A User's Guide to the National and Coastal State I/O Model

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Introduction

The national and coastal state input/output (I/O) model is designed to estimate the economic impacts associated with the harvesting of fish[1] by U.S. commercial fishermen, the importation of fish and seafood products, and the activities of the seafood and retail industries that depend on fish and seafood products. These impacts are expressed in terms of employment (full-time and part-time jobs), labor income, total value added[2] and output (sales/value of shipments by U.S. businesses).

The current model updates a similar model prepared for the National Marine Fisheries Service in 2008. A major part of the updating is the use of 2008 IMPLAN data to describe the economic conditions that affect the impacts created by the harvesting and seafood industry. The previous model used 2006 IMPLAN data.

The model begins with the harvesting of fish in U.S. waters. The scope of the model includes the activities of commercial fishermen (reflected in commercial landings of fish), processors, wholesalers/distributors, retail grocers, and restaurants.

Imported fish and seafood products are a major part of the U.S. seafood industry and the retail outlets for fish and seafood. In 2009 (the most recent data), the value of imported fish and seafood products exceeded $11 billion, whereas domestic landings that year were valued at just under $4 billion.[3] In this model, these imports are treated as direct inputs for processors, wholesalers/distributors, and retailers and contribute substantially to the value added by the seafood industry.

Unlike the previous model, the updated model includes an estimate of the economic activities specifically associated with the importing of fish and seafood. The model assumes that the importation of these products involves brokers who work on relatively modest commissions.

When estimating the impacts of the seafood industry and retail outlets for fish and seafood, the model only addresses the impacts attributable to the value added by these businesses to the fish and seafood products that they purchase. For example, the impacts of seafood processors which purchase fish from harvesters exclude the value of the purchases from harvesters. Similarly, in cases of using imported products, impacts are only based on the value added by processors or other seafood industry business. The value of imported products themselves and the value added by importing these products ~~is~~are considered part of the brokers' segment of the industry. In this way, the model avoids double counting the value of these inputs.

[1] As used here, the term fish refers to the entire range of finfish, shellfish, and other life (i.e., sea urchins, seaweed, kelp, and worms) from marine and freshwaters that are included in the landings data maintained by the National Marine Fisheries Service.
[2] Total value added as defined by IMPLAN includes labor income (i.e. employee compensation and proprietors' income), rent and other property type income, and indirect business taxes.
[3] National Marine Fisheries Service, "Annual Commercial Landings by Group," www.st.nmfs.noaa.gov

The output estimates of the model for processors, wholesalers, and retailers will not equal and will be significantly less than the outputs of those segments as measured by standard secondary sources as a consequence of this attempt to avoid double counting the value of fish and seafood products,. The Census Bureau, Bureau of Labor Statistics, and others report the value of shipments and similar measures of output that include all inputs including the value of purchased fish and seafood. In the cases of wholesalers and grocers, where mark-up on fish and seafood products is relatively modest, the majority of the value of their shipments of finished products is in fact the value of purchased fish and seafood products that is excluded in the model's estimates of output value.

An exception to this rule of only addressing the value added by the seafood industry is the treatment of imports. When imports are included in the model's estimates of impacts, the value of imports and the value added to those imports are both included in the brokers' segment of the seafood industry. Once imports have become part of the output of processors or wholesalers, the model moves them along the value added chain in the same manner as products using domestically harvested fish and seafood as inputs.

Geographically, the model estimates impacts for the U.S. as a whole and for 23 marine coastal states. For the 23 states, estimates for the seafood industry are based on fish and seafood harvested in that state and reported in the NMFS landings data or imported to that state from a foreign source. Because of a lack of data, the state-level estimates that exclude imports may not include the impacts associated with interstate movement of fish and seafood. For example, the model will not necessarily capture all the impacts of a crab processor only using domestically harvested products who uses crabs from another state. As a result, the estimates of state-level impacts based on domestically harvested fish will likely underestimate total employment, income, total value added, and output. In cases where the industry in a given state receives a substantial share of fish or seafood products from other states, the model's estimates should vary substantially from the totality of the seafood industry in that state. This is also true in cases where there are substantial aquaculture activities that drive local seafood industry activities. For example, catfish aquaculture production that drives processing activities in a given state is outside the scope of this model.

When imports are included in the impacts, the model's estimates should approach total impacts for all segments of the seafood industry. Thus, using imports in the estimate tries to account for importing product from both foreign countries and other states. The model, however, cannot distinguish between impacts associated with interstate movement of domestically harvested fish and seafood products and the impacts associated with imports from other countries.

This inability to track state-to-state movement of fish and seafood is a clear weakness. There are, however, few data on the destination of fish and seafood products within states at each stage in the value added process and virtually none on fish and seafood products moving from one state to another. What few data exist suggest that fish and seafood frequently move across state lines as they proceed along the value-added chain.

These limitations of the model in estimating state-level seafood industry impacts have less effect at the national level. There are much clearer (although incomplete) data on the national movement of fish and seafood along the value-added chain within the borders of the U.S. National employment impacts should be reasonably close reflections of total employment with the exception of employment based on aquaculture and other fish and seafood not included NMFS landings data.

The model disaggregates these impacts by 18 species (e.g., shrimp) or groups of species (e.g., East Coast groundfish). These impacts by species and groups of species are shown not only for harvesters, but also for the segments of the seafood industry included in the model.

As noted, with its focus on the impacts of U.S. harvested marine fish, the model does not address activities associated with fish produced by U.S. aquaculture operations. U.S. aquaculture operations have tended to grow over time (e.g., from 691 million pounds in 1992 to an average of over 800 million pounds in recent years), and constitute as much as 30 percent of the value of U.S. commercially harvested fish. The total value of aquaculture production averaged $1.2 billion from 2005 through 2008.[4]

Any model represents an approximation of true conditions and is limited by various uncertainties. In addition to the issues identified above, the most important uncertainty in the present model is likely that associated with the costs and earnings of commercial fish harvesters. Cost and earnings data are typically collected for specific gear types such as trawls or pots in a particular area of the U.S. and the model reflects these regional variations where data are available. For the United States, the goal of this national model is to synthesize these particular data into national averages that address individual species or groups of species harvested in widely varying locations. Given that cost and earnings data for some important gear types are unavailable altogether and other data are available for only some of the relevant locations, there are unavoidable uncertainties built into the current version of this national model.

Another source of uncertainty is the data on product flow, the movement of fish and seafood products between the several segments of the seafood industry that begin with harvesting and imports and end with final sales to domestic consumers or with exports. Although data are available for a few states, there are no data for the great majority of states, for the nation as a whole, or for movements between specific states. Similarly, the allocation of imported products among the segments of the seafood industry is not well understood. Despite these limitations, the model produces estimates of the economic impacts of the nation's fisheries that are logical and reasonable.

This user's guide comprises an overview of the model's operations, a brief discussion of modifying the model, and background information. The guide's purposes are

- to orient the user to the basic ways of using the model,

[4] U.S. Department of Commerce, National Marine Fisheries Service, *Fisheries of the United States, 2009*, available at www.st.nmfs.gov/st1/fus/.

- to provide information on how the model can be updated or used to estimate special cases, and
- to disclose the basic methods and sources of information used to create the model.

Overview of Model Operations

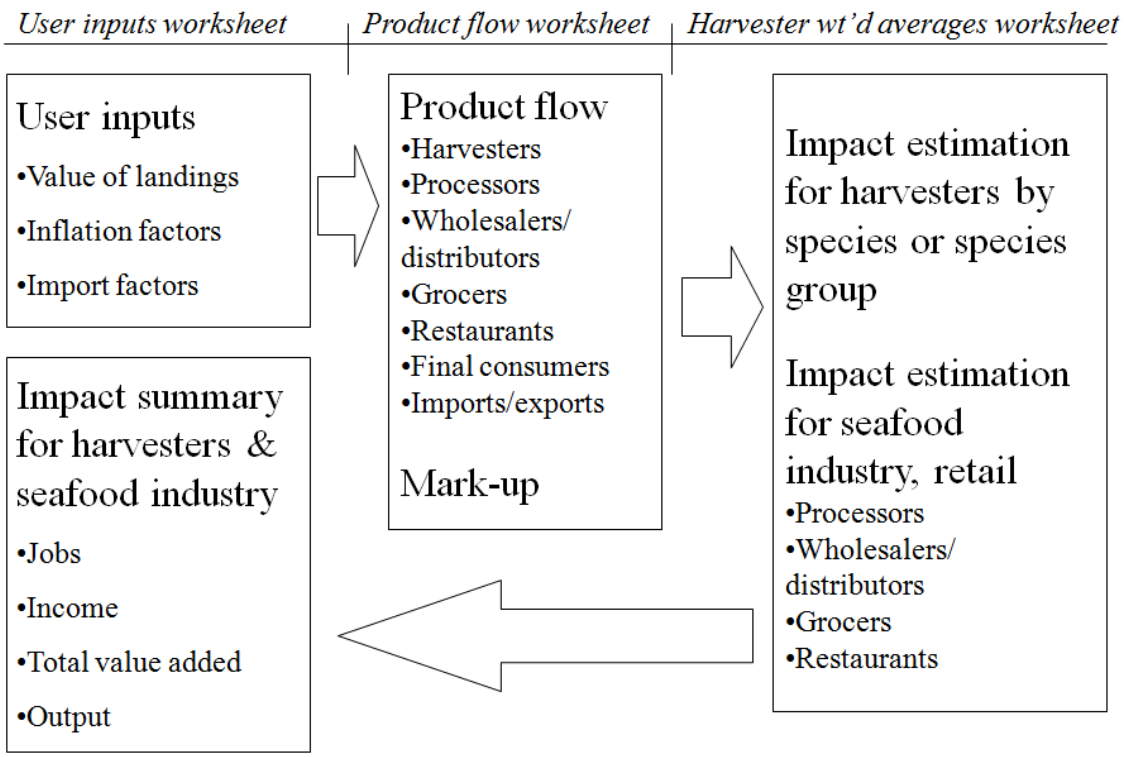
The national and coastal states I/O model can be used with a minimum of effort to generate estimates of national and state-level economic impacts of commercial fisheries and related industry. Alternatively, a user can rework or revise the model to estimate impacts for species, groups of species, or conditions not addressed by the model's original configuration.

