Maine Coastal Zone Management Program

FISHERIES MANAGEMENT AND DEVELOPMENT

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Element E: The Economic Impact of Fisheries in the State of Maine

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Maine Department of Marine Resources
F earch Laboratory
W Harbor, Maine 04575
T 3-5572

Edited by: C. J. Walton

Project Manager: V. C. Anthony

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ELEMENT E: THE ECONOMIC IMPACT OF FISHERIES IN THE STATE OF MAINE

Dr. James Wilson
Dr. Thomas Duchesneau
Hugh Briggs
Kimberly Rollins
Blair Burlingame
Doug Williams

Preface

This report was prepared for the Maine Department of Marine Resources by students and faculty of the Department of Economics of the University of Maine, Orono. It is an input-output table of the economy of the state of Maine tailored especially for the analysis of fishery related economic problems. A secondary purpose of the study was the educational and practical experience gained by the students who worked on the project.

The overall study was under the direction of Dr. James Wilson. Dr. Thomas Duchesneay directly supervised the input-output study. During the summer of 1979, Hugh Briggs and Kimberly Rollins (seniors) and Douglas Williams and Blair Burlingame (graduate students in Agricultural Resource Economics) conducted the field surveys and secondary source searches necessary to accumulate the data for the input-output table. Each student prepared a report on two or more sectors of the fishing industry which appear as appendices to the input-output study.

Most of the writing of the report and the analysis of the input-output model took place during the Fall of 1979. Hugh Briggs, working with funds provided by the UMO Sea Grant program, was completely responsible for the computer programming of the input-output table. Ralph Townsend of the UMO Department of Economics deserves credit for modifications made to the model which increased its accuracy. Carolyn Ford, Gayle Magill, Mary Jaques, and Katja Lomakin patiently typed and

re-typed various drafts of the final report.

The project is also indebted to the generous support and time given by Dana Wallace, Bob Lewis, Walter Welch, and Jim Thomas of the Department of Marine Resources. Charles Colgan and Gary Higgenbottom of the State Planning Office offered many valuable suggestions about data sources and methodology which were very helpful. Lastly, thanks are due to the many people in the state's fishing industry who voluntarily supplied data and their valuable time during the summer of 1979. In almost all instances their efforts also led to an extremely valuable educational experience for the students which would have been impossible to provide in the classroom.

Summary

The Economic Impact of Fisheries in the State of Maine - An Input-Output Analysis

Method and Results:

The purpose of this study was to develop an estimate of the economic impact of the fishing industry on the state of Maine. An estimate of this sort is not accomplished simply by a straightforward measurement of the landed value of fisheries activity.

Economic activity is a complicated web of interdependent behavior. A change in any part of the economy will lead to changes elsewhere. Consequently, the measurement of the effect of any particular economic activity such as fishing requires a tracing out of the changes that occur elsewhere in the economy as a result of fishing activity. In other words, to get a tolerably accurate idea of the effect of the fishing industry, it is necessary to know how fishing and the rest of the economy are related to one another.

The technique economists most often use to obtain these measurements is called input-output analysis. Input-output is basically a massive accounting system which records the sales and purchases of each industry to and from every other industry (and to final consumption). With the help of some fairly sophisticated mathematics and computer calculations, this accounting system can be used to trace the connections between all industries in the economy. This tracing, in effect, accounts for:

(1) the direct effect of purchases by the fishing industry from all other industries in the economy,

(2) the direct effect of purchases by these industries from still other industries necessary to produce the goods and services supplied to the fishing industry, and by these other industries from still others, and so on, and

(3) the induced effects which arise when personal income generated in the fishing industry and in all industries supplying the fishing industry is spent.

These effects can be traced in terms of either the income or the total expenditures they generate. Income is measured as value added in the input-output system. Thus, for example, a $1.00 transaction does not provide $1.00 of income for the seller. The selling price reflects the costs of all inputs purchased by the seller from other industries plus the income earned by capital and labor employed by the seller. The latter portion of the $1.00 transaction is the direct value added, or income, that is generated in this industry. Expenditures, on the other hand, measure the total volume of transactions stimulated by the original sale of $1.00 worth of goods. For many applications, income effects are more pertinent than expenditure effects. The opposite would be true, for instance, if our interest were in determining possible "bottlenecks" of one industry caused by a lack of productive capacity in its supplying industries. Tables E-1 and E-2 list the income and expenditure effects on Maine's economy of fish harvesting and processing in the state. The numbers in Table E-1 have the following meaning: For example, in the herring fishery the combined direct and indirect effect of purchases necessary to increase herring landings by $1.00 leads to an increase in income in the Maine economy equivalent to $0.79 ($0.51 in the herring harvesting sector and $0.28 by all others). The $0.79 in income generated by $1.00 in herring landings is also responsible, as it is in turn spent on consumption items, for an additional $0.79 of income—the induced income effect. Consequently, the total effect or impact on the economy of a dollar of herring landings is $1.58 of additional income. The numbers which indicate the amount of this additional income for each industry are called multipliers. In the herring fishery the direct and indirect income multiplier is 0.79, the induced income multiplier is 0.79 and the total multiplier is 1.58.

Table E-2 is interpreted in a similar manner. For example, again in the herring fishery, the effects of purchase necessary to increase herring landings by $1.00 is to stimulate direct and indirect expenditures of $1.64. The income generated from the $1.64 of expenditures is in turn spent to generate another $1.50 of expenditures. Thus from the original $1.00 in increased landings, a total of $3.14 in increased expenditures results.

Table E-1

Maine State Income Multipliers
For Nine Fishing Industries

Industry	Direct	Indirect	Income Induced	Total
Harvesting				
Clam	.57	.23	.80	1.60
Worm	.30	.49	.79	1.58
Herring**	.51	.28	.79	1.58
Lobster*	.34	.41	.75	1.50
Groundfish	.29	.45	.74	1.48
Processing				
Clam/worm	.28	.57	.85	1.69
Groundfish	.14	.57	.72	1.43
Herring**	.38	.29	.67	1.34
Lobster*	.16	.44	.61	1.21

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* Includes crabs and scallops
** Includes Menhaden

Table E-2

Maine State Expenditure Multipliers For Nine Fishing Industries

Industry	Direct	Indirect	Income Induced	Total
Harvesting				
Groundfish	1.00	.98	1.41	3.39
Worm	1.00	.81	1.51	3.32
Lobster*	1.00	.86	1.42	3.28
Herring**	1.00	.64	1.50	3.14
Clam	1.00	.43	1.53	2.96
Processing				
Groundfish	1.00	1.48	1.35	3.83
Clam/worm	1.00	1.08	1.61	3.69
Lobster*	1.00	1.01	1.14	3.16
Herring**	1.00	.66	1.27	2.93

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* Includes crabs and scallops
** Includes Menhaden

Economic Significance

The magnitudes of the income multipliers for thirty-seven industries representing all products produced in the state are presented in Table E-3 (more complete industry definitions appear in Table E-5).

The difference in the magnitudes of the multipliers of various industries is explained by the extent to which their inputs are produced within the State. By and large the impact of the fisheries on the state's economy tends to be much stronger per dollar of output than most other industries. This reflects the fact that the inputs purchased by the fisheries are, to a greater extent than for the most other industries, produced in Maine.

From the point of view of state development policy, these results suggest that expansion of fish harvesting and processing activity will tend to advance economic opportunities more than other types of industrial expansion. Beyond just creating jobs and incomes for people directly participating in the processing or harvesting of fish, the expansion of fish harvesting and processing enhances the economic environment for industries which support processing and harvesting. Thus more jobs become available in industries which already exist in Maine. Of course, biological constraints and/or the current level of economic exploitation of a fishery may act to block further expansion for some species. For example, the lobster fishery has already been extensively developed in Maine with a large number of participants.

Table E-3

Maine State Income Multipliers

For Thirty-seven Industries

Industry Number	Industry Title	Direct Income	Total Income
23	Communications, broadcasting	.81	1.80
28	Federal govt. enterprises	.73	1.72
37	Clam/worm processing	.28	1.69
32	Clam harvesting	.57	1.60
33	Worm harvesting	.30	1.58
30	Herring harvesting	.51	1.58
3	Ag. & forestry, local govt. services	.54	1.56
31	Lobster/crab/scallop harvesting	.34	1.50
29	Groundfish harvesting	.29	1.48
34	Groundfish processing	.14	1.43
5	Maintenance and construction	.43	1.35
35	Herring processing	.38	1.34
25	Wholesale and retail trade	.74	1.34
27	Miscellaneous retail	.61	1.29
26	Finance and insurance	.68	1.26
13	Leather	.43	1.23
36	Lobster/crab/scallop processing	.16	1.21
1	Livestock	.46	1.20
19	Motor vehicles	.47	1.20
6	Ordnance and accessories	.44	1.18
14	Glass, stone, and clay products	.43	1.18
21	Miscellaneous manufacturing	.37	1.16
18	Electrical manufactures	.43	1.15

Table E-3 (cont.)

Industry Number	Industry Title	Direct Income	Total Income
12	Rubber & miscellaneous plastic prdcts.	.42	1.14
22	Transportation and warehousing	.45	1.07
7	Food and kindred products	.27	1.04
9	Apparel	.28	1.01
2	Wood and paper products	.39	.98
24	Utilities	.41	.94
16	Metal products	.34	.93
17	Engines and machinery	.33	.89
8	Fabrics and miscellaneous textiles	.27	.87
10	Chemical products	.28	.82
20	Professional and photo. equipment	.19	.55
15	Metals manufacturing	.13	.41
4	Mining	.003	.28
11	Petroleum refining	.02	.25

Consequently, opportunities for expansion are limited.

One very bright possibility that is already well known to the industry and to state policy makers and further confirmed by this study, is in groundfish (cod, haddock, pollock, etc.) harvesting and, especially, processing. The groundfish fishery in Maine has historically landed species (flounder, cusk and pollock) that are not presently managed by the Regional Management Council and therefore are not subject to quotas. It would appear that an increase in harvesting effort for these species is possible. Even in the absence of increased landings, much of the groundfish (excluding ocean perch) presently landed in Maine is shipped out of state to be processed. In addition, new processing facilities in Maine might be expected to garner some of the landings of fishermen from other New England states. Policies that can successfully lead to the location of new fish processing plants will tend to have very favorable effects on the state's economy—much more so than other types of manufacturing—since fish processing relies so heavily on locally purchased and produced inputs. This general conclusion applies across the board to all the state's fisheries except in those cases, such as lobster, where expansion is unlikely due to the existing scale of exploitation.

The Overall Effects of Fisheries

If fisheries activity were suddenly eliminated from the state's economy as a result of, for example, a truly massive oil spill, the economy would suffer not only the direct loss of income from the fishery but also the indirect and induced income generated by the fishery. For each sector of the fishing industry taken separately (i.e., if the spill selectively wiped out only that sector) the estimated income loss would be equivalent to the gross value of the product of that sector times the total income multiplier value shown in Table E-1. For example, in the clam fishery the gross value of recorded landings in 1979 was $7.5 million (from Table E-4). If only this part of the fishing industry were wiped out, income in the state would decline by $12 million. Table E-4 shows similar dollar values for 1978 for all sectors of the fishing industry taken individually. If one wanted to estimate the impact of all sectors of the fishing industry taken together it would not be correct to simply add the individual total impact figures (right hand column of Table E-1) to obtain the state-wide effect. This would lead to inadvertent double counting. Specifically, the multipliers for the processing sectors already measure as an indirect effect the income to fishermen from purchases of raw fish. Consequently, a simple adding of individual sector impacts would wind-up counting the value of some raw fish (those that go to in-state processing) twice. The appropriate figures which exclude this double counting effect are shown in parentheses under the individual sector total and are summed at the bottom of Table E-4. This summed figure—$251 million—can be taken as a reasonable estimate of the total effect of fisheries on the

Table E-4

Estimated Multiplied Income and Gross Value of Output, 1979 For Nine Fishing Industries

Industry	Gross Output	Multiplied Impact*
Harvesting Sector		
Groundfish	19,821,000	29,335,080
Herring**	5,344,000	8,443,520
Lobster***	43,993,000	65,989,500
Clams	7,508,000	12,012,800
Worms	2,543,000	4,017,940
Total	79,209,000	119,798,840
Processing Sector****		
Groundfish	11,149,000	15,943,070 (6,020,460)
Herring	72,740,000	97,471,600 (89,470,200)
Lobster	41,670,000	50,420,700 (22,918,500)
Clam/worm	17,561,000	29,678,090 (13,521,970)
Grand Total	222,329,000	251,729,970

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*Direct, indirect, and induced income effects are included.

** Includes menhaden.

*** Includes crabs and scallops.

**** All processing figures are preliminary estimates based on 1979 reported landings and the proportion of landings to processed value in previous years.

State's economy in the year 1979.

Table E-4 also points out an often unappreciated fact about the state's fishery—namely, the importance of herring. In terms of landed value herring is a fairly small fishery, with only about $5 million of landed value in 1979. However, when the processing activity which arises from this catch is taken into account the entire herring harvesting/processing sector is seen to be the most important fishery in the state's economy, accounting for approximately $78 million of gross output and approximately $98 million of income. The lobster fishery on the other hand accounts for $84 in gross output and $88 million in income. The much higher landed value of lobsters does not produce as much total income as herring because lobster processing does not have a particularly high proportion of direct value added. Furthermore, by far the largest expenditure of lobster processing per dollar of output is the purchase of lobsters. Therefore most of the effects of lobster processing are felt through the lobster harvesting industry. (Of course these figures do not take into account the intangible benefit to the state which arises from the reputation of the Maine lobster).

Economic Effect of Groundfish Processing

One of the issues facing the state at the moment is the question of increasing the proportion of Maine harvested fish processed within the state. Input-output analysis is not particularly useful for the purpose of deciding how to bring about this event. However, it does provide a reasonable estimate of the income and expenditure impacts of a successful processing policy. Table E-4 shows the dollar impact of each of the nine fishing industries on the state's economy in 1978. In the row showing the effects of groundfish processing the bracketed figure represents the effect of groundfish processing when it is purged of the indirect effects generated in groundfish harvesting. If this effect is expressed per dollar of gross value—a figure equal to .54—one obtains an estimate of the effect of increasing the State's fish processing capacity. In other words, for each dollar of gross value of processing of Maine fish which is brought about by such a policy, the economy of the State will show an estimated .54 increase in income.

If the presence of greater processing capacity within the State has the effect of bringing about greater groundfish landings, as might be expected, the impact of these additional landings will benefit the State still more. In this case, the value of each additional dollar of landed groundfish going into Maine based processing is estimated to give rise to $1.43 in (total) additional income.

A Word of Caution

The numbers presented in this study should never be used with the thought that they are absolutely precise measures of economic activity. Input-output analysis, in spite of its complexity and use of detailed data, has several drawbacks which, under the best of conditions, cause the resulting estimates to be only approximate. These drawbacks arise from the need to make cost-effective compromises in the collection and updating of data and from the need to employ an analytical model which is not a perfect representation of the economy. Perhaps one of the best things that can be said for input-output analysis is that it gives reasonable, ballpark estimates at a fairly low cost. In this case in particular, better estimates would have involved very rapidly escalating costs but only modest improvements in precision. In short, these numbers should be treated with caution. Their relative magnitudes can be used with some degree of assurance; their precise values cannot.

Further Use of the Input-Output Model

This study does not exhaustively explore all the possible analytical conclusions which might be drawn from this input-output table. For the person or agency interested in particular questions not addressed here we have included in the appendices of the report: (1) the results of the data collection (with specific caveats where we are aware of 'soft spots'), and (2) the central calculations necessary to the large majority of further uses. In addition, there will be available in machine readable format through DMR or the UMO Department of Economics the data and the associated computer programs. These data and programs are available for the cost of duplication.

An Input-Output Table
Designed to Assess the Impact
of the Fishery on the Maine Economy

The following section describes the special characteristics of the input-output table contained in this report, the basic methodology employed in its construction, and the proper use of the table. It should be recalled that the main purpose of this project was to provide a modified input-output table that would allow DMR to generate empirical estimates of the economic impact of changes in the level of fishing and processing activity on the Maine economy.

Special Characteristics of this Table:

This input-output table has two special characteristics. One, the high level of detail given to the fisheries sector of the State's economy. Two, the method used to construct the table.

(1) Fisheries detail: The construction of any input-output table requires the combination or aggregation of many roughly similar economic activities into industry or sector groupings. The number of groups can vary substantially. For example, the U.S. Department of Transportation (USDOT) 1963 input-output table for the state of Maine, used as a base for this study, groups economic activity into 79 different industries or sectors. While some combination of industries is necessary, to the extent that dissimilar activities are assigned to the same sector the analytical value of an input-output table is reduced and may produce misleading results.

The USDOT table for Maine is not useful for analyzing fishing activities because highly dissimilar activities are treated as similar. For example, fisheries harvesting activities are combined with forestry harvesting and fisheries processing activities are combined with other food processing. Additionally, there is the problem that, within the broadly defined fishing industry (on both the harvesting and processing side), there are very large dissimilarities in the nature of input-output relationships across various species (e.g., clam harvesting versus trawling). The USDOT table does not recognize these critical differences. As a result, it is impossible to separate fishery from forestry harvesting activities, to isolate fishery processing from food processing activities, and to identify any activities for a given fishery.

These problems cause the USDOT table to be unsuitable to the task of estimating the economic impact of changes in the level or character of fisheries activities. In order to partially overcome these particular problems, the input-output table constructed during this project is designed to capture the unique input-output relationships within the fishery by using nine separate fisheries sectors. They are:

sector no.	description
31	lobster/crab/scallop harvesting activities
36	lobster/crab/scallop processing and distribution
30	herring/menhaden harvesting
35	herring/menhaden processing

sector no. (cont)	description (cont)
29	groundfish harvesting
34	groundfish processing
32	clam harvesting
33	worm harvesting
37	clam/worm processing

The added detail represents a clear improvement. However, the reader familiar with fisheries activities will quickly recognize that even this relatively more detailed categorization of economic activities in the state's fisheries combines some very dissimilar kinds of processes. For example, in the groundfish harvesting sector, the activities of small gillnetters are treated as being similar to those of large redfish trawlers. This problem cannot be totally eliminated because fisheries activities are extremely heterogenous. The detail necessary to resolve these problems of aggregation would be prohibitively expensive and might not even be possible given the need for confidentiality about the operations of individual firms. In short, we were forced to make a trade-off between accuracy and expense (and confidentiality) in constructing the table. The use of nine fishery sectors represents our judgment with regard to a reasonable level of accuracy at a reasonable cost. We are certain that it represents an improvement over the USDOT table. Further, users wishing to gain greater detail (less aggregation) or to identify distortions arising from our level of aggregation can utilize the description of our methodology in the appendices.

(2) Method of constructing the table: Input-output tables are usually constructed on the basis of census-like surveys. For example, the USDOT table for the state of Maine is constructed, among other sources, from data obtained as part of the U.S. Census of Manufacturing and the U.S. Census of Transportation. Needless to say, construction of input-output tables through a census approach is very expensive and time-consuming; usually five to seven years elapses before an input-output table can be developed from the given national census. For smaller efforts, such as required for this study, the time and cost can be reduced considerably; nevertheless, the costs are still high. On the basis of census-like approaches undertaken elsewhere, we estimated that the costs of developing an analogous input-output table useful for fisheries policy purposes in the state of Maine would require two to three years and involve some $125,000 - $175,000.

From the very beginning of the project it was very clear that the value of an input-output table with highly detailed fisheries sectors was insufficient to justify this kind of expenditure. Consequently, we devised an alternative methodology that: (1) utilized all sectors in the 1963 USDOT table for Maine except those containing fishery activities; (2) obtained detailed fishery information from secondary data on vessel and processing costs from recent studies done in Maine and elsewhere in New England (these studies are cited in the attached appendices); (3) conducted spot surveys to fill in gaps in the secondary data and, in some cases, to validate that data; and (4) utilized the personal knowledge of fishery activities held by project members, DMR personnel and selected industry personnel.

This approach has certain problems. The major problems are inconsistency in data collection methods and limited observations. Consequently, it is not possible to determine statistically the probable error contained in our estimates. On the other hand, the extensive knowledge of the fishery contributed by DMR and industry personnel provides strong assurance that the resulting figures are reasonable estimates of the input-output structure of the nine fisheries sectors. We cannot be sure that the results obtained in this way are less (or possibly even more) accurate than the results which would have been obtained through a standard census approach. However, we are certain that our approach, by providing greater detail for fishery activities, is a substantial improvement over the existing USDOT table.

Disaggregation of the USDOT table

As mentioned above, our methodology utilized data for all nonfisheries sectors of the Maine economy as contained in the USDOT input-output table for the State of Maine and then disaggregated the fishery sector into nine separate activities. Disaggregation involved removing all fishery activities from the USDOT sectors and creating separate rows and columns for the nine fisheries sectors and forestry harvesting and other food processing. The method used to accomplish this disaggregation was simple and straightforward:

(1) Complete transactions data indicating the inputs and outputs for each of the nine fishery activities were assembled.

(2) The data were initially aggregated in a manner consistent with the USDOT methodology: the five fish harvesting activities were combined to be compatible with the USDOT table's sector titled Fisheries and Forestry Harvesting and the four fish processing activities were combined to be compatible with the USDOT table's sector titled Food Processing.

(3) Independent data were obtained from U.S. Fishery Statistics 1963 to indicate the gross value of output for the five fish harvesting sectors and four fish processing sectors.

(4) Data obtained in (3) were used to determine the part of the total activity recorded in the original USDOT table under the titles Forestry and Fish Harvesting and Food Processing attributable to fishery activities.

(5) The part attributable to fisheries activities was subtracted from USDOT sectors, leaving only a forestry harvesting and other (nonfish) food processing sectors. (i.e. a 79 sector USDOT table purged of all fisheries activity).

(6) The fisheries activities data subtracted from the USDOT table were disaggregated into the nine sectors noted above.

(7) The nine fisheries sectors were then added as nine new rows and columns to the modified (i.e., containing no fisheries activities) USDOT input-output table giving a final table consisting of 88 rows and columns, (9 fishery related and 79 nonfishery related) representing the entire Maine economy.

(8) Finally the table was aggregated to 9 fishery and 28 other sectors to conform with the level of aggregation used in annual state data collections.

