A User's Guide To
The Fisheries I/O Model
For Puerto Rico

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Prepared for
NOAA Fisheries
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Southeast Fisheries Science Center
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Acknowledgements

The fisheries I/O model for Puerto Rico relies on secondary data from several sources. In particular, we have relied on Juan Agar and Steve Turner of NOAA Fisheries and Daniel Matos-Caraballo of the DNER Commercial Fisheries Statistics Program of Puerto Rico.

Introduction

The fisheries input-output (I/O) model for Puerto Rico model is designed to estimate the economic impacts associated with the harvesting of fish[1] by Puerto Rican commercial fishermen and the activities of the processing and wholesale segments of the seafood industries that depend on fish and seafood products. These impacts are expressed in terms of employment (full-time and part-time jobs), income, and output (sales by businesses).

The model begins with the harvesting of fish in Puerto Rican waters. The scope of the model includes the activities of commercial fishermen (reflected in commercial landings of fish), processors, and wholesalers/distributors.

When estimating the impacts of the processing and wholesale segments of the seafood industry, 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. In this way, the model avoids double counting the value of these inputs. In this example, the impacts of the purchased fish are included under the impacts of the harvesting sector.

The model disaggregates these impacts by 13 gear types (e.g., beach seine). These impacts by gear types are shown not only for harvesters, but also for the two segments of the seafood industry included in the model.

Any model represents an approximation of actual conditions and is limited by various uncertainties. The most important uncertainty in the present model is likely that associated with the costs and earnings of commercial fish harvesters and the seafood industry in Puerto Rico. Cost and earnings for harvesters typically differ among gear types given differing requirements for fuel, bait, and other inputs. There tends to be some variation among processors given the requirements of different species and seafood products. Alternatively, there is relatively little variation among wholesalers. The uncertainty in the model arises from the relative lack of data on harvesters, processors, and wholesalers in Puerto Rico.

The goal of this model is to generate what might be called first-order estimates of impacts associated with fisheries. As more and better data are available, the model can be modified and amended to reflect conditions in Puerto Rico more accurately.

Another source of uncertainty is the data on product flow, the movement of fish and seafood products between and among the segments of the seafood industry that begins with harvesting and move on to processors and wholesalers. These data are always

[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.

difficult to collect, and the model uses estimates based on the national product flow of the U.S. Despite these limitations, the model produces estimates of the economic impacts 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,
- 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.

