. Since all vessels surely had some fuel expenses, we used the average for the 21 reporting vessels as an indication of the average for the 7 nonreporting vessels in the fleet. On the other hand, some minor cost items, such as utilities, may not be incurred by every vessel. For those items, we assumed that no cost reported meant no cost incurred, which probably results in a slight underestimate of full costs. The Entry Commission's convention of using an estimated crewshare of 7% of gross earnings for each member of the crew was followed. Average annual costs per vessel are shown in Table 9 for the subfleets.

Estimates of shellfish harvesters' purchases from I/0 industrial sectors were derived from the individual cost items. For some categories, there is a direct correspondence. For example, all crewshare expense is assigned to the I/O sector of wages earned by households. Other cost categories may involve purchases from more than one I/O accounting sector. For example, vessel maintenance and repair costs will include some purchases from the services sector (repair and maintenance work), some from the trade sector (wholesale and retail parts dealer's margins), some from local manufacturing, and some from imports (manufacturers of parts and equipment). Most I/O accounting, including that used in our Alaska-Washington I/O, divides the final cost of goods into the producer's value of the goods and the wholesale and retail margins for marketing

Table 9. Average Costs for She llish Harvesting Vessels, 1976 ($/vessel/year)

	Average Cost per Vessel by Subfleet											
	Shrimp Harvesters			Large Crab Boats		Medium Crab Boats		Small Crab Boats				
Item	A1	A2	B-C	I2	I3	G2	H	F1	F2	G1	D	E
Fuel	1,643	35,594	20,151	44,121	55,700	19,310	7,394	3,657	8,132	4,086	4,311	4,572
Food	612	5,281	4,086	5,361	8,633	3,709	2,757	914	1,127	2,147	1,324	1,570
Bait	3,441	---	4,496	9,394	5,019	5,322	3,819	4,480	3,011	4,006	1,486	4,314
Gear loss & replacement	1,571	9,315	11,926	17,833	19,100	6,828	5,906	4,701	11,215	4,420	6,270	9,171
Tender	---	714	---	---	---	---	---	---	43	---	---	---
Bonus	58	---	2	57	---	---	---	375	1,071	528	---	250
Vessel maintenance	4,005	26,500	38,934	47,862	85,500	42,021	16,415	3,387	17,069	6,927	12,561	7,351
Utility	102	122	85	103	33	358	---	154	502	100	164	238
Miscellaneous	811	7,458	6,719	8,739	6,333	4,667	2,131	561	2,315	1,265	2,405	1,370
Dues	615	1,389	1,513	1,039	1,705	1,325	121	55	56	687	524	112
Moorage	285	563	633	1,048	1,550	698	584	429	762	333	583	532
Insurance	1,613	12,740	9,965	19,673	24,167	11,983	5,089	1,692	4,845	4,455	5,082	3,672
Association	1,803	11,950	3,617	2,671	5,000	1,667	4,433	987	2,250	917	520	1,440
License	130	273	399	494	508	263	289	184	216	182	166	198
Skippershare	5,280	21,090	54,361	63,166	46,333	39,515	20,764	14,336	7,204	20,564	5,919	15,502
Crewshare:												
Reported	3,166	30,824	58,184	101,178	93,244	40,787	22,725	9,018	16,790	11,095	8,510	7,757
Alternate calculation[a]	(1,536)	(31,630)	(39,393)	(101,781)	(128,336)	(28,570)	(12,289)	(3,015)	(9,261)	(5,888)	(6,159)	(3,754)

SOURCE: Special tabulation from Shellfish Bio-Economic Data Base.

[a] Estimated at 7% x crew x gross earnings.

the product. We assumed that trade margin share of cost to the fisherman was 20% for fuel, 33% for food and gear, and 40% for maintenance and repairs.

Another major cost allocation issue is the division of the costs between purchases from Washington sectors and imports from outside of either Alaska or Washington. Interviews with industry leaders, marine trade and services firms, and some leading fishermen established general patterns for the source of fishermen's inputs. Estimated fractions of cost items purchased from Alaska, Washington, or other areas are shown in Table 10 for Alaska-based and Washington-based vessels. In reviewing these import shares, it should be noted that the producer's value of inputs purchased locally by a fisherman are treated as imports if the local supplier is merely serving as a distributor, or marketer, re-selling a product that was imported from another state or from abroad.

The I/O accounts for the four shellfish harvesting subsectors (crab and shrimp harvesting by Alaska-based and Washington-based vessels) were composed from the purchases vectors of the subfleets. The Washington-based vessels are relatively large, so they were assumed to be all included in the subfleets of larger vessels. Total landings and gross earnings in 1976 by vessels reporting Washington (or Oregon) home ports were used as a factor to determine the share of operation by Washington-based vessels in these subfleets. The purchases or transactions vectors for the shellfish harvesting sectors are reported in Table 8.

Input/Output Transactions of the Alaska Shellfish Processing Sectors

The input requirements for shellfish processing were based mostly on detailed cost reports on major product forms obtained from a very

Table 10. Assumed Distribution by Origin of Purchases by Alaska Shellfish Harvesting Vessels, Fraction of Total Cost by Cost Category

Cost Category	Alaska-Based Vessels from: AK	WA	Other	Washington-Based Vessels from: AK	WA	Other
Fuel	0.6	0.4	0.0	0.4	0.6	0.0
Food	0.2	0.4	0.2	0.0	0.5	0.5
Bait	1.0	0.0	0.0	1.0	0.0	0.0
Gear	0.3	0.7	0.0	0.0	1.0	0.0
Vessel maintenance	0.3	0.6	0.1	0.0	0.8	0.2
Insurance	1.0	0.0	0.0	0.0	1.0	0.0
Dues & license	1.0	0.0	0.0	1.0	0.0	0.0
Crew	0.8	0.1	0.1	0.0	1.0	0.0
Miscellaneous	0.8	0.2	0.0	0.2	0.8	0.0

small sample of processing plants. Reports of processing costs by Orth, et al. were comparable. It would have beendesirable to have more observations; however, it is very difficult to find processing plants that have good cost accounting and are willing to cooperate.

The processors' reported costs were adjusted to 1976, using relative price changes between 1976 and the reporting season. Processing costs per pound of product were then multiplied by product outputs reported in Alaska 1976 Catch and Production Statistics and summed over product forms to estimate total purchases by the crab and shrimp processing sectors. The difference between estimated total cost and reported wholesale value was attributed to reprocessing, marketing, and overhead costs incurred outside the processing plant. These post-processing costs arise in company headquarters and affiliated plants which are mostly located in Washington, therefore they were assigned as purchases from Washington sectors or as income to Washington resource suppliers.

For crab, the conversion rates implied by the reported costs are about 7% too high, which results in an under-reporting of total purchases of crab by processing from fishing. We adjusted by increasing crab purchase costs and decreasing overhead.

Estimated costs by category, such as labor, freight, fuel, etc., were assigned to the appropriate input/output accounting sectors by a procedure similar to that used for the shellfish harvesting sectors. In the Alaska shellfish processing industry, as in shellfish harvesting, a substantial portion of the inputs are supplied from Washington or imported from somewhere else outside Alaska. A large share of the labor in particular comes not from Alaskans but rather from workers who are permanent residents of other states or countries. On the basis of estimates of people interviewed in the industry and the fishing communities, we distributed labor costs 60% to purchases from Alaska households, 20% to Washington households, and 20% to import of workers from outside of these two states. Other cost items were handled similarly. The resulting input/output purchases vectors for crab and shrimp processing are presented in Table 8, the 1976 transactions matrix.

IV. ECONOMIC IMPACTS OF THE SHELLFISH FISHERY

An input/output model can provide several different indications of economic relationships and economic impacts. Five indicators of the shellfish fishery's economic impacts are presented in this chapter. The measures are:

(1) direct economic linkages between shellfish sectors and the rest of the economy as measured by the transactions between the shellfish sectors and other parts of the economy;

(2) indirect linkages that arise from general economic interdependencies;

(3) multipliers which measure the total economic change per unit change in the shellfish sectors;

(4) distribution of the state's value added (income) among economic sectors and determination of the portion of total state or regional income that can be attributed to the shellfish sectors;

(5) prediction of total economic change that would result if certain hypothesized changes occurred in the shellfish fishery.

Direct Economic Linkages

The shellfish fishery is one of the "basic" sectors upon which the Alaska economy depends. The shellfish industries have the ability to use the state's natural resources to produce a product that can be exported and sold in markets outside of Alaska. The proceeds from those sales bring in outside revenue that is necessary to provide income for Alaska residents and keep the local economy functioning.

The amount of local economic activity that is supported depends on the size of the shellfish sector, the linkages between the shellfish sector and the rest of the economy, and the degree of interdependency within the entire economy. The overall size of the shellfish sectors was previously discussed in Chapter II. The 1976 shellfish harvest had a landed value of $86 million. More appropriately, the value of the product leaving Alaska after processing was $181 million. In the remainder of this section, we will discuss some of the direct linkages between shellfish sectors and the rest of the economy. The influence of the structure of the Alaska economy upon the level of total economic impacts arising from export of shellfish will be discussed in the following sections.

The direct linkages between the shellfish sectors and the rest of the Alaska and Washington economies are reported in detail in the transactions matrix, Table 8. Summary statistics are presented in Table 11. The first section of this table shows the disposition of total revenues for the shellfish sectors according to who receives the business or income payments. The division of total revenues among these expenditure categories was estimated on the basis of the accounting and allocation "judgments" that are described in Chapter III. The estimates in column 7 show that the Alaska shellfish sectors purchased, in 1976, an estimated $23.7 million from other Alaska businesses. This is a sizeable quantity; however, it is only 13% of the total revenue and expenditures of the shellfish sectors. This indicates a relatively high leakage of revenues from the shellfish sectors to businesses outside the Alaska economy. Nevertheless, certain localities in Alaska are heavily dependent on shellfish harvesting and processing, and the local businesses may derive a large fraction of their revenues from the shellfish sectors. This would be true, for example, of Kodiak and Dutch Harbor. However,

Table 11. Alaska Shellfish Sectors' Purchases from Other Industrial Sectors and Income Payments, 1976

Item	Alaska-Based Vessels Harvesting: Shrimp	Alaska-Based Vessels Harvesting: Crab	Washington-Based Vessels Harvesting: Shrimp	Washington-Based Vessels Harvesting: Crab	Alaska Plants Processing: Shrimp	Alaska Plants Processing: Crab	Total All Shellfish Sectors
	($ million)						
Total value in 1976	8.05	42.49	3.51	43.29	23.62	60.16	181.12
Purchases from Alaska businesses	2.02	8.54	0.33	1.44	1.60	9.77	23.70
Purchases from Washington businesses	3.31	15.02	1.56	12.30	4.51	18.12	54.82
Payments to Alaska households	1.48	9.81	---	---	3.70	18.41	33.40
Payments to Washington households	0.00	0.00	0.67	13.87	5.26	3.83	23.63
Other payments (value added)	0.95	7.43	0.78	14.15	1.92	3.08	28.31
Imports from other states or foreign	0.29	1.69	0.17	1.53	6.63	6.95	17.26
	(percent)						
Total expenditures	100	100	100	100	100	100	100
Purchases from Alaska businesses	25	20	9	3	7	16	13
Purchases from Washington businesses	41	35	44	28	19	30	30
Payments to Alaska households	18	23	0	0	16	31	18
Payments to Washington households	0	0	19	32	22	6	13
Other payments (value added)	12	17	22	33	8	5	16
Imports from other states or foreign	4	4	5	4	28	12	10

even in those cases, it is still true that the shellfish harvesters and processors are only spending a relatively small fraction of their revenues to purchase inputs from Alaska businesses.