Comments on the method of disaggregation

The method described above has the advantage of being simple, straightforward, and inexpensive. The primary disadvantage is that it is based upon the assumption that the original USDOT table's observations about fishery activities are accurate. There is reason to believe that reasonable accuracy was achieved in the case of forestry harvesting and other (nonfish) food processing. However, certain peculiarities in the table indicate that the fisheries activities represented within the USDOT table are significantly less accurate and may have been approximations at best. The result of the procedure described above is that any error which may have been present in the original fisheries data is transferred to the forestry and other food processing sectors in the modified table. Consequently the modified table should not be used for the purpose of estimating the economic impact of changes in the level of economic activity on the forestry harvesting and other (nonfish) food processing sectors. As far as use of the table for fisheries estimates is concerned, the error introduced by our procedure is extremely small because of an almost non-existent input-output interdependency between fisheries and these two sectors, forestry harvesting and food (nonfish) processing.

Proper use of this input-output table

The input-output table described in this report is designed to provide answers to two general types of issues about the impact of fishery activities on the Maine economy: (1) the direct and indirect impact of "normal" changes in economic activity in the fishery, e.g., changes in landings by fishery from year to year, and (2) the impact of fundamental changes in the structure of the industry, e.g., a change in the tecnology of harvesting some species.

The first issue is easily handled without having to use any computer techniques. The multiplier values, given in Table E-1, applied to, say, a new value of groundfish landings, will provide an estimate of the direct and indirect economic impact of groundfish landings on the State's economy. As an illustration, the value of 1979 groundfish landings was recorded at $19,821,000 and the appropriate multiplier value for groundfish landings from Table E-1 is 1.48. The multiplier value times landings yields an estimated combined direct and indirect economic value to the state (through increased income) of $29,335,080.

The second issue, estimating the effect of fundamental changes in industry structure or in technology, requires much more elaborate procedures. An input-output table is constructed on the assumption that structural aspects of the economy remain constant (the fixed-proportions assumption). Consequently, if a fundamental structural change occurs in the economy, the original transaction data upon which the table is based are no longer accurate or, put somewhat differently, the assumptions implicit in the table are no longer valid. As a result, estimates of the impact of a structural change require new data for those parts of the economy where the change has occurred in order to recalculate the technical coefficients. In addition to new data, it is necessary to use computer techniques to resolve the input-output table. These techniques are described in Appendix II of the report. This usually results in changed multiplier values for all of the sectors represented in the table.

The type of specific questions that can be addressed by the table are:

(a) What would be the direct impact in terms of income, if the level of fish harvesting activity were to change by some particular amount?

(b) How would the total change in income be distributed across individual industries and sectors of the Maine economy? In other words, which parts of the Maine economy are closely linked?

(c) What would be the economic impact of a significant increase in the proportion of fish processed in the state? How would particular industries and sectors be affected?

(d) What would the economic impact be of an increase in the groundfish fleet and landings? How would the impact be distributed?

(e) What would the impact be from state and federal government investment in pier development which led to increased landings and processing activity?

In short, the table can be used to estimate state-wide impacts of the total level of fishing and processing activity, changes in the total level, or changes in the level of activity in any one of the nine separate fisheries sectors. And, most importantly, the input-output table can be used to identify the specific industries affected by those changes.

In each case, the user of the table can provide answers to such questions under different scenarios about the future, thus allowing one to determine the sensitivity of the results to changes in scenarios. The multipliers the model produces are sensitive to two types of changes: (1) a change in the technology of production, (2) a change in interstate trade flows of goods. To predict the effects of either of these two types of change (the expected change must be derived by some means independent of the input-output table), first the changes must be incorporated into the data of the model and then the input-output must be resolved. (The method for solving the table is described in Appendix II). On the other hand, if the changes stipulated involve changing only the gross outputs of one or several industries, prediction is much easier. For such changes, if one's interest is only in the gross impacts on the state's economy as a whole rather than the impact upon each industry, and it is assumed that neither interstate trade flows nor the technology of production change , then it is sufficient to merely multiply expected changes in gross revenue for the sector(s) by the multiplier value(s) given earlier. For example, the direct and indirect economic value, in terms of income generated, to the State of a dollar of landings in the worm sector is $1.58. If the expected value of the gross revenues of this sector were to rise by $120,000, the combined direct and indirect value to the State's economy would be $189,600 (i.e., 1.58 x $120,000). As was noted in the summary, care must be exercised to avoid double-counting the effects of changes if the outputs of both a harvesting sector and its associated processing sector are changed. The double counting does not occur to any great extent when nonfishery sector outputs are changed due to the high degree of aggregation.

In addition, the technical coefficients matrix can be used to arrive at rough estimates of the impact of changes in costs in any supplying industry on fishery activities. For example, if one wanted to estimate the impact of higher bait costs on the lobster harvesting sector, the technical coefficients (i.e., expenditure for inputs per dollar of gross output) representing lobster harvesting sector expenditures in the groundfish and herring industries would be used. These coefficients are presented in the attached appendices. In this particular case, our results indicate that for every dollar of gross output of lobster harvesting approximately $0.10 is spent for bait. Given that the 1979 level of gross output of lobster harvesting was $40,115,000, this means that lobster fishermen spent a total of $4,011,500 for bait in 1979.

Limitations on the use of this Input-Output Table

As pointed out in the introduction, input-output techniques represent a powerful analytical tool. However, as with any analytical tool, input-output contains certain limitations. By understanding the suitability of the analysis to particular applications, we increase the usefulness of input-output analysis.

First, this is a table for the entire state. It would be incorrect to use this table to answer questions involving regional, intrastate impacts such as: What would be the impact on the economy of the City of Portland or the Island of Vinalhaven from the construction of a new fish pier? This limitation arises because the transaction pattern which serves as the basis for this table is based upon state-wide activities. As a result, application of the table to a local area within the state would falsely imply that all predicted changes in sales and purchases occur in the local area economy. As a result, the impact on the local economy would be grossly exaggerated.

Second, the multipliers cannot be applied in situations where a change in economic activity occurs due to a significant alteration in the technology of production in that sector. The reason is that the pattern of purchases and sales recorded in the table is a direct reflection of the technology used at the time the table was constructed (the fixed proportions assumption). For example, with regard to clam harvesting, the figures in the table reflect the current method of hand digging for clams and it would be incorrect to estimate the impact on the state's economy of a switch to harvesting with sub-tidal hydraulic clam dredges. Such a change would represent an entirely new technology (as far as the data in the table are concerned) and would give rise to a very different pattern of expenditures for inputs than exists with the current harvesting method. To assess the new technology's impact, it would be necessary to collect data reflecting the new pattern of input expenditures and then recalculate the table in the same fashion as was done during this project.

Three, multiplier values estimated from the input-output analysis may tend to overstate the impact on the Maine economy caused by expansion in a specific fishery activity. Overestimation may occur because calculation of the multiplier values implicitly assumes that the required inputs are obtained from Maine-located industries in the same ratio of in-state/out-of-state purchases that existed at the time the USDOT table was constructed. Decreases in the ratio (more out-of-state-purchases) since that time would cause a larger proportion of purchases, and thus income, to flow out of Maine and lead to lower multiplier values.

Finally, it should be emphasized that the construction of this input-output table, and any table, continuously involves compromises between the degree of detail and accuracy and the costs of developing the table. The resulting table is, we believe, respectably accurate. Nevertheless, any estimates generated through the use of this table should always be used as nothing more than good "ballpark" estimates. For almost all conceivable uses, this is all that can be expected of an input-output analysis.

Input-output Results

This section of the report presents the major results of the input-output analysis. The results are discussed in the following sequence: A) the "direct", or first order interindustry relationships in the Maine economy; B) the level of direct value added in each fishery activity; C) the value of the multipliers in each activity; and D) the patterns of final or overall economic interdependency between the fishery sectors and the rest of the Maine economy.

A. Input/Output Relationships

As described in the introduction, the construction of an input-output table is based upon the pattern of transactions that occur between the individual industries that make up the economy. In this way, the I-O table identifies the patterns of economic linkages or the extent of economic interdependency among industries.

The pattern of interdependency between the nine fishing sector activities and other industries in the Maine economy is indicated in Table E-5. The first five pages of this table give abbreviated definitions of the industries that appear in the Maine input-output table, and the numbers corresponding to the industries in the U.S. input-output table. The remaining eight pages of the table list the 37 x 37 industry I-O table. Table E-5 presents the direct input requirements of each activity, i.e. the technical coefficients. The fishery sector is disaggregated into five specific harvesting activities and four processing activities.

The proper use of the table can be illustrated by referring to column 29, (page 12 of the table) which shows the linkages between groundfish harvesting and the other industries contained in the matrix. As one reads down the column, the value .2021 is observed in the row representing industry number 8, fabrics and textile goods. This figure indicates that one dollar's worth of output from groundfish harvesting requires $0.2021 of input from fabrics and textile goods. By and large this figure refers to expenditures for nets and netting— one of the many outputs of the fabrics and textiles industry (#8).

The remaining figures in the column are interpreted in a similar manner. The relationships described by the technical coefficients in Table E-5 serve as the basis for estimating value added in each fishing sector activity and for estimating the impact of growth in any activity on the Maine economy as a whole and for specific industries. These topics are discussed below.

B. Value-Added in Fishing Sector Activities

In Table E-6, direct value added for each of the five harvesting activities and the four processing activities is presented. Value added measures the difference between the value of an industry's output and the value of the inputs used by the industry, i.e. the value added to the raw materials by the industry's activity. Basically, value added includes income earned by capital (i.e., owners) and income earned by labor (employees). There is no deterministic or rigid relationship between the total sales of an industry and value added in the industry. A large industry in terms of sales does not necessarily imply high value added for the industry.

With the input-output data obtained during this project, it is possible to estimate value added for each of the nine activities. The results indicated that the highest two value added activities are clam and herring harvesting. At the other end of the scale, the two lowest value added activities involve lobster/crab and groundfish processing. The results, while subject to some rounding error, indicate substantial variation in levels of value added across the nine activities. Identification of such variation, which requires a relatively high level of disaggregation in the I/O Table, is important in that policy makers obtain a much more refined (and accurate) picture of the importance of each activity in the economy. The use of a table that combined all harvesting and/or processing activities into a single fishing activity would mask important differences between specific activities.

C. Multiplier Analysis

With an input-output table it is possible to conduct an impact or multiplier analysis that provides an estimate of the total impact, based on the direct and indirect requirements, occurring due to a change in demand for a particular industry's output. We have calculated both the expenditure and income multiplier values for each of the nine harvesting and processing activities in the I/O Table. The calculation of multipliers involves increasing the output from a specific activity by $100,000, and then resolving the I/O Table to find the new production levels (or income) stimulated by the initial $100,000 increase. The multiplier is then determined as the ratio of total change in economic activity to the $100,000 increase in fishing. Because each fishing activity has a different pattern of interdependency (input-output relationship) with other industries in the economy, multiplier values are different for specific activities. Multiplier values will be greater in those activities that make a greater proportion of their purchases of inputs from Maine industries or conversely will be reduced when the dependency on imports (inputs purchased from outside of Maine) increases.

Multiplier values, based upon direct and indirect requirements and induced consumer expenditures for each fishing activity are presented in Tables E-1 and E-2. The highest expenditure multiplier, 3.83, occurs in groundfish processing. Thus each dollar increase in output from groundfish processing requires $3.83 of direct and indirect purchases of inputs. Relatively high multiplier values occur in groundfish harvesting and clam/worm processing. Low values occur in clam harvesting and herring processing. The low expenditure multiplier for clam harvesting is explained by its relatively high proportion of direct value added

(.57, from Table E-1). The low expenditure multiplier for herring is explained by relatively low proportion of purchases of inputs within the State (.66, from Table E-2, indirect expenditures).

The use of multiplier values derived from an input-output table requires a certain amount of caution. The predicted impacts are based upon the technological relationships existing between inputs and outputs at the time the table was constructed. Such relationships, while relatively stable in the short run, can change considerably over longer periods. These changes lead to a different pattern of linkage (interdependency) between industries which often lead to changes in multiplier values. In the case of fishing sector activities, an additional caution is to be taken. Assuming that the state of technology has not changed significantly, the multiplier values are likely to be more accurate as predictors of long run impacts than of short run effects of a change in output. In the fishing sector, especially in harvesting, availability of the fish resource causes the relationship between purchased inputs and output to be rather variable from year to year. In the short run, there may be harvesting capacity that is not being fully utilized. An increase in output can take place without the need to purchasing additional inputs when the availability of fish increases. Consequently, changes in landings due solely to changes in the availability of fish stocks may not, in the short run, lead to the expansion predicted by our multiplier analysis. The multipliers presented here are calculated as six year averages in order to minimize the effect of year to year fluctuations in landings due to changes in fish availability. Therefore, these figures are better indicators of long term, rather than immediate, impacts. Finally, as pointed out previously, multiplier values may be overstated if a greater proportion of inputs are purchased out of state than is assumed in the original 1963 (USDOT) table.

D. The Patterns of Economic Interdependency

Input-output analysis is capable not only of estimating the total impact (multiplier) of an increase in output but of identifying the specific industries affected by such an increase. Thus the composition (mix of industries) of the expansion in output is identified and provides the type of micro-level detail required for policy purposes.

The impact of an increase in total output from each of the nine fishing activities on Maine industries is indicated in Table E-7. The estimates are obtained by starting with the original solution to the I/O Table, assuming a $100,000 increase in output for a given activity, and resolving the table to obtain estimates of new output levels for each industry. Based on both direct and indirect requirements, this procedure provides an estimate of the increase in total output in each of the table's industries induced by the initial $100,000 increase. The exercise is conducted for each of the specific harvesting and processing activities.

It should be recalled that this analysis involves the assumption that the structural relationships between inputs and output existing in 1963 and reflected in the original I/O Table are reasonable approximations of the relationships existing in 1979-80. This assumption exists in any I/O Table and clearly involves a certain amount of misrepresentation. The extent of the problem cannot be estimated without the construction of a new table.

Information presented in Table E-7 indicates the changes in output for individual Maine industries caused by a $100,000 increase in output from each of the nine harvesting and processing activities. Table E-7 identifies only those industries in which the increase in total output is at least $4,000. In the case of groundfish harvesting, the $100,000 increase in output, underlined in Table E-7, leads to major increases in output in the broad and narrow fabrics (ropes, etc.) and finance and insurance industries of $32,000 and $14,000, respectively. The $32,000 output from the broad and narrow fabrics industries represents primary expenditures for nets, rope, etc. Other important output increases show up in the case of transportation and warehousing, wholesale and retail trade, livestock and agricultural products, and motor vehicles, which includes boat building and repair.

The pattern of increases in output engendered by a $100,000 increase in production from herring harvesting is quite similar to the case of groundfish harvesting.

The pattern of output stimulated by a $100,000 increase in total output in lobster/crab/scallop harvesting is significantly different. The pattern is much more extensive because more Maine industries have significant linkages with lobster/crab/scallop harvesting. Major linkages involve forestry products (trap materials), broad and narrow fabrics (ropes, etc.), groundfish processing and harvesting (bait), and wholesale and retail trade (various items including gasoline and diesel fuel).

Linkages between clam and worm harvesting and other industries in the Maine economy are quite limited. The limited interdependency reflects the labor-intensive nature of these activities. In the case of clam harvesting, the largest expenditure involves the motor vehicles and equipment industry (trucks). For worm harvesting, the largest linkage occurs with wholesale and retail trade (various items including gasoline).

Turning to processing sector activities, we find that, with one exception, the major input comes from the corresponding harvesting sector activity. For example, a $100,000 in output from groundfish processing requires $61,000 of input from the groundfish harvesting industry. Other industries supplying large values of inputs include broad and narrow fabrics, forestry products, transportation and warehousing, and wholesale and retail trade.

The linkages between herring processing and other industries reveal an interesting and important item. While one might expect that the herring harvesting industry would provide a major impact, the results indicate that this is not the case. In fact, the value of the herring provided by the harvesting industry and required to produce $100,000 of output from the herring processing industry is only $9,000 (including imports of Canadian caught juvenile herring). This reflects the fact that, while large physical amounts of herring would be required, unprocessed herring is an extremely low value product. Major inputs into herring processing are provided by the forestry products, transportation and warehousing, utilities, chemicals, and food and food products (oils and sauces) industries.

The final processing activity, clam/worm processing obtains its major input from its harvesting counterpart. Other industries providing important inputs include forestry products and wholesale and retail trade.

Table E-5: Maine and U.S. Industry Definitions

ME IO	U.S. IO	Industry definition
1		Livestock
	1,2	Livestock and livestock products
2		Wood and paper products
	3	Forestry products
	20	Lumber and wood products
	21	Wooden containers
	22	Household furniture
	23	Other furniture and fixtures
	24	Paper and allied products
	25	Paperboard containers and boxes
	26	Printing and publishing
3		Agriculture and forestry, local government services
	4	Agriculture, forestry services
	79	State and local government enterprises
4		Mining
	5	Iron and ferroalloy mining
	6	Non-ferrous mining
	7	Coal mining
	8	Crude petroleum and natural gas
	9	Stone and clay
	10	Chemicals and fertilizers mining
5		Maintenance and construction
	11	New construction
	12	Maintenance and construction
6		Ordinance and accessories
	13	Ordinance and accessories

Table E-5 (continued)

ME IO	U.S. IO	Industry definition
7		Food and kindred products
	14	Food and kindred products
	15	Tobacco manufactures
8		Fabrics and miscellaneous textiles
	16	Broad and narrow fabrics
	17	Miscellaneous textile goods and floor covers
9		Apparel
	18	Apparel
	19	Miscellaneous textile products
10		Chemical products
	27	Chemical products
	28	Plastics and synthetic materials
	29	Drugs, cleaning and toilet preparations
	30	Paints and allied products
11		Petroleum refining
	31	Petroleum refining and related
12		Rubber and miscellaneous plastic products
	32	Rubber and miscellaneous plastic products
13		Leather
	33	Leather tanning and industrial leather
	34	Footwear and other leather products
14		Glass, stone and clays
	35	Glass and glass products
	36	Stone and clay products

Table E-5 (continued)

ME IO	U.S. IO	Industry definition
15		Metals manufacturing
	37	Primary iron and steel manufacturing
	38	Primary non-ferrous metal manufacturing
16		Metal products
	39	Metal containers
	40	Heating, plumbing and fabricated metal products
	41	Screw machine products, bolts, etc.
	42	Other fabricated metal products
17		Engines and machinery
	43	Engines and turbines
	44	Farm machinery
	45	Construction, mining machinery
	46	Materials handling machinery
	47	Metal working machinery and equipment
	48	Special industry machinery and equipment
	49	General industrial machinery
	50	Machine shop products
	51	Office and computing machinery
	52	Service industry machinery
18		Electrical manufactures
	53	Electrical transportation apparatus
	54	Household appliances
	55	Electrical lighting and wiring
	56	Radio, television equipment
	57	Electronic components and accessories
	58	Miscellaneous electrical machinery and equipment
19		Motor vehicles
	59	Motor vehicles and equipment
	60	Aircraft and parts
	61	Other transportation equipment

Table E-5 (continued)

ME IO	U.S. IO	Industry definition
20		Professional and photo equipment
	62	Professional and scientific equipment
	63	Optical and photographic equipment
21		Miscellaneous manufacturing
	64	Miscellaneous manufacturing
22		Transportation and warehousing
	65	Transportation and warehousing
23		Communications
	66	Communications except radio, TV
	67	Radio and TV broadcasting
24		Utilities
	68	Electricity, gas, water services
25		Wholesale and retail trade
	69	Wholesale and retail trade
26		Finance and insurance
	70	Finance and insurance
	71	Real estate and rental
27		Miscellaneous retail
	72	Hotels and lodging, repair services
	73	Business services
	74	Research and development
	75	Auto repair and service
	76	Amusements
	77	Medical, education and nonprofit services
28		Federal government enterprises
	78	Federal government enterprises

Table E-5 (continued)

ME IO	U.S. IO	Industry definition
29		Groundfish harvesting
30		Herring harvesting
31		Lobster/crab/scallop harvesting
32		Clam harvesting
33		Worm harvesting
34		Groundfish processing
35		Herring processing
36		Lobster/crab processing
37		Clam/worm processing (distribution)

TABLE E-5: Direct Input Coefficients

			COLUMN		
ROW	1	2	3	4	5
1	0.127820	0.000070	0.030895	0.0	0.002875
2	0.013848	0.290001	0.019887	0.000024	0.045213
3	0.039833	0.003386	0.000336	0.000006	0.000609
4	0.004160	0.011066	0.012747	0.000136	0.025099
5	0.006554	0.003554	0.136908	0.000050	0.000283
6	0.0	0.000004	0.0	0.0	0.000135
7	0.167929	0.009809	0.006504	0.000009	0.002038
8	0.000709	0.008704	0.006504	0.0	0.000871
9	0.004033	0.000883	0.000262	0.0	0.000702
10	0.039592	0.039114	0.008785	0.000080	0.019767
11	0.008551	0.007911	0.006373	0.000157	0.025247
12	0.001526	0.004266	0.000710	0.000222	0.007560
13	0.000065	0.000229	0.000449	0.0	0.000038
14	0.000878	0.002071	0.002019	0.000012	0.060469
15	0.000007	0.003255	0.001252	0.000083	0.049581
16	0.002166	0.017358	0.021176	0.000018	0.094503
17	0.000889	0.002850	0.000168	0.000424	0.018093
18	0.000313	0.000977	0.002617	0.000024	0.025454
19	0.000289	0.0	0.001196	0.000044	0.000829
20	0.000003	0.000581	0.000206	0.0	0.004419
21	0.000052	0.000222	0.000374	0.0	0.002558
22	0.019242	0.036475	0.014149	0.174311	0.035319
23	0.002411	0.003256	0.003346	0.000003	0.003125
24	0.002741	0.020471	0.073529	0.000172	0.003480
25	0.046366	0.026024	0.011027	0.030259	0.079230
26	0.008954	0.011109	0.023550	0.006007	0.012355
27	0.013452	0.018676	0.029082	0.000139	0.048630
28	0.000219	0.001068	0.000748	0.000003	0.000304
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0
35	0.019820	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