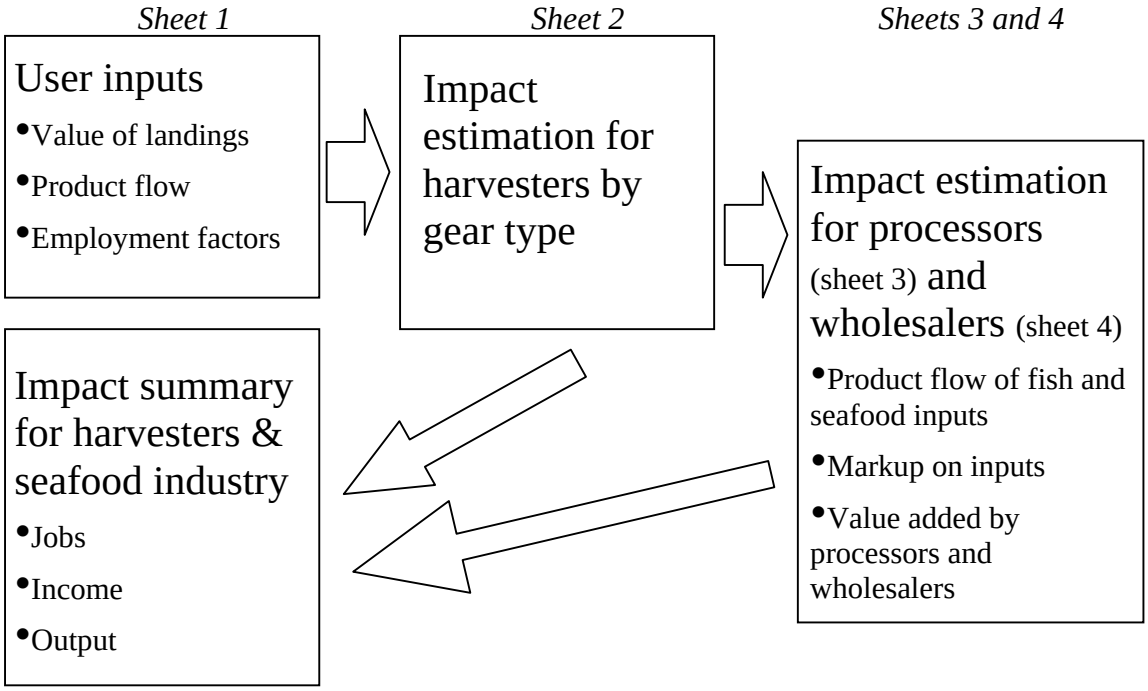
Overview of Model Operations

The Puerto Rico I/O model can be used with a minimum of effort to generate estimates of the economic impacts of commercial fisheries and the related seafood industry. 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 four worksheets. The general operation of the model is shown in Exhibit 1.

Exhibit 1: Overview of the Puerto Rico I/O Model



Initially, the user enters the ex-vessel value of landings by gear type into the EXCEL spreadsheet. Estimated impacts are then calculated by gear type. Product flow to processors and wholesalers and their respective values added are estimated. Estimated impacts of this value-added activity are calculated and aggregated for processors and wholesalers. Impacts for harvesters, processors, and wholesalers are summarized and expressed in 2006 dollars, the most recent year for which landings values are available. Values for converting to other base year values, however, are contained in the User Input section of the EXCEL spreadsheet. The user simply needs to multiply the output (impact) values by the deflator or conversion values to convert to a different base years. The employment numbers, however, do not need to be converted.

Each of the worksheets in the model addresses a distinct set of estimating issues as noted in Exhibit 2. These data are further described later in the user's guide (see Background Information).

Exhibit 2: Worksheets within the Puerto Rico I/O Model

Model worksheets	Description
1. User Inputs	• The user enters the value of landings for specific gear types in the range B3:B15. • The model automatically generates all estimated impacts based on the value of landings for specific gear types. • Summaries of impacts for each gear type and for all gear types can be printed by clicking on the buttons in the range C3:C15. Each button is labeled with the relevant gear type. • All employment related data for gear types are located in the range A39:E69. • Product flow data are located in the range A72:D76. • Mark-up data are located in the range A78:D80. • I/O related data for seafood processors and wholesalers are located the range A83:E95.
2. Harvesters	• The value of landings by gear type is allocated to each of the 13 gear types encompassed by the model. • The value of landings is allocated among the expenses of gear types including labor costs and proprietors' income. • Impacts are estimated based on the value of landings and expenses of harvesters. • These estimates are assigned to gear type-specific tables in the User Inputs worksheet to facilitate their display and printing.
3. Processors	• The value of landings is allocated by gear type to the processors segment, based on product flow data. • The value added to landings by processors is calculated and allocated among the expenses of processors. • Impacts are estimated based on the value added and expenses of processors. • These estimates are assigned to gear type-specific tables in the User Inputs worksheet to facilitate their display and printing.
4. Wholesalers	• The value of landings and the value of seafood inputs (from processors) are allocated by gear type to wholesalers. • The value added to these inputs by wholesalers is calculated and allocated among the expenses of wholesalers. • Impacts are estimated based on the value added and expenses of wholesalers. • These estimates are assigned to gear type-specific tables in the User Inputs worksheet to facilitate their display and printing.

User inputs

The model is designed to generate estimates from a single input—the value of landings. All subsequent calculations are based on these data.

