Economic Impacts Associated with the Commercial Fishery for Longfin Squid (*Doryteuthis pealeii*) in the Northeast U.S.

Andrew M. Scheld, Virginia Institute of Marine Science, William & Mary, 1375 Greate Road, Gloucester Point, VA, 23062, scheld@vims.edu

Summary

Longfin squid (*Doryteuthis pealeii*) is a valuable commercial fishery in the northwest Atlantic, recently generating US $20-30 million or more in revenues annually for vessels landing at ports along the northeast US coast. While the importance of evaluating socioeconomic dimensions in commercial fisheries has been increasingly recognized, data limitations in many fisheries make assessment and quantification of policy-relevant socioeconomic measures challenging. This research collected and analyzed data on expenditures and product distribution from longfin squid processors and fishing vessels. An existing commercial fishery input-output model was then used to estimate economic impacts associated with the US longfin squid fishing industry. Processors reported nearly two thirds of expenditures were related to purchasing fish for processing. Other large expenditure categories included employee wages and commercial freight. Major vessel expenditures reported included captain and crew share, fuel, vessel and engine maintenance, and insurance. Processed product was primarily distributed to wholesalers and distributors, restaurants or food service vendors, or was exported. Variability in reported expenditures and profit margins may reflect heterogeneity across the industry in terms of business operation and vertical integration. Under average landing conditions experienced from 2013 to 2017, the longfin squid fishery was estimated to have produced 2,539 full-time jobs, $99.74 million in total income, and $243.56 million in total economic output annually across all sectors.

Introduction

Longfin squid (*Doryteuthis pealeii*), also known as loligo squid, winter squid, longfin inshore squid, or Boston squid, is a neritic molluscan species distributed from Newfoundland, Canada to the Gulf of Venezuela (Jacobson 2005). The species supports a large commercial fishery, with the majority of catch occurring from Corsair Canyon on Georges Bank to Cape Hatteras, North Carolina (Serchuk and Rathjen 1974; Brodziak 1995). Before the mid-1960s, the fishery was relatively small with minimal participation and landings. International fishing pressure grew quickly during the late 1960s and early 1970s, with vessels from the former USSR, Japan, Spain, and a small number of additional countries catching nearly 40 thousand metric tons (mt) in 1973 (Arkhipkin et al. 2015). Following the establishment of 200-mile territorial waters, the United States began restricting international fishing while simultaneously promoting growth in the domestic industry, which since the 1990s has landed approximately 10-20 thousand mt annually.

The Mid-Atlantic Fishery Management Council (MAFMC) currently manages the US longfin squid fishery under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. The species is managed as a single stock, though multiple genetically distinct stocks have been identified (Buresch et al. 2006). Seasonal quotas (trimester, formerly quarterly) have been in place since 2000 and attempt to align with the species' migrations while maintaining adequate seasonal spawning biomass as well as participation in seasonal fisheries (Hendrickson 2017). Fishing effort is regulated through a limited entry permit program and time-area closures. While historically several gears have been used commercially, nearly all landings by the existing fleet are caught using bottom trawl gear. The most recent stock assessment in 2017 indicated that the stock was not overfished (Hendrickson 2017). Although the fishery management plan and associated amendments include explicit socioeconomic objectives, detailed socioeconomic analyses of the fishery have not been conducted (note, however, that annual Fishery Performance Reports, drafted by an advisory panel and provided to managers, often indicate socioeconomic concerns and prevailing market conditions).

Though initially retained as bycatch and sold commercially as bait, longfin squid is now targeted and marketed primarily for human consumption (Arkhipkin et al. 2015). The species is processed into a number of fresh and frozen product forms (e.g., cleaned tubes and tentacles, tubes only, or rings) and is considered a premium product on the world market as a result of its large size, sweet mild flavor, and desirable color (opaque white when cooked). Landings regularly sell for over US $2/kg and the fleet grosses US $20-30 million annually (NMFS 2018). Large amounts of longfin squid landings are exported, with Italy, Spain, and China representing important export countries (Arkhipkin et al. 2015). In 2018, longfin squid became the first squid fishery in the world to be certified as sustainable by the Marine Stewardship Council, allowing squid products sold by two major seafood processors to carry the organization's ecolabel (Lund's Fisheries Inc., NJ and The Town Dock, RI).