COLUMN

ROW	6	7	8	9	10
1	0.000232	0.299841	0.111122	0.000081	0.000737
2	0.007115	0.0	0.010316	0.011698	0.019786
3	0.000077	0.0	0.000185	0.000065	0.000221
4	0.000232	0.000620	0.001028	0.000065	0.034818
5	0.001005	0.000678	0.002328	0.000680	0.003500
6	0.028072	0.000003	0.000004	0.0	0.0
7	0.002397	0.179635	0.003951	0.001215	0.009653
8	0.0	0.000055	0.365675	0.229391	0.000074
9	0.000619	0.002150	0.002452	0.139744	0.002874
10	0.003016	0.006068	0.120418	0.011860	0.197045
11	0.002320	0.003499	0.001797	0.000664	0.006595
12	0.017323	0.003998	0.001171	0.006529	0.000884
13	0.000077	0.000048	0.000079	0.001474	0.000147
14	0.0	0.013160	0.003119	0.0	0.001547
15	0.055757	0.000042	0.0	0.000324	0.006890
16	0.006883	0.044541	0.000331	0.000794	0.009948
17	0.007192	0.0	0.006245	0.000340	0.004311
18	0.062950	0.000107	0.000049	0.000049	0.000479
19	0.103318	0.0	0.000030	0.000032	0.000074
20	0.008043	0.000246	0.000392	0.000518	0.000147
21	0.000387	0.000215	0.001202	0.012816	0.000147
22	0.008197	0.033330	0.017612	0.006659	0.033971
23	0.009125	0.002994	0.002064	0.003338	0.002984
24	0.004640	0.004811	0.010324	0.002852	0.018238
25	0.016163	0.040598	0.030339	0.030768	0.039387
26	0.009899	0.010152	0.008591	0.013124	0.008990
27	0.025133	0.036403	0.011235	0.011617	0.021701
28	0.001779	0.000855	0.000836	0.001928	0.000663
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

	COLUMN				
ROW	11	12	13	14	15
1	0.0	0.000120	0.010967	0.000131	0.0
2	0.009619	0.027066	0.032281	0.020998	0.002658
3	0.000024	0.000151	0.000113	0.000174	0.000102
4	0.008162	0.000542	0.000581	0.094663	0.001534
5	0.000462	0.002680	0.001315	0.005010	0.001176
6	0.0	0.0	0.000007	0.0	0.0
7	0.000243	0.002017	0.047661	0.001699	0.000511
8	0.0	0.032154	0.032863	0.000087	0.000971
9	0.000049	0.001445	0.005181	0.000828	0.000307
10	0.000559	0.212826	0.015869	0.009497	0.008435
11	0.017733	0.001867	0.001403	0.007711	0.000920
12	0.0	0.054162	0.082014	0.002788	0.000665
13	0.0	0.000090	0.225229	0.000218	0.000051
14	0.002623	0.004727	0.000173	0.085951	0.001227
15	0.000097	0.002740	0.001424	0.007580	0.149328
16	0.000850	0.005389	0.002337	0.006230	0.003170
17	0.000024	0.001505	0.000240	0.006970	0.010940
18	0.0	0.000120	0.000088	0.000392	0.000511
19	0.0	0.000090	0.000042	0.000218	0.0
20	0.0	0.000421	0.000747	0.000261	0.000153
21	0.000024	0.001325	0.003108	0.000261	0.000358
22	0.094493	0.017040	0.012444	0.072882	0.024334
23	0.000267	0.003492	0.003870	0.003790	0.001738
24	0.001482	0.011019	0.004888	0.038728	0.006135
25	0.029490	0.032124	0.031668	0.029667	0.033689
26	0.008162	0.014361	0.013593	0.013810	0.007310
27	0.002381	0.022068	0.023936	0.023089	0.005930
28	0.000073	0.000963	0.003172	0.000566	0.000307
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

COLUMN

ROW	16	17	18	19	20
1	0.000100	0.000048	0.000154	0.000158	0.0
2	0.031417	0.005075	0.022897	0.017584	0.002973
3	0.000100	0.000073	0.000128	0.000109	0.0
4	0.000176	0.000266	0.000437	0.000178	0.0
5	0.001306	0.001233	0.001619	0.002234	0.000991
6	0.0	0.0	0.0	0.000010	0.0
7	0.001833	0.001982	0.003469	0.002392	0.002973
8	0.000578	0.000338	0.000565	0.006652	0.001982
9	0.000779	0.000749	0.001156	0.008204	0.000496
10	0.018584	0.004350	0.020379	0.009597	0.003469
11	0.002009	0.003021	0.003752	0.003123	0.001487
12	0.002888	0.010803	0.020096	0.008342	0.004955
13	0.000502	0.000387	0.000026	0.000128	0.0
14	0.004721	0.004157	0.028705	0.007917	0.003964
15	0.306060	0.109046	0.073626	0.088758	0.018335
16	0.029810	0.029896	0.040321	0.078983	0.010406
17	0.006404	0.113010	0.010459	0.103090	0.009911
18	0.004345	0.021026	0.083186	0.023059	0.030228
19	0.000050	0.000943	0.000154	0.040109	0.0
20	0.001758	0.002248	0.000642	0.004398	0.026264
21	0.000653	0.000387	0.000591	0.000425	0.000496
22	0.020166	0.016893	0.016370	0.015113	0.007929
23	0.003390	0.003553	0.004703	0.004033	0.003964
24	0.006278	0.005196	0.007041	0.007413	0.002973
25	0.028353	0.033424	0.042762	0.027853	0.022299
26	0.014742	0.016773	0.013492	0.010833	0.009911
27	0.020869	0.015347	0.026341	0.020430	0.020813
28	0.000628	0.001015	0.001156	0.001255	0.000991
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

ROW	COLUMN 21	 22	 23	 24	 25
1	0.001871	0.000103	0.000197	0.000065	0.000152
2	0.061471	0.002274	0.003666	0.000979	0.013810
3	0.000160	0.000988	0.000501	0.000224	0.001677
4	0.000374	0.001161	0.0	0.073109	0.0
5	0.002298	0.026054	0.024842	0.026476	0.003529
6	0.0	0.000005	0.0	0.0	0.000008
7	0.003100	0.001907	0.002701	0.000969	0.001158
8	0.021595	0.000194	0.0	0.0	0.000064
9	0.002512	0.000297	0.000286	0.000205	0.000136
10	0.043671	0.001032	0.000179	0.001156	0.000989
11	0.002726	0.023030	0.005580	0.006579	0.010039
12	0.046932	0.003732	0.001019	0.000149	0.001765
13	0.005292	0.000011	0.000036	0.000009	0.000078
14	0.006201	0.000335	0.0	0.0	0.000523
15	0.050887	0.005212	0.000429	0.000233	0.000004
16	0.018922	0.002231	0.000018	0.0	0.000639
17	0.000428	0.002263	0.000072	0.000009	0.000074
18	0.006789	0.002798	0.011768	0.000783	0.000857
19	0.000053	0.005979	0.000250	0.000047	0.000480
20	0.001550	0.000184	0.000429	0.000056	0.000157
21	0.064732	0.000211	0.000590	0.000130	0.000764
22	0.017586	0.058206	0.005008	0.018685	0.009270
23	0.004704	0.006778	0.012948	0.002376	0.009833
24	0.005399	0.005687	0.010677	0.164652	0.018341
25	0.043350	0.018120	0.010069	0.005135	0.016342
26	0.018869	0.028236	0.027828	0.011397	0.071047
27	0.038379	0.025806	0.064420	0.016765	0.057809
28	0.002298	0.001323	0.004310	0.002414	0.004446
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.000464
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.000082
35	0.0	0.0	0.0	0.0	0.000336
36	0.0	0.0	0.0	0.0	0.000492
37	0.0	0.0	0.0	0.0	0.000422

TABLE E-5 (continued)

	COLUMN				
ROW	26	27	28	29	30
1	0.000419	0.000899	0.000164	0.0	0.0
2	0.008236	0.001327	0.005937	0.0	0.002836
3	0.000164	0.000555	0.000361	0.0	0.0
4	0.000003	0.000160	0.011414	0.0	0.0
5	0.059579	0.010678	0.007150	0.0	0.0
6	0.000003	0.000027	0.000033	0.0	0.0
7	0.001158	0.008064	0.002952	0.0	0.0
8	0.0	0.000748	0.001115	0.202140	0.153119
9	0.000003	0.002596	0.001082	0.0	0.0
10	0.001814	0.014451	0.001738	0.0	0.0
11	0.000900	0.006167	0.002854	0.0	0.0
12	0.000538	0.004789	0.001542	0.001689	0.001890
13	0.000017	0.002449	0.000098	0.0	0.0
14	0.000006	0.003625	0.000230	0.0	0.0
15	0.000011	0.000090	0.000066	0.0	0.0
16	0.000325	0.003809	0.000328	0.015203	0.003781
17	0.000025	0.003577	0.000066	0.068131	0.083176
18	0.000068	0.012717	0.000492	0.025901	0.022684
19	0.000023	0.012446	0.001410	0.077140	0.113422
20	0.000399	0.006918	0.000230	0.0	0.001890
21	0.000781	0.006273	0.000328	0.007038	0.0
22	0.002474	0.011028	0.114766	0.096284	0.0
23	0.008103	0.009701	0.001542	0.0	0.0
24	0.005595	0.017690	0.010988	0.0	0.0
25	0.005912	0.036043	0.007380	0.103322	0.070888
26	0.086335	0.068072	0.025879	0.106700	0.034972
27	0.029867	0.055711	0.023485	0.005068	0.0
28	0.008038	0.006273	0.000361	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0
31	0.0	0.008969	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0
36	0.0	0.000006	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

COLUMN

ROW	31	32	33	34	35
1	0.0	0.0	0.0	0.0	0.0
2	0.044497	0.006239	0.012634	0.041041	0.038678
3	0.0	0.002569	0.004859	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.040040	0.017777
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.103396
8	0.033096	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.020190	0.0	0.0	0.0	0.000069
11	0.0	0.0	0.0	0.0	0.0
12	0.002534	0.006972	0.033042	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.001663	0.003670	0.037901	0.0	0.019513
17	0.067142	0.063853	0.011662	0.107608	0.073120
18	0.025337	0.0	0.001944	0.0	0.000972
19	0.089232	0.205505	0.170068	0.0	0.003403
20	0.000871	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.053840	0.0	0.0	0.011512	0.085480
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.017017	0.046733
25	0.078464	0.063853	0.317784	0.018018	0.017013
26	0.090736	0.025321	0.0	0.0	0.015207
27	0.052732	0.051009	0.106900	0.017518	0.038817
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.607107	0.0
30	0.007522	0.0	0.0	0.0	0.066870
31	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0
34	0.047506	0.0	0.0	0.0	0.0
35	0.041251	0.0	0.0	0.0	0.057565
36	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0

TABLE E-5 (continued)

	COLUMN	
ROW	36	37
1	0.0	0.0
2	0.005183	0.015246
3	0.007523	0.028663
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.010282	0.0
11	0.0	0.0
12	0.000334	0.000305
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.006861
17	0.000418	0.002744
18	0.0	0.000152
19	0.0	0.017381
20	0.0	0.0
21	0.0	0.0
22	0.043467	0.001525
23	0.0	0.0
24	0.000334	0.003507
25	0.051910	0.031712
26	0.004514	0.017228
27	0.027000	0.025614
28	0.0	0.0
29	0.0	0.0
30	0.0	0.0
31	0.442448	0.0
32	0.0	0.415460
33	0.0	0.156884
34	0.0	0.0
35	0.0	0.0
36	0.0	0.0
37	0.0	0.0

Table E-6: Value Added by Sector

Harvesting	Value added per dollar output	rank
Groundfish	.2898	7
Herring	.5062	2
Lobster/crab/scallop	.3137	4
Clam	.5677	1
Worm	.2993	6
Processing		
Groundfish	.1364	9
Herring	.4080	3
Lobster/crab/scallop	.1808	8
Clam/worm	.3110	5

Table E-7: Direct and Indirect Requirements per $100K**

		Harvesting					Processing			
ME I-O		Grd	Her	Lob	Clam	Worm	Grd	Her	Lob	C/W
1.	Livestock and ag. products	4								
2.	Forestry, wood products			8			7	6	4	4
.										
.										
5.	Maintenance and construct						5			
.										
7.	Food and kindred products							8		
8.	Fabrics and textiles (nets)	32	24	7			20			
.										
.										
.										
17.	Engines and machinery		4				6			
.										
19.	Motor vehicles (pick-ups)	5	8	7	14	12				9
.										
.										
22.	Trans. and warehousing	12		8			9	10	8	
.										
24.	Utilities, gas, elec. etc.							6		
25.	Wholesale and retail trade	13	9	10	7	34	10	4	10	12
26.	Finance and insurance	14	5	12	4	4	9		7	5
27.	Misc. retail			8	7	14	4	6	7	8
.										
29.	Groundfish harvesting	100					61			
30.	Herring harvesting		100					7		
31.	Lobster harvesting			100					44	
32.	Clam harvesting				100					42
33.	Worm harvesting					100				16
34.	Groundfish processing			5			100			
35.	Herring processing			4				100		
36.	Lobster processing								100	
37.	Clam and worm processing (dist)									100

*For industry titles refer to list given in Table E-5, direct input coefficients for all 37 Maine I-O industries.

**Figures are in thousands of dollars and are shown only where expenditures exceed $5,000.

APPENDIX I

Introduction to Input-Output Analysis:
Measuring Economic Interdependency

by

Dr. Thomas Duschesneau
University of Maine at Orono
Department of Economics

Introduction to Input-Output Analysis: Measuring Economic Interdependency

Input-output analysis is concerned with the economic interdependency of the many industries that comprise an economy. Interdependency arises because each industry employs outputs of other industries as inputs to its production process. Input-output analysis is based upon an empirical analysis of production in an economy and is designed to determine what can be produced and the amount of inputs that are required, given an existing state of technology. As such, input-output analysis provides a quantitative picture of the structure of the economy or, in other words, indicates how the various industries fit together. It represents a useful tool for planning purposes, especially for identifying the impacts flowing from economic development.

Several assumptions are inherent in any input-output analysis. The most important is the assumption of a fixed technological relationship between inputs. This assumes that each industry always uses inputs in the proportions existing at the time the table is constructed. With this assumption, a labor-intensive production process cannot become capital-intensive as industry output increases. Because changes in technology alter the relationships between inputs, the assumption is probably never totally correct but whether this has a serious impact on input-output analysis is disputed.

The construction of an input-output table involves a combination of theoretical, mathematical, and statistical tools and can be based upon quite different levels of aggregation. An input-output table describes an economy as it is and provides no information about what an economy should be, i.e. it is positive rather than normative.

Constructing an Input-Output Table

An input-output table is a matrix that depicts the selling and buying relationships between industries or sectors in an economy. It is basically a system of double-entry bookkeeping that reflects the pattern of transactions existing at the time at which the basic data is collected.

The Mathematics:

The essential mathematics of input-output analysis involves the solution of a set of n simultaneous equations in n variables. As an example, assume an economy composed of three industries: electronic equipment, fishing, and transportation equipment.[1] The three industries are interdependent because each utilizes inputs from the remaining two industries. The extent of interdependency, expressed in dollar terms, is indicated in Table E-8. The columns indicate the amount of inputs required from each supplying industry to produce $1 of output for the

---

[1] The choice of industries and the numbers used to represent interdependency among the industries are only illustrative.

Table E-8

		User of Output		
		Electronic Equipment	Fishing	Transportation Equipment
Producer of Input	Electronic Equipment	0.20	0.20	0.20
	Fishing	0.40	0.10	0.30
	Transportation Equipment	0.20	0.50	0.10
	Labor	0.20	0.20	0.50
	Total	1	1	1

industry represented by each column. Rows indicate the sales by a given industry to each of the industries listed across the top of the table. For example, the table indicates that a dollar's worth of output from the fishing industry requires the following amounts of inputs:

$0.20 of electronic equipment
$0.10 of fishing inputs
$0.50 of transportation equipment
$0.20 of labor services

The use of input-output analysis for planning purposes can be easily illustrated with reference to Table E-8. Assume that output goals have been set for the three products: $50 million in fishing, $100 million in electronic equipment, and $20 million in transportation equipment. The basic question is how much of each product will have to be produced to yield the desired goals. Simply producing $50 million of fishing outputs will not generate $50 million for final consumption because part of the production will be used up by the other industries, as a result more than $50 million will have to be produced. To provide $50 million of fishing outputs for final consumption requires, according to Table E-8, the following:

(total fishing output) equals (amount used in electronic equipment)

$$F = 0.40E$$

plus (amount used in fishing production)

$$+ 0.10F +$$

plus (transportation equipment) plus (consumption goal)

$$0.30T + \$50 \text{ million}$$

$$F = 0.40E + 0.10F + 0.30T + \$50$$

Similarly, the equations for fishing and transportation equipment are:

$$E = 0.20E + 0.20F + 0.10T + \$100$$

$$T = 0.20E + 0.50F + 0.10T + \$20$$

We have three simultaneous linear equations with three unknowns. Solving the equations for the values of F, E, and T provides the answer to the initial questions - how much F, E, and T will have to be produced in order to meet the output targets. The final step is to ensure that the output targets are feasible, i.e. sufficient quantities of inputs are available to produce the desired output levels.

As we pointed out above, input-output tables can be constructed at different levels of aggregation. While greater detail (less aggregation) is generally preferred, computational and statistical problems become quite complicated as tables become less aggregated, i.e., include more industries with narrower definitions for each industry. Our illustration of an input-output table utilized a 3x3 matrix which required 9 figures; a 4x4 matrix would require 16 figures. The number of pieces of statistical information needed for a table increases as the square of the number of industries included. In addition, the number of computational steps required to solve the equations increases as the cube of the number of industries. Thus, while users are likely to always prefer to work with a more detailed table, construction costs, especially data collection costs, rise rapidly when one attempts to construct tables with lower levels of aggregation.

Elements of an Input-Output Table

The three major elements of an input-output table are: 1) the transactions table; 2) technical coefficients; and 3) direct and indirect purchses.

The Transaction Table:

The transaction table shows, in dollar terms, the actual pattern of transactions between industries in the economy. It reveals how the output of each industry is distributed among other industries and final demand sectors. Viewing the transaction from the buying side, the table indicates the inputs that flow into each industry from other industries. Thus, the table indicates each industry's relationship with other industries and sectors in the economy or, as described above, the pattern of economic interdependency. Construction of such a table requires the collection of data which indicate, for each industry, the dollar amounts of purchases of inputs from each industry and the dollar amounts of sales of output to each industry.

A typical transaction table is illustrated in Table E-9. Columns indicate input purchases by each industry or sector, listed along the top of the table, from each industry or sector listed along the left-hand side of the table. Rows indicate sales of output by each of the industries or sectors listed across the top of the table. Thus, if one wants to learn what inputs are purchased by a specific industry, the information is found in the columns. On the other hand, if one is interested in learning where a specific industry's output goes, the information is contained in the rows.

There are three major elements to the table: 1) the processing sector; 2) the payments sector; and 3) the final demand sector. The processing sector is composed of the industries engaged in producing goods and services. Our illustration contains only six industries in

Table E-9

Hypothetical Transactions Table
Industry Purchasing

		Processing Sector						Final Demand					
	Outputs[1] → Inputs[2] ↓	(1) A	(2) B	(3) C	(4) D	(5) E	(6) F	(7) Gross Inventory accumulation (+)	(8) Exports to foreign	(9) Government purchases	(10) Gross private capital formation	(11) Households	(12) Total Gross Output
Processing Sector	(1) Industry A	10	15	1	2	5	6	2	5	1	3	14	64
	(2) Industry B	5	4	7	1	3	8	1	6	3	4	17	59
	(3) Industry C	7	2	8	1	5	3	2	3	1	3	5	40
	(4) Industry D	11	1	2	8	6	4	0	0	1	2	4	39
	(5) Industry E	4	0	1	14	3	2	1	2	1	3	9	40
	(6) *Industry F*	2	6	7	6	2	6	2	4	2	1	8	46
Payments Sector	(7) Gross Inventory depletion (-)	1	2	1	0	2	1	0	1	0	0	0	8
	(8) Imports	2	1	3	0	3	2	0	0	0	0	2	13
	(9) Payments to government	2	3	2	2	1	2	3	2	1	2	12	32
	(10) Depreciation allowances	1	2	1	0	1	0	0	0	0	0	0	5
	(11) Households	19	23	7	5	9	12	1	0	8	0	1	85
	(12) Total Gross	64	59	40	39	49	46	12	23	18	18	72	431

[1] Sales to industries and sectors along the top of the table from the industry listed in each row at the left of the table.

[2] Purchases from industries and sectors at the left of the table by the industry listed at the top of each column. Source: William H. Miernyk, The Elements of Input-Output Analysis (New York, Random House, 1965), p. 9.

the processing sector but in an actual table the processing sector is usually less aggregated and contains some 40-60 industries. The payments sector, represented by rows 7-11 in Table E-9, contains five parts and is read across the table. The gross inventory depletion row indicates the extent to which an industry's output is achieved by lowering inventory levels.

The final demand sector in Table E-9, columns 7-11, contains five components. Transactions originate in the final demand sector and changes in final demand set in motion a series of additional changes which, because of economic interdependency, are transmitted throughout an economy.

The general rules for reading a transactions table were presented above. They can be illustrated, in terms of Table E-9, by considering the transactions of an individual industry such as industry B. In terms of output, the table indicates that industry B made the following sales:

$5 billion to industry A
$4 billion to industry B
$7 billion to industry C
$1 billion to industry D
$3 billion to industry E
$8 billion to industry F

From the Final Demand Sector, industry B:

added $1 billion to inventory levels
exported $6 billion worth of output
sold $3 billion to government
had $4 billion of its output purchased for capital accumulation
sold $17 billion to the household sector

The gross output of industry B, obtained by summing across the row, was $59 billion.

Viewed in terms of the input side, Industry B purchased,

$15 billion from indystry A
$4 billion from industry B
$2 billion from industry C
$1 billion from industry D
zero purchases from industry E
$6 billion from industry F

In addition, in producing its output, industry B utilized the following inputs:

reduced inventories by $2 billion
imported $1 billion of goods
paid taxes totalling $3 billion (reflecting purchases of Government services)
allowed $2 billion of depreciation
paid $23 billion to households for labor services

Summing the column indicated that total gross outlays for inputs by industry B were $59 billion which, by necessity, equals the total gross value of outputs. In other words, the total value of sales for any industry must equal the total value of inputs purchased.

