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Developing a Port-level Economic Impact Model for Alaska Fisheries

C. K. Seung

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National Oceanic and Atmospheric Administration
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NOAA FISHERIES

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C. K. Seung

Resource Ecology and Fisheries Management Division
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE
Seattle WA 98115

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ABSTRACT

The seafood industry expenditure data are critical in developing an economic impact model for fisheries. However, the seafood industry expenditure data from the government or private companies (e.g., IMpact analysis for PLANning, Minnesota IMPLAN Group) are unreliable. This has led to some studies collecting the data via surveys of fishing vessels and fish processors, usually for relatively large regions, like a state or boroughs and census areas (BCA). Fishery managers are often interested in the economic impacts of a fishery management action at smaller spatial scales such as fishing ports within a BCA; however, no economic impact model has been constructed at the fishing port level due to the difficulty of collecting the expenditure data. Given this limitation, this study describes step-by-step procedures to approximate the economic impacts for a small fishing port for which a full model cannot be developed due to data limitations. Using the port of Dutch Harbor as an example, this study first shows how to decompose the changes in the seafood industries' expenditures and household income resulting from a hypothetical policy change. Next, this study maps these changes into IMPLAN sectors. Finally, this study applies the changes to a social accounting matrix (SAM) model constructed off of an existing dataset from IMPLAN to calculate the economic impacts.

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INTRODUCTION

Fish managers worldwide are concerned with the economic impacts of fishery management policies on the regions where the policies are implemented. For example, they often reduce the total allowable catch (TAC) for a species due to its lower biomass caused by climate change and are interested in its economic impacts on the fish-dependent regions. To evaluate the impacts, fishery economists often rely on economic impact models such as input-output (IO) models or the social accounting matrix (SAM) model, which is an extension of the IO models. The data required in these models are typically prepared by the central (or federal) government or a private company (e.g., IMpact analysis for PLANning, Minnesota IMPLAN Group in the U.S.). For instance, the U.S. Bureau of Economic Analysis prepares the IO data for the United States, and the Bank of Korea regularly updates the national and provincial IO data for Korea. In the United States, a private company, IMPLAN, provides the IO data for different geographical regions including zip-code areas, counties (boroughs and census areas), and states as well as the whole US.

However, with no exception, the resulting IO models from these sources are highly aggregated. That is, in almost all cases, the models have only one single fish harvesting industry and one single fish processing industry. In some cases, these two industries are included in two bigger industries typically called Agriculture, Forestry, and Fishing industry and Food Manufacturing industry, respectively. The highly aggregated seafood industries are not very useful if one wants to quantify the economic impacts of a policy for a specific fishery (e.g., trawl fishery) or species (e.g., pollock). This is because the input use profile for a specific fishery or species may be significantly different from that for the single fishing industry in the aggregated IO model. Because of this problem, earlier studies (e.g., Seung et al. 2020) collected the expenditure (input use) data from the different fishing industries via surveys, split the fishing industry in the aggregate model into different sub-industries corresponding to different fisheries/species based on the data thus collected, and developed a disaggregated IO or SAM model.

However, there are some difficulties with conducting the surveys and using the survey-based data to construct a disaggregated IO model. First, it takes a substantial amount of time to develop the survey questions, implement the surveys, and develop a disaggregated IO model based on the data thus collected. Second, the survey response rate is usually very low, which lowers the data's representativeness of actual fishing activity. This led to some studies adopting a different approach to assessing the regional economic impacts of fishery management policies. One such approach is the Fisheries Economic Assessment Model (FEAM) approach (Carter and Radtke 1986, Hanna et al. 1994, Seung and Waters 2005). This approach uses the multipliers from an existing, aggregate IO model. The FEAM approach, first, calculates the changes in revenues and expenditures of fishing vessels, that engage in a particular fishery or species, and those of the seafood processors, arising due to a policy change. Second, the approach computes the change in the income of the households residing in the region, and distributes it across different consumption commodities. Finally, these changes are multiplied by the multipliers from the existing aggregate IO model.