The following introduces the major operations of model. More detailed information on these operations is provided in subsequent sections.

Basic model structure

Created in Microsoft Excel, the model comprises a linked set of three worksheets. The general operation of the model is shown in Exhibit 1.

Exhibit 1: Overview of National I/O Model



Each of the worksheets in the model addresses a distinct set of estimating issues as noted in Exhibit 2. These worksheets also rely on data developed in additional files that support

the development of the model. These data are described later in the user's guide (see Background Information).

Exhibit 2: Worksheets within the National I/O Model

Model worksheets	Description
1. User Inputs	• The user starts in cell A1. • The user determines the geographic unit for the estimate (i.e. the U.S. or one of the 23 coastal states) from the drop-down menu in cell D2. • Next the user selects the year of the landings and the year for the value of outputs (e.g., estimated income) from the drop-down menus in cells D4 and D5. • The user then chooses whether or not to include imports in the estimated impacts from the drop-down menu in cell D6. • The user then goes to cell V1 to download and enter landings data in the worksheet for the U.S. or selected state and the year selected. Instructions for downloading and entering landings data are listed in this part of the worksheet. • Value of landings data are entered in this worksheet. • Tables summarizing estimated impacts are displayed in this worksheet. • All inflation adjustments to input data and output estimates are computed here, based on user provided data. • All macros are described here. Macros are primarily used to print out the model's estimates and can be found in the range L1:U25.
2. Harvester wt'd averages	• The value of landings by species is allocated to the U.S. or selected state's harvester sector. • The value of fish and seafood inputs by species is allocated to each of the other seafood industry and retail segments. • If imports are included in the estimate, the value of imports is allocated among the processing, wholesale, and retail segments. • Impacts are estimated based on the value of landings for the harvesters and, if imports are included, on the value of imports and the value added to fish and seafood inputs for other segments. • These estimates are assigned to a specific array to facilitate their display and printing.
3. Product Flow	• The value of domestic landings is allocated among processors, wholesalers/distributors, grocers, and restaurants. • The value of imported fish and seafood is allocated among processors, wholesalers/distributors, grocers, and restaurants. • These allocations are distinct for the U.S. and different states.

User inputs

The model is designed to generate estimates from two inputs—the value of landings of U.S. or coastal state marine fisheries and the value of imported fish and seafood products. All subsequent calculations are based on these factors.

While the model is primarily concerned with estimates of economic impacts for all landings for the U.S. or a coastal state, it can also be used to make estimates for one or several fisheries that are a subset of all landings for a given area. That is, the user can enter a real or hypothetical value for any of the species or groups of species defined by the model. The estimated economic impacts of these landings will then be displayed in the user-input worksheet.

To properly account for the effects of inflation, the user must also select the dates for the landings and for the output values. Landings data are converted to 2008 dollars to match the I/O data used by the model. The estimated income and output impacts are initially calculated in 2008 dollars and then converted to dollars for the year specified by the user for output values. To select or change these years, the user should click on the cells with the year displayed (D4 and D5) and then click on the icon to the right of the cell. This will prompt a drop-down list of available dates. The user then clicks on the desired year.

Automated user inputs

A significant feature of the model is the ability to download landings data from the NMFS web site. A macro and instructions for this process are included in the range V1:Y22 of the User Inputs worksheet. By using this feature, the user can enter all the landings data for any year from 1998 onward. The model will automatically aggregate the landings data into the 18 categories of species used by the model.

Species groups

NMFS provides landings data on over 400 species or subspecies of fish. In order to make the model manageable, these species have been aggregated into 18 categories of species or groups of species of fish.

These categories were designed to reflect a general understanding of fish and seafood products. In some cases, a given species (e.g., shrimp) is sufficiently important to warrant its own category. At the other extreme, scores of species are included within some categories (e.g., all other finfish). The groups and their general components are listed in Exhibit 3; a detailed listing of species in each group are provided in the Background Information section.

Exhibit 3: Species Groups

Species group	*Major species in group*
Shrimp	All Shrimp
Crab	All Crab except Blue Crab
Lobster	American Lobster
East Coast Groundfish	Cod, Flounder, Goosefish, Haddock, Hake, Plaice, Pollock, Shark (Dogfish)
HMS	Shark (other than Dogfish), Swordfish, Tuna
Reef Fish	Gag, Grouper, Mackerel (King & Spanish), Snapper, Tilefish
West Coast Groundfish	Cod, Hake, Pollock, Rockfish, Sablefish, Sole, Whiting
Halibut	All Halibut
Menhaden/Industrial	Alewife, Ladyfish, Menhaden
Salmon	All Salmon
Sea Scallop	All Scallop
Surf Clam/Ocean Quahog	Surf Clam, Ocean Quahog, Quahog
Other Trawl	Anchovies, Croaker, Herring, Mackerel (other than King & Spanish), Mullet, Sardine, Shad, Squid
All Other Finfish	Amberjack, Drum, Hind, Pompano, Porgy, Scad, Sea Bass, Tautog
All Other Shellfish	Clam, Spiny Lobster, Mussel, Oyster, Sea Urchin, Snail (Conch)
Freshwater	Catfish, Crayfish, Perch, Tilapia, Trout
Inshore and Miscellaneous	Bass, Blue Crab, Seaweed, Sponge
Bait	Worms, Bait fish

Gear Types

The NMFS landings database reports gear used to harvest fish and includes scores of gear types. The model incorporates the variations in gear type operating economics into the estimating factors for the model's 18 species groups.

Seafood Industry

In this model the seafood industry is defined as those businesses that process and distribute fish and seafood products and sell those products to final consumers. These are broadly grouped into four segments: processors, wholesalers/distributors, grocers, and restaurants. Processing can be as little as sizing and packing shrimp or as elaborate as preparing cooked products.

As noted above, the value of imported fish and seafood products can be incorporated into the model's estimates. The model includes the value of the imports themselves in the estimated impacts for brokers that initially imports these products. Impacts asssociated

with brokers are included with the total impacts of imports and are not separately aggregated.

With the exception of imported products and brokers, sost and earnings data for the businesses included in the model are restricted to the value they add to the domestically harvested fish and seafood products that are inputs to their production and retail activities. This avoids double counting the impacts of the value added by those inputs.

Product Flow

For the purposes of this model, product flow refers to the sale of fish and seafood products by harvesters, processors, and wholesalers/distributors. By understanding where these businesses sell their products, the full potential for economic impacts can be better understood. If fish or seafood products are sold to final consumers in the U.S. or exported, the opportunity for adding value and thereby creating new economic impacts ends. Alternatively, when fish or seafood products are sold to businesses that then add value, economic impacts are created.

The model estimates the total product flow for fish beginning with harvesting activities and ending with sales to final consumers or export markets. There is a hierarchy in this estimation of product flow. Flow starts with harvesters who may sell to processors, wholesalers, grocers, restaurants, or directly to final consumers/exporters. Processors may sell to wholesalers, grocers, restaurants, or directly to final consumers/exporters. Finally, wholesalers may sell to grocers, restaurants or directly to final consumers/exporters. In reality, flow of products is more complicated with product moving between processors or from processors to wholesalers to processors and so on. Given the scarcity of data on even the simple hierarchy used in the model, no attempt was made to try to model a more complex, more realistic product flow.

A similar effort allocates imported fish and seafood products to processors, wholesalers, and retailers. Once these businesses have brought imports into the value-added chain, outputs are allocated according to the product flow estimates for domestically harvested fish and seafood.