The linkage between the shellfish sectors and Washington businesses is stronger than the linkage to Alaska businesses. We estimated that, in total, the shellfish harvesting and processing sectors spent $54.8 million, or 30% of their gross receipts, to purchase inputs from Washington businesses. This is more than twice the amount that they were estimated to have purchased from Alaska businesses. The heavy purchases from Washington arise because many of the inputs required for fishing vessels and processing plants are either not available in Alaska or are more expensive if purchased from an Alaska supplier.

The remaining 56% of the total value of the shellfish sectors is divided between value added or income accounts and imports from outside of either Alaska or Washington. We have estimated $33.4 million in wage and salary payments to Alaska households from the shellfish sectors in 1976, consisting of about 90% payments to workers on crab boats and in crab processing plants, and 10% to workers on shrimp boats and in shrimp processing plants. A substantial amount of this income will generate additional business for Alaska economic sectors as the wage and salary earners respend their money for consumer goods within the Alaska economy. But, some of it will be spent elsewhere, especially income of those wage earners who were actually only temporary residents of Alaska. Our estimate of the income payments to Washington workers is $23.6 million, which is slightly less than two-thirds as much as to Alaska residents. Most of this income is the crew and captains“ share of earnings on Washington-based vessels that operate in the Alaska shellfish fishery.

Other value added or income is larger than the earnings by Washington workers. This category includes rents, interest, and profit and capital consumption allowances for the investors in these businesses. One-half of the captain's share on a boat was also classified as a profit or return on investment. The major profit earning category in 1976 was Washington-based vessels operating in the Alaska crab harvest. Alaska-based vessels had almost no income in 1976, over and above the payments to crew and captain of the vessels, that could be returned to the owner or investor in the vessel. The reason for this low return on investment is that many of the Alaska vessels are small, old, and operating in areas where the harvest is small. As a result, many of these vessels do not have gross revenue that is enough larger than operating expenses to pay the crew and captain a customary share and still have something left over to return to the investment in the vessel. Most of these smaller vessels are operated by the owner and often times the crew may be members of the owner's family. Shellfish harvesting is for them a method of making use of their vessel and their own time during the off-season from their principal money-earning activity which is typically salmon fishing. The net "losses" for these small part-time shellfish harvest vessels offset profits earned by some of the larger, more modern Alaska boats that are operated much like -the Washington-based vessels.

Imports from outside of either Alaska or Washington were an estimated $17.3 million in 1976 for all shellfish harvesting and processing sectors combined. The major import items are specialized equipment and packing materials for the crab and shrimp processing plants and equipment for the larger crab boats. This is not an unusually high rate of imports from outside of a state economy. According to these estimates, 90% of the total value of sales of shellfish products will be returned to either the Alaska or Washington economy in the form of purchases from businesses or income payments to individuals. For comparison, in the 1972 Washington economy, imports to all industries combined amounted to 20% of their total inputs and only 80% remained in the form of purchases from other Washington businesses or income payments to Washington residents or companies.

Linkages of the Alaska shellfish sectors with the Alaska economy alone are not so favorable. Only 32% of the total revenues from the sale of shellfish products are being returned directly to the Alaska economy in the form of purchases from Alaskan businesses or payments to Alaskan households. Alaskan sectors generally have a much higher propensity to import than would the typical Washington sector. Even among Alaskan sectors, it would be unusual to have a situation in which only 32% of the total purchases and income payments returned to the Alaska economy.

Indirect Economic Linkages

Because an input/output analysis is a "complete" model of the economy, I/O can be used to estimate all economic effects that follow from a change in any economic activity. The primary advantage of I/O is that it includes the indirect effects which arise as the direct effects of a change ripple throughout the economy. For example, increased purchases of fuel to operate crab boats in an expanded fishery would mean more business for the fuel dealers. Fuel dealers would, in turn, spend the extra revenue to buy more fuel from refineries, pay the wages of more employees, and perhaps yield a greater return to proprietors and investors. Refineries also expand, buy more crude oil from domestic or foreign producers, pay more wages, and return more to owners and investors. Meanwhile, at every stage in this flow of transactions, other industries are also buying various inputs, services, and equipment items, and generating local business as they do. Additional wages and proprietors income that is paid out at every stage in this process means more income to the households of the region. As they spend that income for consumer goods, part is received by local businesses, which then generates additional rounds of increased purchases which means increased sales for other businesses and so on.

The appealing thing about I/O analysis is that it provides a very simple technique for estimating how much all of these impacts will amount to, including the most remote feedbacks working their way out in ever fainter interacting ripples. The I/O method proceeds by defining a sector's purchases from other sectors (a column in the transaction matrix) as its input "requirements" for producing its output. These input requirements can be converted to requirements per dollar of output simply by dividing each by the total value of production. The resulting technical coefficients of input/output are the source of the name of input/output analysis. The coefficients are assumed to be constant so that any change in scale of a sector's output must be accompanied by a proportionate change in every input that is used in its production process. Table 12 is a matrix of these input requirements for the sectors in the Alaska-Washington I/O model.

Calculation of the total economic impacts, taking into account all of the indirect effects, is accomplished by mathematically expressing the sector outputs in terms of sector final demands. The

Table 12. Coefficients of Input Requirement per Dollar of Output for the Alaska-Washington Economy, 1976

ing Sectors	Alaska Purchasing Sectors																	
	AGRI.	SHP.FISH	CRB.FISH	OTR.FISH	FORESTRY	MIN.PETR	LUMB.POP	SHP.PROC	CRB.PROC	OTR.PROC	OTRMANUF	CONST.	TRANSP.	COMM-UT.	F.I.R.E.	TRADE.	SERVICES	STATELOC
AGRI.	0.006	0.002	0.030	0.0	0.0	0.0	0.0	0.0	0.002	0.0	0.019	0.000	0.0	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.229	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.288	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.017	0.019	0.023	0.0	0.0	0.0	0.0	0.0	0.449	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.018	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIN.PETR	0.0	0.0	0.0	0.007	0.0	0.0	0.0	0.002	0.007	0.010	0.049	0.005	0.0	0.0	0.0	0.0	0.0	0.004
LUMB.POP	0.0	0.0	0.0	0.0	0.0	0.0	0.048	0.0	0.0	0.0	0.006	0.005	0.003	0.002	0.001	0.032	0.031	0.032
SHP.PROC	0.0	0.006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.PROC	0.0	0.0	0.0	0.014	0.0	0.0	0.0	0.0	0.0	0.002	0.0	0.0	0.0	0.0	0.0	0.0	0.033	0.031
OTRMANUF	0.036	0.029	0.032	0.044	0.0	0.001	0.001	0.004	0.007	0.031	0.028	0.017	0.003	0.037	0.0	0.303	0.331	0.001
CONST.	0.006	0.0	0.0	0.0	0.0	0.001	0.001	0.0	0.0	0.003	0.001	0.000	0.022	0.010	0.003	0.301	0.031	0.385
TRANSP.	0.036	0.0	0.0	0.014	0.056	0.003	0.025	0.010	0.022	0.095	0.031	0.014	0.094	0.005	0.072	0.064	0.030	0.033
COMM-UT.	0.012	0.031	0.032	0.007	0.0	0.007	0.019	0.017	0.001	0.029	0.029	0.005	0.026	0.086	0.036	0.013	0.016	0.017
F.I.R.E.	0.036	0.057	0.345	0.024	0.0	0.009	0.003	0.006	0.003	0.015	0.003	0.002	0.027	0.005	0.015	0.097	0.331	0.332
TRADE.	0.011	0.027	0.020	0.010	0.0	0.002	0.008	0.001	0.005	0.066	0.004	0.011	0.010	0.012	0.003	0.006	0.331	0.304
SERVICES	0.012	0.111	0.361	0.042	0.018	0.034	0.002	0.0	0.004	0.020	0.008	0.007	0.019	0.019	0.009	0.010	0.013	0.332
STATELOC	0.0	0.002	0.032	0.003	0.0	0.119	0.005	0.006	0.016	0.038	0.006	0.034	0.016	0.037	0.006	0.032	0.032	0.037
[illegible] Sectors: AGRI.	0.150	0.310	0.037	0.009	0.0	0.0	0.0	0.0	0.038	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.299	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FISHPROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIN.CRLG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMB.P.P	0.0	0.0	0.0	0.0	0.0	0.0	0.075	0.001	0.0	0.030	0.0	0.001	0.0	0.0	0.010	0.033	0.0	0.0
OTRMANUF	0.171	0.217	0.150	0.207	0.268	0.014	0.016	0.091	0.043	0.038	0.051	0.013	0.018	0.026	0.010	0.013	0.320	0.338
CONST.	0.0	0.0	0.0	0.0	0.0	0.006	0.001	0.0	0.0	0.0	0.0	0.009	0.0	0.0	0.0	0.0	0.031	0.0
TRANSP.&	0.0	0.0	0.0	0.0	0.0	0.005	0.0	0.015	0.024	0.031	0.001	0.0	0.055	0.0	0.001	0.039	0.321	0.310
COMM-UT.	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.011	0.031	0.037	0.313	0.0
F.I.R.E.	0.0	0.036	0.332	0.034	0.0	0.0	0.003	0.0	0.308	0.0	0.0	0.005	0.0	0.0	0.042	0.013	0.010	0.316
TRADE	0.078	0.078	0.063	0.066	0.036	0.007	0.018	0.002	0.007	0.030	0.061	0.0	0.003	0.021	0.001	0.010	0.026	0.0
SERVICES	0.0	0.041	0.039	0.039	0.0	0.0	0.0	0.019	0.004	0.032	0.001	0.001	0.014	0.007	0.0	0.028	0.318	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.071	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Value Added: W.&.S.	0.503	0.184	0.231	0.244	0.339	0.184	0.406	0.105	0.126	0.210	0.184	0.279	0.371	0.410	0.308	0.362	0.496	0.421
[illegible]	0.0	0.0	0.0	0.036	0.069	0.0	0.014	0.147	0.026	0.014	0.062	0.006	0.004	0.0	0.0	0.0	0.0	0.0
V.A.OTH.	0.031	0.684	0.162	0.122	0.107	0.505	0.136	0.095	0.021	0.044	0.352	0.034	0.299	0.270	0.567	0.138	0.147	0.222