This approach is useful when the survey data from seafood industries are not readily available for a region. A good example is Dutch Harbor in Alaska where a large quantity of fish is landed and processed. This port is in the Aleutians West Census Area (AWCA) in Alaska. A previous study developed a borough or census area (BCA) level economic impact model based on a survey, called the 10-region multiregional social accounting matrix (10MRSAM) model (Seung et al. 2020, https://nwecon.psmfc.org/). The 10MRSAM model is a meaningful advancement to previous models that can evaluate only the impacts for a large region (state of Alaska), and can compute the BCA-level economic impacts from fisheries. Nevertheless, it has the limitation that it cannot assess the impacts on a lower-level geographical area such as a fishing port (e.g., Dutch Harbor). Currently, there is no IO model developed for a fishing port. Yet, fishery managers are interested in the economic impacts on a very small area such as a fishing-dependent port or community.

The present study develops the Dutch Harbor (DH) economic impact model for fisheries, called hereafter DH model for short. The contribution of the present study is to enumerate the specific steps to construct a port-level economic impact model based on available data using an approach similar to FEAM. This paper is organized as follows. The next section provides a short description of the IO model. Section 3 enumerates the procedures to develop the DH model, including a brief description of the original FEAM model. Section 4 briefly describes the study region's fishery and the data used. Section 5 presents and discusses the results from the DH model, followed by the conclusion section.

Input-output (IO) Model

In an Input-Output (IO) model, multipliers are derived from the relationships among different industries in an economy. Analysts use the multipliers to compute the economic impacts from a change in final demand which is usually estimated outside of the model. Since Wassily Leontief developed an IO model of the United States in the 1930s, IO models have been a basic tool for regional economic impact analysis. Applications of the models have been wide-ranging; the models have been used in analyses of regional economic development, resource management problems, and environmental issues. For fisheries, analysts have used the models to assess the economic impacts from commercial and recreational fisheries. This section provides a short overview of the fundamental features of single-region IO models, based on Miller and Blair (1985) and Seung and Waters (2005). For a discussion of interregional and multiregional IO models, see, for example, Miller and Blair (1985) and Hewings and Jensen (1986). Richardson (1985) provides a survey of IO studies conducted before 1985. For a review of IO studies for fisheries, see Andrews and Rossi (1986) and Seung and Waters (2006).

A Brief Description of IO Model

Suppose a regional economy consists of *n* sectors. Let sector *i*'s total output and total final demand for sector *i*'s product be denoted X_i and Y_i, respectively. Then, the following relationship holds:

$$X_i = Z_{i1} + Z_{i2} + \ldots + Z_{ii} + \ldots + Z_{in} + Y_i,\ i = 1, 2, \ldots, n, \quad (1)$$

where Z_{ij} are dollar value of interindustry purchase by sector *j* from sector *i*. The *j*th equation in the above equation system describes how the sector *j*'s output is distributed to the other sectors (industries) and the final users. The elements in the *i*th column on the right-hand side of the equation system above are $[Z_{1i}, Z_{2i}, \ldots, Z_{ii}, \ldots, Z_{ni}]$. These elements represent sector *i*'s purchases of *n* different products from the *n* different sectors. These products are used as inputs in sector *i*'s production. These inputs are called intermediate inputs. A fundamental assumption in IO models is that the flows of the intermediate input from *i* to *j* depend entirely and exclusively on the level of total output of sector *j*. Thus, a technical coefficient or IO coefficient (a_{ij}) is defined as the ratio of the flow of input from *i* to *j* (Z_{ij}) to sector *j's* output (X_j):