Socioeconomic research on the longfin squid fishery and associated industry has been limited. Georgianna et al. (2001) surveyed owners of vessels landing longfin squid, collecting data on fishing effort, vessel characteristics, and expenditures. The authors documented regional differences in trip-taking and costs, as well as differences in net returns across vessel classes. Their findings have informed national and regional input-output models used to assess commercial fishery economic impacts (e.g., Steinback and Thunberg 2006; Kirkley 2009). There has been little additional socioeconomic research specifically focused on the longfin squid industry however, leading to several knowledge gaps. For example, while processing and distribution of fishery products are often major employment and rent-generating activities (Anderson et al. 2015), there is limited information available on the post-harvest sector of the longfin squid fishery. This research sought to better understand the structure and economic impacts associated with the longfin squid fishing industry to inform future management decision-making. Data on expenditures and product distribution was collected from for four of five squid processing companies on the US east coast and entered into an existing commercial fishery economic impact model. In what follows, data collection and analysis are first described before presenting results and a brief discussion of research findings.

Materials and Methods

Data collection

Expenditure and product distribution data was collected from seafood processors and a small number of independent vessels targeting longfin squid. All major seafood processors participating in the longfin squid industry were contacted via phone and/or email (Lund's Fisheries Inc., NJ; Seafreeze Limited, RI; Sea Fresh USA Inc., RI; The Town Dock, RI; and Top Catch Inc., NY). Processors were asked to provide data on expenditure shares across a variety of expenditure categories for their processing facilities as well as product distribution post-processing. As several processors are vertically integrated and own their own vessels, expenditure share and product distribution data for processor-owned vessels was also collected. A small number of independent vessels (n = 5) were contacted and asked to provide data on expenditure shares. Independent vessels were identified through industry contacts and were thought to be representative. Expenditure and product distribution data was collected by providing individuals managing vessel or processor finances with tables containing fields for various expenditure categories. Individuals were asked to provide approximate average expenditure values (dollars or share of total revenues) occurring over the last three years. Prior to providing any data, all participants were given a document briefly explaining the project and detailing expected use of collected data and data confidentiality.

Non-confidential annual coastwide landings from 2013 through 2017, including landed weight and value, were obtained through a data request to the Greater Atlantic Regional Fisheries Office (GARFO). Nominal prices ($/kg) were converted to real prices using the producer price index for all commodities (US BLS 2018)

Economic impact modeling

Data on expenditures and product distribution collected from squid processors and vessels was incorporated into an existing input-output model and used to calculate the economic impacts associated with the US longfin squid fishery. The NMFS Commercial Fishing & Seafood Industry Input/Output Model (CFSI I/O Model) was originally developed in 2000 and has been updated several times (Kirkley 2009). The model uses IMPLAN software, which allows users to construct regional input-output models and calculate economic impacts and multipliers associated with exogenous spending (IMPLAN Group LLC).

The CFSI I/O Model is designed to take commercial landings revenues as input and returns direct, indirect, and induced economic impacts associated with harvest and post-harvest sectors (Kirkley 2009). Employment (full- and part-time jobs), personal income, and output impacts (sales by US businesses) are calculated for the US as a whole as well as for each coastal state. The post-harvest supply chain is broken into four sectors: processors and dealers; wholesalers and distributors; grocers; and restaurants. Economic impacts are the result of value-added expenditures during each step of the supply chain, ending when a product reaches the final consumer or leaves the region under consideration (i.e., coastal state or US).

The CFSI I/O Model was developed to produce national, regional, and state level economic impacts associated with the entire seafood industry (e.g., estimates contained in NMFS 2018). Given this broad scope, as well as the paucity of species-specific data in many instances, the economic impacts of individual species are often not well resolved. For example, the fishery for longfin squid enters the model as part of an aggregate group that includes fisheries in several different geographic regions that harvest species with trawl gear (e.g., small pelagics such as anchovies, herring, and sardines). Aggregating across fisheries in this way could compromise the accuracy of species-level estimates if differences in vessel characteristics, supply chain structure, or expenditures and employment related to fishing or fish processing are not reasonably incorporated. Data on expenditures and product distribution collected from processors and vessels participating in the longfin squid fishery were thus incorporated into the CFSI I/O Model by adjusting existing values (see Appendix Tables A1-A3 for processor/dealer and vessel expenditure and product distribution data used in the CFSI I/O Model; data collected from longfin squid processors was used to replace processor and dealer expenditures in the CFSI I/O Model since the majority of landed product is processed). This produced economic impact estimates that reflected the structure and characteristics of the longfin squid industry specifically.