Table 12. Continued

Selling Sectors	Washington Purchasing Sectors																
	AGRI.	SHP.FISH	CRB.FISH	OTR.FISH	FISHPROC	MIN.OILG	LUMB.P.P	OTRMANUF	CONST.	TRANSP.S	COMM-UT.	F.I.R.E.	TRADE	SERVICES	FORESTRY	AK.M.M.	WA.M.M.
Alaska:																	
AGRI.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.002	0.0
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0
OTR.FISH	0.0	0.006	0.018	0.113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0
FORESTRY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0
MIN.PETR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0
LUMB.POP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.002	0.0
SHP.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0
OTR.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004	0.0
OTRMANUF	0.0	0.065	0.039	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.019	0.0
CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.034	0.0
TRANSP.	0.0	0.0	0.0	0.0	0.0	0.0	0.002	0.002	0.001	0.002	0.0	0.002	0.033	0.002	0.0	0.014	0.032
COMM-UT.	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	0.001	0.300	0.030	0.000	0.0	0.034	0.0
F.I.R.E.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.072	0.0
TRADE.	0.0	0.009	0.036	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.214	0.0
SERVICES	0.0	0.011	0.305	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.164	0.0
STATELOC	0.0	0.003	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.110	0.033
Washington:																	
AGRI.	0.100	0.009	0.004	0.013	0.007	0.007	0.0	0.049	0.000	0.000	0.000	0.0	0.0	0.300	0.002	0.0	0.319
SHP.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.160	0.0	0.031
FISHPROC	0.0	0.0	0.0	0.002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.300	0.0	0.031
MIN.OILG	0.033	0.0	0.0	0.0	0.0	0.013	0.000	0.003	0.005	0.000	0.013	0.0	0.0	0.000	0.000	0.0	0.333
LUMB.P.P	0.033	0.0	0.0	0.0	0.004	0.036	0.206	0.010	0.025	0.001	0.003	0.036	0.005	0.001	0.010	0.0	0.334
OTRMANUF	0.062	0.145	0.110	0.132	0.019	0.039	0.019	0.082	0.070	0.036	0.010	0.023	0.022	0.029	0.022	0.001	0.119
CONST.	0.039	0.0	0.0	0.0	0.010	0.035	0.003	0.001	0.000	0.005	0.003	0.313	0.034	0.033	0.003	0.001	0.007
TRANSP.S	0.012	0.0	0.0	0.029	0.025	0.036	0.028	0.010	0.009	0.072	0.004	0.006	0.037	0.006	0.313	0.000	0.025
COMM-UT.	0.314	0.0	0.000	0.002	0.039	0.022	0.017	0.019	0.003	0.014	0.161	0.034	0.024	0.047	0.006	0.000	0.069
F.I.R.E.	0.007	0.114	0.048	0.007	0.004	0.010	0.005	0.004	0.004	0.012	0.005	0.072	0.011	0.015	0.032	0.0	0.094
TRADE	0.038	0.003	0.051	0.071	0.031	0.013	0.026	0.014	0.027	0.011	0.004	0.009	0.039	0.016	0.016	0.0	0.347
SERVICES	0.028	0.114	0.030	0.029	0.011	0.022	0.019	0.020	0.018	0.022	0.025	0.076	0.047	0.046	0.010	0.0	0.236
FORESTRY	0.0	0.0	0.0	0.0	0.082	0.0	0.077	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.030
Value Added:																	
AK.M.P.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WA.M.P.	0.120	0.120	0.270	0.180	0.060	0.295	0.197	0.226	0.120	0.497	0.121	0.319	0.360	0.300	0.056	0.0	0.0
V.A.OTH.	0.409	0.222	0.290	0.270	1.955	0.321	0.227	0.192	0.109	0.197	0.499	0.376	0.443	0.171	0.115	0.0	0.0

transactions accounts show that part of almost every sector's output must be delivered to other economic sectors to meet their input requirements for producing their own outputs. Those requirements can be indicated by:

$$\sum_{i=1}^{n} a_{ij}X_j \qquad j = 1, .$$

where a_{ij} is the input required from sector i per unit of output by sector j, and X_j is the total output of sector j. The production required of sector i to supply inputs to other sectors thus depends on the output, and input requirements, of every other sector in the economy. The economic outputs of all sectors are interdependent and simultaneously determined, as we intuitively know to be the case.

The solution to this system of simultaneous requirements equations is found by noting that most sectors produce for exports or some other "outside" sector, as well as to meet each other's input requirements. These outside or exogenous sectors are called "final demands" in I/O analysis. Those sectors' purchases do not arise out of requirements for inputs needed to produce a product that is, in turn, needed by other sectors within the economy. Rather, the sales to final demands depend on things such as the export markets for this region's products, the amount that the federal government decides to spend in the region, or the amount of new capital investment that businesses, consumers, and governments decide to make.

The balanced output and sales equations

$$X_i = \sum_{j} a_{ij}X_j + Y_i$$

[19/]Including "exports" to other states as well as exports to foreign countries.

can be formed by adding the final demand, Y for sector i's output to the sum of sales made to supply other sectors' input requirements. These equations can also be written as

$$X_i - \Sigma a_{ij} X_j = Y_i.$$

Total output minus sales to meet other sectors' input requirements equals the amount left for sales to the exogenous, final demands.

The entire set of these output equations can be written in matrix notation as

$$X - AX = Y,$$

where X is a vector of sector outputs, Y is a vector of sales to final demands, and A is an nxn matrix of technical coefficients. This matrix equation can also be written as

$$(I - A)X = Y,$$

where I is a diagonal identity matrix. The solution, for equilibrium output levels as a function of final demands, can be found by

$$X = (I - A)^{-1}Y.$$

There are two alternative formulations of the basic I/O model.. In the first, usually called "Model I," the sectors in the economy all correspond to industries, including things like trade and services as "industries." The exogenous final demands in Model I include personal consumption by the households of the region, exports, federal government purchases, and net private investment. Exogenously supplied inputs include labor and managerial inputs supplied by the region's residents (households), services of capital resources, and imported inputs. Model II differs in that households are treated as an economic sector just like more usual industrial sectors.. The household sector's output is labor which is sold to the other sectors to meet the requirement for labor services in industrial production. Total household sales depend, as with any other input. supplier, on the level of production in the input-demanding sectors. The principal differences in Model II is that household "output" must be accompanied by consumption purchases which are treated as the input requirements for the household sector's production. It is assumed that the household sector must, like any other sector, increase its purchases in proportion to any increase in its output.

The matrices of direct plus indirect requirements for the Alaska-Washington economy are presented in Table 13 for Model I, and Table 14 for Model II. Elements of the inverse matrix, $(I - A)^{-1}$, show the outputs required throughout the economy to support deliveries to final demand., An element, c.., in the inverse matrix indicates the gross output required from sector i in order to deliver one unit of product from sector j. For example, the coefficient in the second row and the eighth column of Table 14 indicates that Alaska shrimp fisheries (SHP.FISH) will have to increase output by $0.229 in order to supply the direct and indirect demands for shrimp that arise if the shrimp processing sector delivers an, additional dollar's worth of shrimp to final demands. These output requirements include indirect requirements as well as the direct requirements by sector j for inputs from other sectors in order to produce for final demand. The indirect requirements include additional outputs needed to meet the secondary rounds of input requirements by the

Table 13. Interdependency Coefficients of Direct and Indirect Requirements per Dollar of Delivery to Final Demand in the Alaska-Washington Economy, 1976, Model I

Selling Sectors	Alaska Purchasing Sectors																	
	AGRI.	SHP.FISH	CAN.FISH	OTH.FISH	FORESTRY	MIN.PETR	LUMB.PUP	SHP.PROC	CAN.PROC	OTH.PROC	OTHMANUF	CONST.	TRANSP.	COMM-UT.	F.I.R.E.	TRADE.	SERVICES	STATELOC
Alaska:																		
AGRI.	1.036	0.034	0.022	0.002	0.303	0.000	0.000	0.001	0.003	0.031	0.040	0.001	0.000	0.032	0.030	0.330	0.333	0.333
SHP.FISH	0.000	1.001	0.333	0.303	0.330	0.000	0.030	0.229	0.000	0.030	0.003	0.300	0.000	0.000	0.030	0.333	0.033	0.360
CAN.FISH	0.0	0.0	1.038	0.0	0.0	0.0	0.0	0.0	0.288	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTH.FISH	0.300	0.018	0.040	1.033	0.031	0.000	0.000	0.005	0.017	0.465	0.003	0.000	0.000	0.030	0.333	0.333	0.033	0.331
FORESTRY	0.000	0.033	0.330	0.303	1.018	0.000	0.032	0.000	0.330	0.033	0.000	0.300	0.000	0.030	0.000	0.033	0.333	0.033
MIN.PETR	0.001	0.002	0.332	0.010	0.000	1.001	0.000	0.001	0.009	0.019	0.051	0.010	0.001	0.002	0.000	0.033	0.333	0.336
LUMB.PUP	0.033	0.303	0.030	0.000	0.000	0.000	1.051	0.000	0.330	0.031	0.005	0.010	0.004	0.003	0.001	0.333	0.331	0.031
SHP.PROC	0.030	0.334	0.038	0.003	0.300	0.000	0.000	1.001	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.030	0.330	0.303
CAN.PROC	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTH.PROC	0.030	0.030	0.031	0.016	0.000	0.000	0.000	0.000	0.030	1.039	0.000	0.000	0.000	0.000	0.000	0.003	0.335	0.331
OTHMANUF	0.037	0.311	0.335	0.047	0.030	0.002	0.032	0.019	0.030	0.024	1.031	0.032	0.006	0.042	0.000	0.031	0.331	0.034
CONST.	0.007	0.001	0.031	0.001	0.002	0.013	0.003	0.001	0.003	0.038	0.004	1.007	0.026	0.015	0.003	0.033	0.332	0.095
TRANSP.	0.039	0.005	0.035	0.021	0.061	0.005	0.032	0.013	0.028	0.121	0.038	0.012	1.109	0.009	0.005	0.076	0.331	0.338
COMM-UT.	0.015	0.336	0.335	0.011	0.032	0.011	0.022	0.021	0.004	0.042	0.036	0.013	0.034	1.098	0.070	0.018	0.318	0.022
F.I.R.E.	0.037	0.059	0.047	0.027	0.092	0.009	0.006	0.020	0.018	0.031	0.005	0.036	0.032	0.036	1.016	0.013	0.334	0.303
TRADE.	0.013	0.328	0.021	0.017	0.001	0.003	0.009	0.009	0.013	0.074	0.006	0.021	0.013	0.014	0.004	1.335	0.332	0.026
SERVICES	0.013	0.114	0.365	0.046	0.320	0.035	0.006	0.028	0.025	0.045	0.012	0.014	0.019	0.022	0.010	0.313	1.319	0.305
STATELOC	0.001	0.004	0.033	0.006	0.001	0.121	0.007	0.008	0.020	0.016	0.013	0.065	0.022	0.043	0.004	0.034	0.333	1.315
Washington:																		
AGRI.	0.140	0.026	0.319	0.025	0.017	0.001	0.002	0.014	0.022	0.012	0.011	0.032	0.002	0.002	0.031	0.332	0.331	0.001
SHP.FISH	0.030	0.303	0.010	0.000	0.000	0.000	0.008	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.373	0.010	0.033
CAN.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.299	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTH.FISH	0.033	0.033	0.330	0.003	0.012	0.000	0.002	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.030	0.033	0.030	0.773
FISHPROC	0.030	0.000	0.030	0.003	0.030	0.000	0.000	0.000	0.031	0.030	0.000	0.000	0.000	0.000	0.000	0.099	0.030	0.333
MIN.OILG	0.001	0.031	0.031	0.001	0.031	0.000	0.000	0.001	0.001	0.001	0.003	0.000	0.000	0.000	0.000	0.330	0.333	0.033
LUMB.PUP	0.004	0.305	0.034	0.005	0.335	0.001	0.102	0.004	0.003	0.033	0.002	0.005	0.002	0.031	0.013	0.335	0.031	0.031
OTHMANUF	0.205	0.257	0.194	0.246	0.107	0.021	0.015	0.180	0.150	0.129	0.072	0.035	0.030	0.038	0.014	0.041	0.326	0.016
CONST.	0.033	0.032	0.032	0.002	0.001	0.006	0.001	0.001	0.002	0.031	0.001	0.017	0.001	0.001	0.031	0.301	0.333	0.332
TRANSP.S	0.037	0.038	0.036	0.007	0.010	0.008	0.006	0.021	0.033	0.014	0.005	0.004	0.069	0.003	0.003	0.017	0.024	0.302
COMM-UT.	0.013	0.317	0.314	0.015	0.011	0.002	0.007	0.011	0.012	0.010	0.006	0.003	0.005	0.018	0.005	0.014	0.321	0.002
F.I.R.E.	0.034	0.048	0.342	0.044	0.003	0.004	0.005	0.025	0.045	0.023	0.002	0.012	0.004	0.001	0.047	0.016	0.313	0.323
TRADE	0.091	0.084	0.076	0.383	0.045	0.009	0.025	0.032	0.050	0.040	0.071	0.005	0.007	0.028	0.003	0.014	0.329	0.332
SERVICES	0.016	0.362	0.057	0.058	0.013	0.003	0.006	0.052	0.045	0.034	0.008	0.007	0.021	0.012	0.005	0.037	0.323	0.603
FORESTRY	0.038	0.033	0.038	0.000	0.073	0.000	0.010	0.000	0.033	0.090	0.000	0.000	0.000	0.000	0.001	0.000	0.333	0.033
Value Added:																		
[illegible]	0.535	0.290	0.318	0.318	0.382	0.275	0.475	0.195	0.252	0.469	0.270	0.580	0.485	0.513	0.328	0.456	0.514	0.534
[illegible]	0.119	0.144	0.120	0.173	0.201	0.817	0.069	0.260	0.219	0.110	0.117	0.039	0.060	0.032	0.027	0.046	0.046	0.021
V.A.OTH.	0.235	0.318	0.336	0.331	0.249	0.560	0.227	0.232	0.371	0.303	0.405	0.167	0.410	0.370	0.616	0.443	0.232	0.287