Model outputs

The model generates estimates for four types of impacts—employment, income, total value added, and output. Each of these impacts is expressed as direct, indirect, and induced effects as well as the total of these effects. As noted previously, income, total value added, and output impacts are expressed in dollars for the year specified by the user. Employment impacts are expressed in terms of a mix of both full-time and part-time jobs.

Estimates are also disaggregated for harvesting and seafood industry activities. For harvesting, impacts are provided for each of the 18 categories of species of fish defined by the model. For the seafood industry, estimated impacts associated with processors,

wholesalers/distributors, grocers, and restaurants are provided. As with harvesting, seafood industry impacts are provided for the 18 categories of species.

Seafood industry impacts related to imports are separately accounted in the model. Although imported products span a wide range of species, all imports are treated as one category.

These impacts can be generated for the U.S. or any of 23 coastal states. The model generates impacts for one geographic area at a time.

Print macros

Print macros allow the user to generate a hard copy of model inputs and outputs in a variety of combinations. Tables of summary impacts are available for employment, income, total value added, and output impacts by species as well as a summary table for all species. There are also tables that present aggregated data for each of the 18 species or group of species and for imports, if they are included in the impact estimates.

To facilitate the use of these macros, a set of buttons has been created. For each macro, there is a separate button, labeled with the type of summary impacts (e.g., labor income impacts) or the species impacts (e.g., shrimp) presented in the tables. In addition, one button activates a print macro for input data. These buttons are located in the range L1:U22 of the User Inputs worksheet.

Adjustments for inflation

Because the estimates are based on IMPLAN's model of the national economy in 2008, the most recent year available when the model was developed, two adjustments for inflation have been incorporated. The value of landings in 2003 (or any other year from the period 1998 through 2010), for example, is converted to year 2008 dollars before impacts are estimated. After estimates of labor income, total value added, and output are created, they are converted to whichever year dollars the user has selected for the model's outputs.

The principal reason for converting input dollars to 2008 dollars is to avoid distorting estimates of employment impacts. Employment impacts are estimated on the basis of jobs per million dollars of expenditures. As a result, the effects of inflation overstate or understate employment impacts. Expressed as full-time and part-time jobs, these employment impacts, generated on the basis of 2008 dollars, are not subsequently adjusted.

Limitations and notes

At the time the model was developed, IMPLAN data for 2008 were the most recent year available. The impacts of Hurricane Katrina, in particular, and other recent distortions in

the economy that affect the harvesting processing and sale of seafood fish are presumably reflected in these data from IMPLAN.

Although cost-earnings data for harvesters exist for virtually all species for virtually all regions, the quality and specificity of these data range widely. Alaska has a wealth of data, resulting from a substantial survey effort by the state. Other areas of the country are not as well served. Data for processors' costs that might indicate locational variations based on the mix of inputs or other factors are much more limited.

Product flow estimates are another source of uncertainty. Data are available from state-level studies of New York and Virginia and a study of the shrimp industry. National flow data would almost certainly show different patterns of sales between and among harvesters and seafood establishments. Based on product flow data for New York State (TechLaw 2001), it is also likely that more comprehensive data would demonstrate a pattern of product flow more complex than the model assumes. This complexity could include more sales between seafood industry establishments and more value added by these establishments. To the extent that the model's assumptions underestimate value added, the economic impacts of this value added are also underestimated.

In addition to product flow studies, this analysis had the benefit of a study of the seafood processing industry. That study provided state-by-state estimates of the output of seafood processors. Using these output data as well as state-level data on processors and wholesalers from sources such as the 2007 Economic Census and the Bureau of Labor Statistics, it was possible to deduce the estimated flow of fish and seafood products to processors not only from domestic harvesters but also from imports.

Notwithstanding these attempts to understand the flow of seafood products from harvesters to processors to wholesalers to retail outlets, no data were found that estimate the flow of products between and among states. As a result the model is only able to capture the economic activity associated with processing, distributing, or selling to end users fish and seafood products that move from state to state by trying to match the model's estimates against the various secondary sources of data on employment in the seafood industry. These secondary data do not distinguish between domestic or imported inputs. Consequently, the model almost certainly underestimates the total economic contribution of domestically harvested seafood and the seafood industry in general, while trying to capture a reasonable picture of the impacts of the total industry when all inputs are considered.

It should be noted, however, that the very limited state-level data indicate that there is substantial movement of fish and seafood between states. As a result there are significant "leakages" that limit state-level seafood industry impacts based on domestically harvested products.

Modifying and Updating the Model

The default configuration of the model supports estimating the impacts of U.S. and state commercial landings in their totality. With additional effort by the user, the model can estimate the impacts of any particular component or components of those landings, hypothetical values of landings, or of landings from other years.

Basic inputs

The user must provide five types of data in order for the model to operate. All of these data are entered in the first worksheet, User Inputs, by following the instructions described in Step 1 through Step 5 in cells A1 through B7.

> 1. The user chooses the U.S. or a coastal state from the drop-down list in cell D2. This assures that the model uses the appropriate U.S. or state multipliers for the landings.
>
> 2. The year of landings' value is entered from the drop-down list in cell D4. The model is able to generate estimates landings in any year dollar from 1998 through 2010 although landings data are only available for years through 2009 at the time of this writing.
>
> 3. The year of output value is entered from the drop-down list in cell D5. The model is able to convert estimates to dollars in any year dollar from 2003 through 2010.
>
> 4. The inclusion or exclusion of imports in the estimated impacts of the seafood industry and retail outlets is selected from the drop-down list for cell D6.
>
> 5. Finally, values for landings are entered in the model automatically when the user downloads the entire set of landings data from the NMFS web site by following the steps listed beginning in cell V1.

The model computes estimates for whichever cells are filled in the range E9:E26. This range is filled automatically when landings are downloaded from the NMFS web site. The user can override this capability of the model by manually entering data in this range.

> *NOTE. If landings data are entered manually, the user should avoid saving that version of the model because the links that allow downloads from the NMFS web site to be entered automatically into the model will be lost.*

Variations on basic inputs

One straightforward variation of the inputs is to consider the impacts associated with a single species not individually addressed by the default configuration. Because most of the species groups in the model are for multiple species, most individual species are not addressed by the default configuration.

For example, grouper is a reef fish included with many other reef fish in the default configuration. The value of grouper landings can be entered under the category of reef fish. The model will then generate estimates of the economic impacts associated with grouper landings. Because the methods of harvesting grouper are generally similar to those for all other reef fish, substituting the value of grouper landings for reef fish landings provides a reasonable estimate of the impacts for this individual species.

Not all species categories allow for the simple substitution of individual species for categories of species. The category "Inshore and Miscellaneous" is dominated by Blue Crab that accounts for the great majority of the total value of this category. Because Blue Crab harvesting is primarily by pots and traps, this gear accounts for most of the allocation of value for the category. The second most important contribution to this category's value is Striped Bass (less than 10 percent), harvested primarily by gill and trammel nets and hand lines. Using the category calculations to estimate the economic impacts of Striped Bass would add a substantial element of uncertainty. To provide a more accurate estimate in such a case requires a more substantial effort.

Modifying product flow estimates

Changes to data on product flow can be entered in the "Product Flow" spreadsheet. The range A31:H60 in the Product Flow spreadsheet holds the data used by the model to allocate sales among harvesters and seafood industry segments for domestically harvested fish and seafood. In the range A61:K128, the distribution of imported fish and seafood products are maintained. In both ranges, data are state-specific.

If these data are modified, care must be taken to account for all sales from harvesters and each seafood industry segment including those to export markets and final consumers or to account for the distribution of all imports. Because of the potential for creating circular logic in the model's calculation of impacts, any modifications to product flow for domestically harvested fish and seafood must avoid allocating sales from downstream segments to upstream segments in the value-added chain. (See discussion of product flow in the next section on background data.)

As noted earlier, the significant risk of any modification that overrides parts of the model that interact with other portions of the model is losing the model's default values and configurations. This potential problem can be avoided by not saving the changes made to the model before exiting the model. Alternatively, the user could save different versions of the model with customized components.

Updating Gross Domestic Product implicit price deflators

This model uses the Gross Domestic Product (GDP) implicit price deflators to adjust for the effects of inflation. The model converts the dollar values of landings to year 2008 dollars to match the IMPLAN data used to estimate impacts. The model then converts the value of labor income, total value added, and output impacts from 2008 dollars to the dollars indicated by the user in cell D4 of the User Inputs worksheet.

Over time the user may wish to modify the model to allow adjustments to 2011 or later year dollars. Inflation adjustments will be possible by incorporating GDP implicit price deflator data for 2011 or later years into the model in the User Inputs worksheet.