$$a_{ij} = \frac{Z_{ij}}{X_j} \text{ or } Z_{ij} = a_{ij}X_j \ . \qquad (2)$$

Substituting Equation (2) into Equation (1) and rearranging the terms yields,

$$\begin{array}{lllllll}
(1-a_{11})X_1 & - & a_{12}X_2 - \ldots & & - a_{1i}X_i - \ldots & & - a_{1n}X_n = Y_1 \\
-a_{21}X_1 & + & (1-a_{22})X_2 - \ldots & & - a_{2i}X_i - \ldots & & - a_{2n}X_n = Y_2 \\
\cdot & & & & & & \\
\cdot & & & & & & \\
-a_{i1}X_1 & - & a_{i2}X_2 - \ldots & + & (1-a_{ii})X_i - \ldots & & - a_{in}X_n = Y_i \\
\cdot & & & & & & \\
\cdot & & & & & & \\
-a_{n1}X_1 & - & a_{n2}X_2 - \ldots & & - a_{ni}X_i - \ldots & + & (1-a_{nn})X_n = Y_n \ .
\end{array} \qquad (3)$$

Expressing the system of equations in (3) in matrix terms,

$$\mathbf{(I - A)\ X\ = Y} \qquad (4)$$

or

$$\mathbf{X = (I - A)^{-1}Y}\ , \qquad (5)$$

where $\boldsymbol{I}$ is an $n \times n$ identity matrix; $\boldsymbol{A}$ is an $n \times n$ input-output coefficient matrix of a_{ij}'s; $\boldsymbol{X}$ is a column vector of X_i's (industry outputs); and $\boldsymbol{Y}$ is a column vector of Y_i's (final demand for commodities). Here, $\boldsymbol{X}$ is a vector of endogenous variables and $\boldsymbol{Y}$ a vector of exogenous variables. $\boldsymbol{(I-A)^{-1}}$ is often referred to as Leontief inverse whose elements represent total impacts on individual sectors (industries) when there is an exogenous change in final demand *by one unit*. So Equation (5) can be used to calculate the total impact on output (***X***) in the different sectors of the economy when there is a change in final demand (***Y***).

The final demand (***Y***) for a sector's product in Equation (5) comprises household demand, government demand, investment demand, and exports. Households spend their labor income to purchase goods and services for their final consumption. The amount of their purchases depends on their labor income, which they earn in return for their labor services to production processes. Therefore, their labor income depends on the level of output of each of the production sectors. Because household expenditures make up a major fraction of the final demand in most economies and because the level of household income (labor income) is determined by the level of industry output in an economy, one could make the household sector an endogenous sector. This is known as closing the model with respect to households. Hence the model closed with respect to households is called a "closed model" while the model in Equation (5), where only production sectors are endogenous, is called an "open model."

Direct, Indirect, and Induced Effects

There are three types of effects calculated in an IO model – direct, indirect, and induced effects. Direct effects refer to the initial changes in the final demand. Indirect effects represent the effects transpired by iteration of changes in industries' purchases from other industries in response to the direct effects. Induced effects are the additional changes caused by the change in household income and spending which is generated by the direct and indirect effects.

Total effects are the sum of direct and indirect effects in an open IO model while, in a closed IO model, the total effects are the sum of all the three types of effects above. Multipliers are obtained simply by dividing the total effects by the direct effects. Depending on which of the two models (open or closed model) is used, two types of multipliers are computed – simple multipliers and total multipliers. The former is derived using only direct and indirect effects (from an open model) while the latter is calculated using all three types of effects (from a closed model). To calculate the multipliers, the Leontief inverse in Equation (5) is used; the multiplier for an industry is derived by summing the elements in the column representing the industry in the Leontief inverse.

Backward Linkage and Forward Linkage

In regional economic impact analysis, there are two broad categories of inter-industry linkages that need to be considered, depending on the direction the impacts that occur – backward linkage and forward linkage. Backward linkage refers to the relationship between an industry and the industries from which the first industry buys the inputs needed to produce its output. So an exogenous change in the first industry will generate backward-linkage effects on the industries that supply inputs to the industry. The IO model in Equation (5) is designed to capture only the backward-linkage effects. Forward linkage is the relationship between an industry and the industries to which the first industry sells the outputs needed to produce outputs in the industries that buy the first industry's output. So an exogenous change in the first industry will produce forward-linkage effects on the industries that depend on the first industry for its output, however, these forward linkages are not included in IO models.