Table 13. Continued

Selling Sectors	Washington Purchasing Sectors														
	AGRI.	SHP.FISH	CRB.FISH	OTR.FISH	FISHPROC	MIN.CILG	LUMB.P.P	OTRMANUF	CONST.	TRANSP.S	COMM-UT.	F.I.R.E.	TRADE	SERVICES	FORESTRY
Alaska:															
AGRI.	0.330	0.003	3.002	0.000	3.000	0.030	0.003	0.300	0.000	0.000	0.000	0.003	0.333	0.033	0.307
SHP.FISH	0.000	0.000	0.030	0.030	0.300	0.330	0.000	0.000	0.000	0.008	0.000	0.000	0.030	0.000	0.339
CRB.FISH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
OTR.FISH	0.370	0.006	0.018	3.116	0.002	0.033	0.002	0.300	0.000	0.000	0.000	0.333	0.330	0.330	0.019
FORESTRY	0.390	0.000	0.008	0.030	3.000	0.030	0.000	0.900	0.000	0.000	0.000	0.000	0.300	0.303	0.030
MIN.PETR	0.330	0.006	0.032	0.001	0.000	0.030	0.000	0.001	0.000	0.000	0.000	0.090	0.035	0.003	0.009
LUMB.PCP	0.033	0.000	0.000	0.030	0.300	0.030	0.000	0.000	0.000	0.050	0.000	0.000	0.030	0.303	0.033
SHP.PROC	0.003	0.000	0.000	0.030	0.000	0.030	0.000	0.000	0.600	0.000	0.030	0.030	0.030	0.000	0.300
CRB.PROC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0
OTR.PROC	0.300	0.000	0.000	0.002	0.003	0.030	0.000	0.900	0.000	0.000	0.000	0.900	0.030	0.003	0.300
OTRMANUF	0.300	0.068	0.041	0.005	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.330	0.003	0.031
CONST.	0.000	0.001	0.000	0.030	0.003	0.030	0.000	0.700	0.000	0.000	0.000	0.003	0.333	0.303	0.030
TRANSP.	0.301	0.005	0.003	0.003	0.333	0.030	0.004	0.003	0.004	0.033	0.000	0.333	0.034	0.003	0.001
COMM-UT.	0.000	0.003	0.002	0.001	0.030	0.030	0.003	0.300	0.000	0.000	0.001	0.003	0.333	0.000	0.333
F.I.R.E.	0.300	0.001	0.001	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.303	0.330
TRADE.	9.030	0.005	0.007	3.001	0.000	3.033	0.000	0.000	0.000	0.000	0.000	0.033	0.030	0.330	0.039
SERVICES	0.000	0.013	0.006	0.005	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.300	0.001
STATELOC	0.333	0.004	0.002	0.001	0.000	0.030	0.000	0.300	0.000	0.000	0.000	0.033	0.030	0.303	0.330
Washington:															
AGRI.	1.117	0.020	0.013	0.026	0.310	0.010	0.003	0.061	0.009	0.003	0.001	0.032	0.032	0.002	0.008
SHP.FISH	0.030	1.000	0.000	0.000	0.030	0.033	0.000	0.300	0.000	0.000	0.000	0.000	0.030	0.303	0.030
CRB.FISH	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTR.FISH	0.009	0.000	0.000	1.030	0.013	0.030	0.016	0.000	0.001	0.008	0.000	0.300	0.033	0.303	0.160
FISHPROC	0.000	0.000	0.000	0.002	1.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.033	0.003	0.031
MIN.CILG	0.001	0.001	0.031	0.031	0.001	1.014	0.001	0.004	0.010	0.001	0.017	0.031	0.331	0.001	0.301
LUMB.P.P	0.006	0.004	0.003	0.003	0.010	0.010	1.266	0.015	0.060	0.038	0.005	0.008	0.038	0.003	0.013
OTRMANUF	0.082	0.177	0.134	0.119	0.032	0.048	0.037	1.099	0.147	0.047	0.017	0.034	0.029	0.037	0.055
CONST.	0.311	0.003	0.002	0.001	0.018	0.036	0.004	0.003	1.001	0.006	0.004	0.315	0.334	0.034	0.001
TRANSP.S	0.016	0.006	0.004	0.035	0.030	0.039	0.041	0.014	0.023	1.081	0.007	0.010	0.039	0.309	0.021
COMM-UT.	0.026	0.021	0.013	0.014	0.016	0.032	0.033	0.031	0.018	0.023	1.235	0.053	0.035	0.365	0.013
F.I.R.E.	0.010	0.120	0.077	0.016	0.006	0.012	0.010	0.006	0.010	0.015	0.008	1.082	0.014	0.018	0.006
TRADE	0.046	0.076	0.060	0.086	0.037	0.016	0.038	0.019	0.056	0.015	0.006	0.013	1.012	0.019	0.032
SERVICES	0.039	0.140	0.066	0.047	0.018	0.028	0.033	0.028	0.044	0.029	0.036	0.092	0.054	1.355	0.721
FORESTRY	0.000	0.000	0.000	0.000	0.083	0.031	0.095	0.001	0.005	0.000	0.001	0.001	0.031	0.000	1.001
Value Added:															
[illegible]	0.000	0.031	0.022	0.036	0.001	0.000	0.002	0.002	0.002	0.002	0.001	0.032	0.032	0.001	0.006
[illegible]	0.219	0.306	0.383	0.305	0.122	0.347	0.326	0.296	0.340	0.580	0.188	0.416	0.416	0.442	0.136
V.A.CTR.	0.604	0.490	0.430	0.422	2.025	0.367	0.376	0.291	0.318	0.267	0.649	0.497	0.514	0.458	0.217

Table 14. Interdependency Coefficients of Direct and Indirect Requirements per Dollar of Delivery to Final Demand in the Alaska--Washington Economy, 1976, Model II

[illegible] Sectors	Alaska Purchasing Sectors																	
	AGRI.	SHP.FISH	CAN.FISH	OTH.FISH	FORESTRY	MIN.PETR	LUMB.PUP	SHP.PROC	CAN.PROC	OTH.PROC	OTHMANUF	CONST.	TRANSP.	COMM-UT.	F.I.R.E.	TRADE	SERVICES	STATELOC
Alaska:																		
AGRI.	1.039	0.035	0.033	0.035	0.002	0.001	0.002	0.002	0.005	0.033	0.041	0.032	0.002	0.034	0.031	0.032	0.332	0.002
SHP.FISH	0.000	1.301	0.033	0.333	0.000	0.000	0.000	0.229	0.000	0.033	0.000	0.000	0.000	0.030	0.030	0.053	0.333	0.033
CAN.FISH	0.038	0.003	1.030	0.050	0.000	0.000	0.000	0.000	0.289	0.030	0.003	0.300	0.000	0.030	0.030	0.003	0.330	0.333
OTH.FISH	0.002	0.019	0.042	1.031	0.003	0.001	0.002	0.006	0.018	0.467	0.001	0.001	0.002	0.032	0.031	0.032	0.332	0.033
FORESTRY	0.030	0.300	0.333	0.030	1.318	0.000	0.032	0.000	0.000	0.000	0.003	0.000	0.000	0.030	0.033	0.033	0.333	0.333
MIN.PETR	0.302	0.033	0.333	0.011	0.032	1.002	0.002	0.004	0.010	0.016	0.052	0.007	0.002	0.004	0.031	0.031	0.032	0.336
LUMB.PUP	0.303	0.002	0.032	0.002	0.032	0.002	1.053	0.001	0.002	0.033	0.006	0.007	0.006	0.005	0.003	0.035	0.333	0.005
SHP.PROC	0.030	0.034	0.030	0.300	0.000	0.000	0.000	1.001	0.000	0.030	0.000	0.000	0.000	0.000	0.030	0.033	0.333	0.333
CAN.PROC	0.001	0.001	0.031	0.031	0.031	0.001	0.001	0.000	1.035	0.031	0.031	0.001	0.001	0.001	0.001	0.031	0.331	0.031
OTH.PROC	0.003	0.032	0.333	0.016	0.302	0.002	0.003	0.001	0.002	1.012	0.002	0.002	0.003	0.003	0.002	0.033	0.334	0.034
OTHMANUF	0.074	0.340	0.045	0.057	0.013	0.010	0.017	0.025	0.036	0.039	1.039	0.028	0.020	0.058	0.011	0.015	0.318	0.318
CONST.	0.020	0.038	0.338	0.009	0.011	0.019	0.015	0.006	0.009	0.019	0.010	1.011	0.038	0.077	0.011	0.013	0.014	0.398
TRANSP.	0.038	0.021	0.322	0.039	3.083	0.019	0.057	0.025	0.042	0.155	0.052	0.034	1.130	0.035	0.020	0.094	0.328	0.033
COMM-UT.	0.051	0.026	0.027	0.033	0.029	0.029	0.034	0.034	0.022	0.073	0.054	0.029	0.065	1.132	0.030	0.346	0.053	0.351
F.I.R.E.	0.065	0.091	0.081	0.062	0.044	0.039	0.055	0.041	0.046	0.052	0.034	0.038	0.082	0.061	1.052	0.056	0.050	0.354
TRADE.	0.176	0.118	0.117	0.111	0.119	0.085	0.154	0.070	0.091	0.217	0.089	0.109	0.157	0.170	0.105	1.138	0.161	0.153
SERVICES	0.159	0.193	0.149	0.132	0.124	0.108	0.132	0.081	0.094	0.171	0.085	0.094	0.146	0.159	0.099	0.129	1.159	0.131
STATELOC	0.098	0.052	0.059	0.059	0.065	0.165	0.085	0.042	0.062	0.093	0.057	0.088	0.097	0.126	0.058	0.075	0.387	1.389
Washington:																		
AGRI.	0.187	0.033	0.025	0.033	0.027	0.003	0.007	0.026	0.032	0.019	0.017	0.003	0.006	0.006	0.003	0.036	0.035	0.033
SHP.FISH	0.000	0.030	0.033	0.033	0.090	0.000	0.000	0.100	0.300	0.000	0.000	0.300	0.000	0.000	0.033	0.003	0.333	0.030
CAN.FISH	0.030	0.000	0.030	0.303	0.000	0.000	0.000	0.000	0.299	0.030	0.000	0.000	0.000	0.000	0.000	0.030	0.330	0.003
OTH.FISH	0.333	0.009	0.030	0.033	0.012	0.000	0.002	0.000	0.001	0.010	0.000	0.000	0.000	0.030	0.000	0.030	0.013	0.030
FISHPROC	0.033	0.300	0.030	0.003	0.300	0.000	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.033	0.030	0.090
MIN.CTLG	0.001	0.032	0.031	0.002	0.002	0.000	0.001	0.002	0.001	0.031	0.001	0.000	0.001	0.001	0.000	0.031	0.331	0.000
LUMB.P.P	0.006	0.309	0.037	0.039	0.010	0.002	0.104	0.009	0.038	0.037	0.005	0.004	0.004	0.004	0.015	0.337	0.034	0.033
OTHMANUF	0.253	0.331	0.233	0.299	0.368	0.036	0.068	0.248	0.210	0.172	0.109	0.036	0.060	0.065	0.033	0.066	0.356	0.036
CONST.	0.007	0.036	0.035	0.036	0.006	0.007	0.004	0.007	0.007	0.035	0.004	0.011	0.004	0.003	0.002	0.033	0.036	0.031
TRANSP.S	0.022	0.321	0.018	0.022	0.027	0.013	0.018	0.039	0.049	0.027	0.016	0.009	0.078	0.013	0.010	0.025	0.315	0.020
COMM-UT.	0.044	0.348	0.041	0.052	0.055	0.010	0.027	0.062	0.056	0.038	0.032	0.011	0.024	0.033	0.015	0.029	0.059	0.016
F.I.R.E.	0.037	0.378	0.069	0.080	0.046	0.012	0.027	0.074	0.088	0.052	0.028	0.017	0.024	0.019	0.059	0.033	0.342	0.332
TRADE	0.175	0.172	0.152	0.186	0.169	0.027	0.077	0.162	0.179	0.117	0.144	0.025	0.056	0.064	0.030	0.053	0.372	0.329
SERVICES	0.065	0.133	0.119	0.143	0.112	0.019	0.050	0.171	0.147	0.087	0.068	0.026	0.061	0.043	0.028	0.068	0.061	0.027
FORESTRY	0.001	0.001	0.031	0.001	0.076	0.000	0.018	0.001	0.003	0.031	0.000	0.000	0.000	0.000	0.001	0.031	0.303	0.303
Value Added:																		
[illegible]	0.760	0.612	0.441	0.453	0.544	0.380	0.660	0.278	0.358	0.661	0.379	0.451	0.664	0.717	0.465	0.612	0.731	0.665
[illegible]	0.210	0.233	0.199	0.208	0.327	0.039	0.128	0.408	0.346	0.193	0.192	0.049	0.115	0.077	0.059	0.091	0.048	0.054
T.A.CTR.	0.496	0.500	0.510	0.551	0.511	0.467	0.430	0.467	0.597	0.532	0.649	0.203	0.608	0.971	0.766	0.598	0.410	0.434