Technical Coefficients:

While transaction data serves as the basis for an input-output table, in most cases, the input-output table will not be presented in terms of absolute values of transaction but rather will utilize technical coefficients. In the following sector, we describe how technical coefficients are calculated from the transaction table.

Calculating Technical Coefficients:

Technical coefficients indicate the amount of inputs required from each industry to produce $1 worth of output for a specific industry. Such coefficients are only calculated for processing sector industries and are based on transactions data. They can be expressed either in dollar or physical terms.

Technical coefficients are calculated by: 1) subtracting the value of inventory depletion from industry gross output to obtain adjusted gross output and 2) dividing the values in each industry's column (a measure of the industry's purchases from each supplying industry) by gross output. The procedure can be illustrated with reference to industry B's transactions displayed in Table E-9.

adjusted gross output = gross output - inventory depletion

$57 = $59 - $2

technical coefficient = $\frac{\text{each column entry}}{\text{adjusted gross output}}$

The technical coefficients, representing the amount of direct purchases by industry B from other industries, indicate that a $1 output from B requires:

$.263 of inputs from industry A

$.070 of inputs from industry B

$.033 of inputs from industry C

$.017 of inputs from industry D

$.00 of inputs from industry E

$.103 of inputs from industry F

The direct coefficients for each of the processing sector industries would be calculated in the same manner.

Direct and Indirect Purchases:

Direct coefficients, while indicating the direct linkages among industries, do not provide a complete picture of the extent of economic interdependency. Direct coefficients represent only the first round of expenditures that takes place in response to a $1 increase in output. They fail to capture the indirect increase in expenditures that occur because each supplying industry, in order to increase its putput, will have to increase its purchases of inputs. Thus the total requirements needed to produce an additional dollar's worth of output equals the sum of the direct and indirect effects. Computational techniques exist to estimate the sum of direct and indirect effects.

Applications of Input-Output Analysis

As an analytical tool input-output analysis has a number of important applications. Three major uses of input-output models are discussed below. They are: 1) structural analysis of the economy; 2) forecasting; and 3) impact or multiplier analysis. Structural analysis is concerned with the relationship that exists among various parts or sectors of the economy. Given this knowledge, input-output techniques can greatly facilitate the planning activities of both private and public decision makers. As an example, public policy makers can identify the level of final demand required to generate full employment and, most importantly, determine the consistency between the required demand level and the existing resource base. Forecasting the ramifications and spill-over effects of an economy's expansion are possible with an input-output table. Because the fixed proportions assumption makes an input-output table essentially static, input-output analysis is better suited to forecasting within relatively short time periods.

The final application involves impact or multiplier analysis. Economic analysis has had a long interest in estimating the aggregate impact on income or employment resulting from autonomous changes in investment levels. With the development of input-output techniques, it becomes possible to determine the multiplier effects in terms of the impacts on individual industries and sectors. As such, the analyst obtains a detailed picture of how the multiplier effects flow throughout the economy and how individual industries are affected. With such knowledge, policy makers are in a much better position to guide and facilitate growth and change in the economy.

As a final point it should be indicated that input-output analysis while a powerful tool, is not a substitute for individual decision making in the policy process. It represents an analytical technique capable of providing the decision maker with an improved understanding of the economy and a means of identifying the effects of various policy actions but it does not indicate what policies should be taken.

APPENDIX II

Technical Notes

by

Hugh Briggs, III
University of Maine at Orono
Senior, Economics Department

Technical Notes

The multipliers presented earlier are derived in a straight-forward manner from the calculation of a set of industry production levels consistent with a given set of final demands. However, prior to a solution of the system of equations presented by the input-output system, two issues had to be resolved. The first was how to account for the volume of trade between Maine and the rest of the U.S. economy so as not to mistakenly count the income effects of purchases made outside the state as if they had been made within the state. Second was how to "close" the model in order to generate the induced income multipliers. The resolution of these two problems, the method used to calculate multipliers, and the method used to remove the effects of fish harvesting and processing from the sectors they had been included in in the USDOT table are the subject of this appendix.

Interstate Trade

As an aid in the following discussion, define symbolically the following sets of data:

[TR]: 37 x 37 transactions matrix (one row and column for each industry), an element of which will be denoted $tr_{i,j}$, sales from the i-th industry (located anywhere in the U.S.) to the j-th Maine industry,

TP: 37 element vector of total production of each industry in Maine, an element of which will be denoted tp_i, the output of the i-th industry, TC: 37 element vector of total interindustry and final demand consumption in Maine from production of industries located in or out of the state, an element of which will be denoted tc_i, total consumption of product i,

FD: 37 element vector of final demands for each industry's output, an element of which will be denoted fd_i. Each element fd_i is the sum of personal consumption expenditures, state and local government purchases, federal government purchases, gross private investment, net inventory change, foreign exports, and residual accounting elements including service industry residuals, scrap, and secondary transfers out.

W: 37 element vector of intermediate consumption of each industry's output, an element of which will be denoted w_i. An element of this vector is calculated as $w_i = tr_{i,j}$.

Note that all the data mentioned above are represented by the 1963 volume of transactions and are measured in thousands of 1963 dollars.

To calculate multipliers we want to change the output of one industry and then calculate the impact on the remainder of the economy. It may prove instructive here to show how the general closed-economy (i.e., no trade or negligible trade outside its boundaries) input-output solution is obtained prior to a discussion of the regional, open-economy input-output model used here. In the general model, we are, once again, attempting to determine the amount of output required of each industry given, (1) a set of purchasing relationships among industries that represents the technology of production, and (2) a set of goods desired for final consumption. We know that, since the economy is closed in our simple example here, total production equals total consumption. Further, total consumption equals the sum of final demand consumption and intermediate consumption (goods consumed in the process of producing other goods). Utilizing the symbols defined above, we have:

$$(1)\ TP = TC, \text{ and}$$

$$(2)\ TC = FD + W.$$

We now define a matrix [A] whose (i,j) element is calculated $a_{i,j} = tr_{i,j}/tp_i$. Then $a_{i,j}$ represents the dollar requirements of inputs from industry j per dollar of output of industry i. We can then represent W as

$$(3)\ W = [A]TP$$

We can now derive a solution for TP (total production in each industry) given some set of final demands in the following manner:

$$(4)\ TP = FD + [A]TP$$

$$(5)\ TP - [A]TP = FD$$

$$(6)\ [I - A]TP = FD$$

$$(7)\ TP = [I - A]^{-1}FD$$

The multiplication, in equation 7, of the matrix $[I - A]^{-1}$ by any vector of final demands will yield the total production required to satisfy those final demands.

The solution becomes more complicated in the regional model. It may be that Maine produces more of a commodity than is consumed in the state, less of a commodity than is consumed in the state, or precisely the amount of a commodity that is consumed in the state. The algorithm detailed above is stymied at (1) since total production in Maine can no longer be said to equal total consumption. To perform analogous calculations for a regional input-output model we need some relationship between total consumption and total production in each industry. The assumption we made about this relationship must reflect what we think will happen to imports into the state and exports out of the state when the level of consumption within the state changes. At one extreme, we could assume exports and imports are unaffected by changes in economic activity. In this case, all changes in consumption are from changes in in-state production. At the other extreme, we could assume all changes in consumption are satisfied by changes in exports and imports. Obviously, neither of these extreme cases is realistic. Instead, we used the following assumption. If Maine was a net importer of a product in the base year, we assume Maine will continue to be a net importer. If Maine was a net exporter of a product in the base year, we assume that Maine will continue to supply all in-state demands, but exports are not affected by increases in in-state consumption at the base year level. Specifically, we assume that the percent of total consumption supplied by an in-state industry is constant. Mathematically, let us define a diagonal matrix [P]. An element, $p_{i,i}$, of this matrix is defined:

$$p_{i,i} = 1 \qquad \text{if } tp_i/tc_i > 1$$

$$p_{i,i} = tp_i/tc_i \qquad \text{if } tp_i/tc_i < 1.$$

Further, if $tp_i > tc_i$, then final demand fd_i is increased by the amount of net exports for industry i, $tp_i - tc_i$.

With [P] calculated as detailed above, we can proceed as in the simpler model presented earlier:

$$(1)\ TC = FD + W$$

$$(2)\ W = [A]TP$$

$$(3)\ TP = [P]\ (FD + [A]TP)$$

$$(4)\ [P]^{-1}TP = FD + [A]TP$$

$$(5)\ [P]^{-1}TP - [A]TP = FD$$

$$(6)\ [P^{-1} - A]TP = FD$$

$$(7)\ TP = [P^{-1} - A]^{-1}\ FD$$

Closing the Model

The aim of closing the model is to capture the increases in expenditures and incomes that occur as people receive payments for services sold to industries and in turn re-spend these payments to generate even more incomes and expenditures. This is accomplished by including a new industry, the "household sector", in the transactions table. The new column added to the table, the purchases of the household sector from all other sectors, is simply the personal consumption expenditures component of the final demand vector. The new row added to the interindustry transactions table represents the payments of all sectors to the household sector for services rendered in the process of production.

If the data had been available, the household sector column would have been personal consumption expenditures in the base year of the table. The absence of this data required that, for each commodity, the proportion of final demand comprised of personal consumption expenditures be calculated for a year for which we did have the requisite data (1970); these proportions were then applied to the final demand data of the table to obtain personal consumption expenditures in the base year. (Note that, as with any other industry, the pattern of purchases of the household sector is assumed to be constant). Since the sum of all personal consumption expenditures was a smaller amount than the sum of all incomes and there did not exist any data (i.e., savings, income taxes, etc.) to reconcile this difference, we assumed the ratio of total consumption to total income was a constant.

After the construction of the household sector and its inclusion as a new industry in the A matrix, the solution for the closed model was calculated in the same manner as was documented above for the open (no household sector) model.

Calculation of Multipliers

Income and expenditure multipliers were calculated for both the open and closed models. The open model treats all final demands as exogenously determined. Thus the multipliers obtained by solving the open model system include only the incomes and expenditures generated by interindustry transactions. These multipliers measure the "direct" and "indirect" effects of an increase in the total production of an industry. In the closed model, personal consumption expenditures are endogenously determined. In effect, by treating individual consumers as another industry, the model assumes that personal consumption expenditures are determined by the amount of production of all other industries. (In turn, the production of all other industries is determined by the remaining components of final demand [foreign exports, federal govenment expenditures, etc.]). By including the household sector as an industry in the transactions table, the closed model is able to capture the feedback effects on production and income that occur as individuals spend the income they acquired from selling goods and services. The multipliers obtained by solving the closed system include the direct, the indirect, and the income induced effects.

Multipliers were calculated for both the open and closed models in the same manner. In terms of the symbolic notation previously established, the multipliers were obtained by the series of calculations outlined below.

1. Generate initial solution.

   $TP = [R]FD$, where $R = (P^{-1} - A)^{-1}$

2. Calculate new solution for TP using a Final Demand (FD) which is approximately \$100,000 greater for the

fishery activity in question.[1]

3. Determine expenditure multiplier as ratio of changes in total expenditures to change in output.
4. Determine income multiplier as ratio of changes in value added to change in output.

Removing the Fisheries from the Original Table

The data collected by student surveys of industry personnel and knowledgeable observers, presented in other appendices in this paper, were the source of the technical coefficients used both to subtract the effects of the fishery from forestry and food and kindred products sectors and to create the nine new fishery sectors in the table. Given this data, in the form of direct requirements per dollar or output for each fishing sector, a decision had to be made as to what to use for control totals for the value of production for each sector to generate the raw data to be used in the transactions table. Actual 1963 data on

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[1] Strictly speaking, we were interested not in the effect of increasing final demand by \$100,000, but rather the effect of increasing total production of the industry in question by \$100,000. If an industry uses its own output, final demand for its product will not have to increase by \$100,000 to generate a \$100,000 increase in its output. The following algorithm was used to calculate the change in Final Demand required to generate a \$100,000 change in total output:

Let: Y = initial industry K output + \$100,000
X = the portion of industry K's output not determined by the final demand for K, i.e.
$X = r_{k,j}(FD_j)$
Then: $Y = X + r_{k,k}(fd_k)$ and $fd_k = (Y-X)/r_{k,k}$.

value of landings for each species were the obvious choice for control totals for the subtraction of fishery effects from the forestry products sector. Its use avoided problems raised by possible changes in the scale of production and changes in the prices of raw fish relative to other commodities since 1963. For addition of the newly created fishery sectors to the transactions table, 1963 data were not used. Instead, the average landings pattern from 1973-1979 was used. This approach was used because these sectors exhibit such volatility in output from year to year. If fishery sectors are aggregated, the weights used to combine them are not selected from one year, but rather as the average of several years.

Control totals for the processing sector were, for both the subtraction of harvesting sector effects from food and kindred products sector and their inclusion as new sectors, derived from the landings data control totals described above. Processing sector control totals were obtained by calculating, for each processing sector, the reciprocal of the processing sector input coefficient for raw fish, and then multiplying this number by the amount of raw fish available for processing. For example, assume that all herring landings are processed in Maine, no herring imports, and herring landings are $10,000. With an input coefficient for raw fish of .1000, the amount of herring processed can be determined as the product of the reciprocal of the input coefficient (1/.1000) and the amount of raw fish available ($10,000), or $100,000 of processed herring products. Since any source of data for the value of processed products would eventually have had to have been reconciled with the already existing input coefficients for raw fish inputs to the processing sectors, the adoption of this methodology seemed reasonable. Table E-10 presents the value for processed products computed in this manner and the value of processed products from the 1963 U.S. Fishery Statistics.

It should be noted that in several instances the subtraction process creased negative residual coefficients for the forestry and food and kindred products sectors. When such negatives could neither be attributed to obvious errors of classification of inputs nor removed by the aggregation of the table down to 37 industries, transactions were assumed to be zero.

For calculating outputs of the fishery sectors, several assumptions prevail across sectors. First, a lack of information on what proportion of fish processed in the state is consumed in the state required that a reasonable guess of this number be made for the processing sectors—we selected 2%. Second, as previously noted, it was assumed that all fish processed in the state were originally caught in the state. Note also that the converse, all processing of Maine caught fish occurs within the state, is also true. The sole exception is groundfish, where it was assumed that 15% of the catch was processed in the state. Finally, it was assumed that all processed fish destined for human consumption were sold through the wholesale and retail trade sector. In conjunction with this assumption we should note one defect. The standard practice in entering sales through this sector is to enter the margins on the sales rather than the total value of the sales. Due to a time constraint, total value of sales to Maine wholesalers and retailers was entered rather than the margins of such sales. This leads to some overstatement of economic impacts; but given the relatively small proportion of in-state consumption, we assume this overstatement is negligible.

Table E-10. Value of Landings and Processed Products, 1963

Value of landing*	$20,994,000
Value of processed products	$34,877,000
Computed value of processed products	$37,479,000

Source: U.S. Fishery Statistics, 1963.

*Value of landings excludes: smelt, shrimp, Irish moss, sea urchins, periwinkles and cockles, salmon, oysters and mussels.

APPENDIX III

Data and Methods Used to Estimate Input Coefficients for the Finfish (except herring) Sector

by

Kimberley Rollins
University of Maine at Orono
Senior, Economics Department

Data and Methods Used to Estimate
Input Coefficients for the
Finfish (except herring) Sector

I. Introduction: Summary of data and estimation procedures for the harvesting sector.

An input-output analysis of the entire finfish (except herring) harvesting industry of Maine requires detailed information on the various sub-sectors (gillnetter, small dragger, etc.) in order to piece together an accurate statistical picture of the industry as a whole. The basic data on input costs for the several types of gear and various vessel sizes utilized to harvest finfish were provided from unpublished data, used in support of "Tariffs are the Problem", Maine Commercial Fisheries, March 1977, by James Wilson. The proportion of total pounds harvested by each vessel size category was estimated from landings and other data to be presented below. To obtain input cost estimates for the whole harvesting industry, the data on proportion of landings by each vessel size category were used as weights for combining the input costs of each gear type and size category.

Characteristics of the harvesting industry—yearly landings, species catch by gear type, prices of fish, and costs of equipment are highly variable from year to year. To dampen the swings in landings for various species from year to year, a six year average of the harvest for each species was calculated. The years 1970-1975 were used to obtain the six year average because the catch by gear statistics corresponding to those years are generally considered more accurate than more recent catch by gear data. Caution was required to minimize the possibility of combining inconsistently measured data because not all data were from the same base year. Costs of inputs for each gear type, presented in raw terms in the tariff study, were divided by the total revenue earned by each gear type. The technical coefficients thus obtained were used to estimate costs rather than the raw values of the source.

The task of obtaining the input costs in proportion to the total output of the whole industry required a method for combining the technical coefficients of each gear type and vessel class. The following series of weights were calculated and systematically applied to the input cost data:

(1) Landings by species (six year average)

(2) Species catch by gear type (six year average)

(3) Output value by species (for 1972, but since this was the last step, any year's prices could be used).

These weights were tabulated and combined to arrive at output value by pounds, by species and by gear type. The weights were then applied to the proportion of gear input costs by pounds harvested for each vessel size and class.

This procedural summary is not a comprehensive explanation of the methodology employed in resolving the heterogenous elements of the finfish harvesting sector into its basic input-output structure. Rather it is offered as a brief overview of a complex series of steps, so that the reader may always bear in mind the direction of the analysis.

II. Initial Specification of Inputs

The initial input cost data for various sizes and types of vessels were obtained in part from Dr. Wilson's tariff study of 1976. The relatively detailed list of input costs provided on the worksheets of that study were first aggregated to correspond with the sectors of the I-O table and then converted to dollar expenditures on inputs per dollar of output. Thus, in the first entry under gillnetters in Table E-19, we observe that $.11 of every dollar of output is attributed to nets.

The list of inputs is admittedly incomplete. It consists of a limited number of vessel and gear costs, yet finfishing activity includes inputs such as boxes, traps, harpoons, and others. There are certainly more gear types used than are accounted for in Table E-19. However, input-output analysis handles all input cost data in proportion to the output of the industry. Relative to all finfish harvesting, the costs for the gear types excluded are insignificant. Table E-11 indicates the methods by which finfish are harvested in Maine and the total pounds taken be each gear type over a six year period. The major portion (all but about 4%) of the total finfish catch is taken by trawls, gillnets, and lines. Time did not permit a complete survey of all gears used to

Table E-11. 6-Year Average Landings (pounds) by Gear, 1972-1975

Year	Trawls	Purse Seines	Gillnets & Lines	Weirs	Stop Seines
'70	70,800,700	2,781,000	2,454,800	2,051,800	4,896,600
'71	64,272,700	21,071,100	2,749,000	468,100	7,113,500
'72	53,979,400	7,616,800	5,210,500	3,503,500	33,596,300
'73	49,504,000	30,266,200	5,099,300	1,918,600	12,004,000
'74	39,443,500	45,747,100	8,597,900	6,011,500	6,000,300
'75	31,929,000	31,851,700	12,597,600	5,306,600	15,138,700
6-yr. ave's	51,604,883	27,722,350	6,118,050	3,204,017	13,124,900
% ave. total catch	49.2%	26.0%	5.8%	3.0%	12.5%
% ave. total vessel catch	60.0%	32.0%	7.0%		

Year	Floating Traps	Harpoons	Bagnets	Dipnets	Boxtraps
'70	367,100	62,300	32,400	1,694,100	37,600
'71	122,800	136,000	45,000	1,968,200	55,100
'72	63,800	183,300	50,200	2,225,700	70,200
'73	307,500	40,600	62,700	2,528,700	76,000
'74	162,300	211,400	55,700	3,309,500	79,600
'75	107,800	95,000	75,900	3,729,000	154,800
6-yr. ave's.	18,550	121,433	53,650	2,575,867	78,883
% ave. total catch	0.2%	0.1%	0.5%	2.4%	0.1%

Source: U.S. Fishery Statistics, 1970-1975 catch finfish off the Maine coast.

The tariff study gave no cost specifications for the very large trawlers used for redfish harvesting, which account for a significant percentage of the total Maine finfish harvest. There are ten large, company-owned redfish trawlers used in Maine. Unfortunately, input-output data were not forthcoming from either of the two firms. The Department of Marine Resources supplied a list of specifications for nine of the ten vessels (see Table E-12). The specifications, along with various secondary sources and conversations with knowledgeable persons, were used to derive representative input-output cost for these vessels.

Input costs for gillnetting vessels were obtained from UMO fisheries extension agent David Dow. Gillnetting and longlining were lumped together; either activity's separate input costs were minute in comparison to the whole industry, and the inputs for both gear types fit easily into the same industry categories.

III. Calculation of the Proportion of Total Landings for Each Vessel Size and Type Class:

Two basic steps were involved in estimating the proportion of total annual landings attributable to each vessel class. First the carrying capacities for each vessel class were estimated. Then these capacities were multiplied by each vessel class's estimated time at sea.

Table E-12. Specifications on the 10 Large Redfish Trawlers

Rockland, smaller vessels

	Length	Gross Tons	Net Tons	Capacity	Beams
	88.3 ft.	160	115	45	23.8 ft.
	106.1	199	137	62	26
	118.5	238	108	130	22
	114.5	199	86	113	23.3
	101.3	198	152	46	24.1
av.	105.7	198.8	119.6	79.2	23.8

Portland, larger vessels*

	Length	Gross Tons	Net Tons	Capacity	Beams
	133.7	320	165	155	26.1
	133.3	321	146	175	26.1
	138.2	458	240	218	-- -
	133.7	315	151	164	26.1
av.	134.7	353.5	175.5	178	26.1

*Data on one of the Portland vessels are missing.

Source: DMR

A. Derivation of Carrying Capacity Ratios:

The calculations which follow illustrate the derivation of carrying capacity ratios used to determine the indices of proportionate total landings per vessel weight class and are carried out in Table E-13, sections A through D. The raw percentages of total vessel weights by class were obtained from the New England Fishery Management Council Census of 1977. The data represent a 60% sample of New England fishing vessels. The following calculations were based only on those vessels owned and wharved in Maine.

The following basic assumptions were made in the calculations of vessel capacity in Table E-13 A:

(1) vessel tonnage is an appropriate index of carrying capacity (e.g., if vessel "A" weighs 10 tons and vessel "B" weighs 30 tons, then vessel B can hold 3 times as much fish as vessel A),

(2) all vessels on any given trip fill their holds to the same proportionate level as all other vessels (e.g., they all fill their holds to 75% of their carrying capacities, the actual level is unimportant),

(3) all vessels fish the same number of days per year.