While the model is primarily concerned with estimates of economic impacts for all landings, it can also be used to make estimates for one or several gear types/fisheries that are a subset of all landings. That is, the user can enter a real or hypothetical value for any gear type defined by the model. The estimated economic impacts of these landings will then be displayed in the User Input worksheet.

Seafood Industry

In this model the seafood industry is defined as those businesses that process and distribute fish and seafood products. These are broadly grouped into two segments: processors and wholesalers/distributors. Processing can be as little as sizing and packing fish or as elaborate as preparing cooked products.

Cost and earnings data for these businesses are restricted to the value they add to the fish and seafood products that are inputs to their production 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 and processors. By understanding where these businesses sell their products, the full potential for economic impacts can be better understood. When fish or seafood products are sold to final consumers 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 wholesalers. There is a hierarchy in this estimation of product flow. Flow starts with harvesters who may sell to processors, wholesalers, or others. Processors may sell to wholesalers or others (e.g., grocers, restaurants, or directly to final consumers/exporters). In reality, the 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 model a more complex, more realistic product flow. As is true with many areas, data on product flow in Puerto Rico are particularly scarce. The model uses product flow estimates based on national data.

Model outputs

The model generates estimates for three types of impacts—employment, income, 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 and output impacts are expressed in 2006 dollars. Employment impacts are expressed in terms of a mix of full-time and part-time jobs.

Almost all commercial harvesting is characterized by a high degree of seasonal and part-time work. To provide a better understanding of the number of individuals who earn a living from commercial fishing activities, the model estimates the "unique count for labor." This value represents the number of individuals engaged in commercial fishing as opposed to the number of commercial fishing jobs. On average, in Puerto Rico, one individual is estimated to hold almost two commercial fishing jobs during a given year. Consequently, the estimated value of the unique count for labor is roughly half the number of commercial fishing jobs.

Estimated impacts are also disaggregated for harvesting and seafood industry activities. For harvesting, impacts are provided for each of the 13 gear types defined by the model. For the seafood industry, estimated impacts associated with processors and wholesalers are provided. As with harvesting, seafood industry impacts are provided for the 13 gear types.

Print macros

Print macros allow the user to generate a hard copy of model outputs easily. Tables of summary impacts are generated by gear type as well as a summary table for all gear types. 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 impacts (e.g., beach seine, scuba diving) presented in the tables. These buttons are located in the range C3:C16 of the User Inputs worksheet.

Limitations and notes

At the time the model was developed, the only IMPLAN data available for Puerto Rico were based on economic data for 1997. To the extent that the economy has significantly changed since then, the model fails to capture those changes. For example, if the seafood processing sector has different inputs or capacities now, the model will improperly model those relationships.

Cost-earnings data for all gear types do not exist. This introduces another uncertainty into the model's estimates.

Product flow estimates are another source of uncertainty. In related work on fisheries in the U.S. product flow data have been found only in a few state-level studies and a study of the shrimp industry. Data can be inferred from other studies of the national seafood

industry. Flow data specific to Puerto Rico would almost certainly show different patterns of sales between and among harvesters and seafood establishments than the estimates used in the model. 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.

Modifying and Updating the Model

The default configuration of the model supports estimating the impacts of Puerto Rican commercial landings for 2006 in their totality. With additional effort by the user, the model can estimate the impacts of any particular component or components of those landings or hypothetical values of landings.

Basic inputs

The user need only provide landings data for the model to operate. The model's default status is to enter the total value of landings for 2006.

Variations on basic inputs

One straightforward variation of the inputs is to consider the impacts associated with a single gear type. Similarly, a value of landings for a specific species can be entered using the gear type most relevant to that species.

Modifying product flow estimates

Changes to data on product flow can be entered in the Product Flow range of the User Input spreadsheet. The range A72:D76 holds the data used by the model to allocate sales among harvesters and the seafood industry segments.

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. Because of the potential for creating circular logic in the model's calculation of impacts, any modifications to product flow for harvested fish and seafood must avoid allocating sales from downstream segments to upstream segments in the value-added chain.