Table 14. Continued

Selling Sectors:	Washington Purchasing Sectors																
	AGRI.	SHP.FISH	CRB.FISH	OTR.FISH	FISHPROC	MIN.OILG	LUMB.P.P	OTRMANUF	CONST.	TRANSP.S	COMM-UT.	F.I.R.E.	TRADE	SERVICES	FORESTRY	AK.H.H.	WA.H.H.
Alaska:																	
AGRI.	0.000	0.003	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000
SHP.FISH	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CRB.FISH	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.001	0.000
OTR.FISH	0.000	0.006	0.019	0.116	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.004	0.000
FORESTRY	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MIN.PETR	0.000	0.004	0.003	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.003	0.000
LUMB.POP	0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.000
SHP.PROC	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CAB.PROC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
OTR.PROC	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.003	0.003	0.006	0.000
OTRMANUF	0.000	0.069	0.041	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.032	0.033
CONST.	0.000	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.025	0.031
TRANSP.	0.032	0.009	0.007	0.006	0.001	0.033	0.006	0.005	0.004	0.008	0.002	0.006	0.037	0.006	0.032	0.052	0.038
COMM-UT.	0.000	0.005	0.004	0.004	0.000	0.030	0.001	0.001	0.000	0.001	0.002	0.031	0.031	0.001	0.031	0.068	0.031
F.I.R.E.	0.000	0.004	0.004	0.007	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.001	0.031	0.001	0.031	0.109	0.031
TRADE.	0.030	0.019	0.014	0.013	0.003	0.031	0.001	0.001	0.001	0.002	0.001	0.031	0.031	0.001	0.072	0.309	0.032
SERVICES	0.333	0.022	0.013	0.016	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.031	0.031	0.031	0.033	0.272	0.032
STATELOC	0.031	0.010	0.030	0.008	0.031	0.032	0.002	0.002	0.001	0.003	0.001	0.032	0.032	0.032	0.002	0.165	0.035
Washington:																	
AGRI.	1.125	0.013	0.029	0.019	0.015	0.025	0.016	0.072	0.013	0.028	0.009	0.019	0.019	0.021	0.014	0.004	0.044
SHP.FISH	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CRB.FISH	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.031	0.033
OTR.FISH	0.000	0.000	0.030	1.000	0.013	0.031	0.016	0.001	0.001	0.001	0.000	0.001	0.031	0.031	0.163	0.000	0.031
FISHPROC	0.000	0.000	0.000	0.003	1.000	0.030	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.031	0.000	0.031
MIN.OILG	0.002	0.002	0.002	0.002	0.301	1.015	0.002	0.004	0.006	0.003	0.017	0.002	0.032	0.032	0.031	0.000	0.033
LUMB.P.P	0.039	0.009	0.009	0.008	0.012	0.015	1.268	0.019	0.035	0.011	0.008	0.014	0.014	0.010	0.016	0.004	0.017
OTRMANUF	0.130	0.149	0.225	0.232	0.059	0.129	0.112	1.165	0.124	0.182	0.059	0.129	0.125	0.139	0.088	0.039	0.239
CONST.	0.015	0.009	0.009	0.007	0.020	0.012	0.010	0.038	1.004	0.016	0.007	0.022	0.012	0.012	0.003	0.004	0.018
TRANSP.S	0.028	0.023	0.025	0.053	0.037	0.027	0.056	0.030	0.023	1.111	0.016	0.032	0.031	0.032	0.028	0.017	0.055
COMM-UT.	0.065	0.077	0.083	0.071	0.037	0.094	0.092	0.083	0.044	0.129	1.258	0.126	0.139	0.144	0.038	0.019	0.195
F.I.R.E.	0.046	0.180	0.142	0.068	0.027	0.071	0.065	0.056	0.037	0.114	0.059	1.150	0.084	0.093	0.029	0.023	0.173
TRADE	0.162	0.244	0.272	0.254	0.132	0.205	0.215	0.179	0.133	0.331	0.105	0.238	1.234	0.259	0.106	0.038	0.554
SERVICES	0.129	0.271	0.232	0.179	0.069	0.176	0.171	0.153	0.104	0.278	0.113	0.266	0.210	1.243	0.079	0.036	0.455
FORESTRY	0.021	0.001	0.001	0.001	0.083	0.001	0.098	0.002	0.003	0.001	0.001	0.001	0.001	0.001	1.001	0.000	0.002
Value Added:																	
AK.H.H.	0.002	0.046	0.034	0.054	0.032	0.033	0.006	0.005	0.003	0.007	0.002	0.005	0.035	0.005	0.099	1.424	0.038
WA.H.H.	0.321	0.465	0.565	0.466	0.182	0.525	0.491	0.444	0.283	0.079	0.276	0.623	0.624	0.667	0.207	0.059	1.536
V.A.GTR.	0.733	0.434	0.690	0.629	2.099	0.603	0.579	0.474	0.289	0.639	0.759	0.751	0.768	0.734	0.304	0.359	0.656

sectors that produce for sector j's direct input needs and those that produce to meet the needs of secondary suppliers, households' expanded consumption, and so forth. In Model II, the household sector enters into the generation of indirect requirements just as do the more conventional industrial sectors. That is, an industrial sector's direct requirement for increased labor causes the household sector to, in turn, require more of various products to meet the consumption needs of an expanded work force. And, the sectors producing products to meet consumer (worker) demands must expand their output, hiring more workers and thereby generating still more consumer purchases, more demand for industrial production, and so on. Thus, the household sector, when internalized in Model II, contributes to the generation of indirect requirements for outputs in the same way as the usual industrial sectors do. So, the coefficients of direct plus indirect requirements calculated by Model II, with households endogenous, are considerably larger than those for Model I, where household consumption demands are not increased automatically as the level of labor use and wage payments increases.

The total output required from the local economy to deliver one unit to final demand from sector j is given by the sum of direct plus indirect requirements for all sectors in the economy. This quantity is calculated by summing a column in the inverse, $(I - A)^{-1}$, matrix of direct and indirect requirements. Since the I/O model is perfectly balanced, multiplying each sector's requirements by actual final demand levels and summing for all sectors would yield a total output requirement exactly equal to actual output from the economy.

In most cases, the output coefficients under Model II give a more accurate estimate of what will really happen to the local economic activity if a sector increases its deliveries to exports or other exogenous final demands. In the real world, increased production and hiring of labor by an industrial sector means more workers residing in the area or more employment and income to present residents. This increased number of households and/or increased income per household will mean more consumption spending, and thus more sales for local businesses, as Model II assumes.

Total indirect and induced requirements for shellfish sectors are shown in Table 15. Each coefficient indicates how much economic activity will change if there is a change of one unit in delivery to final demand from the specified sector. The indicated output changes do not include the production that goes directly to the final demand, only the output that arises indirectly in other sectors that supply the sector that is changed or is induced as consumption spending increases along with growth of incomes.

The indirect and induced output change coefficients for shellfish sectors are relatively large when compared to other sectors. Coefficients for the Alaska and Washington services sectors are shown in Table 15 to illustrate this fact. The difference is especially wide for Alaska when only the indirect effect is included (Model I). Even in Model II, which takes account of business generated due to the high level of wage payments per dollar of output in the services sector, the shellfish sectors show indirect plus induced output changes that are 1.5 to 2 times as large as the effect of the services sector.