Procedures to Develop the Dutch Harbor Economic Impact Model

Procedures to develop the DH model are similar to those to develop the FEAM, but the structure of the DH model is simpler than the original FEAM. This section first provides a cursory description of FEAM (Seung and Waters 2005). For more details, see Seung and Waters (2005). Next, the specific procedures to develop the DH model are enumerated.

Fisheries Economic Assessment Model (FEAM)

The Fisheries Economic Assessment Model was developed in the early 1980s by William Jensen and Hans Radtke to estimate the contributions of the commercial and recreational fishing industries to the economies of Alaska and West Coast regions including California, Oregon, and Washington. The FEAM is a production-oriented model that can estimate the impacts of supply-side (harvesting sectors) changes. Because the fishery sectors are specified in a highly disaggregated manner, one can predict the economic impacts coming from a change in landings of a particular species, by a specific vessel type, and at a particular port area. FEAM consists of two sub-models: the first calculates the revenues and expenditures of harvesting and processing industries, and the second sub-model is IMPLAN. The regional economic impacts are computed by multiplying revenues (incomes) and expenditures by multipliers from an IMPLAN model. For each of the harvesting and processing subsectors, FEAM provides data on output by species, value-added components, and use of intermediate inputs. Value-added components include labor income (crew share, processing workers' income, and administrative salaries), capital income (operating income), and indirect business taxes (fish taxes and business/property taxes).

Intermediate input categories (goods and services) in FEAM include vessel/engine repair, fuel and lubricants, ice and bait, supplies, insurance, and other goods and services. Compared with IMPLAN, which provides fishery-related data for only two aggregated sectors (fish harvesting and processing sectors), FEAM provides much more detailed information at a disaggregated level. FEAM does not provide any information on final demands for processed products. In FEAM, fishery sectors' revenues (sales) are allocated to expenditure categories such as vessel/engine repair, utilities, crew shares, and operating income. Next, each expenditure category is allocated to several different IMPLAN sectors. The multiplier for each expenditure category is calculated as the weighted average of the underlying IMPLAN multipliers. Weights are calculated as the ratio of the amount of the expenditure allocated to a given IMPLAN sector to the total expenditure in the category. The multipliers for these expenditure categories thus calculated are used to estimate changes in regional income resulting from a change in fishery sectors' output levels. The approach employed in FEAM is very similar to the U.S. Minerals Management Service [MMS, Restructured and renamed Bureau of Ocean Energy Management (BOEM)] approach (Coffman et al. 2002) in which expenditures on offshore oil and gas activities are allocated to different IMPLAN sectors in each of different regions. The approach has also frequently been used by the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) to estimate recreation expenditure impacts. Seung and Waters (2005) provide a detailed description of the structure of the FEAM.

Procedures to Develop Dutch Harbor Model

Suppose that landings of a certain species change due to a management action. Then it will induce a change in (i) expenditures on the intermediate inputs used in the seafood industries (harvesting and processing industries) and (ii) value added (labor income and capital income) in the industries, which will lead to (iii) a change in the income of the households residing in the region that supply the factors of production (labor and capital).

First, the change in the expenditures on inputs by the harvesting sector is calculated by

$$\Delta COST_{f,i,s} = ioc_{f,i,s} \left(TR_{f,s}^{1} - TR_{f,s}^{0}\right), \tag{6}$$

where $\Delta COST_{f,i,s}$ is the change in expenditure made by seafood sector *f* (harvesting or processing sector) on input *i* used to catch species *s*, $ioc_{f,i,s}$ is the input-output (IO) coefficients describing the technology of *f* catching or processing *s*, $TR_{f,s}^{1}$ and $TR_{f,s}^{0}$ are post- and pre-policy levels of revenue (ex-vessel revenue or wholesale revenue) from catching or processing *s* by seafood sector *f*.