Deviations from the assumed linear relationship between tonnage and capacity may arise. For example, different physical or structural characteristics of the vessels may affect the weight-carrying capacity

Table E-13. The Derivation of Catch by Vessel Calss

A. Derivation of Carrying Capacity Ratios

Wt. Class Median Wt.	10 ton	30 ton	50 ton	70 ton	90 ton	125 ton	175 ton	225 ton
Carrying capacity ratio	X	3X	5X	7X	9X	12.5X	17.5X	22.5X
Percent of all vessels in class	84.2%	12.3%	1.3%	.4%	.4%	.4%	.4%	.4%

Derivation of the ratios:

(1) $.842(X) + .123(3X) + .013(5X) + .004(7X) + .004(9X) + .004(12.5X)$
$+ .004(22.5X) = 1.55X$

(2) $1.55X = 1.100$

Substituting X into equation (1) yields the carrying capacity for each vessel class presented in Table E-13 B.

ratios. Our second assumption may also be somewhat in error; vessels may return to port with little or no harvest, or they may return brimful. But these kinds of problems will distort our estimates only if they are systematically related to vessel size.

The above assumptions and data yield the percentages calculated at the bottom of Table E-13 A. These percentages are only first approximations of total landings by vessel size. What remains to be considered is that not all boats fish the same number of days per year. The next step, therefore, weights these percentages by estimates of days of fishing by vessel size.

B. The Proportion of Total Landings by Vessel Class:

The results of the calculations set forth in Table E-13 A and presented in Table E-13 B, the percentage of total landings by carrying capacities for each vessel class, were adjusted by a second series of ratios, the relative numbers of fishing days for each vessel class in Table E-13 C. This adjustment is necessary because it is generally believed that a systematic bias exists between the number of days fished and vessel size (most probably, the bias is a function of weather). Estimated fishing days per vessel were supplied by extension agent David Dow. The multiplication of the fishing days ratios presented in Table E-13 C by elements of Table E-13 B, resulted in an adjusted percent total landings by vessel class presented in Table E-13 D.

Although these vessel classes do not exactly coincide with the

13 B. Carrying Capacity by Vessel Class

lass nnag	% of Total Landings by Weight
	54.3%
	23.8%
	4.3%
	1.8%
	2.3%
	3.2%
	4.5%
	5.8%

*The accoh of the redfish landings.

DataEnglaManagement Council Census, 1977.

Table E-13 C. Derivation of Adjusted % Total Landings by Weight

Vessel Characteristics								
Median wt. class	10 ton	30 ton	50 ton	70 ton	90 ton	125 ton	175 ton	225 ton
Fishing days ratio	.333X	.333X	.583X	.722X	.833X	1X	1X	1X
% of total landing indices	54.3%	23.8%	4.3%	1.8%	2.3%	3.2%	4.5%	5.8%

Derivation of the ratios:

$.543(.333X) + .238(.333X) + .043(.538X) + .018(.722X) + .023(.833X) + .032(1X) + .045(1X) + .058(1X) = 1.$ Or, = 100%

$1\ (100\%) = .452X$

$X = 2.213$

The fishing days ratio expresses the number of days fishing for each vessel class in terms of the number of days the largest vessel classes fish.

Substituting X into each term of the weighting expression yields the adjusted % total landings by weight per weight class.

Table E-13 D. Estimated Carrying Capacity by Vessel Class, Adjusted for Days Fishing.

Weight Class	Adjusted % of Total Landings
10	40.0%
30	17.5%
50	5.5%
70	2.9%
90*	4.2%
125*	7.1%
175*	10.0%
225*	12.8%

*1.6% of all Maine vessels harvest 34.1% of all finfish landed.

Fishing days supplied by David Dow.

categories in the Table E-19, the landings percentages in Table E-13 D were an invaluable tool in the analysis.

Table E-14 directly provides landings data which, in turn, gave an estimate of total revenue for the Maine redfish fleet. Because the data used to derive the proportions of landings utilizes vessel size classes in the breakdown, the proportions do not differentiate between gear types, but only between sizes of vessels. Therefore, after a breakdown of landings by gear type (e.g., gillnets, trawls, etc.), the landings proportions of Table E-13 D were applied to the various sized vessels for each gear type.

IV. Cost Estimates for the Redfish Fleet:

The proportions of landings by vessel size (Table E-13 D), are a starting point for allocating the Maine finfish fleet to vessel types by gear and harvest. From Table E-13 A, it is apparent that the largest of the Maine vessels (between 90 and 225 tons) represent approximately 1.6% of the total Maine fleet. The data in Table E-13 D suggest that this same 1.6% of the vessels are responsible for about 34% of the total annual harvest by weight. The ten redfish vessels in Maine (see Table E-12) approximate the sizes and weights of vessels represented by the data in Table E-13 D. Furthermore, a six-year average of 86,408,109 pounds/year of finfish (Table E-11) were harvested by Maine vessels (Table E-11 includes herring, and Table E-13 includes herring vessels). Of this yearly total, 34% are harvested by the largest

1.6% of the Maine vessels, or roughly 37,000,000 pounds of redfish were harvested (Table E-17). This information led me to assume that, for all practical purposes 34.1% (Table E-13 D) of the total Maine harvest by weight could be attributed to the ten redfish vessels.

The proportion of total yearly finfish landings represented by the ten redfish vessels (34.1%) was next converted to a proportion of total industry output value. The 30,000,000 pounds of redfish attributed to the ten vessels (see above text) represented about 79% of the total six year average of redfish landings (37,000,000 pounds in Table E-17). For the same six year period, redfish value was 47% of the total industry value (Table E-17). Therefore, by multiplying 79% of the 47% of the total value accounted for by the redfish, we obtain a total finfish harvesting industry value proportion of 37% contributed by these ten vessels. The remaining 63% of the industry output value was attributed to the rest of the Maine finfish fleet.

The analysis indicates that the input categories attributable to the ten large redfish vessels represent 37% of the total finfish harvest value. However, the input structure comprising this 37% was further divided into two sections, each representative of two basic cost structures of the ten vessel fleet. The specifications for the ten redfish trawlers (Table E-12) indicate two different types of vessels. The Portland based fleet is composed of relatively larger, older and heavier vessels than the five vessels in the Rockland based fleet

(Table E-12). Different cost structures were associated with the physical characteristics of these two fleets.

No input cost data for any of the ten redfish trawlers were available; consequently, models were developed of the expected cost structures for the two types of vessels described above. The two redfish trawler cost structures shown in Table E-19 were constructed be relying upon basic vessel size and hull-house, engine, maintenance, and other applicable data from Dr. Wilson's tariff study, along with studies on vessel cooling systems and conversations with knowledgeable persons (David Dow in particular) about gear costs.

The two input cost structures obtained for the redfish fleets next had to be transformed into I-O ratios. This ultimately meant that each of the two redfish trawler categories had to be weighted by the proportion of total finfish value associated with them. As a first step, total finfish landings were apportioned between the two fleets. The five larger vessels (Table E-12) fit approximately into the 175 to 225 ton categories in Table E-13 D, the percentage of total landings by vessel weight class. Consistent with the entries in Table E-13 D, it was assumed that the larger vessel landed 22% of total finfish landings. The other five, smaller, redfish vessels (Table E-12), were assumed to be responsible for the remaining 12% of the total finfish harvest accounted for by the redfish fleet.

Within the redfish category we may reasonably assume proportionality between harvest weight and harvest value. Therefore we are now able to convert the proportions by total weight into proportions by total value. Of the 37% of total finfish value attributed to the ten large redfish trawlers, the five larger redfish vessels are responsible for 64% (22%/34%), or 24% of the total finfish value. Similarly, 35% (12%/34%), or 13% of the total finfish harvest value is assumed attributable to the five smaller redfish vessels. In this way final I-O ratio weights were obtained for the two redfish vessels categories (in Table E-19).

V. Non-Redfish Input Cost Estimates:

The remaining 63% of total finfish harvest had to be distributed systematically over the rest of the input cost structures. The most difficult problem encountered in this step was the handling of the different inputs (gear types and vessel sizes) and the amount of total value (the different species of fish have extremely variable prices per pound) attribuatable to each of the inputs. The next five steps illustrate how this problem was resolved. These five steps, each corresponding to one of the five following tables, are:

1. Six year averages of species catch (pounds) by gear type were taken directly from National Marine Fisheries Statistics, 1970-1975. These figures appear on Table E-14.
2. Using the same six year average of total pounds landed of all species for each gear type (Table E-12), and the total pounds landed of

each species for all gear types (added across Table E-14), each entry in Table E-14 was transformed into two percentages exhibited in Table E-15. These percentages are:

(A) The percentage shown on the left of each entry is the proportion of pounds landed of the particular gear type (column) attributable to the species in question (row). For example, 72.4% of all trawler landings for the period 1970-1975 were of ocean perch.

(B) The percentage shown on the right of each entry is the proportion by weight of the particular species (row) caught by the gear in question (column). For example, 99.9% of the ocean perch landed from 1970-1975 were landed by trawls.

3. Total catch by weight and total value for each species in Table E-16 were supplied by the Maine Department of Marine Resources. Dividing these two figures yielded prices for each species.
4. In Column 2 of Table E-17 the six year average total landings for each species is represented as a percentage of total harvest by weight for

all species (each entry in column 1 is divided into the total of column 1). Column 3 shows the 1972 price per pound figures determined in Table E-16. These are multiplied by the six year average total catch figures for each species to result in a 1972 value per species in column 4 (this column is not identical to the first column on Table E-16, although they are both representative of 1972 value by species, because the figures in Table E-17 reflect an estimated 1972 value by species using six year average total landings). The final column of figures in Table E-17 represents the estimated proportion of total 1972 value for each species (each 1972 value by species in the fourth column was simply divided into the total estimated 1972 value of finfish, or the total of column 4). This last result, percentages of total 1972 value by species, will be carried through to Table E-18, weights for combining sub-sectors of the fishery are derived.

5. In Table E-18, the percentages of total value for each species and the percentages of each of

those species caught be different gear types (or, the input cost structures represented by these gears) are converted into final percentages of total value represented for each of the input cost structures.

Columns 1, total percent 1972 value; 2, percent caught by trawlers; and 4, percent caught by gillnets and lines, were determined in Tables E-17, E-15, and E-15, respectively. The percentages of total 1972 values for each species were multiplied by the proportions of each species caught by each gear type to yield percentages of total harvest values for each species for each gear type. Adding the columns for the gear types results in the percentages of total harvest value for each gear type. Trawlers account for 82% of the total value, gillnets and lines for 14%. These values only account for 96% of the total landed value of finfish. The difference of 4% is assumed to reflect the different types of gear (boxes, harpoons, etc.) not considered in this I-O analysis.

The 14% weight was directly applied to gillnet/lines input cost structures in Table E-19. However, the estimated 82% of total value attributable to trawlers included redfish, which we have already determined to represent 37% of the total finfish harvest value. Therefore 45% of the total harvest value may be assumed attributable to the remaining trawlers (Table E-19). This 45% was further allocated to three different cost structures representing three sizes of trawlers: small draggers (55 ft., 30 tons), medium draggers (70 ft., 30-70 tons), and large draggers (95 ft., 70-100 tons) (Table E-19).

The vessel size classes as percentages of all vessels on the top of Table E-13 A indicate that there are, proportionately, many more 30 ton class vessels (small to medium trawlers on the worksheet), than larger non-redfish vessels. However, the data on Table E-13 A include purse seiners (and sardine carriers) which land about 32% of the total vessel landings (Table E-11). For all practical purposes there are proportionately more of the smaller size trawlers than the larger 70 ton trawlers, but not as much as Table E-13 A indicates (because the purse seiners and sardine carriers would represent the larger vessels). It will be assumed that there are enough of the smaller vessels to compensate for the carrying capacity advantage of the larger vessels; therefore, we will assume that the total landings of the three trawler classes are about equal. The 45% total value held by the trawlers will

Table E-14. *6-Year Average Catch (in pounds) by Species, by Gear*

Species	Trawl	Purse Seine	Gillnets & Lines	Weirs	Floating Traps	Harpoon	Bagnets	Dipnets	Box Traps
Alewives	27,117	6,550						2,560,017	
Cod	2,692,333		1,953,033						
Cusk	187,767		315,233						
Eels									78,750
Flounder:									
Blackback	279,000				217				
Dab	719,450				2,983				
Gray Sole	774,934				550				
Yellowtail	193,300								
Haddock	513,333		100,267						
White Hake	926,584		1,996,250						
Halibut	34,683		24,700						
Mackerel	4,950	30,600	2,500	34,883	117,967				
Ocean Perch	37,363,100		19,817						
Pollock	863,733		1,617,350						
Sharks									
Skates	12,133		2,083			133			
Smelts	1,800		10,100	83			53,650	5,117	
Swordfish	67	67	51,350			650			
Tuna		400	40,567			119,650			
Whiting	6,397,083		5,733						

Source: NMFS

Table E-15. 6-Year Average Catch (percentages) by Species, by Gear

Species	Trawl	Seine	Gillnets & Lines	Weirs	Floating Traps	Harpoon	Bagnets	Dipnets	Box Traps
Alewives	*/1.	*/*						99/99	
Cod	5.0/58		32/42						
Cusk	.4/37		5/63						
Eels									100/100
Flounder:									
Blackback	.5/99.9		*/.1						
Dab	1.4/99.6		*/.4						
Gray Sole	.5/99.9		*/.1						
Yellowtail	.4/100								
Haddock	1.0/83.6		1.6/16.3						
Hake	1.8/31.7		32.6/68.3						
Halibut	.1/58.4		.4/41.6						
Mackerel	*/2.0	.1/12.2	*/1.0	1.1/13.9	94.4/70.9				
Ocean Perch	72.4/99.9		.3/.05						
Pollock	1.7/34.8		26.4/65.2						
Sharks									
Skates	*/84.6		*/14.5			.1/.9			
Smelt	*/2.2		.3/24.9		*/.1		100/66.4	.2/66.4	
Swordfish	*/.1		.8/98.5			.5/1.2			
Tuna		*/.2	.7/25.2			98.5/74.5			
Whiting	12.4/99.9		.1/.1						

*Signifies less than .1%

Table E-16. 1972 Landings and Prices

Species	Value (thous.$)	Catch (thous. lbs.)	'72 price/lb.
Alewives	49	2,216	$0.02
Cod	437	4,432	$0.10
Cusk	39	432	$0.09
Eels	25	70	$0.36
Flounder:			
Blackback	38	282	$0.135
Dab	67	527	$0.127
Gray Sole	147	993	$0.148
Yellowtail	47	276	$0.17
Haddock	165	491	$0.336
Hake	176	2,949	$0.06
Halibut	51	74	$0.69
Mackerel	14	92	$0.15
Ocean Perch	2,268	42,748	$0.06
Pollock	93	1,326	$0.07
Smelts	17	74	$0.23
Tuna	30	252	$0.12
Whiting	331	4,095	$0.08
	3,994	61,329	

Source: DMR

Table E-17. 6-Year Average Percentage of Species Catch by Weight and Value

Species	6-year ave. total lbs.	% total lbs.	$0.00/lb.	'72 $ value	% total '72 value
Alewives	2,593,684	4.3%	$0.02	$ 51,874	1.3%
Cod	4,645,366	7.7%	$0.10	$ 464,537	11.7%
Cusk	503,000	.8%	$0.09	$ 45,537	1.1%
Eels	78,750	.9%	$0.36	$ 28,350	.7%
Flounder:					
Blackback	279,217	.5%	$0.135	$ 37,694	1.0%
Dab	722,433	1.2%	$0.127	$ 91,749	2.3%
Gray Sole	775,484	1.3%	$0.148	$ 114,772	2.9%
Yellowtail	193,300	.3%	$0.17	$ 32,861	.8%
Haddock	613,600	1.0%	$0.336	$ 206,170	5.2%
Hake	2,992,834	4.8%	$0.06	$ 175,370	4.4%
Halibut	59,383	.1%	$0.69	$ 40,974	1.0%
Mackerel	250,950	.3%	$0.15	$ 37,642	1.0%
Ocean Perch	37,382,917	62.2%	$0.05	$1,869,146	47.1%
Pollock	2,481,083	4.1%	$0.07	$ 173,676	4.4%
Sharks, skates	14,349	.002%	$0.08	$ 1,148	*
Smelts	80,750	.1%	$0.23	$ 18,572	.5%
Swordfish	521,134	.009%	$0.90	$ 46,921	1.2%
Tuna	160,617	.3%	$0.12	$ 19,274	.5%
Whiting	60,662,523 (3)	10.6%	$0.08	$ 512,225	12.9%
				$3,968,225	100.0%

Sources: DMR, NMFS

Table E-18. Percentages of Total Value Attributable to Trawls & Gillnets/Lines

Species	Value (Table E-17)	Trawls (Table E-15)	*% Value towards trawls	% Caught by gillnets & lines	*% Value towards gillnet/line
Alewives	1.3%	1.0%	.013		
Cod	11.7%	58.0%	6.786	42%	4.914
Cusk	1.1%	37.0%	.407	63%	.693
Flounder:					
Blackback	1.0%	99.9%	.999	.1%	.001
Dab	2.3%	99.6%	2.291	.4%	.009
Gray Sole	2.9%	99.9%	2.897	.1%	.003
Yellowtail	.8%	100.0%	.800		
Haddock	5.2%	83.6%	4.347	16.3%	.848
Hake	4.4%	31.7%	1.395	68.3%	3.005
Halibut	1.0%	58.4%	.584	41.6%	.416
Mackerel	1.0%	2.0%	.020	1.0%	.001
Ocean Perch	47.1%	99.9%	47.053	.05%	.024
Pollock	4.4%	34.8%	1.531	65.2%	2.569
Sharks	-	84.6%	-	14.5%	-
Smelt	.5%	2.2%	.011	24.9%	.124
Swordfish	1.2%	.1%	.001	98.5%	1.182
Tuna				25.2%	.126
Whiting	12.9%	99.9%	12.887	.1%	.013
			*82.022%		*14.228%

14.228
+82.022
96.250* As previously mentioned, the 10 large redfish vessels account for 37% of the total value, that is all trawlers (99.9%, Table E-19), so 82% - 37% leaves 45% of total value for the mid-sized trawlers (see work sheet).

Data from Tables E-17 and E-15.

Table E-19 Technical Coefficients by Gear Type

U.S. I-O no.	Item	Gillnetters (40-45 ft. 10 tons)	Dragger (55 ft. 30 tons)	Medium Dragger (70 ft. 30-70 tons)	Large Dragger (95 ft. 70-200 tons)	Large Redfish Dragger (135 ft. 125-225 tons)	Small Redfish Dragger (106 ft. 90-125 tons)
17	Synthetic lines		.0181	.2188	.2251	.1243	.2000
19	Synthetic nets	.1146	.0636	.1042	.0479	.0717	.0890
32	Lifesaving equipment	.0010	.0027	.0016	.0029	.0010	.0012
42	Cable		.0218	.0156	.0072	.0120	.0130
42	Chain		.0018	.0078	.0036	.0048	.0065
43	Engines	.0276	.0258	.0536	.0306	.0359	.0534
48	Refrigeration					.0087	.0144
49	Hydraulic lifting gear	.0068	.0704	.0365	.0168	.0191	.0304
56	Radar, Loran, radios	.0366	.0582	.0276	.0101	.0155	.0209
61	Hull, House	.0821	.0773	.0573	.0599	.0956	.1087
64	Hooks, Jigs, Tools, etc.	.0042	.0018	.0156	.0072	.0072	.0087
65	Transportation	.2167	.2000	.1250	.1149		
69	Fuel	.0609	.1415	.1040	.0718	.1076	.1652
69	Other		.0073				
70	Insurance	.0281	.0545	.0792	.0431	.0478	.0782
70	Loan Interest	.0572	.0290	.0625	.0479	.0598	.0852
73	Office	.0026	.0091	.0078	.0036	.0036	.0065
	Value added	.3614	.2168	.1871	.3075	.3854	.1201

The six types of vessels listed above were assigned the following weights to obtain the technical coefficients for the industry:

Gillnetters	.14	Large dragger	.15
Small dragger	.15	Small redfish dragger	.12
Medium dragger	.15	Large redfish dragger	.24

Technical coefficients for the industry are presented in Table E-20. Note: columns may not sum to 1.0 due to rounding.

then be divided equally among the three size classes. Each third of the 45% yields 15% of the total finfish harvest value attributable to each of the three trawler classes. These percentages were applied as weights to the basic trawler input cost structures.

All the major input cost structures included in the finfish harvesting sector have percentages of total value weights associated with them (refer to Table E-19). Each individual input for each vessel class was multiplied by its respective total value weight. These results were then added across the worksheet to yield the final estimates presented in Table E-20.

VI. Finfish Processing Sector I-O Estimates:

The finfish processing sector I-O estimates were calculated in much the same manner as were the harvesting sector estimates. Input costs structures were obtained for representative processing operations, then, according to each category's contribution to total processed output, weights were determined. These weights were multiplied by representative cost structures, and the results were summed to yield final I-O estimates.

Input cost structures were obtained by interviewing processing plant representatives. Because of confidentiality, these figures (processing plant categories' input structures) will not be included here.

Table E-20. Technical Coefficients for the Finfish Harvesting Sector

U.S. I-O no.	Industry Title	Technical Coefficient
17	Miscellaneous textile goods	.1251
19	Miscellaneous fabricated textiles	.0769
32	Rubber, miscellaneous plastics	.0017
42	Fabricated metal products	.0152
43	Engines and Turbines	.0359
48	Food products machinery	.0040
49	General industrial equipment	.0280
56	Radio and communication equipment	.0259
61	Other transportation equipment	.0771
64	Miscellaneous manufacturing	.0071
65	Transportation and warehousing	.0963
69	Fuel	.1034
70	Finance and insurance	.1066
73	Business services	.0051
	Value added	.2993

Table E-21. All Maine Finfish Processing Plants - 1972

	% lb. value	% $ value
Pollock	10.9	68.8
Cod	13.1	12.2
Haddock	9.6	18.6
Flounders	4.1	4.8
Redfish	47.2	43.4
W. Hake	5.2	5.1
Cusk	5.8	6.3
Whiting	2.9	.8
Other	1.2	2.1

Source: NMFS unpublished data

Estimation of I-O Weights:

The input costs structures of the industry were broken down in terms of:

(1) high volume, relatively capital-intensive processors

(2) high volume, less capital-intensive redfish processors

(3) small, more labor-intensive, low volume processors.