A 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.

Background Data

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

Product flow

Seafood industry economic impacts are determined in large part by estimating product flow. Flow data estimate 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 Puerto Rico, they continue to create impacts on the economy. Whenever they are purchased by final consumers or are exported, new economic impacts are no longer generated.

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. 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 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 that includes information on product flow in that state.

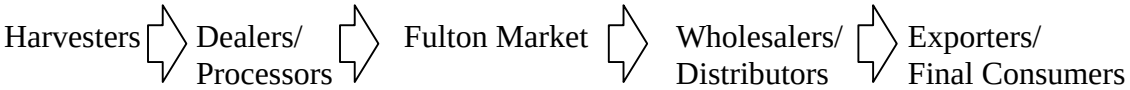
Another set of data was used to estimate flow related to domestically harvested fish and seafood. NMFS has surveyed seafood processors and has state-level data on that segment. These data were used to adjust flow from harvesters to processors.

While these sources of product-flow data do not directly address all issues related to fish and seafood in Puerto Rico, 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 3 presents the estimated product flow from these sources.

Exhibit 3: Product flow for fishing and seafood industries related to U.S. 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	40.0%	45.0%	2.5%	7.0%	0.0%	5.5%
Harvesters: shrimp, except as noted	87.5%	12.5%	0.0%	0.0%	0.0%	0.0%
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	90.0%	5.0%	1.0%	1.0%	0.0%	3.0%
Harvesters: non-bait species in CT, FL, HI, ME, NJ, NY, RI, SC	20.0%	25.0%	5.1%	6.2%	35.0%	8.7%
Harvesters: non-bait species in US	60.7%	27.8%	2.5%	4.0%	5.0%	0.0%
Harvesters: bait	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Processors: non-shrimp, non-bait: except AK	0.0%	51.7%	17.7%	23.0%	0.0%	7.6%
Processors: shrimp: except AK	0.0%	10.0%	72.0%	17.8%	0.3%	0.0%
Processors: AK		5.0%	1.0%	1.0%	93.0%	0.0%
Wholesalers/distributors: except AK			60.0%	30.0%	8.0%	2.0%
Wholesalers/distributors: AK			6.0%	3.0%	91.0%	0.0%

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.



Cost-earnings and related data for harvesters

In the course of this project, a considerable effort was made to identify and collect available cost-earnings data for commercial harvesters. Formal sources are listed in the bibliography. The primary source of costs and earnings data for the harvesting sector of Puerto Rico was the study done by Agar et al. (2005). Wholesale and processing sector data for the U.S. and various states were to construct the wholesale and processing sector models of Puerto Rico.

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 generated by IMPLAN (see Exhibit 4). While IMPLAN data for Puerto Rico are not as refined as they are for the U.S., over three-quarters of harvesters' expenditures are attributed to proprietors' income, labor, fuel and oil which can be reasonably addressed by the IMPLAN data set for Puerto Rico.

Exhibit 4: 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 are used to generate estimated economic impacts.

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

1. Costs and earnings are specific to gear types.

2. Cost-earnings data have been converted to a percentage distribution of costs and income, including profit.

3. In the absence of better data, all capital expenses are assigned to transportation equipment. This may overestimate the expenditures of fishing monies on vessels and motor vehicles and underestimate the expenditures for other capital costs.

4. The IMPLAN data set includes an estimate of the local economy's ability to supply the demand for a given good or service. For example, the supply of fuel is dependent in large part on refinery capacity. Few region's have enough refinery capacity to meet all local demand. These values, called the regional purchase coefficients (RPCs), have been adjusted for certain sectors to reflect likely conditions for the commercial fishing and seafood sectors. For example, the IMPLAN model assumes that about 78 percent of the demand for fishing products (i.e. bait required by many gear types) is met locally. For the model, it is assumed that all demand for bait by the commercial fishing operations is met locally.