Because some portion of the intermediate inputs used in the seafood sectors is imported, the change in total expenditure ($\Delta COST_{f,i,s}$) should be adjusted so that the initial shock applied to the DH model is not overestimated. The net initial shock from the intermediate input use in both harvesting and processing sectors is given by:

$$\Delta RCOST_{i,s} = \textstyle\sum_{f} re_{f,i,s}\, \Delta COST_{f,i,s}, \tag{7}$$

where $\Delta RCOST_{i,s}$ is the change in the purchase of *locally produced* inputs by the whole seafood sector (harvesting plus processing) and $re_{f,i,s}$ is the share of total expenditure on input *i* supplied by its local production. In a remote region such as Dutch Harbor, this share is significantly small because a large portion of the inputs are imported from outside.

The change in total value-added (labor and capital income) from catching or processing *s* is derived as:

$$\Delta VAL_{f,s} = \sum_k va_{f,s,k} \left(TR_{f,s}^1 - TR_{f,s}^0\right), \tag{8}$$

where $\Delta VAL_{f,s}$ is the change in total value-added in sector *f* from catching or processing *s*, *k* denotes the type of factor owners (labor owners or capital owners) that earn the value-added, $va_{f,s,k}$ is the ratio of the value-added distributed to *k* used for catching or processing *s* by the seafood sector *f*.

Not all of the change in the value-added ($\Delta VAL_{f,s}$) remains in the region and flows to regional households. This is because in Alaska seafood industries, a large portion of labor is non-Alaska residents and a large portion of the capital is owned by non-Alaska residents. This means that a large portion of the factor income from Alaska fisheries (here Dutch Harbor fisheries) exits the region. Factor income leakage is one of the important characteristics of Alaska fisheries. Thus, to compute the change in the household income that remains and is spent in the region, the portion of the value-added exiting the region should be subtracted. The change in household income remaining in the region is thus computed as:

$$\Delta HH_s = \sum_f leak_{f,s} \Delta VAL_{f,s}, \tag{9}$$

where ΔHH_s is the change in the remaining household income from catching and processing *s* and $leak_{f,s}$ is the value-added leakage rates.

The change in household expenditure on commodity *i* from the policy change (i.e., change in the harvest of *s*) is computed as:

$$\Delta HCON_{i,s} = hcc_i \Delta HH_s, \tag{10}$$

where hcc_i is the household consumption coefficient.

The change in the total demand for commodity *i* from a change in harvest of *s* ($\Delta TEXP_{i,s}$) is the sum of the change in the seafood industries' expenditure on the commodity (input) above ($\Delta RCOST_{i,s}$) and the change in the household consumption of the same commodity ($\Delta HCON_{i,s}$):

$$\Delta TEXP_{i,s} \;=\; \Delta RCOST_{i,s} + \Delta HCON_{i,s}\,. \tag{11}$$

Finally, given the multipliers ($mult_i$) from Dutch Harbor SAM (Appendix Table A.1) constructed off of IMPLAN, the economic impacts from a change in the catch of *s* on the total regional industry output are calculated as:

$$IMPACT_s \;=\; \sum_i mult_i\, \Delta TEXP_{i,s}\,. \tag{12}$$

Note that to compute the multipliers from Dutch Harbor SAM, the rows for fish harvesting and processing industries in the SAM are set to zero to prevent double-counting problem. This is equivalent to setting the regional purchase coefficients to zero. See, for example, Seung et al. (2016) for details.

Dutch Harbor Fisheries and Data

Dutch Harbor is a port located on Amaknak Island within the City of Unalaska, which is 800 miles southwest of Anchorage in the heart of the North Pacific and the Bering Sea fisheries. The major industries in the city include commercial fishing, fish processing, fleet services, and marine transportation.[1] In 2022, Unalaska accounts for 92% ($614 million) of the total AWCA GDP ($668 million) (IMPLAN). For more than the past 20 years, Dutch Harbor has been the top fish landing port in the United States in the volume of landings. In 2020, the total landings were

[1]https://www.ci.unalaska.ak.us/sites/default/files/fileattachments/City%20Manager%26%23039%3Bs%20Office/page/963/community_profile_-_unalaska_alaska_5-16-2024.pdf