The data for these implicit price deflators are published by the Bureau of Economic Analysis of the U.S. Department of Commerce and are available online at www.bea.gov/bea/. The data are updated routinely and are available as annual and quarterly estimates. An example of the basic information and layout for the BEA table of GDP implicit price deflators is presented in Exhibit 4.

The model uses annual values for GDP implicit price deflators to adjust for inflation. The range A68:C110 in the "User Inputs" worksheet includes all calculations relevant to the use of GDP implicit price deflators by the model.

Exhibit 4: GDP Deflators Table from BEA Web Site

National Income and Product Accounts Table

Table 1.1.9. Implicit Price Deflators for Gross Domestic Product
[Index numbers, 2000=100] Seasonally adjusted

Today is: 2/10/04 Last Revised on January 30, 2004 Next Release Date February 27, 2004

First Year 2002-A & Q Last Year 2003-A & Q Annual(A) Quarterly(Q) Refresh Table

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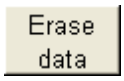
Line		2002 I	2002 II	2002 III	2002 IV	2003 I	2003 II	2003 III	2003 IV
1	**Gross domestic product**	**103.315**	**103.814**	**104.084**	**104.556**	**105.146**	**105.427**	**105.851**	**106.126**
2	**Personal consumption expenditures**	**102.503**	**103.241**	**103.757**	**104.199**	**104.923**	**105.060**	**105.517**	**105.676**
3	Durable goods	96.278	95.580	94.858	94.137	93.075	92.148	91.208	90.331
4	Nondurable goods	100.779	102.191	102.534	102.785	104.075	103.525	104.485	104.599
5	Services	104.748	105.479	106.364	107.167	108.021	108.751	109.299	109.739
6	**Gross private domestic investment**	**100.966**	**101.613**	**100.628**	**101.186**	**101.495**	**101.530**	**101.995**	**102.709**
7	Fixed investment	101.276	101.096	100.907	101.340	101.806	101.795	102.318	103.166
8	Nonresidential	99.297	98.923	98.554	98.658	98.579	98.293	98.678	99.154
9	Structures	106.778	106.897	106.974	107.269	108.264	108.553	109.283	110.390
10	Equipment and software	96.743	96.229	95.735	95.788	95.411	94.968	95.258	95.568
11	Residential	106.468	106.752	106.987	108.173	109.871	110.475	111.311	112.985
12	Change in private inventories	---							
13	**Net exports of goods and services**	---							
14	Exports	98.295	98.999	99.808	99.962	100.841	101.042	101.432	102.098
15	Goods	97.829	98.349	99.162	99.313	100.161	100.590	100.531	101.471
16	Services	99.442	100.572	101.372	101.535	102.484	102.157	103.579	103.619
17	Imports	94.213	96.597	97.471	97.662	100.403	99.349	100.011	100.282
18	Goods	93.146	95.558	96.200	96.332	99.053	97.321	97.939	98.059
19	Services	99.773	102.024	104.157	104.671	107.514	110.201	111.098	112.203
20	**Government consumption expenditures and gross investment**	**104.162**	**105.005**	**105.581**	**106.046**	**107.941**	**107.957**	**108.423**	**108.554**
21	Federal	104.284	104.870	105.192	105.059	107.025	107.392	107.748	107.836
22	National defense	104.004	104.609	105.081	104.933	106.960	107.291	107.644	107.764
23	Nondefense	104.792	105.342	105.393	105.289	107.143	107.577	107.938	107.964
24	State and local	104.088	105.068	105.781	106.576	108.431	108.242	108.774	108.930
	Addendum:								
25	Gross national product	103.304	103.804	104.069	104.541	105.138	105.425	105.853	---

Background Data

Additional detail the on model is presented here. This section also includes a discussion of IMPLAN and its use in the methodology employed by the national model.

Downloading landings data

The model was designed primarily to evaluate the entire set of annual landings for the U.S. or individual states. The source of these data is NMFS which publishes this information on its web site. The model includes a process for automatically capturing these data from the NMFS web site and aggregating these data into the 18 species categories used by the model. These aggregated data are then used by the model to estimate economic impacts. To initiate this process, the user goes to cell V1 of the “User Input” worksheet. The seven steps in this process are summarized below.



1. Click the "Erase data" button (shown to the left). This macro erases all old landings data and then invokes a hyperlink to the NMFS web site. If online, the user is automatically taken to the web page where a given year’s landings data are retrieved from NMFS’s database of landings.

2. Select year for landings and click on "Submit" button. The user selects the desired year for landings and then clicks the “Submit” button to generate the chosen landings data.

3. Select all landings data (use Ctrl + A). This selects all information on the web page with the landings data.

4. Copy all landings data (use Ctrl + C). This places all selected data on the clipboard.

5. Return to this worksheet. The user then needs to return to the User Input worksheet of the model.

6. Move cursor to cell Z1. This assures that the landings data will be entered in the proper location in the model.

7. Paste all landings data in this worksheet (Ctrl + V). By pasting the landings data in their assigned location, the aggregations into 18 species categories are made and the aggregated data made available for the estimation of economic impacts. The model also uses the labeled year in the landings data to inform the model of the year of input values.

Species groupings

One of the first major tasks of the project was to determine a manageable way to group the many species of fish reported in the NMFS landings database. The option of grouping species exclusively by the gear used to harvest them was not chosen because of the general lack of understanding of gear types. While gear types are frequently used to determine expenditure patterns, it was decided that defining groups primarily by species would communicate more effectively with most people.

The final categorization of groups was based on several factors. One, the economic value of landings helped to identify a few highly valuable species (e.g., shrimp, lobster) and closely related groups of species (e.g., groundfish). Two, location was significant in the cases of groundfish (i.e., East Coast versus West Coast), reef fish, and inshore fisheries (e.g., Blue Crab, Striped Bass). Three, the use of specific gear (i.e., trawls) defined one group. Remaining species were allocated to broad categories (e.g., all other finfish, freshwater). Exhibit 5 on the following pages details the species in each group

Product flow

The determination of seafood industry economic impacts is determined in large part by estimating two types of what are termed product flow.

> 1. One set of flow estimates where commercial harvesters and segments of the seafood industry sell their products. So long as these products remain in the chain of value-added activity within the U.S., they continue to create impacts in the U.S. economy. Whenever they are purchased by final consumers or are exported, new economic impacts are no longer generated.
>
> 2. A second set of flow estimates the destinations of imported fish and seafood products and which segment of the seafood industry, including retail outlets, is the initial destination. A potential destination of imports is re-exporters.

Several sources of data on product flow of domestically harvested fish and seafood were reviewed. A study of the shrimp industry in the Southeastern U.S. addressed product flow of shrimp from harvesters to dealers to processors to final markets. (Keithly 1994) While this was a narrowly focused study, shrimp are the single most valuable species harvested commercially in the U.S., accounting for 17 percent of the total value of landings in 2001 and almost 10 percent in 2009. Two other studies looked at a broad range of fish and seafood products from the perspective of individual states, specifically Virginia and New York. (A.T. Kearney 1997, TechLaw 2001) The state-level studies presented their own idiosyncrasies. In Virginia, a substantial share of harvested, processed, and distributed fish and seafood products is exported outside of the state. Most of these exports from Virginia, however, are sold within the U.S. New York's fish and seafood product flow is substantially influenced by Fulton Market, a mecca for fish and seafood products from many locations (including Virginia) that occupies a unique place in the national seafood

industry structure. The State of Alaska has begun to develop a model of the state's commercial fishing and processing industry. Data supplied by Alaska included information on product flow in that state.