Weights corresponding to these three categories representing the proportion of total value attributable by each to the total finfish processing sector production. This table appears above with each entry represented as a proportion of total value by weight and by dollar value.

Since redfish was a category within itself, the percent of total value attributable to redfish was taken directly from Table E-21. The remaining two weights were more difficult to establish. In 1972 the first category, that of high volume capital-intensive processors did not exist. The processed fish produced by this category are almost all imported and therefore they would not be properly represented by Table E-21. The total pounds processed per year by this category (obtained from interview) were added to the totals in Table E-21. The proportion of the new total by value attributable to this category was extracted from the new totals of Table E-21. Again, the figures will not be shown (to protect the privacy of the firms involved). The resulting weight was multiplied by the input costs for the large high-volume, capital-intensive category.

The remaining proportion of total value was assumed to represent the last input category, and was multiplied by the associated input costs. All three categories were then added, input by input, to yield the I-O estimates in Table E-22.

Table E-22. Technical Coefficients of the Finfish Processing Sector

Industry	Inputs	I-O estimate
3	raw fish	.6195
12	plant depr., maint., and repair	.0398
25	containers and wrap	.0399
46	forklifts, trucks, (company owned)	.0163
48	skinning, filleting, freezing machinery	.0676
65	trucking services	.0125
69	fuel, wholesale, retail trade	.0236
70	marketing, offices, administration	.0205
75	automotive repair	.0025
68	utilities	.0229
Value added		.1399

APPENDIX IV

Estimation Techniques Used in Compiling the Herring/Menhaden Sector for the Maine Input-Output Table

by

Hugh Briggs
University of Maine at Orono
Senior, Department of Economics
University of Maine at Orono

Estimation Techniques Used in Compiling the Herring/Menhaden Sector for the Maine Input-Output Table

I. Methodology:

Input-output analysis is based on a detailed accounting system for economic transactions that occur between industries with a buyer-seller relationship. As an accounting technique, one of its foremost requisites is a detailed definition of each different industry's output. The Maine input-output table contains two activities for the herring/menhaden sector: (1) the harvesting of herring and menhaden and (2) the processing of herring and menhaden. The herring/menhaden harvesting sector of the Maine economy is defined, for measurement purposes, as being comprised of the economic activity of individuals who reside in Maine and land herring or menhaden in Maine ports or elsewhere and incur costs and receive payments as a result of fishing for herring and menhaden. The herring harvesting sector includes two subsectors, the juvenile herring fishery, a source of raw material for sardine and fish steak canning plants, and the adult herring fishery. The herring processing sector is the industry which transforms either raw herring or processed herring by-products into products utilized as either human and animal foodstuffs or inputs to other industrial processes. Thus, the herring processing sector's output includes sardines, canned fish steaks, marinated herring, salted and smoked herring, herring fillets, herring roe and spreads, and fish meal and pearl essence which serves as an input to another industry. Menhaden are sold either as bait to lobstermen or as inputs to fish meal processing plants. In addition, 9.9% of the herring harvested is sold directly as lobster bait (Maine Herring Management Plan 1978, 1979, 1980).

Although the foregoing seems to be a complete description of the various types of herring products and fisheries identifiable in Maine, as a practical matter, there were several problems in collecting the data. For example, the amount of herring landed by Maine fishermen in ports outside Maine could not be determined. Similarly, it could not be determined what proportion of Maine landings are caught by fishermen who are not residents of Maine. These two limitations in the available data dictated a strategy of assuming that all herring landings in Maine were by Maine fishermen and that Maine herring landings accounted completely for all the herring landed by individuals from Maine. In the processing sector, the sheer number of different types of products and the reluctance of participants in some of the industries to release information combined to force the exclusion of some of the relatively minor activities from the total value of processed herring products. More specifically, the processing sector used to construct the table includes input cost descriptions for the fish meal processing, sardine and steak canning, and filleting sectors of the industry. (Refer to Table E-23 for a more accurate picture of what has been omitted in value terms).

Table E-23. Weighting System for Processed Herring and Menhaden

Product	Value (1000 1975 dollars)	% of total	Adjusted %
Sardines	24,917	47.25	53.92
Roe, spreads, and fish	3,348	6.35	---
Pearl essence	3,172	6.02	---
Fillets	2,827	5.36	6.12
Industrial	18,466	35.02	39.96
TOTAL	52,730	100.00	100.00

Source: U.S. Fishery Statistics, 1975.

The above data yield the following weighting system for processing sector input costs:

.5392(s) + .0612(f) + .3996(i) = industry input coefficient, where s=sardines, f=fillets, i=industrial products.

With the foregoing definitions and caveats as a framework, two types of data were obtained. At the level of the firm, annual input costs and total revenues for the "average" firm in each subdivision were required for the calculation of the technical coefficients. One step up the economic hierarchy, each industry's (or gear's, in the case of harvesting) proportion of the total value of processed and harvested herring and menhaden had to be calculated to determine an appropriate weighting scheme for combining their respective technical coefficients to acquire a set of technical coefficients appropriate for each of the combined processing and harvesting sectors.

Except where noted below, estimates of input costs and total revenue were obtained by interviewing individuals connected with the particular type of activity. Interviews typically began with an explanation of our research purposes and a request for an estimate of the total annual cost of each input required for the specific activity. In cases where an input could be used for more than one year, a useful-life estimate and an estimate of maintenance costs were also requested. Problems occurring when two people gave different estimates for the same item were generally resolved by averaging the two costs unless further evidence indicated that one of the cost figures was more plausible. Because some individuals were unwilling to provide total revenue estimates, a variety of techniques, detailed below, were used to estimate total revenue for the average unit.

II. The Harvesting Sector

As was previously mentioned, two subsets of the herring harvesting sector were covered in the study; the fishery for juvenile fish and the fishery for adult fish. For an input-output model, separate treatment is important. Although they utilize the same fishing gear, the majority of adults are landed with mobile gear, while the majority of juveniles are landed with fixed gear. Both fisheries include operators of stop seines, purse seines, and weirs. Purse seines account for 77% of the adult harvest (Maine Herring Management Plan, 1978, 1979, 1980). Therefore, the input costs of harvesting adult fish are represented by the input cost structure of purse seiners, the input costs of weirs, and the input costs of stop seines weighted with 77%, 11.5%, and 11.5% of the catch, respectively.

For the juvenile herring harvesting sector, high year-to-year variation in catch by gear forced the use of a ten year average (1969-1978) of catch by gear statistics to determine the weighting system to be used for combining the input costs of the three types of gear (see Table E-24). Note that, consistent with the definition of juvenile fish harvesting, method of catch by sardine case statistics were used rather than the more conventional measures of catch (tons, for example). Catch by gear statistics would have included adult-fish harvesting activities.

The most recent three years for which statistics indicate the proportions of juvenile and adult herring landed, 1974-1976, were averaged in weighting the input costs of the two fisheries. The weighting formula was calculated by multiplying proportion of total herring landed (lbs.) that was used for filleting by the 1979 price per pound. The same procedure was used for juvenile herring. The resulting figures served as weights in combining the two herring fisheries (see Table E-25).

Well over 90% of the menhaden caught each year are landed with

Table E-24. Percentage of 1/4 Oil and Mustard Pack Cases by Method of Catch, 1969-1978

Year	Gear Type		
	Purse Seine	Stop Seine	Weir
1969	59.11	22.00	18.89
1970*	73.78	19.52	6.70
1971*	57.56	40.30	2.13
1972*	8.15	83.17	8.68
1973	54.07	39.70	6.23
1974	67.25	16.22	16.53
1975	33.91	44.76	21.33
1976	10.69	80.91	8.40
1977**	22.31	72.25	5.44
1978**	24.71	36.06	39.23
10 year average	41.15	45.49	13.36

Source: Maine Sardine Council

* In these years, the category "mixed" appears in the source data and has been excluded here. Mixed gear accounted for .04% of the catch in 1970, .31% in 1971, and .84% in 1972.

**In these years, the category "trawlers" appears in the source data and has been excluded here. Trawlers accounted for 1.5% of the cases in 1977 and 2.8% in 1978.

Table E-25. Total Value of Herring Harvest and Value by Adult and Juvenile Sub-sectors, 1974, 1975, 1976

	Year		
	1974	1975	1976
Juvenile fishery			
Landings	42,202	33,473	66,552
Value	2,182	1,731	3,441
% of total value	75.01	72.16	86.98
Adult fishery			
Landings	5,196	4,775	3,677
Value	727	668	515
% of total value	24.99	27.84	13.02
Total			
Landings	47,398	38,248	70,229
Value	2,909	2,399	3,956
% of total value	100.0	100.0	100.0

Average 1974-1976: Juveniles 78.05% of total landed value of herring
Adults 21.95% of total landed value of herring

Source: U.S. Fishery Statistics
Herring Management Plan

All values are in thousands of current dollars.

purse seines (see Table E-26). The cost structure for purse seiners was used to represent the costs of harvesting menhaden.

Technical coefficients for each type of gear are presented in Table E-29. The technical coefficients for the industry are presented in Table E-30. To obtain input coefficients for the herring/menhaden harvesting sector these technical coefficients were combined according to a weighting scheme (derived in Table E-28) that utilizes information stated earlier on catch by gear for adult herring, juvenile herring, and menhaden and the proportion of the total menhaden and herring landings attributable to herring (adult and juvenile) and menhaden (presented in Table E-27).

Weir Operations:

The operators of two weirs—a newly constructed weir and a relatively long-standing weir—were interviewed to obtain the costs for their operations.

Due to the amount of annual variation in total revenue for a weir operator, total revenue for a weir operator was calculated by first applying the weir catch by gear proportion to the juvenile herring landed figures for 1972-1975 (obtained from U.S. Fishery Statistics) and then multiplying by 1979 prices and dividing by the number of weirs for each year.

Stop Seine Operations:

For stop seine operations, the individual interviewed fished for

Table E-26. Value* of Menhaden Landings by Purse Seine 1973-1975

Year	Value of Menhaden Landed	Value of Catch by Purse Seine	% of total
1973	144	142.6	99.03
1974	155	152.4	98.32
1975	196	196	100.0

Source: U.S. Fishery Statistics

*Thousands of current year dollars.

Table E-27. Herring and Menhaden Landings and Proportion of Total Herring and Menhaden Landings, 1973-1979

Year	Herring	(% of total)	Menhaden	(% of total)	Total*
1973	1,080	(.8824)	144	(.1176)	1,224
1974	1,793	(.9204)	155	(.0796)	1,948
1975	1,423	(.8795)	195	(.1205)	1,618
1976	2,909	(.9065)	300	(.0935)	3,209
1977	2,399	(.9713)	71	(.0287)	2,470
1978	3,956	(.9579)	174	(.0421)	4,130
1979	4,584	(.8578)	760	(.1422)	5,344

1973-1979 average...herring 91.08% of total herring/menhaden harvested value, menhaden 8.92% of harvested value.

*Units are thousands of current dollars.

Table E-28. Weighting System for Herring/Menhaden Harvesting

Let:

w = weir technical coefficient

ss = stop seine technical coefficient

ps = purse seine coefficient

Then:

Adult herring input coefficients = .77(ps) + .115(w) + .115(ss)

Juvenile herring input coefficient = .4115(ps) + .1336(w) + .4549(ss)

Menhaden input coefficient = 1.00(ps).

The two herring subsectors are combined according to their proportion of the total landed value of herring:

.2195(.77 (ps) + .115(w) + .115(ss)) + .7805(.4115(ps) + .1336(w) + .4549(ss)) = .4902(ps) + .1295(w) + .3802(ss).

To obtain technical coefficients for the whole harvesting sector, herring harvesting is combined with the menhaden harvesting according to their proportion of total value of menhaden and herring landings:

.0892(1.00(ps)) + .9108(.4902(ps) + .1295(w) + .3802(ss)) = .5357(ps) + .1179(w) + .3483(ss).

Table E-29. Herring Harvesting Technical Coefficients

U.S. I-O no.	Industry Title	Weir fishery	Stop seine fishery	Purse seine fishery
3	Forestry products	.0277		
19	Misc. textile products	.2461	.1466	.1358
20	Lumber and wood products	.0010		
32	Rubber and misc. plastics			.0036
42	Other fab. met. products			.0082
43	Engines, turbines	.0159	.0617	.0727
45	Constr. machinery and equipment	.0027		
49	General mach. and equip.		.0049	.0411
56	Radio and TV equipment	.0074	.0098	.0370
61	Boatbuilding and repair	.0524	.0780	.1561
62	Prof. and scientific instruments	.0074	.0031	
69	Wholesale and retail trade	.0208	.1159	.0472
70	Real estate, insurance			.0708
	Value added	.6186	.5800	.4275

Table E-30. Combined Harvesting Technical Coefficients

U.S. I-O no.	Industry Title	Input Coefficient
3	Forestry products	.0032
19	Miscellaneous textile products	.1528
20	Lumber and woods products	.0001
32	Rubber and miscellaneous plastics	.0018
42	Other fabricated metal products	.0040
43	Engines and turbines	.0617
45	Construction machinery and equipment	.0003
49	General machinery and equipment	.0221
56	Radio and TV equipment	.0028
61	Boatbuilding and repair	.1132
62	Professoinal and scientific instruments	.0021
69	Wholesale and retail trade	.0713
70	Finance and insurance	.0347
	Value added	.5098

herring six months of the year and scalloped the other six months. His operation was assumed to be representative of stop seine operations. For that reason, items that are presumably also utilized as scalloping gear were depreciated only half a year.

Due to the unknown nature of the functional relationship between catch (and therefore total revenue) and other variables, this individual's average revenue figure was used rather than some other estimate. The individual stated that expenses accounted for about 42-44% of his total revenue. To calculate total revenue, the equation (.42) total revenue = cost was solved to yield a total revenue of $27,971. The result was lent further credence as the individual also noted that, in an average year, he landed approximately 400 hogshead of herring, which, at $70/hogshead, yields a total revenue of $28,000.

Purse Seine Operations:

The input cost data for purse seining were obtained from a 1976 tariff study undertaken at UMO. All figures used in the study were in 1975 dollars.

III. The Herring Processing Sector

The processing sector, as previously noted, includes the input costs for sardine and steak canneries, fresh and frozen fillet plants, and fish meal processors. The data from the three sectors were collected by interviewing participants in each sector, and were weighted by using the 1975 proportion of total value of herring output attributable to each sector and adjusting these figures upward to reflect the exclusion of the pearl essence and roe, spreads and fish categories (see Table E-23).

The quantity of herring imported from Canada varies highly from year to year. Therefore a ten year average of the percentage of total U.S. herring supply that was imported was used for the table (see Table E-31).

Processing sector input coefficients are presented in Table E-32. For the most part, these figures can be considered fairly accurate. The technical coefficients for each processing sector have not been shown in order to satisfy confidentiality requirements placed by their sources.

Table E-31. Percentage of Sardine Pack Imported from Canada, 1968-1977

Year	Percent Imports	Year	Percent Imports
1968	49.37	1973	46.34
1969	42.00	1974	53.4
1970	47.19	1975	60.8
1971	59.92	1976	29.2
1972	50.41	1977	19.2

10 year average—45.8%

Table E-32. Herring Processing Technical Coefficients

U.S. I-O no.	Industry Title	Input Coefficient
12	Maintenance and repair construction	.0178
14	Food and kindred products	.0134
21	Wooden containers	.0093
25	Paperboard containers	.0294
29	Cleaning supplies	.0001
39	Metal containers	.0187
40	Fabricated metal products	.0006
42	Other fabricated metal products	.0002
44	Farm machinery and equipment	.0008
45	Construction machinery and equipment	.0011
46	Material handling machinery	.0017
48	Special machinery and equipment	.0384
49	General machinery and equipment	.0311
53	Electrical transmission equipment	.0010
59	Motor vehicles and equipment	.0034
65	Transportation	.0855
68	Electricity, water, gas	.0467
89	Wholesale and retail trade	.0170
70	Finance and insurance	.0152
73	Business services	.0388
	Herring harvesting	.0702
	Herring processing	.0576
	Value added	.0938

APPENDIX V

Input-Output Estimates for the Lobster/Crab/Scallop Sector

by

Blair Burlingame
Graduate Student
University of Maine at Orono
Department of Agricultural
and Resource Economics

Input-Output Estimates for the Lobster/Crab/Scallop Sector

I. Explanation of Entries of Costs into the Lobster/Crab Harvesting Sector.

A. Introduction: Lobster Harvesting

Several problems arose from our attempts to identify the costs of the "average" full-time lobstermen. The operating characteristics of full-time lobstermen change as the season progresses from April to December. Furthermore, even at a given time during the harvesting season, one observes varying costs as he travels from east to west along the coast. This appendix will detail the sources consulted and methods used to construct the lobster/crab/scallop sector of the input-output table.

For most fishermen lobstering is only a six to seven month job. Large numbers of lobstermen switch to other fisheries for relatively short periods during the year according to the seasonal or cyclical abundance of other species. Still, lobster fishing remains the primary source of income for the majority of Maine fishermen. And, despite this switching behavior, the full costs of inputs used by lobstermen are attributed to lobstering. The sole exception to this rule applies to lobstermen who also harvest scallops. Costs common to both lobstering and scalloping are attributed 1/2 to scalloping, 1/2 to lobstering. All costs are based on 1978 figures unless otherwise specified.

The remainder of this report consists of eight tables that either itemize costs of lobster, crab and scallop harvesting or processing or show how the costs were included in the I-O table. Knowledgeable members of Sea Grant, UMO, and DMR, and industry sources were consulted to obtain the estimates. The text which follows explains entries which were the most troublesome to estimate.

B. Methods of Estimation for Table E-33, Lobster/Crab Harvesting Costs

Inputs: (underlined numbers refer to "Entry" numbers in Table E-33).

1 Sea Grant and UMO sources estimated that traps cost $20 each and have a lifespan of five years. All traps were assumed to be made of wood rather than metal. Wooden traps constitute the majority and are regaining popularity over time in the opinion of members of Sea Grant and industry participants interviewed. It was estimated that the average full-time lobsterman fishes 250 traps which are hauled 100 times a year with each trap containing an average of .5 pounds per haul. This implies that the "average" full-time lobsterman landed 13,200 pounds in a year. Crediting 1 million pounds of the recorded 19 million pounds landed in 1978 to part-timers would suggest the presence of only 1,350-1,400 full-time lobstermen in Maine. Yet it is usually estimated that there are approximately 2000 full-time lobstermen in Maine. However, it is also generally believed that recorded landings represent only a percentage of actual landings. If recorded lobster landings were 75% of the actual landings, our estimate of the number of full-time lobstermen increases to 1,900-2,000.

Table E-33. Lobster/Crab Harvesting Costs (purchases of inputs)

Entry	U.S. I-O no.	Description	Cost/$1 sales
1		260 traps @ $20 per trap 5 yr. life $5200 total	
1a	28	Toggle (foam)	.0048
1b	17	Twine @ $5 per trap $1300	.0108
1c	28	Buoy @ $1.50 per trap $390	.0033
1d	20	Wood @ $5.50 per trap $1430	.0119
2	3	Bait 347 bushels at $7 per bu. $2,429	.1022
3	61	Hull and house $12,000 20 yr. lifespan	.0250
4	43	Main engine $7,000 10 yr. lifespan	.0291
5	49	Pumps $100 2 yr. lifespan	.0208
6	56*	Radar $3,500 6 yr. lifespan	.0121
7	56*	Loran $3,500 6 yr. lifespan	.0121
8	56	Radio $100 3 yr. lifespan	.0013
9	32	Life saving equipment $200 5 yr. lifespan	.0020
10	49	Hydraulics $2,500 6 yr. lifespan	.0173
11	17	Syn line $500 4 yr. lifespan	.0052
12	69	Fuel $2,00 per year	.0833
13	70	Insurance $300 per year	.0125
14	73	Office $300 per year	.0125
15	65	Truck $5500 4 yr. lifespan	.0572
16	24	Shed (storage)	.0145
17	42	Tools $450 10 yr. lifespan	.0018
18	32*	Boots $30	.0006
19	62	Compass $75 25 yr. lifespan	.0001
20	62	Depth finder $150 7 yr. lifespan	.0008
21a	28	Trap maintenance	.0076
21b	17		.0190
21c	28		.0057
21d	20		.0208
Maintenance (parts)			
22	61	Hull, house $700 per yr.	.0291
23	61	Engine (main) $500 per year	.0208
24	61	Hydraulic gear $100 per year	.0125
25	61	Paints and varnishes $100 per year	.0041
26	75	Truck parts $200 per year	.0083
27	70	Interest $1900 per year	.0791

*Half of the cost is charged to scalloping.

2 Demand for bait does not respond greatly to changes in cost. Estimates of bait costs range from $3.50 per bushel to as much as $12.00. Final estimates of $7 per bushel and 1 bushel of bait per 75 traps per haul were used.

9 No estimate could be made of the percentage of boats that have lifesaving equipment required by law. This entry assumes 100% compliance with the law.

21 (a b c d) Trap maintenance based on 35% replacement for depreciation and storm loss.

C. Introduction: Crab Harvesting

It is believed that virtually all crab landings are harvested by lobstermen. Furthermore, sources at DMR claim that no significant amount is harvested south of Portland (because of overfishing and poor habitat) and east of Frenchmen's Bay (due to poor habitat). There appears to be little or no additional costs for a lobsterman to also harvest crabs.

Pounds per trap per haul is highly variable due to seasons and diverse habitat. The limited data available indicates that the catch per trap per haul ranges from 0.0 in York County to as much as 12.5 crabs per trap per haul in Belfast.

It is generally agreed that the recorded landings (those going to crab processing plants) are only about 1/2 actual landings. The remainder goes to people who pick crabmeat in their own homes and sell to stores, operate roadside stands, etc.

Recorded landings for crabs were doubled, then divided by the number of full-time lobstermen to obtain estimates of total crab catch per lobsterman (each crab weighs roughly 1 pound, depending on the time of year). But this methodology gives no credit for crab landings to the part-time lotsterman. If we assume that part-timers contributed to crab harvesting in the same proportion as they contribute to lobster landings (5.3%), then, the results would indicate 2,717,000 (actual) lbs. harvested by full-time lobstermen and 1,993 pounds per full-time lobsterman. At 12 cents per pound ex-vessel price, each lobsterman lands $239.16 worth of crab.