Table 15. Indirect and Induced Output Change Association with a Change of $1 in Delivery to Final Demands by Shellfish Sectors, Model I and Model II

Initiating Sector	Indirect Output Change Model I, Households Exogenous: Output of Alaska Industries	Indirect Output Change Model I, Households Exogenous: Output of Washington Industries	Indirect and Induced Output Change Model II, Households Endogenous: Output of Alaska Industries	Indirect and Induced Output Change Model II, Households Endogenous: Output of Washington Industries
Alaska Sectors				
Shrimp fishing	0.277	0.512	0.549	0.804
Crab fishing	0.227	0.414	0.558	0.671
Shrimp processing	0.363	0.441	0.568	0.921
Crab processing	0.461	0.710	0.730	1.111
Services	0.042	0.143	0.562	0.311
Washington Sectors				
Shrimp fishing	0.117	0.574	0.152	1.098
Crab fishing	0.084	0.373	0.116	1.029
Services	0.005	0.208	0.012	0.957

The output change coefficients reflect the previously noted linkages between Alaska shellfish sectors and the Washington economy. The Model II results indicate that $1 delivery to final demand from Alaska-based shrimp harvesting vessels will lead to $.804 of added output in Washington industries, but only $.549 in Alaskan industries (other than the shrimp harvesting sector itself). Crab fishing and the shrimp and crab processing sectors both show a similar pattern. As expected, the Washington shell-fishing sector (vessels based in Washington but fishing in Alaska) show even more predominance of indirect and induced effects in the Washington economy rather than in Alaskan industries. For example, the output of Alaskan industries, other than fishing or fish processing, increases by only about 12¢ for each $1 of additional outshipments from the Washington-based crab fishing vessels.

The output change coefficients for the shellfish processing sectors are particularly significant because almost all of the shellfish passes through processors rather than being shipped directly from the harvesting vessels. The coefficients for the processing sectors include the output increase that is required in the harvesting sectors in order to supply them the raw product required to produce their. product. For crab, the raw product inputs per dollar of output in 1976 amounted to $.29 of crab from Alaska vessels, and $.30 from Washington vessels. For shrimp, raw product inputs were $.23 from Alaska and $.lO from non-Alaska vessels. If the coefficients of indirect and induced effects are reduced by these amounts, they will show the effects outside of the shellfish sectors. In that case, they are more directly comparable to the coefficients of indirect and induced effects for the shellfish harvesting 'sectors.

Income Multipliers

Input/output analyses are often used to derive income, or value added, multipliers. There are several different forms of these income multipliers, depending upon whether Model I or Model II is used (i.e., whether households are treated as endogenous or as exogenous), and on whether the multipliers are expressed per dollar of delivery to final demand or per dollar of income earned in the specific sector.

Income or value added multipliers are based on converting the output impacts, discussed 'in the previous section, to value added or income impacts. This is accomplished by multiplying the income or value added per dollar of output originating in each sector (which appear in the form of that sector's payments to suppliers of required primary inputs such as labor, capital, and other resources) by the outputs required from each of those sectors to support an increase in delivery to final demand from a certain sector and then summing all such effects that are triggered by a given final demand change.

The advantage of value added or income multipliers rather than the output coefficients discussed above is that the income effects are more nearly a measure of net gain to the region. Income coefficients measure economic change that is realized in the form of wages, profits, or returns to invested capital.

Income multipliers for the shellfish sectors are shown in Table 16. These coefficients are all based on Model II. They assume that any additions to income earned by households will be reflected in an increase in the spending by those households that is proportional to the state's average rate of consumption spending per dollar of income earned. There are four coefficients for each sector. The first two

Table 16. Changes in Value Added Associated with a $1 Delivery to Final Demand from Shellfish Sectors, Model II

Sector	Value Added Change Realized By: Alaska Households	Washington Households	Other Alaska-Washington	All Primary Input Suppliers
Alaska				
Shrimp harvesters	0.412	0.233	0.508	1.153
Crab harvesters	0.441	0.199	0.518	1.158
Shrimp processors	0.278	0.408	0.467	1.153
Crab processors	0.358	0.346	0.597	1.301
Washington				
Shrimp harvesters	0.046	0.465	0.654	1.165
Crab harvesters	0.034	0.585	0.690	1.309

multipliers measure the effects on income of the households in Alaska and in Washington. These coefficients include wages, salaries, and earnings of sole proprietorships. The third multiplier is other value added which is principally capital consumption allowance, return on investment, and profits for companies. The last is a summation covering total value added or income- earned within the states of Washington and Alaska.

In interpreting these income multipliers, it is important to keep in mind that they are a measure of income change associated with a change in delivery to final demand from a particular sector. The change in output of the sector may differ very substantially from the change in final demand if the sector is heavily involved in both producing for exports or other final demand and also producing an input for use by other industries within the state's economy. In the case of the shellfish sectors, this distinction is not too important because shellfish harvesting sectors are. almost exclusively producing for inter-industry sales to the processing industry rather. than for sales to. final demand. The, processing sectors, on the other hand, sell almost exclusively to final demand for export out of the state of Alaska.

It is also important to keep in mind that the income change that is expected to come with economic change does not necessarily mean that the current residents' incomes will be improved. One of the basic assumptions of input/output models is that all inputs will increase-in proportion as the output of a sector grows. That assumption implies that labor, management, capital, and other basic resources will also increase as a sector's output grows. Thus, the amount of labor and other primary factors used in production will be growing at exactly the same rate as the income payments that are being made to those factors. If there is a large contingent of labor and capital goods that is unemployed but residing in the region, then it is possible that the expansion might be based on use of these unemployed resources. If that is the case, then total income received by the residents of the region will be increasing as the unemployed workers and idle capital move from a zero return to earning at the established wage rate. However, if the region must attract or retain additional labor, capital, and other primary inputs, the income generated by growth will flow to the new workers and the owners of the new capital that is brought in to expand the output of the sector. Some; perhaps most, of the greater income will be going to people who are not now residents of the region. Therefore, it is not wise for the region's present residents to treat even the growth of income earned as a result of expansion of a sector as though it would all be money in their own pockets. This is particularly important to keep in mind when considering proposals that would require the present residents to bear large development or subsidy expenses on the presumption that they will recoup it through the added income generated by expanded economic activities.

Total Economic Impact

The input/output model can also be used to determine the portion of total state income that is attributable to the production and sales of the shellfish sectors. Income generated within the regional economy as a result of the shellfish industries includes not only the income earned directly within those sectors, but also the income that is earned in other sectors as they produce to supply needed inputs for the fishing sectors. This division of total income can be calculated using the interdependency coefficients from the matrices shown in Table 13 and Table 14. Each of the interdependency coefficients shows the production required from the various-sectors in the economy in order to support delivery to final demand by a particular sector. When these coefficients are multiplied by the 1976 delivery to final demand from a shellfish sector, the results show the total requirements--direct, indirect, and induced--from each of the sectors within the economy in order to support the 1976 deliveries to final demand from the shellfish sectors. The required production from each sector can then be multiplied times that sector's coefficient of value added per unit of production in order to calculate the total income earned in each of the economic sectors as they produced goods and services needed to support the 1976 deliveries of shellfish from Alaska to its external markets.

Estimates of income or value added attributable to the shellfish sectors' export sales are presented in Table 17. Since the fishing sectors themselves sell virtually all of their output to the processors, the deliveries to final demands all come ultimately from the processors rather than from the fishing sectors. The requirements for output from the fishing sectors are included in the interdependency coefficients for the shellfish processing sectors. These data are for Model II with households endogenous. That means that the production of consumer goods for the households that earn their income in the shellfish sectors or in the other sectors that are serving the shellfish sectors will be included as a part of the estimate of economic impacts and income attributable to the-shellfish production.

The largest receipts of income in conjunction with the production of shellfish products for delivery to final demand are those earned

Table 17. Value Added Earned in Alaska and Washington Economic Sectors Attributable to the 1976 Production and Delivery of Alaskan Shrimp and Crab to Export Final Demands, Model II,. Households Endogenous

Sector Where Value Added is Earned	Value Added Attributable to: Processed Shrimp Products	Processed Crab Products	All Other Products & Services
	----------($1,000,000)----------		
Alaska Sectors			
Agriculture	0.1	0.3	5.4
Shrimp fishing	2.2	0.0	0.0
Crab fishing	0.0	15.1	0.5
Other fishing	0.1	1.0	54.5
Forestry	0.0	0.0	2.5
Mining & petroleum	0.1	1.0	467.6
Lumber, pulp & paper	0.0	0.1	72.0
Shrimp processing	10.9	0.0	0.0
Crab processing	0.0	24.5	0.5
Other fish processing	0.0	0.1	72.8
Other manufacturing	0.5	3.2	75.8
Construction	0.1	0.4	912.9
Transportation	0.6	4.0	375.6
Communication & utilities	0.8	2.1	142.6
Finance, insurance & real estate	1.3	5.6	192.5
Trade	1.8	9.2	455.5
Services	1.8	8.4	335.7
State & local government	0.9	5.6	338.2
Alaska subtotal	21.2	80.6	3,439.8
Washington Sectors			
Agriculture	0.5	2.7	1,089.4
Shrimp fishing	1.2	0.0	0.0
Crab fishing	0.0	23.5	0.5
Other fishing	0.0	0.0	33.2
Fish processing	0.0	8.8	330.9
Mining	0.0	0.1	57.7
Lumber, pulp & paper	0.1	0.5	1,839.7
Other manufacturing	3.6	12.4	4,507.6
Construction	0.1	0.2	981.5
Transportation	1.0	4.8	1,291.9
Communication & utilities	1.4	4.9	1,182.9
Finance, insurance & real estate	1.8	8.6	1,260.5
Trade	5.1	20.2	4,690.7
Services	4.5	15.6	2,677.3
Forestry	0.0	0.1	63.1
Washington subtotal	19.3	102.4	20,006.9
Total Earnings in All Sectors	40.5	183.0	23,446.7

directly in the shellfish harvesting and processing sectors. However, other (non-shellfish) sectors, in total, had far more value added as a consequence of the shellfish production than was earned directly in the harvesting and processing sectors. For example, the shrimp sectors resulted in a total income earned within the Alaska and Washington economies of $40.5 million. Of that, $10.9 million is earned directly in the shrimp processing sector by employees and other primary input suppliers. The shrimp fishermen and vessel owner receive $3.4 million in making a total of $14.3 million earned directly in shrimp harvesting and processing. The remaining $26.3 million is income earned in other sectors as they supply inputs to the shrimp harvesting and processing sectors, supply inputs to each other for their production for the shrimp processing sectors, and supply consumer goods to the workers in the shrimp sectors and to the workers in the supporting industries. In total, the income earned in the supporting sectors is nearly twice as large as the income earned directly in the shrimp production and processing sectors.

Income earned as a result of crab production is more than four times larger than in the shrimp sectors. However, the income earned indirectly in other economic sectors is also approximately twice as large as income earned directly in crab harvesting and processing.

The key role that Washington plays as a supplier of inputs to the Alaskan economy is reflected in the fact that total income earned in Washington supporting sectors (sectors other than shellfish processing and harvesting) is nearly twice as large as the income earned in Alaska supporting sectors. For shrimp production, the Washington supporting sectors earned $18.2 million versus $8.1 million in the Alaska supporting sectors. This relatively large benefit to the Washington economy from the harvesting of an Alaska resource is not principally due to Washington fishermen obtaining the greatest share of the shrimp in Alaska. Actually, their catch and income earned directly in shrimp fishing was only about half as large as the catch and income earnings by Alaska-based vessels. The principal reason for the benefit to the Washington economy is the reliance on the Washington economy by Alaskan fishermen, fish processing plants, and all other sectors including consumers. Any production and economic activity that takes place within Alaska generates substantial benefits for Washington. In fact, the share of income received by Washington residents is probably even larger than the share of income earned in Washington businesses. This is true because many Alaska businesses remit a substantial share of their payments to employees who are in fact residents of Washington only temporarily working in Alaska or to owners and company headquarters who are located in Washington rather than in Alaska.