Exhibit 5: Species Allocated to Species Groups

Shrimp	East Coast Groundfish	HMS	Reef fish
Mantis Shrimps	Flounder, Summer	Shark, Sandbar	Runner, Rainbow
Shrimp, Blue Mud	Flounder, Windowpane	Shark, Shortfin Mako	Scamp
Shrimp, Brine	Flounder, Winter	Shark, Soupfin	Scorpionfishes
Shrimp, Brown	Flounder, Witch	Shark, Thresher	Sheepshead
Shrimp, Ghost	Flounder, Yellowtail	Shark, Tiger	Snapper, Black
Shrimp, Marine, Other	Goosefish	Sharks	Snapper, Blackfin
Shrimp, Ocean	Haddock	Spearfishes	Snapper, Cubera
Shrimp, Pacific Rock	Hake, Atlantic, Red/White	Swordfish	Snapper, Gray
Shrimp, Penaeid	Hake, Offshore Silver	Thresher Sharks	Snapper, Lane
Shrimp, Pink	Hake, Red	Tuna, Albacore	Snapper, Mutton
Shrimp, Rock	Hake, Silver	Tuna, Bigeye	Snapper, Queen
Shrimp, Royal Red	Hake, White	Tuna, Blackfin	Snapper, Red
Shrimp, Seabob	Plaice, American	Tuna, Bluefin	Snapper, Silk
Shrimp, Spot	Pollock, Walleye	Tuna, Little Tunny	Snapper, Vermilion
Shrimp, White	Scups Or Porgies	Tuna, Skipjack	Snapper, Yellowtail
Shrimp, Atlantic & Gulf, Roughneck	Sea Bass, Black	Tuna, Yellowfin	Snappers
Crab	Shark, Dogfish	Tunas	Squirrelfishes
Crab, Atlantic Rock	Shark, Smooth Dogfish	**Reef fish**	Tilefish
Crab, Cancer	Shark, Spiny Dogfish	Bigeye	Tilefish, Blueline
Crab, Deepsea Golden	Skate, Big	Gag	Tilefish, Goldface
Crab, Deepsea Red	Skates	Grouper, Black	Tilefish, Sand
Crab, Dungeness	Sole, Yellowfin	Grouper, Marbled	Wenchman
Crab, Green	Wolffish, Atlantic	Grouper, Red	Yellowtail
Crab, Jonah	**HMS**	Grouper, Snowy	**West Coast Groundfish**
Crab, King	Bonito, Atlantic	Grouper, Warsaw	Cod, Pacific
Crab, Red Rock	Bonito, Pacific	Grouper, Yellowedge	Flounder, Arrowtooth
Crab, Snow	Dolphin	Grouper, Yellowfin	Hake, Pacific (Whiting)
Crab, Southern Tanner	Finfishes, Pelagic, Other	Groupers	Lingcod
Crabs	Shark, Atlantic Sharpnose	Hogfish	Pollock
Lobster	Shark, Bigeye Thresher	Jack, Almaco	Rockfish, Aurora
Lobster, American	Shark, Blacktip	Jack, Bar	Rockfish, Bank
Lobster, Slipper	Shark, Blue	Jack, Crevalle	Rockfish, Black
East Coast Groundfish	Shark, Hammerhead	Jacks	Rockfish, Black-And-Yellow
Cod, Atlantic	Shark, Leopard	Mackerel, King & Cero	Rockfish, Blackgill
Cusk	Shark, Longfin Mako	Mackerel, Spanish	Rockfish, Blue
Flatfish	Shark, Makos	Pompano, African	Rockfish, Bocaccio
Flounder, Flukes	Shark, Pacific Angel	Rosefish, Blackbelly	Rockfish, Bronzespotted
Flounder, Starry	Shark, Porbeagle	Runner, Blue	Rockfish, Brown

Exhibit 5: Species Allocated to Species Groups (continued)

West Coast Groundfish	West Coast Groundfish	Other trawl	All other finfish
Rockfish, Canary	Seabass, White	Bluefish	Amberjack
Rockfish, Chameleon	Sole, Butter	Butterfish	Amberjack, Greater
Rockfish, Chilipepper	Sole, Curlfin	Croaker, Atlantic	Amberjack, Lesser
Rockfish, China	Sole, Dover	Croaker, Pacific White	Barracuda, Pacific
Rockfish, Copper	Sole, English	Dory, American John	Barracudas
Rockfish, Cowcod	Sole, Flathead	Grenadiers	Barrelfish
Rockfish, Darkblotched	Sole, Petrale	Herring, Atlantic	Black Driftfish
Rockfish, Flag	Sole, Rex	Herring, Atlantic Thread	Brotula, Bearded
Rockfish, Gopher	Sole, Rock	Herring, Lake Or Cisco	Cabezon
Rockfish, Grass	Sole, Sand	Herring, Pacific	Cobia
Rockfish, Greenblotched	**Halibut**	Herring, Pacific, Roe On Kelp	Creole-Fish
Rockfish, Greenspotted	Halibut, Atlantic	Herrings	Cunner
Rockfish, Greenstriped	Halibut, California	Jack Mackerel	Cutlassfish, Atlantic
Rockfish, Kelp	Halibut, Greenland	Lumpfish	Dealfish
Rockfish, Olive	Halibut, Pacific	Mackerel, Atlantic	Drum, Black
Rockfish, Pacific Ocean Perch	**Menhaden/Industrial**	Mackerel, Chub	Drum, Red
Rockfish, Pink	Alewife	Mullet, Striped (Liza)	Drums
Rockfish, Pinkrose	Ladyfish	Mullet, White	Eel, American
Rockfish, Redbanded	Menhaden, Atlantic	Mullets	Eel, Conger
Rockfish, Redstripe	Oilfish	Octopus	Eels
Rockfish, Rosy	**Salmon**	Redfish Or Ocean Perch	Escolar
Rockfish, Rosy	Salmon, Chinook	Sardine, Pacific	Finfishes, Groundfishes, Other
Rockfish, Sharpchin	Salmon, Chum	Sardine, Spanish	Finfishes, Marine, Other
Rockfish, Shortbelly	Salmon, Coho	Seatrout, Sand	Finfishes, Unc For Food
Rockfish, Silvergray	Salmon, Pacific	Seatrout, Spotted	Finfishes, Unc General
Rockfish, Speckled	Salmon, Pink	Shad, American	Finfishes, Unc Spawn
Rockfish, Splitnose	Salmon, Sockeye	Shad, American Buck	Grunts
Rockfish, Starry	**Sea scallop**	Shad, American Roe	Hagfishes
Rockfish, Stripetail	Scallop, Bay	Shad, Gizzard	Harvestfish
Rockfish, Swordspine	Scallop, Sea	Shad, Hickory	Hind, Red
Rockfish, Treefish	**Surf clam/Ocean quahog**	Spot	Hind, Speckled
Rockfish, Vermilion	Clam, Atlantic Surf	Squid, California Market	King Whiting
Rockfish, Widow	Clam, Ocean Quahog	Squid, Longfin	Launces
Rockfish, Yelloweye	Clam, Quahog	Squid, Northern Shortfin	Leatherjackets
Rockfish, Yellowmouth	**Other trawl**	Squids	Lookdown
Rockfish, Yellowtail	Anchovies	Thornyhead, Longspine	Mackerel, Frigate
Rockfishes	Anchovy, Northern	Thornyhead, Shortspine	Margate
Sablefish	Atka Mackerel		Mojarras

Exhibit 5: Species Allocated to Species Groups (continued)

All other finfish	All other shellfish	Freshwater	Inshore and miscellaneous
Moonfish, Atlantic	Abalones	Carps & Minnows	Crab, Blue, Peeler
Opah	Clam, Arc, Blood	Catfish, Blue	Crab, Blue, Soft
Parrotfishes	Clam, Atlantic Jackknife	Catfish, Channel	Crab, Blue, Soft & Peeler
Pigfish	Clam, Butter	Catfish, Flathead	Echinoderm
Pinfish	Clam, California Jackknife	Catfish, Channel	Permit
Pinfish, Spottail	Clam, Manila	Catfish, Flathead	Sea Cucumber
Pompano, Florida	Clam, Pacific Geoduck	Catfishes & Bullheads	Seaweed, Kelp
Porgy, Jolthead	Clam, Pacific Littleneck	Chubs	Seaweed, Rockweed
Porgy, Knobbed	Clam, Pacific Razor	Crappie	Seaweeds
Porgy, Red	Clam, Pacific, Gaper	Crayfishes Or Crawfishes	Sponge, Grass
Porgy, Whitebone	Clam, Softshell	Drum, Freshwater	Sponge, Sheepswool
Pout, Ocean	Clams Or Bivalves	Finfishes, Fw, Other	Sponge, Yellow
Prickleback, Monkeyface	Cockle, Nuttall	Gars	Sponges
Puffers	Crab, Florida Stone Claws	Goldfish	Starfish
Rudderfish, Banded	Crab, Horseshoe	Perch, White	Turtle, Soft-Shell
Scad, Bigeye	Lobster, California Spiny	Perch, Yellow	Turtles
Scads	Lobster, Caribbean Spiny	Quillback	**Bait**
Sculpins	Mollusks	Silversides	Ballyhoo
Sea Bass, Giant	Mussel, Blue	Sturgeon, Green	Bloodworms
Sea Catfishes	Mussel, California	Sturgeon, White	Finfishes, Unc Bait & Animal Food
Sea Raven	Oyster, Eastern	Sturgeons	Mummichog
Searobins	Oyster, European Flat	Suckers	Sandworms
Sheephead, California	Oyster, Olympia	Sunfishes	
Skippers	Oyster, Pacific	Tilapias	
Smelt, Eulachon	Periwinkles	Trout, Lake	
Smelt, Rainbow	Sea Urchins	Trout, Rainbow	
Smelts	Shellfish	Turtle, Snapping	
Spadefishes	Snails (Conchs)	Turtles, Baby (Young FW)	
Surfperches	**Freshwater**	Walleye	
Tautog	Bass, Rock	Whitefish, Lake	
Toadfishes	Bowfin	Whitefish, Round	
Triggerfish, Gray	Buffalofishes	**Inshore and miscellaneous**	
Tripletail	Burbot	Bass, Longtail	
Wahoo	Carp, Common	Bass, Striped	
Weakfish	Carp, Grass	Bass, White	
Wolf-Eel		Crab, Blue	

Another set of data was used to estimate flow related to domestically harvested fish and seafood. NMFS has surveyed seafood processors and has state-level data on that segment. In addition, standard sources including the U.S. Census Bureau and the Bureau of Labor Statistics have state-level for fish and seafood processors and wholesalers. These data were used to adjust flow from harvesters to processors and from processors to wholesalers.