Cost-earnings data for seafood industry

Some of the sources that were used to develop product flow also included information on costs and earnings for seafood industry establishments. These data were standardized using IMPLAN expenditure categories. Typical expenditure categories for processors and wholesalers/distributors are shown in Exhibit 5.

Exhibit 5: 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 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 129 percent; for wholesalers/distributors, the figure is 63 percent.

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 129 percent; for wholesalers/distributors, the figure is 63 percent.

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 Puerto Rico in terms of as many as 94 economic sectors, roughly correlated 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, and employment.

Multipliers and other variables used in the analysis were generated using IMPLAN's software and a separate IMPLAN data file for Puerto Rico. Multipliers for the year 1997 economy are available as a report from the basic model of the Puerto Rican economy created by IMPLAN software. Margins and RPCs are available in the "Edit" portion of 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), income, and employment. These impact measures are defined as follows:

- Output is the gross sales by businesses within the local economy.

- Income includes personal income (wages and salaries) and proprietors' income (income from self-employment).
- Employment is specified in terms 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 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.

- 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 the initial 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 Puerto Rico. The multipliers do not account for economic impacts taking place outside of the study area (i.e., outside Puerto Rico).

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 this model, a simplifying assumption is made that all expenditures occur in Puerto Rico.

In estimating the impacts of expenditures on goods, IMPLAN requires the disaggregation of expenditures into value-added shares attributed to manufacturing and wholesale/retail activities, using allocations (termed margins) generated by IMPLAN. Because the IMPLAN data do not distinguish between wholesale and retail sectors and many commercial harvesters and seafood businesses make purchases from wholesalers, the model may understate the importance of production and overstate the importance of retail.

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. For the purchase of fuel, the model estimates that 66 percent of the demand will be met by Puerto Rican manufacturers (i.e. refineries). Thus, a purchase of fuel will create economic impacts in Puerto Rico, but will also generate impacts elsewhere (e.g., Mexican or Canadian refineries).

The provision of services tends to be much more local. For almost all services, it is assumed that establishments located within the region being analyzed can meet the all demand for the service.

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 meet 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 Puerto Rico data set. 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 two sectors: petroleum refining and wholesale/retail businesses. These multipliers address output, income, and employment impacts.

Custom multipliers were developed for two types of expenditures that do not directly correspond to a specific sector in the IMPLAN multiplier system. These consisted of expenditures for grocery or food expenditures 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 wholesale/retail sector.

Spending of wages is similar to groceries in that it represents 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 wholesale/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 model, 75 percent of wages is assumed to be personal consumption spending in the local economy.

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 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 Puerto Rican households, were then used to estimate impacts from the expenditures of commercial fishing and seafood industry operations as well as wage earners.

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 manually to produce impact estimates.

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 Puerto Rico.

- 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 local businesses.

- Appropriate margins were applied to the purchase of goods where there is activity in the wholesale/retail sector 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 Puerto Rican waters and subsequent processing and distribution of fish and seafood products.

Opportunities to improve the Puerto Rico 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.

Better cost-earnings data on harvesters may be the best opportunity for improvement. No data are available for several gear types.

In addition, better information on the flow of fish and seafood products within Puerto Rico would improve understanding of the economic impacts of the commercial fishing and seafood industries. Current flow data is available only for a few states and for shrimp.

The absence of better data has led to some simplifying assumptions about product flow. For example, the model assumes that processors receive inputs only from harvesters. Better data could support a more complex and comprehensive understanding of the movement of food and seafood products in the seafood industry.

The absence of better product flow data likely results in an underestimation of the economic impacts of 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 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.

Economic Impacts of Commercial Fisheries

In 2006, the total landed ex-vessel value of all commercial fisheries of Puerto Rico equaled $3.9 million. This is relatively small compared to total landings of most U.S. states. Although this study classifies all species and gear types into 13 categories, thee gear types—bottom line, fish trap, and scuba gear—account for 81.0 % of the total landed value. Rod and reel gear accounted for only $95.0 dollars of the $3.9 million landed in 2006.