800.1 million pounds valued at $ 186.7 million. Alaska pollock accounted for 92% of the volume and 52% of the value. An additional 35% of the value of Dutch Harbor landings is from king crabs and snow crabs (National Marine Fisheries Service 2022). Other major fisheries include Pacific cod and halibut. In 2022, the port accounted for almost 100% of all the fish landed in all AWCA ports and over 93% of total ex-vessel revenue from all the AWCA landings.[2] During the period from the fourth quarter 2022 to the third quarter 2023, there were a total of 11 fish processing facilities in Unalaska (Alaska Department of Labor and Workforce Development 2024). The city government of Unalaska levies fishery-related taxes as well as other taxes. The city collects raw seafood sales tax (2%). The city also receives 25% of the fisheries business tax (3%) and fisheries resources landing tax (3%) collected by the state of Alaska.

There are two post offices in the city of Unalaska: one in Unalaska Island (zip code 99685), and the other in Amaknak Island (zip code 99692) where Dutch Harbor is located. IMPLAN provides separate data for these two zip-code areas for the city of Unalaska. This study combined the two areas into one when constructing a SAM using the 2022 IMPLAN dataset. The SAM thus constructed is an industry-by-commodity version. As mentioned, the rows for the two seafood industries are set to zero to avoid the double-counting problem that arises when using the model to compute the impacts of a change in the *final demand* (Seung et al. 2016). To derive the multipliers, this study used the SAM for the combined region. Fish harvest and landings data for 2022 were prepared using the Fish Ticket dataset[3].

The SAM for the combined region does not provide species-level information about the input use coefficients ($ioc_{f,i,s}$ in Equation 6), the shares of locally produced inputs ($re_{f,i,s}$ in Equation 7), the value-added distribution ratios ($va_{f,s,k}$ in Equation 8), and the value-added leakage rates ($leak_{f,s}$ in Equation 9). Therefore, this study used the corresponding information from the AWCA portion of the 10MRSAM assuming that these shares or ratios are similar to those for AWCA. This is a reasonable assumption given that Dutch Harbor is located within

[2] Lee, J. Pacific States Marine Fisheries Commission. Personal communication. 2024.
[3] Lee, J. Pacific States Marine Fisheries Commission. Personal communication. 2024.

AWCA and accounts for the majority of total seafood production. The household consumption coefficients (hcc_i in Equation 10) are from the SAM developed for the study region.

RESULTS AND DISCUSSION

This section presents the multipliers from the DH model for output, value-added, and employment for five major species (pollock, king crab, Pacific cod, Tanner crab, and halibut) landed in Dutch Harbor (Table 1), and the economic impacts of a hypothetical fishery management action (10% reduction in pollock TAC) computed by the model, as an example (Table 2). Multipliers in Table 1 are defined as the increase in the variable (output or value-added) when there is one dollar's worth of increase in the fish landed. On the other hand, employment multipliers are defined as the increase in the number of workers or jobs when the initial increase in the fish landed by $1 million.

When there is one dollar's worth of increase in king crab landing, the wholesale revenue from processing the raw fish increases by $1.309 (second column). The sales in non-seafood industries increase by $0.107 with the total industry output in the region (Unalaska) increasing by $2.416. Pollock generates the largest effect on the total regional output; a dollar's worth of increase in pollock landing causes the total regional output to increase by $3.402. This occurs because the value of processed pollock per unit of raw fish is the highest among the five species; one dollar's worth of raw pollock generates $2.183 worth of processed pollock.

The results from the DH model are compared to the borough-level (AWCA) results that are calculated using the 10MRSAM model assuming the initial shock (direct effect) is the same as that for the DH model (Table 1). For example, the indirect and induced effects for the region from pollock landing is $0.219 (DH model) which is much smaller than the effects computed for the AWCA using the MRSAM ($0.386). This produces the result that the total regional output from the DH model is 4.7% smaller than that from the MRSAM model. This finding is consistent with the findings from typical IO or SAM models. That is, the smaller the study region, the smaller the multiplier effects because the smaller region has smaller industries, therefore it has to import more of goods and commodities from outside of the region. The percentage difference in the multipliers from the two models ranges from 2.9% to 4.7%.