While these sources of product-flow data do not directly address all issues related to domestically harvested fish and seafood, they provide an overall picture of the movement of fish and seafood through the supply chain. In the absence of other data, they represent the best picture of product flow currently available. Exhibit 6 presents the estimated product flow from these sources.

Exhibit 6: Product flow for fishing and seafood industries related to domestically harvested fish and seafood

Source of fish, seafood products	*Destination of fish, seafood products (percentage distribution)*					
	Processors	Whole-salers/ distributors	Restaurants/ Food service	Groceries/ retail markets	Exports	Final consumers
Harvesters: non-shrimp, non-bait, except as noted	30.0%	45.0%	2.5%	10.0%	7.0%	5.5%
Harvesters: shrimp, except as noted	50.0%	27.5%	0.0%	0.0%	20.0%	2.5%
Harvesters: shrimp, in LA, TX	25.0%	45.0%	2.6%	10.0%	7.0%	10.4%
Harvesters: bait	0.0%	95.0%	0.0%	0.0%	0.0%	5.0%
Harvesters: non-bait species in AL,MS	90.0%	5.0%	2.5%	2.5%	0.0%	0.0%
Harvesters: non-bait species in AK	30.0%	3.0%	1.0%	1.0%	45.0%	20.0%
Harvesters: non-bait species in CT, FL, HI, LA, ME, NC, NJ, NY, RI, SC, TX	15.0%	25.0%	5.1%	6.2%	35.0%	13.7%
Harvesters: non-bait species in US	45.0%	40.0%	2.5%	4.0%	5.0%	3.5%
Processors: non-shrimp, non-bait: except AK	0.0%	51.3%	16.0%	25.1%	0.0%	7.6%
Processors: shrimp: except AK	0.0%	10.0%	52.0%	37.8%	0.3%	0.0%
Processors: bait		0.0%	0.0%	25.0%	0.0%	75.0%
Processors: AK		3.0%	1.0%	1.0%	93.0%	2.0%
Processors: states except AK		30.0%	10.0%	15.0%	45.0%	0.0%
Wholesalers/distributors:			44.0%	54.0%	2.0%	0.0%

US						
Wholesalers/distributors: AK			6.0%	3.0%	91.0%	0.0%
Wholesalers/distributors: except AK			30.0%	25.0%	25.0%	20.0%

A data set concerning the volume and value of imported fish and seafood products was also used to estimate product flow. This data set included information on the port of entry and the state to which these products were consigned. The place of consignment was assumed to be the location where these products entered the value added chain, typically entering this chain through processors and wholesalers.

The TechLaw study of product flow in New York (2001) found that product flow was complex with harvesters and seafood establishments selling some portion of their output to virtually all seafood industry segments as well as exporters and final consumers. Such patterns of sales present challenges to modeling which are met by simplifying assumptions. The model assumes a linear flow of product sales from upstream to downstream segments of the value-added chain. At any given point, a business establishment is assumed to sell its output to any downstream establishment. Segments of the value-added chain are arrayed from upstream to downstream as follows.

Harvesters ⇨ Dealers/ Processors ⇨ Fulton Market Wholesalers/ Distributors ⇨ Exporters/ Final Consumers

Cost-earnings data for harvesters

In the course of this project, an effort was made to update available cost-earnings data for commercial harvesters. These data were found in a variety of reports as well as databases. Formal sources are listed in the bibliography.

These data were collected and standardized. The method of standardization was to match the types of expenditures reported in these sources with the categories of expenditures that can be examined by IMPLAN (see Exhibit 7). These expenditures included profits, not strictly speaking, an expenditure, but included to reflect the total distribution of revenues.

Exhibit 7: Typical categories of harvester expenditures

- Purchases of goods
  - Fishing gear
  - Miscellaneous hardware & supplies
  - Electronics
- Repair & maintenance
  - Fishing gear, nets
  - Vessel & engine

    - Electronics
- Trip expenses
    - Groceries, food, & supplies
    - Fuel & lubricants
    - Ice
    - Bait
- Fixed and general expenses
    - Moorage
    - Dues, fees
    - Licenses, permits
    - Accounting
    - Insurance
    - Bank fees and services
    - Vehicle costs
- Fixed and general expenses (continued)
    - Capital costs, boats
    - Other expenses
    - Taxes
- Income and profit
    - Crew & captain shares, other income
    - Profit

By accounting for all revenues associated with costs and earnings for harvesters, it was possible to associate the value of landings (i.e., revenues for harvesters) with a set of expenditures. These expenditures in turn are used to generate estimated economic impacts.

The review of cost-earnings data and its conversion to a standardized format involved a series of judgements on particular data issues. The following notes address those judgements.

1. Costs and earnings are specific to the species of interest. In some cases, source data were configured in this manner. In other cases, source data were converted to align with the 18 species groups in the model.

2. Cost-earnings data from all sources have been converted to a percentage distribution of costs and income, including profit. Even in the few cases where data from published sources provided just this type of information, certain assumptions have been made in order to use the data in the developed national model. The authors of this national model take responsibility for these judgements.

3. Unless explicit information to the contrary is available in data sources, all capital expenses are assigned to boats, rather than motor vehicles. This may overestimate the expenditures of fishing monies on vessels and underestimate the expenditures for trucks and other motor vehicles.

4. When ice and bait costs are aggregated, they are split evenly between these two cost categories.

5. Fishing gear repair is assumed to be the repair of electronic equipment unless more specific information on the repair of equipment is available.

Cost-earnings data for seafood industry

Some of the same sources that were used to develop product flow also included information on costs and earnings for seafood industry establishments. These sources of data were standardized using IMPLAN expenditure categories. Typical expenditure categories for processors, wholesalers/distributors, grocers, and restaurants are shown in Exhibit 8.

Exhibit 8: Typical categories of seafood industry expenditures

- Supplies/packaging
- Other supplies
- Breading
- Ingredients
- Transportation
- Real estate
- Utilities, telephone
- Administration
- Overhead, miscellaneous
- Insurance
- Accounting
- Maintenance and repairs
- Bank fees and services
- Capital costs
- Ads, promotion
- Taxes/employment taxes
- Wages & profits

It is important to emphasize that these expenditures do not include the cost for fish or seafood products purchased by the seafood industry as inputs into their value-added activities. The economic impacts of these inputs have been estimated as a part of the activities of harvesters or dealers/processors that are providing these inputs. By focusing the estimation of economic impacts on the value added by the seafood industry, the analysis avoids double counting of impacts.

The estimation of value added to the fish or seafood products purchased by seafood industry establishments is based on data from Alaska's survey of seafood processors and from value added statistics published in *Fisheries of the United States* (2006). For processors this figure is 126 percent; for wholesalers/distributors, the figure is 63 percent; for grocers, markup on seafood inputs is 33 percent, while for restaurants, the figure is 182 percent.

Weighted averages files

The custom sector capability of IMPLAN was utilized in the model because of the complexity and quantity of calculations required by a model that addresses:

- The U.S. and 23 coastal states
- 18 species groups
- Harvesters and 4 downstream segments of the seafood industry
- The potential to include or exclude imported fish and seafood products

These variables allow for 4,320 combinations of place, species, segment, and imported inputs. Accordingly, the final model uses weighted averages for 2,160 combinations of place, species, and segment. (Imports can be added into the calculations of impacts as a separate process.)

These weighted averages use the percentage distribution of costs and earnings data in combination with IMPLAN data for the economic sectors associated with each type of expenditure. The resulting weighted average can be used in the final model as a standalone IMPLAN sector. This greatly reduces the memory requirements of the final model, simplifying calculations, and generally streamlining and making the model more efficient.

IMPLAN and general methodology for estimating impacts

IMPLAN (IMpact analysis for PLANning) is a system for conducting economic analyses based on national input-output (I/O) structural matrices. IMPLAN was originally developed by the U.S. Forest Service and has gained wide acceptance in a variety of impact assessment applications. In addition to the Forest Service, users of IMPLAN have included the U.S. Army Corps of Engineers, the National Park Service, the Soil Conservation Service, the Federal Emergency Management Agency, the Bureau of Land Management, universities, and numerous state and regional planning agencies.

The basic IMPLAN model performs an I/O analysis for a given region in terms of as many as 440 economic sectors, roughly corresponding to NAIC codes. In addition, IMPLAN allows the analyst to add custom sectors for a particular application. Impacts are specified in terms of output, income, total value added, and employment.