It is interesting to note that, from 1978 to 1979, the ex-vessel price for crabs has increased from 12 cents to as much as 25 cents per pound and will probably continue to rise at a steady rate.

D. Breakdown of Costs Table E-34 - Lobster/Crab Harvesting:

How to read Table E-34. The first column item indicates the U.S. Input-Output Industry Code to which each entry is allocated.

The second column contains a description of the cost item.

The third column contains the technical coefficient, or cost, per dollar of output, of the input described in the second column.

Total revenue for the "average" lobsterman is computed in the following manner:

13,200 lbs. lobster at $1.80/lb. (DMR) =	$23,760
1,993 lbs. crab at $.12/lb. (1978 DMR)=	$ 239
	$24,000

Table E-34. Lobster/Crab Harvesting Table

U.S. I-O no.	Industry	Technical Coefficient
3	Groundfish sector	.1022
17	Textile products	.0349
20	Lumber, wood products	.0327
24	Paper, allied products	.0145
28	Plastics, synthetics	.0214
32	Rubber misc. plastic	.0026
42	Other fab. metal products	.0018
43	Engine, turbines	.0291
49	General machine equipment	.0381
56	Radio, TV, etc. equipment	.0255
61	Other transport equipment	.0915
62	Professional scientific instruments	.0009
65	Transport, warehousing	.0572
69	Wholesale, retail trade	.0833
70	Finance, insurance	.0916
73	Business services	.0125
75	Automotive repair	.0083
	Value added	.3519

II. Explanations of Entries into the Scallop Harvesting Sector

A. Introduction

The scallop season runs from November 1, to April 15. There are apparently no full-time scallopers operating in the state of Maine. Since the lobster season runs from June or July to October or November and the average lobster boat is relatively easily adapted to scalloping, much of the scalloping is done by lobstermen.

Because boats can be easily adapted to scalloping, the level of activity in scalloping can be variable. During times of abundant stocks, many boats will go scalloping. Stocks quickly become depleted and fishermen store their dragging equipment until such time as the beds restore themselves. This process has been occurring for the past 10 years with a 2-3 year cycle. The figures used here for the "average" scalloper represent costs for a "good" year.

B. Explanation of Entries in Table E-35, Scallop Harvesting Costs

Entry Number:

5,6,7 Based on 1976 Tariff Study, 1/2 of the cost being attributed to scalloping. Accurate figures on the number of boats equipped with radar and loran are not readily available. Based on discussions with lobstermen, the assumption was made that all boats had radar and loran.

8 The presence of life-saving equipment appears to be related to the time of year the fishing actually occurs. Accurate data are not available; it is assumed that all boats have the equipment.

Estimates of average fishing days per year were obtained from interviews with fishermen. Total landings per fisherman estimates ranged from 9,000 to 15,000 pounds. If the average lobsterman lands 12,500 pounds per year, and the ex-vessel price is $2.10 per pound, total revenue for each fisherman equals $26,150*. The resulting technical coefficients are presented in Table E-36.

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*This suggests that, given the total pounds landed in 1977 (395,000), there were only 32 full-time scallopers. If we instead base the estimate on the average "good" year, such as 1978, then there were 73 full-time scallopers. There are no estimates available of the number of scallopers nor could any estimate be made of the percentage of total landings represented by recorded landings.

Table E-35. Scallop Harvesting Costs

Entry Number	U.S. I-O no.	Item Description	Cost/$1 sales
1*	61	Hull and house $12,000 20 yr. lifespan	.0114
2*	43	Main engine $7,000 10 yr. lifespan	.0133
3	61	Mast and boom $1,200 30 yr. lifespan	.0015
4*	49	Pumps $100 5 yr. lifespan	.0003
5*	56	Radar $3,500 6 yr. lifespan	.0111
6*	56	Loran $3,500 6 yr. lifespan	.0111
7*	56	Radio $100 2 yr. lifespan	.0006
8	32	Life saving equip, $100 5 yr. lifespan	.0007
9	49	Hydraulic gear $1000 10 yr. lifespan	.0038
10	49	Other lifting gear $2000 15 yr. lifespan	.0050
11*	17	Synthetic line $250 2 yr. lifespan	.0047
12	50	Triple drag $1000 per year	.0380
13	50	Cable (100 fathom) $220 2 yr. lifespan	.0041
14	20	Dump box $100 5 yr. lifespan	.0007
15	50	Chain $100 4 yr. lifespan	.0009
16	69	Fuel $1800 per year.	.0685
17	70	Insurance $1000 per year	.0380
18	70	Interest $1000 per year	.0380
19	73	Office $200 per year	.0076
Maintenance (parts)			
20	61	Hull $500	.0190
21	61	Rigging $300	.0114
22	69	Engine $200	.0076
23	69	Radar $75	.0028
24	69	Radio $20	.0007
25	61	Other gear $50	.0019

*Half of cost charged to lobstering

Table E-36. Scalloping Harvesting Table

U.S. I-O no.	Industry	Technical Coefficient
17	Textile products	.0047
20	Lumber, wood products	.0007
32	Rubber, misc. plastics	.0007
43	Engines and turbines	.0133
49	General machinery and equipment	.0091
50	Machine shop products	.0430
56	Radio, TV, etc., equipment	.0228
61	Other transportation equipment	.0528
69	Wholesale and retail trade	.0720
70	Finance, insurance	.0760
73	Business services	.0076
		.3027
	Value added	.6973

III. Explanations of Entries into Table E-37, Lobster Processing and Distribution Costs:

Our estimate is that 75 percent of recorded lobster landings, or 14,250,000 pounds, go through the distribution chain. Of this amount, some 1,050,000 pounds are processed. Approximately one pound of meat is obtained from three pounds of live lobster; from the 1,050,000 pounds of Maine lobster processed approximately 350,000 pounds of meat are obtained. In addition, about 300,000 pounds (live weight) of lobster meat processed in Maine in 1978 came from Canada.

Entry Number: (corresponding to Table E-37)

3 Holding capacity in the state of Maine is 4,200,000 pounds. Rental cost is estimated to be $0.20 per pound for lobster going in, with a

turn-over rate of 2-3 times a year. We assumed that distributors handle 300,000 pounds lobster/year (actually there are about 110 dealers in Maine and sometimes pound owners are also dealers). In our interviews of industry members, the 300,000 pound size unit was the reference size used by firms in providing estimates of operating costs. This would suggest the presence of about 50 distributors (14,250,000 total pounds divided by 300,000 pounds per distributor). If all dealers shared pounding equally, then 4,200,000 pounds of holding capacity divided among 50 dealers yields an estimate of 8,400 pounds for each dealer. With rental costs of $0.20 cents per pound, our estimate of cost for each time the pound is filled is $16,800. Again assuming turnover to be 2 per year, the total cost for each dealer for pounding is $33,600.

4 Salt for bait costs $3.25 per 80 pounds salt. A lobster pound handling 300,000 pounds of lobster annually uses 213,000 pounds of salt.

8 Trucking costs, a highly variable item, were estimated by assuming a capacity of 20,000 lbs/truck and base costs of $190 for a trip from Stonington to Bangor. The 300,000 pounds output per dealer divided by 20,000 lbs/truck indicates 15 trips. At $190/trip (average trip) total trucking costs would be $2,850. The $2,850 was rounded to $3,000 for our estimate.

13 Includes all taxes (payroll, social security, etc.). Estimated to be .20 cents per dollar.

Table E-37. Lobster Processing and Distribution Costs

Entry Number	U.S. I-O no.	Item description	Cost/$1 sales
1	24	Shipping crates $10 per crate replace 400 per year	.0047
2	24	Lobster car $3,000 8 yr. lifespan	.0004
3	65	Pounds $33,600 per year	.0400
4	27	Salt for bait $8853 per year	.0103
5	3	Mortality	.0131
6	24	50 wooden pallets $3 3 yr. lifespan	.00006
7	46	Fork lift $4,500 15 yr. lifespan	.0003
8	65	Trucking costs $3,000 yr. lifespan	.0035
9	70	Interest $2500 per year	.0029
10	73	Legal fees $2000 per year	.0023
11	70	Insurance $1200 per year	.0014
12	79	Property tax $2000 per year	.0023
13	79	Payroll tax $4368 per year	.0052
14	70	Banking 200 per year	.0002
15	69	Energy $400 per wk. $20,800 per year	.0247
16	73	Office $400 per wk. $20,800 per year	.0247
17	68	Town water $300 per year	.0003
18		Salary 3 people total $21,840 per year	.0260
19	69	Boat fuel diesel @ .55 per gallon 20,000 gal. $11,000 per year	.0130
20	69	Truck fuel 30,000 gal. per year @ .60 per gal, $18,000/year	.0214
21		Lobster purchases from lobstermen $551,019/yr	.6560
Processing meat costs (.3)			
1*	23	Stanless steel table $275 30 year lifespan	
2*	32	Shipping containers plastic lbs. $700/yr.	.0002
3*	48	Broiler $8,500 30 yr. lifespan	.0001
4*		Picker $1.10 per pound $22,000/yr.	.0078

*Costs weighted by .3 to reflect number of processors.

Costs of prepared meat: 300,000 pounds of prepared meat are processed yearly. The processors interviewed produced about 20,000 pounds yearly. If we assume that this is the average for all then 15 processors (300,000/20,000 equals 15) produce prepared lobster meat. This is 30% of the supposedly 50 dealers (those licensed) thus costs were weighted by .3.

All other entries were based on 1978 estimates by interviewed firms. Total revenue, based on 300,000 pounds of lobster at a wholesale price of $2.80 per pound, is $840,000 per year. The technical coefficients calculated for the lobster processing sector are presented in Table E-38.

Table E-38. Lobster Distributor - Processor Table

U.S. I-O no.	Industry title	Technical Coefficient
3	Lobster/Crab/Scallop harvesting	.6691
24	Paper and allied products	.0052
27	Chemicals, select. products	.0103
32	Rubber, misc. plastics	.0002
46	Material handling machinery	.0003
48	Special machinery and equipment	.0001
65	Transport and warehousing	.0435
68	Elect., gas, water, sanitary services	.0003
69	Wholesale and retail trade	.0591
70	Finance and insurance	.0045
73	Business services	.0270
79	State, local government	.0075
		.8271
	Value added	.1729

IV. Explanation of Entries into Table E-39, the Crab Processing Sector

All of the recorded landings of crab go to processing plants. Of the 1978 landings of 172,080 pounds, DMR reported that 150,000 pounds were processed by 12 of the 42 crab processing facilities. This is 12,500 per year for the 12 large processors. This is consistent with estimates made by industry sources. Figures in this study pertain to the "average" large processor.

Entry Number (corresponding to Table E-39)

3 About 1/2 the total amount of the average amount of crabmeat processed is shipped in each size container. Thus 6,500 lbs x 7 cents = $445 and 6,500 lbs x 4 cents = %520.

9 Mortality claims 10% of the June-September catch. From 1,000 pounds of live crabs, 131 pounds of meat can be obtained. If a plant processes 13,000 pounds crabmeat then 100,000 pounds of crabs were handled. If it is assumed that the same amount of crabs are caught each of the 7 months of operation (not the actual case) then 14,286 lbs. of crab were handled each month; 57,142 lbs. crab for the months of June-September. But this represents only 90% of the total amount of crabs purchased since we have assumed a 10% mortality rate. Adding on 10% of 57,142, we obtain 63,491 pounds of crab handled during the months of June-September with mortality claiming 6,349 lbs. of this total. At .12 cents per pound mortality losses equal $761.

10 As explained in the previous statement from 13,000 lbs. crabmeat we

get 100,000 pounds of crab; by adding in the 6,349 lbs. crabs claimed by mortality we obtain 106,349 pounds of crab purchased. At a cost of $0.12 per pound, this implies that $12,761 worth of crabs are purchased per year.

<u>11</u> Labor is paid at the rate of $1.10 per pound of meat picked. For 13,000 pounds, total costs equal $14,300.

<u>19</u> It is assumed most office work is done by the owner or his wife.

Note: Shipping costs were not counted here. Some processors have their own trucks but most appear to sell to a distributor. Restaurants and other purchasers pick up their own orders. DMR and industry sources all felt that 90% of the Maine processed crabmeat was sold in the state of Maine.

Total revenue was figured for 13,000 pounds of meat per year, 3,000 pounds is body meat at a $3.50 wholesale price per pound in 1978. The remaining 10,000 pounds is leg meat sold at a $5.00 wholesale price a pound.

$3.50/lb.	$10,500
$5.00/lb.	$50,000
	$60,500 total revenue

The resulting technical coefficients are presented in Table E-40.

Table E-39. Crab Processing Costs

Entry Number	U.S. I-O no.	Item Description	Cost/$1 sales
1	24	20 crab boxes @ $10 3 yr. lifespan	.0010
2	24	Lobster car $4,000 7 yr. lifespan	.0094
3	32	containers, plastic 1/2 lb. $.04	.0084
		1 lb. $.07	.0075
4	24	40 1 lb. shipping box @ 1.00 per box	.0053
5	42	Picking knives	.00003
6	32	Plastic (process) buckets 15 small $12 2 yr. lifespan	.0014
		15 large $22 2 yr. lifespan	.0027
7	48	Broiler $8,500 30 yr. lifespan	.0046
8	23	3 stainless steel tables $275 30 yr. lifespan	.0004
9	3	Mortality 10%	.0125
10	3	Purchases from lobstermen $12,761 per year	.2109
11		Pickers salary @ $1.10 per lb. $14.300/yr.	.2363
12		Seasonal help $8,000 per year	.1322
13	79	Payroll tax $1,600/yr. .20 on the dollar	.0246
14	70	Interest $2,500 per year	.0413
15	75	Legal fees $500 per year	.0082
16	70	Insurance $800 per year	.0132
17	79	Property tax $2000 year	.0330
18	46	Fork lift $4500 15 yr. lifespan (50% have)	.0024
19	73	Office $75 per week $2100 per year	.0347
20	68	Town water $300 per year	.0049
21	69	Energy $100 per week $2800 per year	.0463

Table E-40. Crab Processing Table

U.S. I-O no.	Industry	Technical Coefficient
3	Lobster/Crab	.2234
23	Other furniture	.0004
24	Paper and allied products	.0157
32	Rubber, misc. plastics	.0200
42	Other fab. metal products	.00003
46	Material handling machinery	.0024
48	Special machinery and equipment	.0046
68	Electricity, gas, water, sanitary service	.0049
69	Wholesale, retail trade	.0463
70	Finance and insurance	.0545
73	Business services	.0429
79	State and local government	.0576
		.4727
	Value added	.5273

V. Scallop Distribution

In most cases the scallops are shucked on the boat while the fishermen are dragging. Other than shipping the meat, there is little additional handling by the distributor. Most scallop meat is removed immediately and thus no freezer storage is required. Since the supply of scallops is so erratic no dealer depends on them solely. Instead, scallop meat is treated as an added benefit. Usually, if a dealer has scallops and some additional room on a truck, then the scallops are shipped.

For these reasons, a separate scallop distributing sector is not included. Since the operational costs of a dealer will be affected little, if any, by handling scallops during a given year, any costs of of handling scallops would be included in the lobster and crab data.

APPENDIX VI

Data and Procedures used to Estimate Technical Coefficients for the Clam/Worm Sector

by

Doug Williams
Graduate Student
Department of Agricultural
and Resource Economics
University of Maine at Orono

Data and Procedures used to Estimate Technical Coefficients for the Clam/Worm Sector

I. Introduction

With the wholesale price of processed clam meat rising to $30 per gallon, it is not surprising that the soft-shell clam industry is one of the state's higher value fisheries. The commercial harvesting sector is comprised of more than four thousand individual diggers, most of whom use a multi-tined hand rake to turn over the mud flats of the inter-tidal zone to uncover the valuable bivalves. Clam digging is a part-time occupation for the majority of licensed diggers who turn to the flats during the summer months when touritst demand for steamed clams is at its seasonal peak. Maine diggers average 1.7 bushels per tide. A bushel of clams can be sold retail as steamers (shell stock) for over $50 or shucked and sold wholesale for up to $40 per gallon.

Once out of the tidal mud flats, clams are processed in many ways. Two out of every three are sold as shellstock to be used primarily for steamed clams. The rest are shucked by hand in state-certified shucking plants by local people (mostly women) working on a piece-work basis and then sold in one gallon cans for fried clams.

The analysis of the dealer/processor sector conducted by Dunham, *et al.* (1974) indicates that across a 52-firm sample, the mean value of clam sales was $82,000 with a range of $1 to $1 million. Of the firms surveyed, 42% had clam sales of $10,000 or less. This indicates that a few large firms dealing in large volumes are major factors in the processing sector. A study of the dealer/processor sector in Maine will be conducted in the summer of 1980.

The problems shared by most common property resources are present in the Maine clam industry. Biological problems with paralytic shellfish poison, green crab infestation, pollution and depletion due to overfishing have combined in recent years to raise the value of the resource through a kind of "abundant scarcity." Increased demand in the New York and Boston markets, which have a great influence on the prices of fishery products, has put pressure on the Maine resource which is evident in the trend to more commercial digger licenses in recent years. Though the peak was apparently reached in 1973 when almost 6,000 Maine residents were licensed to dig clams, the number has remained over 4,000 every year since 1972. This coincides with the widespread destruction of southern New England clam beds in Hurricane Edna in 1972.

Management schemes have been used or discussed in an attempt to solve the major problem of finding a way to ensure an abundance of the high demand, easily harvestable, renewable resource. Examples of practices either used or discussed include local digging ordinances, size limits, transplanting of seed clams, and periodic bed closure. At the present time, green crab infestations and intensive harvesting have severely damaged recent-year-classes. Consequently, scientists at DMR predict resource depletion as increases in demand attracts more diggers to the industry. This is offset, however, by the limited entry policies of some fishing communities. Municipal ordinances frequently restrict access to the clam flats.

Depuration of clams from polluted flats and the possibility of aquaculture may offer slight relief from the pressures on the resource in the future. However, decreasing supply is probably most deserving of the blame for the negative outlook for the industry foreseen by the majority of the firms in the Dunham study (1974). Over 50% of all dealers responding envisioned decreasing opportunity for their firm to grow.

II. Dealer/Processor Sector Data Base (all prices are for 1978)

A. The "Typical" Firm:

The problem of what can be considered the "average" dealer/processor and the "average" size of such a firm is central to a discussion of the marketing/distribution sector of the soft-shell clam industry. The type of operation varies from a small shucking house, the owner of which digs his/her own clams and sells them to large dealers, to massive multi-divisional national firms owning other fish and shellfish processing plants on the Maine coast.

The I-O table for clam processing is best described by figures for a full-time year round "average" operation. Though many dealers are not processors, and vice versa, for reasons of simplicity and time limitations, the "average" soft-shell clam firm is described on the basis of dealer estimates through interviews. Such a firm is a "dealer/processor" organization under sole proprietorship which employs two year-round people and one part-time individual, possesses both a dip tank and skimmer, and handles clams for shell stock and for shucked meat (DMR, sales reports of dealers, 1978). The firm utilizes one auto or pick-up truck on a full-time basis to transport the product to wholesale dealers (shucked clams) and retail markets (steamers). Such a firm operates out of a small shucking plant, and, it is estimated, handles approximately 1050 bushels of shell stock and 734 bushels of clams to be shucked (24 gal. week - 8 gallons/day, 3 days/week) for a total of 1784 bushels per year. The estimate of the number of gallons per year is based on dealer estimates obtained from interviews. The shell stock estimate is based on the ratio of bushels of clams for shell stock (70%) to bushels for shucked meat (30%) sold by certified Maine shellfish dealers in 1978 (DMR). At 1978 prices, this would indicate a total revenue of $62,700—$30/bu. for shell stock and $25/gallon for shucked clams. Purchases amount to $33,271.60 or 53% of the total revenue; and costs would average $23,000 or 37% of the total sales revenue (Table E-41). Value added is nearly $20,000 or 10% of the total revenue.

DMR estimates that well over 20% of Maine clam processors incorporate at least one other type of seafood dealing or processing operation into their business to enlarge their operation and to supplement activities during the lean, winter months. Some of the large plants, with parent companies outside Maine, switch to clams imported from Canada or, in good years, from Maryland and other mid-Atlantic states. When not shucking clams, smaller dealers may also process fresh crab meat, sell mussels on order, run fish markets, or supply lobsters. Most large processors also handle other fish products (Dunham, *et al.*, pg. 39).

B. Processing Sector Estimate Sources:

1. All equipment and materials estimates are based on interview results and averaged to the volume indicated. Depreciation figures are based on IRS allowable figures.

Equipment purchase prices used:

(a) Skimmer - $600
(b) Dip Tank - $1000 (assuming purchase of a new prefabricated tank)
(c) Stainless Steel Shelving - $150
(d) Stainless Steel Baskets - 4 at $10 each
(e) One Vehicle - $5000

2. Vehicle fuel estimate from interview:

100 miles/day, 5 days/week, 15,600 miles/year
$.80/gallon, 18 miles/gallon

In most cases, the average, small processor delivers products to wholesale outlets (larger dealers) and to retail stores close to the operating base. Very few small dealers ship directly to out-of-state markets since large wholesalers have a ready market for all clam meats at their subsidiary operations in Boston and New York. Increases in fuel costs and, therefore, the cost of a common carrier, have made shellfish wholesaling a viable business in Maine.

3. Labor cost is based on an average of $90/week per person. This low value results from the method by which the workers are paid. With piece-work systems, the greater abundance (and value) of clams in the summer months leads to an increase in wages over what can be earned in winter. Additionally, if they are paid a salary (approx. $150/week), part of it must be attributed to the other aspects of the business such as a fish market, crab processing or other sales.

4. Utility costs are estimates of monthly amounts which could be charged to the business. Most dip tanks are heated by small oil burner and by law, refrigeration capacity is required. Therefore, oil and electricity costs are higher than for a normal home. Since no dealer could, or would, give precise figures, our figures are only estimates.

C. Purchases by Dealer/Processor

The work of Dunham, *et al.* (1974) indicates that among the 51 clam processors responding to their survey, 79% of the clams were purchased from the harvesting sector, 20% from other dealers and 1% from depuration plants.