In Table 1, value-added and employment multipliers exhibit a similar pattern to the output multipliers. The percentage difference from the two models ranges from 5.5% to 12.0% for value-added multipliers and from 0.9% to 3.8% for employment multipliers. Table 2 presents the impacts of a 10% reduction in pollock landing at the port. A 10% cut in the harvest ($13.4 million) will cause the total port-level industry output to decrease by $45.4 million with the regional employment decreasing by 272 workers or jobs.

This study used several assumptions associated with specifying the seafood industries when developing the DH model. The assumption that the input use coefficients for the industries (in Equation 6) are the same as those for the larger area (AWCA) seems reasonable because the input use pattern of a seafood industry in the smaller area (Dutch Harbor) is not likely to be different from that in the larger area (AWCA). For the same reason, the assumption that value-added distribution ratios (in Equation 8) for the seafood industries in the smaller area are the same as those for the larger area appears to be probable.

In contrast, the assumption that the shares of locally produced inputs used in the seafood industries (in Equation 7) in the smaller area are the same as those for the larger area warrants further discussion. In general, the smaller the area, the larger its dependence on imports from outside the area. However, this may not be the case for Alaska seafood industries. The seafood industries in most remote areas in Alaska depend to a large extent on imported inputs from outside of Alaska rather than on those from the rest of the state. Even though a remote area within a BCA imports some inputs from the rest of the BCA or the rest of Alaska, the quantity is likely to be very small. Thus, it does not seem to be a strong assumption that the shares of locally produced inputs for a fishing port such as Dutch Harbor are the same as those for the larger area (AWCA) where the port is located.

Similarly, the assumption that the rate of leakage of value-added (in Equation 9) is the same as that for the larger area may be acceptable because of a similar reason. That is, most of the labor and capital (crew members and vessel owners) used in the seafood industries in the study area are either from the study area or from non-Alaska states. Some crew members or vessel owners may be from elsewhere in Alaska. However, the numbers of these factor owners may be relatively small. To the extent that the proportion of the nonlocal labor and capital used by the seafood industries in the study area (Dutch Harbor) is larger than that for the larger area (AWCA), the leakage of factor income in the DH model might be overestimated to some extent and therefore, the economic impact for the study area might be slightly underestimated.

CONCLUSION

This study described in detail the procedures to develop a regional economic impact model for a very small area for which the disaggregated IO models are not available. This study constructed a SAM for the combined region of two zip-code areas within the city of Unalaska, and showed that it is feasible to conduct such a task given the aggregated IO model, basic data including landings and processing data, estimates of various coefficients depicting the study region's economy such as input use coefficients. It is desirable that the economic model be constructed based on detailed information about important parameters such as inter-industry transactions for fisheries, the share of intermediate inputs supplied from local sources, the distribution of value-added to different factors of production, and the rate of leakage of value added. However, very often it is difficult to construct such a model in a timely manner because it takes a substantial amount of time and resources to collect the data. As an alternative, this study constructed a model similar to FEAM. Existing studies of the economic impacts of fisheries around the world tend to conduct the analysis only for relatively large regions. These studies are useful for some purposes but fail to evaluate the economic impacts from fisheries for a smaller region, such as a fishing port as in this study. One of the fishery managers' concern is how their decisions affect a very specific, sometimes very small in size, communities such as a small fishing port. This study enumerates the steps to construct an economic impact model for such an objective.

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Table 1. -- Multipliers.