Multipliers and other variables used in the analysis were generated using IMPLAN's software and a separate IMPLAN data file for each study area. In this case the IMPLAN data files for the United States and 23 coastal states were used to create national and state level variables, corresponding to the national and state study areas. Multipliers for the year 2008 economy are available as a report from the basic model of the national economy created by IMPLAN software. Margins and RPCs are also available in the basic model created by IMPLAN software.

The I/O methodology employed here measures economic impacts in terms of business sales (referred to as "output" in I/O terminology), labor income, total value added, and employment. These impact measures are defined as follows:

- Output is the gross sales by businesses within the economic region affected by an activity.

- Labor income includes employee compensation (wages and salaries) and proprietors' income (income from self-employment).

- Total value added includes labor income plus rental and other property income and indirect business taxes.

- Employment is specified on the basis of full-time and part-time jobs. There is significant part-time and seasonal employment in commercial fishing and many other industries.

Multipliers are presented for direct, indirect, induced and total impacts. Multipliers express the respective impacts resulting from demands for goods or services associated with a particular activity such as commercial fishing. Types of impacts are defined as follows:

- Direct effects express the economic impacts (for output, income or employment) in the sector in which the expenditure was initially made. For example, the direct income multiplier for the wholesale trade sector would show the total income generated among wholesale employees and proprietors by demand for services from the wholesale trade sector. This direct impact would result, for example, from expenditures made by commercial fishermen in wholesale establishments.

- Indirect effects measure the economic impacts in the specific sectors providing goods and services to the directly affected sector. For directly affected wholesalers, indirect effects would include the purchases of products from manufacturers and purchases of accounting services. These indirect impacts extend throughout the economy as each supplier purchases from other suppliers in turn. For example, the accounting firms would need to purchase office supplies and business equipment. Thus, the indirect output multiplier would represent the total output generated in the various supplier sectors resulting from demand for goods or services from the direct sector.

- Induced effects are the economic activity generated by personal consumption expenditures by employees in the directly and indirectly affected sectors, as wholesalers, accountants, and other directly and indirectly affected employees spend their paychecks. These household purchases have additional "indirect" and "induced" effects as well, all of which are defined as induced effects.

- Total effects are the sum of the direct, indirect and induced economic impacts. Total effects quantify the total impact (i.e., for output, income or employment) throughout the economy created by demand for goods and services by the direct sector.

The multipliers express the economic impacts, which occur within a defined study area, in this case, the U.S. and 23 coastal states. The multipliers do not account for economic

impacts taking place outside of the study area (i.e., outside the U.S. or an individual state).

As noted above, a combination of sources has been used to estimate budgets and expenditures for commercial fishers and the seafood industry. These estimates of expenditures serve as the base for estimating economic impacts of the industries' activities.

Given these estimated expenditure patterns, I/O multipliers were developed by economic sector for the U.S. These multipliers express the economic impacts generated as a function of the amount of these expenditures. For output (sales), income, and employment, impact ratios were developed for direct, indirect, induced and total multipliers.

In estimating the economic impacts of specific expenditures, the first step is to determine whether the expenditures occurred in the study area. For the national model, a simplifying assumption is made that almost all expenditures occur in the U.S. Exceptions are made for certain gear, including boats, where a minority of spending was made outside the U.S. and electronics where half of all spending is made outside of the U.S. To the extent that these estimates of purchases of goods actually are directly made in the U.S., the model will underestimate economic impacts. Alternatively, other assumptions may overstate impacts by assuming that all spending was made in the U.S. (e.g., Norwegian insurance companies traditionally specialize in services for large factory trawlers).

In estimating the impacts of expenditures on goods, IMPLAN requires the disaggregation of expenditures into value-added shares attributed to manufacturing, transportation, wholesale, and retail activities, using allocations (termed margins) generated by IMPLAN. The model assumes that all purchases by commercial fishing and seafood industry establishments are made from wholesalers. Consequently, the model uses IMPLAN's information on margins to distribute the value of purchased goods among manufacturing, transportation, and wholesale sectors, thereby creating adjusted margins.

Although it is likely true that some purchases made by commercial fishing and seafood industry establishments occur at the retail level (e.g., some groceries), it is believed that almost all purchases of goods are made at the wholesale level. This assumption is based on the common practice of businesses purchasing supplies from wholesalers. Anecdotal data suggest that even certain purchases by commercial fishing establishments from retail outlets are made at discounts that approximate wholesale prices. That is, retailers may be willing to provider commercial fishing establishments discounts in return for continuing, high-volume purchases. To the extent that purchases are made from retail, rather than wholesale, establishments, the model overstates the importance of production and understates the importance of retail. In the absence of survey data, the assumption of wholesale purchases is believed to introduce less distortion.

The one exception to the assumption of purchases made at the wholesale level is the spending made by wage earners that create induced impacts. These expenditures are assumed to occur in the retail sector.

A substantial portion (usually a majority) of the value of any good is created by the manufacturing of the item. The economic impacts associated with expenditures on goods will then largely occur where those items are manufactured, often different than the location of the purchase. Given the increasingly global nature of manufacturing, this is true even when the scope of the impact analysis is the U.S. Thus, for the purchase of fuel, the model assumes that approximately 68 percent of the demand will be met by U.S. manufacturers (i.e. refineries). Thus, a purchase of fuel will create economic impacts in the U.S., but will also generate impacts elsewhere (e.g., Mexican or Canadian refineries).

The provision of services tends to be much more local. For many services, it is assumed that establishments located within the region being analyzed can meet the great majority of demand for the service. Thus, the model assumes that 99 percent of motor freight services and 100 percent of wholesale services are met by U.S. businesses.

The estimation of the ability of the economic region being analyzed to meet regional demands for goods and services is measured by regional purchase coefficients (RPC). RPCs are generated by IMPLAN and are specific to economic regions. Generally, regions with larger and more comprehensive economies are more able to meet demand for goods and services and have higher values for their RPCs. Thus, California with its large and complex economy would generally capture more of the total potential impacts of commercial fishing than would a smaller state like Rhode Island with fewer opportunities to the demands initially created by commercial fishing.

The I/O methodology converts expenditures to economic impacts with multipliers. These multipliers were developed using IMPLAN software and the U.S. and various state data sets. The multipliers for economic sectors corresponding to particular types of expenditures made by commercial fishing and seafood industry establishments were used to estimate economic impacts. For example, impacts of purchases of diesel, gasoline and other fuels and lubricants were estimated using the IMPLAN multipliers for several sectors: petroleum refining, transportation services, and wholesale businesses. Purchases of repair and maintenance services for the harvester sector were estimated using the boat repair sector. These multipliers address output, income, and employment impacts.

Custom multipliers were developed for several types of expenditures that do not directly correspond to a specific sector in the IMPLAN multiplier system. This resulted in custom multipliers, analogous to the standard IMPLAN industry sector multipliers. These consisted of expenditures for grocery or food expenditures, for vehicle ownership costs, for marinas, and for wages.

Grocery expenditures are developed using a standard “basket” of foodstuffs and other grocery goods purchased by consumers. Like all other goods, part of the value of grocery purchases is assigned to the transportation and wholesale sectors.

Wages are similar to groceries in that they represent a mix of purchases made by typical households. These include food, shelter, transportation, and other goods and services consumed by households. For goods, part of the value is assigned to transportation, wholesale, and (because these are purchases made by consumers) retail activities. Unlike all other expenditures addressed by the model, a percentage of wages is assumed to be saved, devoted to taxes, or otherwise not spent in the economy. For the nation, 76 percent of wages is assumed to be personal consumption spending and 66 percent of wages are spent in the U.S. The difference comes from the value of imported goods (e.g. toys from China or petroleum from Cananda) and to a lesser extent services. For individual states, this figure for in-state spending tends to be much lower than the national value, for example, an estimated 59 percent of Californians' income is spent in that state.

For both grocery expenditures and wages, custom sectors were created using data available from IMPLAN. IMPLAN generates a "Household Commodity Demand" report, based in turn on estimates by the U.S. Bureau of Economic Analysis of personal consumption expenditures. Expenditures related to food and groceries were used to estimate groceries purchased by fishing operations. The entire set of expenditures was used to estimate the induced effects of wages.

These expenditure files for the U.S. economy for the year 2008 were used to create weighted averages for multipliers, RPCs, margins, and other components of the estimating algorithms. The weighted averages, based on the expenditures of all U.S. households, were then used to estimate impacts from the expenditures of commercial fishing and seafood industry operations as well as wage earners. Grocery expenditures by commercial fishing and seafood industry operations are assumed to occur at the wholesale level. Wage expenditures are at the retail level.