In terms of total economic impacts across all sectors—harvesting, processing, and wholesaling, the sales or output generated equaled $22.1 million; income generated equaled $8.6 million; and employment generated was 2,311 full and part-time jobs (Exhibit 6). Average income generated per individual in the harvesting sector equaled approximately $2,100.00 per year in 2006. The harvesting sector generated employment for 1,163 individuals in 2006; in this case, we consider only the total number of individuals working in fisheries without double counting because of working in other fisheries. If we consider the many individuals worked in other fisheries, the total employment for the harvesting sector equaled 2,060, just in harvesting. The total number of jobs generated for the economy of Puerto Rico equaled 2,311. Average income generated per individual over all sectors equaled $3,704.00. The economic impacts of each of the gear types are presented in Exhibits 7-19.

Exhibit 6: Economic Impacts of All Gear types

Summary of All Impacts for All Gear Types

Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	1,163			
Employment impacts (full- & part-time jobs)	2,060	16	52	2,129
Income Impacts (000 of dollars)	2,374	548	1,491	4,412
Output Impacts (000 of dollars)	3,938	1,964	4,635	10,537
Primary processors				
Employment impacts (full- & part-time jobs)	64	15	22	101
Income Impacts (000 of dollars)	922	483	637	2,042
Output Impacts (000 of dollars)	2,030	1,355	1,980	5,366
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	43	16	22	81
Income Impacts (000 of dollars)	838	644	624	2,106
Output Impacts (000 of dollars)	2,242	1,980	1,938	6,159
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	2,167	48	96	2,311
Income Impacts (000 of dollars)	4,134	1,674	2,752	8,560
Output Impacts (000 of dollars)	8,210	5,299	8,553	22,062

Exhibit 7: Economic Impacts of Beach Seine

Summary of All Impacts for Beach Seine				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	46			
Employment impacts (full- & part-time jobs)	82	0	1	82
Income Impacts (000 of dollars)	24	6	15	45
Output Impacts (000 of dollars)	40	20	47	107
Primary processors				
Employment impacts (full- & part-time jobs)	1	0	0	1
Income Impacts (000 of dollars)	9	5	6	21
Output Impacts (000 of dollars)	21	14	20	54
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	8	7	6	21
Output Impacts (000 of dollars)	23	20	20	62
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	83	0	1	84
Income Impacts (000 of dollars)	42	17	28	87
Output Impacts (000 of dollars)	83	54	87	224

Exhibit 8: Economic Impacts of Fish Trap

Summary of All Impacts for Fish Trap				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	122			
Employment impacts (full- & part-time jobs)	217	3	8	228
Income Impacts (000 of dollars)	382	88	240	711
Output Impacts (000 of dollars)	634	316	747	1,698
Primary processors				
Employment impacts (full- & part-time jobs)	10	2	4	16
Income Impacts (000 of dollars)	148	78	103	329
Output Impacts (000 of dollars)	327	218	319	864
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	7	3	4	13
Income Impacts (000 of dollars)	135	104	100	339
Output Impacts (000 of dollars)	361	319	312	992
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	234	8	16	257
Income Impacts (000 of dollars)	666	270	443	1,379
Output Impacts (000 of dollars)	1,323	854	1,378	3,554

Exhibit 9: Economic Impacts of Lobster Trap

Summary of All Impacts for Lobster Trap				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	28			
Employment impacts (full- & part-time jobs)	50	1	2	53
Income Impacts (000 of dollars)	89	21	56	165
Output Impacts (000 of dollars)	147	74	174	394
Primary processors				
Employment impacts (full- & part-time jobs)	2	1	1	4
Income Impacts (000 of dollars)	35	18	24	76
Output Impacts (000 of dollars)	76	51	74	201
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	2	1	1	3
Income Impacts (000 of dollars)	31	24	23	79
Output Impacts (000 of dollars)	84	74	73	231
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	54	2	4	60
Income Impacts (000 of dollars)	155	63	103	320
Output Impacts (000 of dollars)	307	198	320	826