D. Conclusions

The estimates in the input-output table for the soft-shell clam industry provide a basis for estimating the economic impact of changes in production levels. To obtain the clearest picture possible amid the jumble of hugely varied independent operations, it was necessary to utilize an "average" dealer/processor. It is not possible to determine how many dealer/processors are closely represented by the "average" firm.

Our data are weakest in the area of energy costs, equipment depreciation and product output. During the interviews no dealer could precisely indicate the level of energy costs attributable to the clam processing part of his business. Equipment depreciation is sensitive to output levels and, more importantly, varies by firm and season. Output levels vary tremendously from one day to the next due to fluctuations in tides, weather, diggers, paralytic shellfish poison, the market for clams and the availability of other species such as scallops.

III. Data Sources - Clam Processing and Distribution:

A. Interviews:

1. Six dealers - Hancock County
2. Two processors - Hancock County
3. Five Scientists - Maine Department of Marine Resources, West Boothbay Harbor and Hallowell, Maine.
4. Mr. Dana Wallace, Director of Industry Services, DMR, Hallowell.

Note: Hancock County was the focus of the data gathering due to the following considerations:

(a) Dr. W.C. Dunham's (*et al.*) 1974 Analysis of the Dealer Processor Sector of the Maine Soft-Shell Clam Industry, published in April 1977, resulted in a large response from dealers in Hancock County. See Table E-41.

(b) Budget and distance restrictions forced the majority of data gathering to be centered within one hundred miles of the University of Maine at Orono.

(c) Some 33% of the total volume of shucked clams obtained from various locations in Maine (43 firms, Dunham, *et al.*, 1974) were from Hancock County.

Note: Another 46% of the total was obtained from Washington County, immediately east of Hancock County. The counties west of Hancock provided a combined total of 20%. Canada provided 1%.

B. Literature:

1. Dunham, *et al.*
2. Maine Department of Marine Resources:
   a. Annual summary of Maine landings and value
   b. Commercial shellfish license lists
   c. Commercial Interstate Shellfish Dealers lists
   d. Resident Commercial Fishing characteristics

e. Shellfish processing regulations

f. Maine Clam Production and Value - Table - 1887 to 1978

g. Depuration figures by area and month

h. Depuration in Maine, Phillip L. Goggins, 1964

i. Maine Clam, Robert Dow and Dana Wallace, 1957

j. Status of Soft-Shell Clam in Maine, Walter Welch, March 1979.

3. The Soft Shell Clam Industry of Maine: Its Institutions of Regulation and Management, Susan Dearborn, University of Maine at Orono, Graduate School, August 1977.

4. Some Economic Aspects of Management: The Atlantic Coast Clam Industries, Richard W. Smith, NE-91 Research Coordinator, Northeast Regional Research Project, September 30, 1977; unpublished manuscript, University of Maine at Orono.

5. Fishery Statistics of the United States, 1978

6. Input-Output Structure of the U.S. Economy: 1963 - Volume 2, U.S. Dept. of Commerce.

IV. Commercial Harvesting Sector Data Base

A. Equipment Figures:

Hods

Boots and Gloves

Hoes

Costs based on combined estimates of listed data sources
(of Section 1 A of this appendix)

B. Depreciation Figures:

Vehicles - $3500 value, 100 days fishing, 10 miles/day

Boats - $1200 value, 100 days fishing, 3 miles/day

Trailer - $600 value

Outboard Motor - 25 horsepower, $1000 value

Based on typical Internal Revenue Service allowable depreciation percentages and estimated longevity of equipment. Mileage and days fishing estimates are from interview sources.

C. Fuel, Mileage and Repair Costs Estimates:

Vehicle - 1000 miles/year, 18 miles/gallon, $.80/gallon, $200/year maintenance.

Boat - 300 miles/year, 40 miles/gallon, $.80/gallon, $200/year maintenance. Based on interview data source estimates and 1978 gasoline prices.

D. Output per Digger

Average full-time digger: 5 months/year, 100 days/year, 5 days/week, 100 primary tides plus 20 second tides (Wallace-DMR) 1.75 bushels/tide/digger.

(DMR license data)

210 bushels/year/digger at $18.65/bushel (DMR)

Total revenue (average): $3916.50

V. How to Read the I/O Table for Clams:

The initial two columns of each table indicate the numbers and classifications for industries supplying inputs to either the harvesting sector (Table E-42) or the processing sector (Table E-41) of the Maine soft-shell clam industry.

For both harvesting and processing the total cost per year for each input is divided by the total revenue of that sector to arrive at a percentage of that revenue which the input item represents. The column total of these percentages represents the proportion of total revenue paid out to supplying industries.

The value added figure for the processor represents value over and above the "landed value" paid to the harvester and other expenses paid to other industries supplying inputs. Value added includes returns to capital and labor.

In the harvesting sector, value added is the earnings over and above total cost incurred by the individual digger.

VI. Maine Marine Bait Worm Industry: Input/Out Table, 1978 Values

A. Introduction

Several interviews were conducted with diggers and processors in order to determine the input/output structure of the marine bait worm industry in Maine. Budgetary and time restrictions prevented a more complete sampling of industry representatives.

The interviews provided the data necessary to depict costs for an

Table E-41. Clam Processing Input Costs

U.S. I-O no.	Industry title (item)	Technical Coefficient
21	Wooden containers (vegetable boxes,	.0109
	bushel baskets)	.0003
23	Other furniture (stainless steel shelf dep. 10%/yr.	.0002
32	Rubber miscellaneous plastics (plastic hose and barrels)	.0004
42	Other fabricated metal products (marine hardware)	
	Shovel	.0002
	Knives & bowls	.0004
	Steel baskets Dep. 10%/yr.	.0001
48	Special machinery and equipment	
	Skimmer	.0010
	Dip tank and boiler Dep. 10%/yr.	.0016
59	Motor vehicles and equipment (Dep. 25%/yr. 1 vehicle)	.0199
68	Electricity, gas water, sanitation service (electricity and water)	.0038
69	Wholesale, retail trade	
	(heating oil,	.0287
	vehicle fuel)	.0111
70	Finance, insurance (insurance)	.0159
73	Business services	
	(telephone	.0115
	legal and other office)	.0080
75	Automobile repair service (maintenance 1 vehicle)	.0080
79	State, local government ent.	
	(license,	.0008
	taxes)	.0319
39	Metal containers (cans)	.0080
	Clam harvesting	.5306
82	Value added	.3067

Table E-42. Clam Harvesting Input Costs

U.S. I-O no.	Industry title (item)	Technical Coefficient
20	Lumber, wood products (2 hods)	.0061
32	Rubber, miscellaneous plastics (boots and gloves, 1 pr. each)	.0071
42	Other fabricated metal products (marine hardware) (clam hoe)	.0038
43	Engines and turbines (Dep. 25%/year outboard)	.0638
59	Motor vehicles and equipment (Dep. 25%/year 1 vehicle)	.1596
61	Other Trans. equipment (Dep. 10%/year boat, trailer)	.0460
69	Wholesale, retail trade (boat maintenance, boat gasoline, vehicle gasoline)	.0639
70	Finance, insurance (insurance)	.0255
75	Auto. repair service (maintenance 1 year)	.0511
79	State, local government ent. (license)	.0026
	Value added	.5705

"average" year-round harvester (worm digger) and an "average" year-round processor (worm wholesaler). The data are in the form of costs of each piece of equipment, type of material and kind of service purchased by an "average" digger and processor for the purpose of harvesting or processing worms in 1978.

There are two types of marine bait worms on the Maine coast, bloodworms and sandworms. Bloodworms, while slightly shorter than sandworms, are thicker and are considered a better bait. High prices in recent years for bloodworms are seen by some to have contributed to an overharvesting of the resource. Though bloodworms are still available, there seem to be fewer diggers digging bloodworms exclusively. This is probably due to the number of sandworms available and the existence of ready markets for either type of worm. The substitution of sands for bloods is readily apparent in the landings figures for 1977 and 1978 presented in Table E-43.

From 1977 to 1978, landings for bloodworms decreased by 1.2 million worms while the price increased by $1.20 per 100 worms. The relative abundance of sandworms and 1/2 million worm increase in landings during the same period seem to indicate that sands are being substituted for bloods.

Table E-43. Maine Bait Worms: Landings and Value
1977 and 1978 (Maine).

	Bloodworms		Sandworms	
	1977	1978	1977	1978
Landings* (# of worms)	17,473,656	16,202,000	29,505,520	29,913,000
Price/100** (# of worms)	$6.00	$7.20	$3.25	$3.60

* Source: Maine Department of Marine Resources
**Source: Interview with a worm buyer

Worms are dug from flats at low tide using a multi-tined rake similar to a clam hoe. The digger collects worms in plastic buckets or wooden hods, delivers them to a buyer (processor) and is paid on a price per hundred basis. The processor packages each type of worm separately in cardboard boxes lined with seaweed for shipping to bait companies, sporting goods dealers, marinas, and bait dealers primarily in the New York-New Jersey area. In recent years, some dealers have made shipments to overseas buyers as the demand in the New York area has decreased. Some sources attributed the decrease in demand from the New York market to substitutes and to a decrease in the stock of striped bass due to pollution and overfishing.

B. Harvesting Sector:

In 1978, there were 1155 licensed marine bait worm diggers in Maine. The majority of these diggers do not rely fully upon worm harvesting for income. Diggers switch easily to harvesting the soft-shell clam and many other seasonal occupations. An interview with a worm buyer indicated that although most diggers sell to a single buyer for many years, they will switch buyers readily if they believe they are not getting the highest possible price.

All figures for types and amounts of gear used were based on estimates by those interviewed and include the stock components of the worm harvesters. Depreciation figures were based on IRS allowable figures.

Our estimates are that 45% of all diggers use a boat and motor to travel to the flats. In addition, 10 percent of all diggers continue to use digging lights, although their use is decreasing. These percentages were used to weight costs for those items in Table E-44.

Total worm landings in Maine were over 46 million worms in 1978 with a ratio of 1 bloodworm to 1.85 sandworms. This suggests an average output per digger of over 39,000 worms. Interview data indicated the following characteristics of the averge year round digger: 150 tides dug per year, 3 tides per week, 225 miles driven per week to reach the flats.

C. Processing:

In 1978 there were twenty full-time and one part-time shipper of worms. There were thirty-nine worm dealers licensed in Maine (DMR) in 1978. All of the shippers were also licensed as dealers. The costs incurred by shippers were included in the I-O table since this is the only real processing that takes place in the worm industry. No one dealt exclusively in bait worms unless he shipped to out of state buyers.

The interviews provided an estimate for the average output by a full-time shipper of 4,000,000 worms per year with a 1.85 sandworm to 1 bloodworm ratio. Costs are based upon expense figures as a percent of output for the shippers interviewed. Expenses were computed to be roughly 18% of total sales not including purchases of worms. Labor was treated as a value added to the resource.

Revenues were based upon wholesale price of $5.50/100 sandworms and $9/100 bloodworms. The resulting technical coefficients are presented in Table E-45.

Table E-44. Marine Bait Worms Harvesting Sector Input Costs, 1978

U.S. I-O no.	Industry title (item)	Technical Coefficient
20	Lumber, wood products (hods)	.0128
32	Rubber, miscellaneous plastics (buckets, boots, gloves)	.0332
42	Other metal products (worm hoes, digging lights)	.0382
43	Engines, turbines (depreciation: 1 outboard)	.0121
55	Electric lighting equipment (batteries)	.0017
59	Motor vehicles (depreciation, 1 vehicle)	.1337
61	Other trans. equipment (depreciatiou boat, trailer)	.0362
69	Wholesale and retail (gas, boat and motor maintenance)	.3174
75	Auto repair services $300.00 (maintenance, one vehicle)	.1070
79	State and local government (license)	.0053
	Value added	.3024

Table E-45. Marine Bait Worms Processing Sector Input Costs, 1978

U.S. I-O no.	Industry title (item)	Technical Coefficient
25	Paperboard containers (materials and supplies)	.0290
51	Office machines (office equipment)	.0037
59	Motor vehicles, equipment (vehicle depreciation)	.0086
65	Transportation and warehousing (transportation)	.0070
68	Electric, gas service (electricity, water, heating)	.0022
69	Wholesale and retail trade	.0028
70	Finance, insurance (interest, insurance)	.0128
71	Real estate, rental (rental)	.0019
73	Business services (telephone, etc.)	.0135
79	State and local government (property taxes, payroll taxes)	.0144
	Worm harvesting	.7230
	Value added	.1811

Appendix VII

The Economic Value of Soft-Shelled Clam *(Mya arenaria)* Production in Maine with Generated Consumption Values for 1979. (Using: A Multiplier for Computing the Value of Shellfish; E.F.M. Wong, 1969).

Douglas R. Williams
Research Assistant
Department of Agricultural
and Resource Economics
University of Maine
Orono, Maine 04469

The objective of Edward F.M. Wong's study: A Multiplier for Computing the Value of Shellfish, (U.S. Department of the Interior, Federal Water Pollution Control Administration, New England Basins Office, Needham Heights, MA., October, 1969) was to formulate a simple method for determining the economic value of a local area's commercial shellfish production or of its potential resource. The study formulae can be applied to data for production from a single community or, as it has been used here, to delineate the value of commercial shellfish production in the entire State of Maine.

In order to demonstrate economic benefits of the proper utilization of a resource like the soft-shelled clam *(Mya arenaria)* of Maine, a series of values were established by Wong to denote the worth of shellfish during the entire commercial process. The Landed Value (LV) is the price paid directly to the fisherman. This is only a portion of the total value accruing to an area. Gain credited to the value of the shellfish beyond the Landed Value, between the wholesaler and the consumer/retailer, is considered the Value Added (VA). Values added to the shellfish from gains in the local area (in this case the State of Maine) are the State Value Added (SVA). Gains accruing to the shellfish from sales outside of Maine are the Non-State Value Added (NSVA). The State Value (SV) is, therefore, the sum of the total paid to the diggers and the value added in Maine. The Total Value (TV) is the sum of the State Value and all other values accruing outside the state. This is a potentially generated economic value of shellfish production in Maine.

Another factor necessary for the computations is the Shellfish Multiplier (SM), for an explanation and derivation please see page four of Wong's study.

The tables used to arrive at all of the values necessary for this examination contain four basic sets of criteria (Wong) showing how shellfish are sold, distributed, treated, moved or used by the shippers and final consumers.

(Tables E-46 and E-47). These four groups are:

Median Number of Clams per Wholesale............. = Value N_w (Table E-46)

Wholesale Price per Wholesale.................... = Value P_w (Table E-46)

Median Number of Shellfish per Consumer Unit..... = Value N_r (Table E-47)

Consumer Price per Consumer Unit................. = Value P_r (Table E-47)

Table E-46 shows how soft-shell clams, as packed by weight or volume, are distributed at the wholesale level and their cost at that level. This cost reflects the prices of individual diggers.

Table E-47 shows the distribution and final cost of clams in consumer units expressed by the ways in which they are sold at the retail level. For the purposes of a state-wide study, processed (shucked) clam meats have been included as a retail item in out-of-state sales and as fried clams in in-state sales.

Table E-46

A. Number and Value of Soft-Shell Clams by Bulk Unit at the Wholesale Level[1]

Condition of Clam	Average Size of Clams	Wholesale Unit	Pounds per Unit	Median No. of Clams per Wholesale Unit (Value N_w)	1979 Wholesale Price/Unit (Value P_w)[2]
In Shell	2 inches	bushel	60	2024	$24.00

B. Soft-Shell Clams (Maine)

1 bu. = 15 lbs. of shucked meats depending upon season, service and trim at 8 lbs./gal.

1 bu. = 1.875 gals. of shucked meats.

1 gal. has a 1979 price per unit value of $25.[2]

Landings (first six months of 1979): 159,333 1/3 bu.

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[1] All values for pounds per unit, median number per unit and wholesale price depend upon the season and source (DMR).

[2] Price per unit data are an annual average for 1979 (DMR).

NOTE: Wholesale price is price paid to digger.

Table E-47

Number and Value of Shellfish by Units at Retail Level

Market Condition	Average Size of Clams	Consumer Unit[1]	Median No. Clams/Unit[2] (Value N_r)	1979 Consumer Prices/Unit[3] (Value P_r)
Fried	2 inches	pint	26	$ 5.30**
Steamed in shell	2 inches	pint	34	3.50
Shellstock	2 inches	pound	34	.70
Shucked Meat	1 3/4 inches	gallon	1079.5	25.00**

[1] One pint = One pound for purposes of this examination.

[2] Numbers sources:

Fried clams - mean value observed in restaurants Sept. 1979 across Maine

Steamers, shellstock & shucked meats - from DMR figure of 2024 clams in shell per bushel (See Table E-46-B).

[3] Prices per unit are estimations made from spot checks in restaurants and shucking houses throughout Maine. Prices will vary due to location, season and type of establishment. These prices are minus side dishes and complete dinner extras.

**For the purposes of this study, shucked meat is considered a retail product sold by shucking houses to buyers from outside of Maine. Fried clams in Maine are assumed to be 100% of shucked meat sold in Maine.

Percentages of total landings indicating how clams were used were established from dealer reports collected by the Maine Department of Marine Resources for 1979.

Table E-48

Ways in Which Soft-Shell Clams from Maine were Sold in 1979.

Market Condition	Where Sold	Percent of Total Landings
Fried Clams[1]	In State	18
Shellstock[2]	In State	19.6
Steamer Clams	In State	8.4
Shellstock	Out of State	39
Shucked Meats	Out of State	15
		100

Source: Maine Department of Marine Resources

[1] All clams sold as shucked meats in Maine were assumed to be used for fried clams.

[2] Shellstock sold in Maine were assumed to be distributed as follows:
- a) 30% wholesale to restaurants (sold as steamed clams) *8.4% of total landings)
- b) 70% retail to individuals, groups, institutions, etc. (19.6% of total landings).

Summary of Study Results: 1979

1 of clams sold in Maine as Fried Clams (f) = 10.1

2 of clams sold in Maine as Steamers (st) = 9.6

3 of clams sold in Maine as Shellstock (ss) = 1.9

4 of clams sold outside Maine as Shellstock (ss) = 1.9

5 of clams sold outside Maine as Shucked Meats (m) = 2.1

nded Value (LV) of clam production in Maine
00% of clams dug) = $ 7,525,500

A_f of clams sold in Maine as Fried Clams
8% of all clams) = $12,326,769

A_{st} of clams sold in Maine by restaurants as
eamers (8.4% of all clams) = $ 5,436,421.20

A_{ss} of clams sold in Maine at retail as
ellstock (19.6% of all clams) = $ 1,327,498.20

VA_{ss} of clams sold outside Maine as Shellstock
9% of all clams) = $ 2,641,450.50

VA_m of clams sold outside Maine as Shucked Meats
5% of all clams) = $ 1,241,707.50

ate Value (SV) of clams sold in Maine
6% of all clams) = $26,616,188.40

tal Value (TV) of clam production in Maine and
nerated values (1979 gross) =$30,499,346.40

of clam production in Maine (1979 Net=Gross-5%
ss) =$28,874,379.10

Appendix A: Derivation of Summary Values

I. From Tables 1 and 2:

Value P_w soft-shelled clams (Marine Resources) 1 bu. = $21.75

Value P_r fried clams, per serving 1 pt. = 5.30

Value P_r steamed clams, per serving 1 pt. = 3.50

Value P_r shellstock, per unit 1 lb. = 0.70

Value P_r shucked meats, per unit 1 gal = 25.

Value N_w soft-shelled clams (Marine Resources) 1 bu. = 2024

Value N_r fried clams, per serving 1 pt. = 26

Value N_r steamer clams, per serving 1 pt. = 34

Value N_r shellstock, per unit 1 lb. = 34

Value N_r shucked meat, per unit 1 gal = 1079.5

II. Shellfish Multiplier (SM) =

$$\frac{\dfrac{\text{No. in wholesale}}{\text{No. in retail unit}} \times \text{Price of retail unit}}{\text{Price of wholesale}}$$

$$SM = \frac{\dfrac{N_w}{N_r} \times P_r}{P_w}$$

$SM_{\text{fried clams}} = 10.1$

$SM_{\text{steamers}} = 9.6$

$SM_{\text{shellstock}} = 1.9$

$SM_{\text{meat}} = 2.1$

III. Computing Values for LV, SVA, NSVA, SV and TV

a. State Landed Value (LV_s) = (Number of Shellfish Units) (Wholesale price per unit)

In values for 1979 this computes to:

LV_s = (346,000 bu.) (\$21.75/bu.) = \$7,525,500.

This is Equation 1, Appendix A of Wong.

b. State Value Added (SVA) & Non-State Value Added (NSVA)

SVA = LV_s (Summation of various retail use) (multiplier -1)

SVA = LV_s (% consumed in a given manner) (SM-1)

$SVA_{\text{fried clams}}$ = \$7,525,500 (18%) (10.1-1) = \$12,326,769

SVA_{steamers} = \$7,525,500 (8.4%) (9.6-1) = \$ 5,436,421

$SVA_{\text{shellstock}}$ = \$7,525,500 (19.6%) (1.9-1)= \$ 1,327,498

$NSVA_{\text{shellstock}}$ = \$7,525,500 (39%) (1.9-1) = \$ 2,640,450

$NSVA_{\text{meats}}$ = \$7,525,500 (19%) (2.1-1) = \$ 1,241,707

c. State Value (SV)

SV = Landed Value + State Values Added for Fried Clams + Steamer Clams

$SV = LV_s + SVA_f + SVA_{st}$

SV = \$7,525,500 + \$12,326,769 + \$5,436,421 + \$1,327,498

SV = \$26,616,188

This is the generated state value for all clams dug in Maine and sold in the State as fried clams, steamers and shellstock.

d. Total Value (TV)

TV = State Value + Non-State Values Added for shellstock and shucked meats.

$TV = SV + NSVA_{ss} + NSVA_{m}$

TV = \$26,616,188 + \$2,641,450 + \$1,241,707

TV = \$30,499,346

Total Value of clam production for 1979 including generated values within and outside of Maine.

e. Industry members indicate that loss due to breakage and spoilage amounts to approximately five percent of the total number of clams handled. This can be deducted from the TV figure:

(TV) (5%) = \$1,524,967

TV 1979 (adjusted for loss) = $TV-TV_{loss}$ = \$28,974,379