The largest indirect earnings of income are for Washington-trade with $25.4 million earned through business directly and indirectly supporting the production of Alaska shellfish products. The Washington services sector was second with $20.1 million, and third was the general manufacturing sector in Washington with $16 million earned. Washington general manufacturing earned most of its income in direct support activities producing items of equipment for the fishing and processing industries. Especially important in this has been ship building. The trade and services sector, on the other hand, is more involved in providing secondary support to industries that are more directly serving the fisheries sectors. Other sectors with income or value added of more than $10 million as a result of the 1976 production of shellfish products from Alaska include the Alaska trade and services sector and the Washington finance, insurance, and real estate sector.

The high ratio of $1.9 earned indirectly in supporting sectors for every dollar earned directly in the shellfish harvesting and processing sectors confirms the fact that the shellfish industry in Alaska is a basic sector to both the Alaska and Washington economies. In contrast, supporting sectors such as trade and services have income earned in the process of making their total deliveries to final demand that is considerably less than the total income that was earned within the sector in that year. The reason for this discrepancy is that a large share of the income earned directly within their sector resulted from their role in support of basic sectors such as the fishing sectors, mining and petroleum, lumbering, and construction.

Economic Impacts of Potential Changes in the Shellfish Sectors

Input/output models can be used not only to provide economic impact coefficients, but also to estimate the secondary changes in economic production, trade flows, and income that will result from specific initial changes to the economy.

Economic changes may arise for any one of a number of reasons. Resource availability might change, the technology used in production or the economic structure of a sector could change. Government policies and regulations might force changes. These changes can be translated into changes in economic output, input purchases, income, or sales of final products. Input/output picks up the story from this point and estimates how other economic sectors will be affected, given the linkages among production sectors and input/output-patterns in the economy.

To illustrate the use of the Alaska-Washington input/output model for this type of impact analysis, we have selected five scenarios of possible changes to the shellfish sectors. The scenarios are:

Scenario I. Crab and shrimp harvests are at 150% of 1976 production. Industry composition and inputs per unit of output are unchanged.

Scenario II. Crab harvests are at 150% of the 1976 level and shrimp harvests drop to 50% of 1976 production..

Scenario III. Crab harvests are at 150% of 1976 production and shrimp harvests are unchanged. The entire 50% increase is captured by Washington-based vessels.

Scenario IV. Crab harvests are at 150% of 1976 production and shrimp harvests are unchanged. The entire 50% increase is captured by typical Alaska vessels.

Scenario V. Crab and shrimp harvests are at 1976 production levels but there is a shift of production from Washington vessels to Alaska vessels.

Scenario I

The first "scenario" is an across-the-board change in the harvests of shrimp and crab to 150% of 1976 production. It is assumed that there are no underlying changes in cost, structure, or in relative contributions of subsectors within the industry. Since the input/output model is completely linear, all changes are proportional and the quantity changes would apply to either an increase or decrease in output of the shellfish fisheries. The only--'difference would be in the direction of effect upon the other economic sectors.

The predicted economic changes under Scenario I are shown in Table 18. Shellfish production at 150% of 1976 output would, in the long-run, result in $150 million in added business in Alaska plus $95 million in Washington. Of the total, 55% would be increases in shellfish harvesting and processing (mostly in Alaska) and 45% expansions in other sectors (two-thirds in Washington).

It would be a mistake to think of he gross business expansion of $245 million as a measure of "benefits" from an increase in shellfish harvests. About $143 million out of the total either flows out of the region to pay for needed goods and services or flows among the sectors to pay for products that are needed inputs to other businesses. Only $112 million is left, in value added, for paying workers, investors, and business owners. And most of that will be paid out to attract workers and investors to come to this growth industry rather than to their next best alternative employment. In the end, only a very small part of the total will be gains in real net incomes.

Scenario II

The second output scenario assumes, that shrimp and crab outputs change to approximately the level actually harvested in 1979 and continue at that level. This would involve a change to approximately 50% larger crab harvest, and approximately 50% smaller shrimp harvest than the 1976 base levels.

The results for Scenario II show that the 50% decline of the shrimp harvest would offset part of the economic effects from a larger crab harvest. However, there would still be substantial net gain due to the much larger 1976 base of the crab industry.

Table 18. Alaska and Washington Economic Output and Income, 1976 Base, and Changes under Alternative Scenarios

	1976 Base	Change with Shellfish Scenarios I	II	III	IV	V
	($ million)					
OUTPUT						
Alaska:						
Shrimp fishing	8	4.0	-4.0	0.0	0.0	0.0
Crab fishing	42	20.6	20.6	0.0	0.0	21.0
Shrimp processing	35	17.6	-35.2	0.0	41.0	0.0
Crab processing	146	70.3	70.3	70.3	70.3	0.0
Other sectors	8,712	37.1	25.2	22.2	60.5	9.3
Total Alaska	8,943	149.6	76.9	92.5	171.8	30.3
Washington:						
Shrimp fishing	3	1.8	-1.8	0.0	0.0	0.0
Crab fishing	43	21.0	21.0	42.0	0.0	-21.0
Other sectors	41,653	71.7	42.9	64.8	27.4	-7.6
Total Washington	41,699	94.5	62.1	106.8	27.4	-28.6
Total Alaska & Washington	50,643	244.1	139.0	199.3	199.2	2.3
VALUE ADDED						
Alaska workers	3,654	30.2	20.4	17.0	31.0	8.6
Washington workers	12,075	31.6	17.2	32.6	15.9	-8.1
Other value added	18,245	50.3	33.9	46.0	37.9	-3.6
Total value added	33,976	112.1	71.5	95.6	84.8	-3.1

It should be emphasized that in these estimates of the impacts of production at the 1979 level, the input/output model assumes that the input requirements of all industries change exactly in proportion to the change in their output. The rate of capital utilization and composition of different sized units within the industry are also assumed to remain the same. These assumptions imply that there is time for re-adjustment from any distortions or disequilibria that arise from output changes. Thus, the impacts are estimates of response to a permanent change that has continued in effect over a long period of time. During the adjustment period, it is likely that net incomes would be less than indicated due to losses that would have to be absorbed by resources "trapped" in the declining shrimp industries.

Scenario III

This scenario evaluates the economic impacts if there was an increase, equaling the 1976-79 growth in crab harvests, all captured by the Washington vessels rather than being divided between them: The fourth and fifth scenarios consider. the economic impacts of an increased harvest by Alaskan vessels coming either out of increased production or at the expense of an equal reduction in the amount of crab captured by the Washington-based vessels. All three scenarios assume that typical vessels in the Alaska and Washington fleets will have the same costs and catch per vessel as in 1976. By implication, increased shares in the harvest would come about through an increase in the number of typical vessels that are operating in a subfleet. The impacts are those that would be expected after a long enough period to fully adjust to the redistribution of catch between the fleets.

In Scenario III, an increase in crab production equal to that realized between 1976 and 1979 is assumed to be absorbed entirely by the Washington-based vessels. In the input/output model, this means that all of the increased deliveries of shellfish to the processing sector will come from the Washington-based vessels with no change in the quantity delivered by the Alaska vessels.[20/]

A scenario with all of the increased catch being captured by the Washington fleet is consistent with recent experience. Vessels typical of those in the Washington fleet have a definite advantage because they are able to operate in the Bering Sea, where the increase in catch has been occurring. Vessels in that size class are invariably built and/or serviced in Puget Sound ports because Alaska's facilities are not adequate.

If an increase of 94 million pounds in crab harvest was captured by Washington vessels alone, Alaska would realize a total change in business output of $94 million, at 1976 prices. Almost all of this increase is in the form of $70 millionadditional output of processed crab from plants in Alaska. Only $24 million is realized in additional output, from the sectors that provide local services in Alaska to the Washington fleet and the secondary sectors within the Alaskan economy that service the processors, fleet, service sectors, and the employees within the processing plants. The Washington economy would realize an increase of $106 million in sales as a result of this change. These are made up of

---

[20/]Mechanically, this is accomplished by first changing the deliveries to final demand of the processing sector to reflect the hypothesized change in total sales of crab and shrimp. Offsetting dummy deliveries to final demand directly from the harvesting sectors are then introduced to adjust the Washington sector up until it supplies all of the increased shellfish and adjust the Alaska sector down so that it continues to operate exactly at the level before the hypothesized change.

substantial sales from Washington marine trade and services sectors directly to the Washington fleet plus sales by Washington industries that are supplying Alaska consumers and businesses through the Alaska-Washington trade.

Scenario IV

The fourth scenario assumes that all of a 94 million pound per year increase in crab harvest would be captured by Alaska-based vessels rather than by Washington-based vessels. This would be more attractive to those who prefer to see more of Alaska's resources exploited by residents of Alaska.

The economic impacts, shown in Table 18, indicate that more Alaska business would be generated if the harvest were captured by vessels typical of the 1976 Alaska-based fleet. It is important to keep in mind that the business gains for Alaska will be realized only if the vessels are not only owned by Alaska residents but also are mostly serviced and stocked in Alaska. If the added vessels were of a size and type that could fish the, Bering Sea, they would tend to take most of their service and supply business to Washington State, whether they were Alaska-owned or not. In that case, their impact on the Alaska and Washington economies would be about the same as if the added vessels were in the Washington subfleet, and the only advantage for the Alaska economy would be the flow of owners' profits to Alaska residents rather than out of state. Income for Alaskans is not an irrelevant concern, but it may not do much to further the Alaska economy.

Scenario V

The fifth scenario portrays a redistribution of the catch with Alaska vessels harvesting $25 million more. crab and Washington vessels reducing their catch by an equal amount. If there is no increase in the resource that can be used to expand the Alaska fleet, redistribution of the existing catch would be the only way to expand the Alaska fleet. The redistribution might be achieved by regulations designed to save more of the Alaska resource for exploitation by Alaska fishermen. Changed economic conditions also might make it less profitable for a Washington-type operation to fish in Alaska but leave the way open for the smaller and more diversified Alaska-based vessels to operate profitably in the crab fishery. A shift of $21 million in crab catch from the Washington vessels to the Alaska fleet is equivalent to the shift of about 50% of the current annual catch of the Washington fleet over to provide approximately a 50% increase in the catch of the Alaska fleet.

The economic changes with this resource reallocation are shown in the last column on Table 18. The increase in the total sales of Alaska sectors other than the shellfish harvesting sector is $9.3 million. Washington non-shellfish sectors, on the other hand, experienced a decline of only $7.6 million. So, the net effect is to increase the total sales of the Washingtonand Alaska economies by almost $2 million. The reasons for the increase in sales is that the Alaska-based vessels, which are hypothesized as taking over more of the fishery, have relatively higher costs per dollar's worth of crab harvested. Thus, as they take over more of the harvest, the total spanding for inputs from other sectors would increase.

A shift of the crab catch from Washington to Alaska vessels would reduce total income earned by workers, owners, and others. Alaska would gain $8.6 million in wages and income of self-employed persons and Washington would lose almost as much, $8.1 million. In addition, other value added (i.e., rents on basic resources, returns to capital, and profits of entrepreneurs) would be reduced by $3.6 million. Some of the $3.6 million income decline would fall on Alaska resource owners; however, most of the decline would fall on outsiders who supply capital for Alaska operations. A substantial part of this other value added would be lost when the more profitable Washington boats are replaced with Alaskan vessels that use more labor and purchased inputs per volume of shellfish harvested but return much less to the owners of the vessels.