	King crab	Tanner crab	Pacific cod	Pollock	Halibut
Output from DH model					
Direct effect on harvesting	1	1	1	1	1
Direct effect on processing	1.309	1.55	1.298	2.183	1.01
Indirect and induced effect on non-seafood industries	0.107	0.127	0.124	0.219	0.088
Total effect on regional output	2.416	2.677	2.422	3.402	2.098
Output from MRSAM model					
Indirect and induced effect on non-seafood industries	0.198	0.241	0.211	0.386	0.151
Total effect on regional output	2.507	2.791	2.509	3.569	2.161
% difference in total effect	-3.6	-4.1	-3.5	-4.7	-2.9
Value added from DH model					
Direct effect on harvesting	0.657	0.657	0.624	0.526	0.682
Direct effect on processing	0.177	0.316	0.171	0.681	0.006
Indirect and induced effect on non-seafood industries	0.070	0.082	0.082	0.140	0.059
Total effect on regional value added	0.904	1.055	0.877	1.347	0.747
Value added from MRSAM model					
Indirect and induced effect on non-seafood industries	0.149	0.192	0.158	0.325	0.102
Total effect on regional value added	0.984	1.165	0.953	1.531	0.789
% difference in total effect	-8.1	-9.4	-8.0	-12.0	-5.3
Employment from DH model (workers/jobs, per $1million change in harvesting)					
Direct effect on harvesting	4.9	4.9	13.2	3.3	24.9
Direct effect on processing	9.4	11.2	9.4	15.7	7.3
Indirect and induced effect on non-seafood industries	0.7	0.8	0.8	1.4	0.6
Total effect on regional employment	15.0	16.9	23.4	20.4	32.8
Employment from MRSAM model					

(workers/jobs, per $1million change in harvesting)					
Indirect and induced effect on non-seafood industries	1.1	1.3	1.2	2.1	0.9
Total effect on regional employment	15.4	17.4	23.8	21.2	33.1
% difference in total effect	-2.6	-2.9	-1.7	-3.8	-0.9

Note: The multipliers for output and value added are per $1 change in harvesting while those for employment are per $1 million change in harvesting.

Table 2. -- Impacts of 10% reduction in pollock harvest.

	Output ($million)	Value added ($million)	Employment (workers/jobs)
Direct effect on harvesting	13.4	7.0	44
Direct effect on processing	29.2	9.1	210
Indirect and induced effect on non-seafood industries	2.8	1.8	17
Total regional effect	45.4	17.9	272

Note: 10% reduction in pollock harvest is equivalent to $13.4 million.

APPENDIX

Appendix Table A.1 -- Structure of Dutch Harbor SAM.

		ENDOGENOUS ACCOUNTS					EXOGENOUS ACCOUNTS			
	INDUSTRIES	COMMODITIES	FACTORS	INDIRECT BUSINESS TAX	HOUSEHOLD	STATE /LOCAL GOVT	FEDERAL GOVT	CAPITAL	REST OF WORLD	TOTAL
INDUSTRIES		Industry production of commodities (Make matrix)								Total industry output
COMMODITIES	Interindustry demand (Use matrix)				Household demand	S & L govt demand	Federal govt demand	Investment demand (gross business investment)	Exports	Total commodity demand
FACTORS	Payments to factors									Total factor receipts
INDIRECT BUSINESS TAX	Indirect business tax payments									Total indirect business tax
HOUSEHOLD			Factor payments to households			S&L govt transfers to households	Federal transfers to households			Total household income
STATE/ LOCAL GOVT				Indirect business tax to S & L govt	S&L govt taxes	Inter-government transfers	Federal transfers to S&L govt			Total S&L govt revenue
FEDERAL GOVT				Indirect business tax to fed. govt	Federal income tax					Total federal govt receipts
CAPITAL					Household savings	S&L govt savings	Federal govt savings		External savings	Total savings
REST OF THE WORLD	Imports		Leakage of factor income		Imports	Imports	Imports	Imports		Total ROW receipts
TOTAL	Total industry outlays	Total commodity supply	Total factor payments	Total indirect tax payments	Total household payments	Total S&L govt payments	Total federal govt payments	Total investment payments	Total ROW expenditure	

U.S. Secretary of Commerce
Gina M. Raimondo

Under Secretary of Commerce
for Oceans and Atmosphere
Dr. Richard W. Spinrad

Assistant Administrator, National
Marine Fisheries Service.
Janet Coit

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7600 Sand Point Way N.E.
Seattle, WA 98115-6349