Exhibit 10: Economic Impacts of Gill Net

Summary of All Impacts for Gill Net				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	134			
Employment impacts (full- & part-time jobs)	238	0	2	240
Income Impacts (000 of dollars)	70	16	44	130
Output Impacts (000 of dollars)	116	58	137	311
Primary processors				
Employment impacts (full- & part-time jobs)	2	0	1	3
Income Impacts (000 of dollars)	27	14	19	60
Output Impacts (000 of dollars)	60	40	58	158
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	1	0	1	2
Income Impacts (000 of dollars)	25	19	18	62
Output Impacts (000 of dollars)	66	58	57	182
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	241	1	3	245
Income Impacts (000 of dollars)	122	49	81	252
Output Impacts (000 of dollars)	242	156	252	651

Exhibit 11: Economic Impacts of Bottom Line

Summary of All Impacts for Bottom Line				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	150			
Employment impacts (full- & part-time jobs)	265	5	17	287
Income Impacts (000 of dollars)	767	177	482	1,425
Output Impacts (000 of dollars)	1,272	634	1,497	3,403
Primary processors				
Employment impacts (full- & part-time jobs)	21	5	7	33
Income Impacts (000 of dollars)	298	156	206	659
Output Impacts (000 of dollars)	656	438	640	1,733
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	14	5	7	26
Income Impacts (000 of dollars)	271	208	201	680
Output Impacts (000 of dollars)	724	639	626	1,989
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	300	15	31	346
Income Impacts (000 of dollars)	1,335	541	889	2,765
Output Impacts (000 of dollars)	2,652	1,712	2,762	7,126

Exhibit 12: Economic Impacts of Troll Line

Summary of All Impacts for Troll Line				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	23			
Employment impacts (full- & part-time jobs)	41	1	3	44
Income Impacts (000 of dollars)	117	27	74	218
Output Impacts (000 of dollars)	195	97	229	521
Primary processors				
Employment impacts (full- & part-time jobs)	3	1	1	5
Income Impacts (000 of dollars)	46	24	31	101
Output Impacts (000 of dollars)	100	67	98	265
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	2	1	1	4
Income Impacts (000 of dollars)	41	32	31	104
Output Impacts (000 of dollars)	111	98	96	304
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	46	2	5	53
Income Impacts (000 of dollars)	204	83	136	423
Output Impacts (000 of dollars)	406	262	423	1,091

Exhibit 13: Economic Impacts of Long Line

Summary of All Impacts for Long Line				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	5			
Employment impacts (full- & part-time jobs)	9	0	1	10
Income Impacts (000 of dollars)	27	6	17	49
Output Impacts (000 of dollars)	44	22	52	118
Primary processors				
Employment impacts (full- & part-time jobs)	1	0	0	1
Income Impacts (000 of dollars)	10	5	7	23
Output Impacts (000 of dollars)	23	15	22	60
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	1
Income Impacts (000 of dollars)	9	7	7	24
Output Impacts (000 of dollars)	25	22	22	69
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	10	1	1	12
Income Impacts (000 of dollars)	46	19	31	96
Output Impacts (000 of dollars)	92	59	96	247

Exhibit 14: Economic Impacts of Land Crab Trap

Summary of All Impacts for Land Crab Trap				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	7			
Employment impacts (full- & part-time jobs)	12	0	0	13
Income Impacts (000 of dollars)	21	5	13	39
Output Impacts (000 of dollars)	35	17	41	94
Primary processors				
Employment impacts (full- & part-time jobs)	1	0	0	1
Income Impacts (000 of dollars)	8	4	6	18
Output Impacts (000 of dollars)	18	12	18	48
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	1
Income Impacts (000 of dollars)	7	6	6	19
Output Impacts (000 of dollars)	20	18	17	55
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	13	0	1	14
Income Impacts (000 of dollars)	37	15	25	76
Output Impacts (000 of dollars)	73	47	76	197