The typical Alaska vessels' relatively high input purchases per dollar of crab harvested and low return to the owner does much to explain why the "Seattle-type" vessels increased in numbers throughout the 1970s. The larger, vessels are more profitable and hence attractive to investors. This suggests that it would be difficult and costly to bring about a shift toward the Alaska vessels. Taxes or restrictions on the vessels from outside might help to reduce competition, but expansion of the local fleet would still require more assistance. To somewhat improve the profitability of the Alaska vessels, subsidies to vessel owners could be used. One potentially helpful step would be to develop maintenance, repair, and ship supply facilities in Alaska to service vessels in the 100 foot to 150 foot size class. Facilities of this type would make it possible to develop a truly Alaska-based fleet to operate in the Bering Sea and other off-shore fisheries.

V. SUMMARY AND CONCLUSIONS

The shellfish fishery is an important part of the base of the Alaska economy. The $180 million worth of shellfish products produced in 1976 amounted to about 2% of the total value of industry sales in Alaska. More importantly, shellfish products accounted for 12% of the total value of products exported from Alaska to other states or to foreign countries, making them an important source of the external funds that are needed to buy the many imported goods and services that Alaska requires.

The shellfish industries not only produce a valuable product and revenue source for Alaska, but they also generate business and an income source for other Alaskans as they buy equipment and services, hire workers, and yield a return to vessel and processing plant owners. The Alaska shellfish harvesters and processors spent about $25 million in 1976 for inputs purchased from other Alaska industries and paid $33 million in wages to Alaskans who worked on vessels or in the plants. A relatively low percentage of the $180 million gross value is respent in Alaska because of a tendency in the shellfish sectors, as throughout the Alaska economy, to buy many of their needs from outside. There is a particularly strong propensity to import from the state of Washington because of its accessibility by air or water transportation and because of common features in the Alaska and Washington economies. The tendency to buy from Washington is further increased for the shellfish sectors by the fact that several of the vessels and processing plants are owned by Washington-based individuals or firms. Overall, the shellfish sectors obtain about 50% more inputs from Washington than from Alaska industries and workers.

The high propensity to import in the shellfish sectors, and the rest of the Alaska economy as well, dampens the local economic impact of the fishery. Nevertheless, value added through Alaska business generated directly or indirectly by the shellfish sectors totaled $49 million in 1976. That is larger than the $40 million earned directly by Alaska residents working in the shellfish sectors. Another indication of these indirect impacts is provided by the direct plus indirect requirement coefficients from the input/output analysis. Every $1 of processed shrimp requires an average of $0.23 of output from shrimp fishermen plus $0.34 of output from other Alaska sectors. From this total output, Alaskans realize $0.28 in wage earnings--$0.ll directly in shrimp processing, $0.04 in shrimp harvesting, and $0.13 in other businesses. Similarly, $1 of crab product requires $0.29 worth of crab sales from fishermen plus $0.44 of output from other Alaska businesses. The wages for Alaskans involved in this production are $0.12 in crab processing, $0.07 in crab-harvesting, and $0.16 in other Alaska businesses.

The Washington economy gains substantially from the Alaska shell-fish fishery. In 1976, Washington-based vessels accounted for about one-half of the crab and one-third of the shrimp harvested in Alaska. The shellfish are delivered to processors in Alaska and become part of Alaska's economic output, but the money received from sales by the Washington-based vessels are mostly respent in Washington. For each $1 of sales from Washington-based crab fishing vessels, Washington households receive, in addition to wages of $0.27 earned directly by the crew on the vessel, $0.32 in wages earned in businesses that are indirectly involved in servicing the vessel's, crew, etc., and $0.69 in other value added, which mostly accrues to residents of Washington. Even Alaska-based fishing vessels and processing plants generate substantial business and earnings in Washington. Each $1 of sales from Alaska-based crab boats leads to $0.20 earned by employees in Washington businesses. A substantial share of $0.36 in value added other than wages or direct income to vessel owners also ends up in Washington State.

Overall, the harvesting and processing of Alaska shellfish in 1976 resulted in business activity in Washington that led to approximately $135 million in wages and other payments to Washington residents. Most of this amount was earned indirectly rather than directly through Washington fishing operations in Alaska. In fact, earnings in Washington's other sectors that was indirectly attributable to shellfish production totaled $97 million, which is slightly more than total direct and indirect earnings in Alaska sectors.

An expansion of the shellfish fishery could potentially contribute to a general expansion of the Alaska and Washington economies, if a number of important conditions are met. First, the expansion would have to be economically feasible. Vessel owners and operators now have rather narrow profit margins, on the average. So, expansion would have to be based on discovery of ways to have larger sustained harvests from present grounds or new grounds that can be worked without significantly higher costs. Second, the increase of shellfish output must not cause a significant decrease in the wholesale price of shellfish products. A price decrease would make fishing less profitable, unless fishermen are somehow able to reduce costs per pound harvested. If fishermen's net returns are reduced by a decrease in price, it is likely that some will quit, negating the original expansion and the economic stimulation caused by the initial production expansion. Third, the expanded shellfish production would have to be accomplished with harvesting and processing activities that use local Alaska and Washington inputs at about the same rate as do present shellfish harvesters and processors. An expansion could be achieved with much less than proportional increase in inputs if, for example, limitations on entry were used to insure that the increase in harvest and processing is accomplished by existing vessels and plants working a longer season. If so, spending for routine maintenance of vessels and plants, interest on invested capital, and other fixed costs would not increase proportionally and that source of stimulus to the rest of the economy would be lost. However, profit margins above operating costs would be higher, which would provide a partially offsetting source of economic stimulus. In addition, fishery management policies that held down the fixed cost component could make it feasible to expand the fishery into some areas with higher operating costs or to sustain the harvest at a higher level even though product prices were somewhat lower as a result of larger quantities reaching the product markets.

The Alaska' shellfish fishery's effect on the Alaska and Washington economies could-'be significantly changed by regulations or economic changes that significantly alter the pattern of purchases by the shellfish sectors or the structure of the Alaska and Washington economies. An increase in the share of inputs purchased locally, in Alaska, would increase Alaska's share in the businesses that are directly and indirectly involved in providing inputs to the fishing vessels and processing plants. More Alaska-based vessels would help somewhat to achieve a higher Alaska fraction in inputs, as long as the Alaska-based vessels were not built, maintained, and supplied in Washington ports. A more important contribution would be development in Alaska of vessel maintenance and supply facilities capable of handling the "standard" modern vessel in the Alaska shellfish fleet. General "broadening" of the Alaska economy, especially in the principal fishing regions, would also help to capture a larger share of the indirect and induced effects for the Alaska economy rather than have them "leak" out to Washington or other states:

REFERENCES

Alaska Department of Commerce & Economic Development, Division of Economic Enterprise. The Performance Report of the Alaska Economy. Juneau, 1977 & 1978.

Alaska Department of Fish & Game, Division of Commercial Fisheries. Alaska 1976 Catch and Production. Statistical Leaflet No. 29, Juneau, July 1979.

Alaska Department of Labor, Research & Analysis Section. Alaska Statistical Quarterly, Fourth Quarter, 1977. Juneau.

Blakeslee, L. "Income Generation and Distribution in Input/Output Models." Unpublished paper, Washington State University, 1974.

Blakeslee, L., et al. "Wheat in the Washington Economy: An Input/Output Study." Washington Agricultural Experiment Station Bulletin 775, Washington State University, April 1973.

Bourque, P.J., and R.S. Conway, Jr. The 1972 Washington Input/Output Study. Graduate School of Business Administration, University of Washington, June 1977.

Chenry, H.B., and P.G. Clark. Interindustry Economics. New York: John Wiley & Sons, Inc., 1959.

Combs, E.R., Inc. Capital Requirements Analysis for the Alaska Commercial Fishing and Agriculture Bank, Volume I--Executive Summary Market Analysis. Prepared for the Alaska Department of Commerce and Economic Development. Mercer Island, Wash.

Davis, C.H., and E.M. Lofting. A Multisectoral Model of Pacific and Mountain Interstate Trade Flows. Center for Economic Studies, Institute for Water Resources. U.S. Army Corps of Engineers, Alexandria, Va., 1972.

Donaldson, W., and M. Dick. Commercial Fisheries Research and Development Act, Kodiak Alaska Tanner Crab. Prepared for National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C. Alaska Department of Fish & Game, Juneau, November 1977.

Dorfman, R., P.A. Samuelson, and R.M. Solow. Linear Programming and 'Economic Analysis. New York: McGraw-Hill Book Co., 1958.

Fullerton, H.H., and J.R. Prescott. An Economic Simulation Model for Regional Development Planning. Ann Arbor, Michigan: Science Publishing, Inc., 1975.

Leontief, W. "Multiregional Input/Output Analysis," Structural Interdependence and Economic Development, Tibor Barna (ed.). New York: St. Martins Press, 1963.

_________. The Structure of the American Economy, 1919-1939. White Plains, N.Y.: International Arts & Sciences Press, Inc., 1951.

Logsdon, C.L., and K.L. Casavant. "Alaska-Washington Trade: An Applied Input/Output Study." College of Agriculture Research Center, Bulletin 848, Washington State University, June 1977.

Mathematical Sciences Northwest, Inc., and Human Resources Planning Institute, Inc. "A Social and Economic Study of Off-Shore Petroleum and Natural Gas Development in Alaska." Report to the Bureau of Land Management, Department of Interior, October 1976.

Miernyk, W.H. The Elements of Input/Output Analysis. New York: Random House, Inc., 1965.

North Pacific Fishery Management Council. Fishery Management Plan for Alaska King Crab (Draft). Anchorage.

_________. Fishery Management Plan for the Commercial Tanner Crab Fishery off the Coast of Alaska. Anchorage, May 1978.

Orth, F.L., J.A. Richardson, and S.M. Piddle. Market Structure of the Alaska Seafood Processing Industry. University of Alaska Sea Grant Report No. 78-10, December 1979.

Polenske, K.R. A Multiregional Input/Output Model for the United States. Harvard Economic Research Project for U.S. Department of Commerce, Economic Development Administration. Report No. 21, December 1970.

Queirolo, L.E., et al. Alaska Shellfish Bio-Economic Data Base. Alaska Commercial Fisheries Entry Commission, Juneau, 1978;

Stokes, R.L. The Economics of Alaska Groundfish Development: A Preliminary Assessment (Draft). Prepared for Northwest Fisheries Center; National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, April 1979.

Tiebout, C. "The Urban Economic Base Reconsidered," Land Economics, Vol. 32(l), 1956.

Tussing, A.R., T.A. Moorhouse, and J.D. Babb, Jr. (eds). Alaska Fisheries Policy. Institute of Social, Economic, and Government Research, University of Alaska, Fairbanks, 1972.

U.S. Army Corps of Engineers. Waterborne Commerce Statistics of the United States. Washington, D.C., annual.

U.S. Department of Commerce, Bureau of the Census. County Business Patterns 1973 (Washington, Oregon, and Idaho). U.S. Government Printing Office, Washington, D.C., 1974.

Annual Survey of Manufactures, 1976. U.S. Government Printing Office, Washington, D.C., 1977.

County Business Patterns 1976. U.S. Government Printing Office, Washington, D.C., 1977.

U.S. Department of Commerce, National Marine Fisheries Service. Current Fishery Production, Annual Summary. Washington, D.C., 1976.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration/National Marine Fisheries Service. Processed Fishery Products, Annual Summary 1976. Washington, D.C., 1978.

Wilkins, J.R. Construction of a Multiregional Input/Output Model for the Pacific Northwest. Northwest Energy Policy Project, prepared by U.S. Department of Agriculture, Corvallis, Oregon, 1978.