Vehicle ownership costs are based on American Automobile Association data on operating and fixed costs. The specific costs for this custom sector were based on the ownership costs of an SUV (the closest model to a pickup truck) driven 15,000 miles annually with a useful life of 8 years. Costs include gas and oil, maintenance, tires, insurance, fees and taxes, capital costs, and bank loan fees. Similarly, marina costs are based on survey work done by A.T. Kearney that looked at typical expenditures of these businesses.

Finally, an overall model was developed which integrates the above data in an Excel spreadsheet. This model allows the user to input the domestic landings data either directly from the NMFS web site or manually by the user to produce impact estimates and also to include or exclude imports from these estimates. Estimates are available for the U.S. as a whole and for 23 states with marine commercial fisheries.

The model also allows for modifications to structural parameters such as the RPCs, distribution of cost and earnings/expenditures, and other economic variables. These modifications may be made to the model, but also require some caution on the part of the user as they tend to override the default configuration of the model and diminish the model's ability to make impact estimates with a minimum of user inputs and effort.

The following summarizes the key aspects of the I/O analysis.

- The IMPLAN economic analysis system served as the starting point for the I/O analysis and directly generated most of the variables used in the analysis.

- Sets of multipliers were developed for the U.S. as a whole and 23 coastal states.

- Custom multipliers were developed for critical sectors not effectively represented by the standard IMPLAN model.

- For each expenditure, a Regional Purchase Coefficient was applied to estimate the portion of demand which could be fulfilled by U.S. businesses.

- Appropriate margins were applied to the purchase of goods where there is activity in the transportation, wholesale, or retail sectors as well as the manufacturing sector.

- These variables were used to evaluate representative expenditures for commercial fishing and seafood industry activities resulting from the harvesting of fish in U.S. waters and subsequent processing, distribution, and retail sale of fish and seafood products.

- Weighted averages for each combination of geography, species, and industry segment were compiled to create a more efficient model.

Opportunities to improve the national model

Any model is a tool for creating estimates. Necessarily, elements of uncertainty are introduced into models. Not surprisingly for a model that covers this many distinct activities, there are opportunities to improve the current model and reduce the uncertainties built into the current version of the national model.

Better cost-earnings data on harvesters may be an important opportunity for improvement. No data are available for several individual groups of species for some states.

In addition, better information on the national, intrastate, and interstate flow of fish and seafood products would help understand the economic impacts of the domestic commercial fishing and seafood industries. Current flow data is available only for New York and Virginia and for shrimp. While these data account for a significant share of total U.S. landings, the flow data for the great majority of landings are poorly understood. Furthermore, many of the existing flow data address flow within a state, not across state or within national boundaries. These data are also old, predating Hurricane Katrina, the Deepwater Horizon oil spill in the Gulf of Mexico, and trends in the industry that constantly impact production activities.

The absence of better data has led to some simplifying assumptions about product flow. For example, the model assumes that dealers/processors receive inputs only from harvesters and that wholesalers/distributors only sell their products to retail level businesses or final consumers. Better data could support a more complex and comprehensive understanding of the movement of food and seafood in the seafood industry.

The absence of better product flow data almost certainly results in an underestimation of the economic impacts of domestically harvested fish and seafood products. Estimates of product flow in New York state (TechLaw 2001) indicate that product flow is quite complicated with seafood products often moving among several processing- or wholesale-level seafood industry establishments before moving to the retail level, to exporters, or to final consumers. This national model makes a number of simplifying assumptions that may well underestimate the number of processing or distribution establishments that handle these products. Consequently, to the extent that the model underestimates the number of processing or distribution steps taken, it also underestimates the value added by these establishments and the overall economic impact of the seafood industry.

Finally, a better treatment of the activity involved in the importing (and perhaps exporting) of fish and seafood would be beneficial. A separate industry segment devoted to this activity would capture the value added by importers to imported fish and seafood products. The current model acknowledges the role of brokers in importing fish and seafood products, but this activity has not been carefully reviewed and analyzed.

Testing the accuracy of the model

It would be helpful to have independent and accurate estimates of harvesting and seafood industry employment, income, and outputs. These could be used as benchmarks to test each of the model's estimates and provide greater confidence in the model's ability to evaluate the impacts of alternative scenarios for policymakers.

While such benchmarks are generally unavailable for harvesters, there are a few national sources of information on the downstream seafood industry that can be used to test the validity of the model. The U.S. Bureau of the Census conducts the Economic Census for years ending in 2 or 7 and annually publishes County Business Patterns and, in years not ending in 2 or 7, the Annual Survey of Manufacturers.

These sources use the NAICS to define the overall economy. As a result, the model's segments of the seafood industry do not always align with the codes used by these data sources. The best alignments are estimates of the seafood processing industry (NAICS 3117). There are also estimates of seafood wholesalers (NAICS 42446, Fish and seafood merchant wholesalers) that correspond to the model's wholesale segment although there are also food wholesalers that handle fish and seafood, but are not principally involved with fish and seafood. There are also estimates of retail outlets for fish and

seafood─groceries and other retail food stores and of restaurants, but these estimates do not separate activities dependent on fish and seafood from other activities.

Exhibit 9 compares the model's estimates of seafood processing employment in 2009 with estimates published in the 2007 Economic Census, the 2008 and 2009 Annual Survey of Manufacturers, and in Fisheries of the United States - 2009. Because these estimates include all inputs, they are most similar to the model's estimates that include imports. For the U.S., all these estimates indicate seafood processing employment in the mid-30,000 range from almost 34,000 to almost 38,000. At the level of individual states, the source sometimes agree, but more often diverge. Many states have no estimated employment, typically states with relatively low employment. The differences between these sources may reflect methodological variations or industry trends. In the latter case, Florida appears to have had a precipitous decline in jobs from 2007 to 2009. Regardless of the reasons for these disparate estimates, the fact that there is so much variation makes it difficult to judge the accuracy of the model's estimates.

Exhibit 9. Comparison of seafood processing employment estimates

Source of estimate	*Current model*	*Economic Census*	*Annual Survey of Manufacturers*		*Fisheries of the United States*
Year	2009	2007	2008	2009	2008
United States	34,415	37,842	37,252	33,685	37,397
Total 23 states	33,908	NA			34,957
Alabama	1,265	1,367			1,724
Alaska	7,784	8,903	8,893	7,469	9,027
California	2,359	2,547	2,243	2,239	1,216
Connecticut	95	NA			71
Delaware	19	NA			NA
Florida	1,128	2,165	1,559	1,141	1,511
Georgia	383	NA			NA
Hawaii	286	NA			NA
Louisiana	1,370	1,241			1,700
Maine	1,110	458			732
Maryland	1,091	1,418			713
Massachusetts	2,255	2,047	2,315	2,282	2,640
Mississippi	836	2,838	2,456	2,389	2,906
New Hampshire	180	154			269
New Jersey	819	761			563
New York	449	465			431
North Carolina	413	317			602
Oregon	1,021	1,079			1,063
Rhode Island	186	166			268
South Carolina	61	NA			NA
Texas	1,104	1,222		1,015	1,378
Virginia	1,008	961			1,635
Washington	8,687	9,143	9,409	8,847	6,508

Exhibit 10 compares the model's estimates of seafood processing employment in 2009 to the estimates from the Economic Census, the Annual Survey of Manufacturers, and Fisheries of the United States. The model tended to try to benchmark its estimates against the Economic Census and Annual Survey of Manufacturers because these are similar estimates and cover a 3-year period. By definition, of course, the model's estimates are 100 percent of themselves. Compared to these secondary sources, the model's estimates are in the range of 90 percent to 110 percent in 25 of 59 cases where there are direct comparisons of the model to these secondary sources. The largest error appears to be the model's estimate for Maine which is 242 percent of the 2007 Economic Census estimate and 152 percent of the Fisheries of the United States estimate for 2008.

Exhibit 10. Comparison of model's estimates to other estimates

Source of estimate	*Current model*	*Economic Census*	*Annual Survey of Manufacturers*		*Fisheries of the United States*
Year	2009	2007	2008	2009	2008
United States	100%	91%	92%	102%	92%
Total 23 states	100%				97%
Alabama	100%	93%			73%
Alaska	100%	87%	88%	104%	86%
California	100%	93%	105%	105%	194%
Connecticut	100%				134%
Delaware	100%				NA
Florida	100%	52%	72%	99%	75%
Georgia	100%				
Hawaii	100%				
Louisiana	100%	110%			81%
Maine	100%	242%			152%
Maryland	100%	77%			153%
Massachusetts	100%	110%	97%	99%	85%
Mississippi	100%	29%	34%	35%	29%
New Hampshire	100%	117%			67%
New Jersey	100%	108%			145%
New York	100%	97%			104%
North Carolina	100%	130%			69%
Oregon	100%	95%			96%
Rhode Island	100%	112%			69%
South Carolina	100%				
Texas	100%	90%		109%	80%
Virginia	100%	105%			62%
Washington	100%	95%	92%	98%	133%

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