Exhibit 15: Economic Impacts of Cast Net

Summary of All Impacts for Cast Net				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	9			
Employment impacts (full- & part-time jobs)	16	0	0	16
Income Impacts (000 of dollars)	5	1	3	9
Output Impacts (000 of dollars)	8	4	9	21
Primary processors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	2	1	1	4
Output Impacts (000 of dollars)	4	3	4	10
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	2	1	1	4
Output Impacts (000 of dollars)	4	4	4	12
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	16	0	0	16
Income Impacts (000 of dollars)	8	3	5	17
Output Impacts (000 of dollars)	16	10	17	43

Exhibit 16: Economic Impacts of Rod and Line

Summary of All Impacts for Rod and Line				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	1			
Employment impacts (full- & part-time jobs)	1	0	0	1
Income Impacts (000 of dollars)	0	0	0	0
Output Impacts (000 of dollars)	0	0	0	0
Primary processors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	0	0	0	0
Output Impacts (000 of dollars)	0	0	0	0
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	0	0	0	0
Output Impacts (000 of dollars)	0	0	0	0
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	1	0	0	1
Income Impacts (000 of dollars)	0	0	0	0
Output Impacts (000 of dollars)	0	0	0	1

Exhibit 17: Economic Impacts of Skin Diving

Summary of All Impacts for Skin Diving				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	9			
Employment impacts (full- & part-time jobs)	15	0	0	16
Income Impacts (000 of dollars)	14	3	9	26
Output Impacts (000 of dollars)	23	12	27	62
Primary processors				
Employment impacts (full- & part-time jobs)	0	0	0	1
Income Impacts (000 of dollars)	5	3	4	12
Output Impacts (000 of dollars)	12	8	12	31
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	0	0	0	0
Income Impacts (000 of dollars)	5	4	4	12
Output Impacts (000 of dollars)	13	12	11	36
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	16	0	1	17
Income Impacts (000 of dollars)	24	10	16	50
Output Impacts (000 of dollars)	48	31	50	129

Exhibit 18: Economic Impacts of Scuba Diving

Summary of All Impacts for Scuba Diving				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	484			
Employment impacts (full- & part-time jobs)	857	5	17	880
Income Impacts (000 of dollars)	782	180	491	1,454
Output Impacts (000 of dollars)	1,297	647	1,527	3,471
Primary processors				
Employment impacts (full- & part-time jobs)	21	5	7	33
Income Impacts (000 of dollars)	304	159	210	673
Output Impacts (000 of dollars)	669	446	652	1,768
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	14	5	7	27
Income Impacts (000 of dollars)	276	212	205	694
Output Impacts (000 of dollars)	738	652	638	2,029
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	892	16	32	940
Income Impacts (000 of dollars)	1,362	552	907	2,820
Output Impacts (000 of dollars)	2,705	1,746	2,818	7,268

Exhibit 19: Economic Impacts of Trammel Net

Summary of All Impacts for Trammel Net				
Industry Sector	Direct	Indirect	Induced	Total
Harvesters				
Unique count for labor (full- & part-time jobs)	146			
Employment impacts (full- & part-time jobs)	258	1	2	260
Income Impacts (000 of dollars)	76	18	48	141
Output Impacts (000 of dollars)	126	63	149	338
Primary processors				
Employment impacts (full- & part-time jobs)	2	0	1	3
Income Impacts (000 of dollars)	30	15	20	65
Output Impacts (000 of dollars)	65	43	63	172
Wholesalers/distributors				
Employment impacts (full- & part-time jobs)	1	1	1	3
Income Impacts (000 of dollars)	27	21	20	67
Output Impacts (000 of dollars)	72	63	62	197
Harvesters + Processors + Wholesalers				
Employment impacts (full- & part-time jobs)	262	2	3	266
Income Impacts (000 of dollars)	132	54	88	274
Output Impacts (000 of dollars)	263	170	274	707

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