Several aspects of the longfin squid industry were important to consider in assessing economic impacts and were accounted for in adjustments to the CFSI I/O Model. First, landings in this fishery are made by both independent and processor-owned vessels, who may have different cost structures and distribution networks. Landings tend to be dominated by the fleet of independent vessels, though processor-owned vessels also land considerable volumes.

Importantly, while some data has been collected on cost structures of the former group (independent vessels; Georgianna et al. 2001), no relevant information exists for the latter (processor-owned vessels). Second, catch may be landed fresh (stored on ice or in refrigerated sea water) or frozen at sea. Freezer trawlers tend to be larger, differ operationally (e.g., longer duration trips), and have different associated expenditures (e.g., product packaging; Georgianna et al. 2001). To accommodate and accurately represent these aspects of the industry in estimates of economic impacts, the analyses here used weighted averages of vessel expenditure shares and product distribution, assuming that 75% of landings were made by independent vessels, 25% were made by processor-owned vessels, and also that 50% of landings were fresh while 50% were frozen at sea. Finally, vessels targeting longfin squid also participate in a variety of other commercial fisheries. The CFSI I/O Model apportions expenditures as fractions of total revenues, implying vessel costs are non-separable and proportionately distributed across target species. In calculating harvest sector employment levels, it was assumed that vessels actively participating in the fishery earn 50% of their income from longfin squid.

Estimates of processing sector employment and total crew dependent on the longfin squid fishery were arrived at following conversations with industry participants. Three distinct vessel size classes were identified: large freezer trawlers with crews of approximately 12; medium sized trawlers who largely land frozen product and tend to have crew sizes of about six; and small trawlers who land exclusively fresh product and have crew sizes of four. From 2013 to 2017, on average, 97.4 vessels landed ~22,680 kg (50,000 lb) or more of longfin squid annually (MAFMC 2018). This group of vessels was considered to be the fleet actively targeting longfin squid. Assuming an average crew size of 6.5 (50% product landed fresh and 50% landed frozen, the latter split equally among the two vessel size classes), and that vessels actively participating in the fishery earn 50% of their income from longfin squid, total fishery employment was calculated as 316.55 individuals, or about one person for each 38,500 kg (85,000 lb) of longfin squid landed. Conversations with processing sector representatives regarding employment levels, average processing volume, and financial dependence on longfin squid (all processors processed multiple species) indicated that each full-time job corresponded to approximately 57,000 kg (125,000 lb) of processed squid. Assuming 70% of landed product is processed, this equates to 150.29 full-time positions on average during 2013 to 2017.

Longfin squid landings exhibit considerable inter-annual variability, and thus economic impacts might also be expected to vary from year-to-year. Economic impact estimates produced here assumed average annual landings and ex-vessel revenues, where averages were calculated by state for landings from 2013 to 2017. All states with non-zero landings during this time period were considered (Connecticut, Massachusetts, Maryland, North Carolina, New Jersey, New York, Rhode Island, and Virginia). Revenues were converted to 2017 US$ before averaging.

Results

Expenditures and Product Distribution

Data on expenditures and product distribution was obtained from four major seafood processors who, combined, process approximately nine thousand mt (20 million lb) of longfin squid landings annually (~70% - 80% of landings). Similar data elements were also collected for processor owned vessels (n = 9) and a small number of independent vessels (n = 3). Vessels providing data represented both fresh (n = 9) and frozen-at-sea (n = 5) segments of the fleet (multiple vessels landed both fresh and frozen-at-sea product).

Longfin squid processors reported the majority of revenues were spent on purchasing fish for processing (63.90%; Table 1). Employee wages (10.35% of revenues), freight costs (4.02%), packaging (1.78%), and cold storage (1.59%) were also important cost components. Profit margins reported by the processing sector were relatively modest (6.23% of revenues retained as profit), though variable. Expenditure shares were relatively similar across processors for the majority of cost categories considered (coefficient of variation < 1 for 20 out of 31 expenditure categories). However, differences in expenditures on advertising, employee benefits, and offloading fees suggest differences in business structure and operation. In comparison to processor and dealer expenditure shares included in the CFSI I/O Model, longfin squid processors spent a considerably greater share of revenues on fish and fish products and substantially less on employee wages (Table A1). Note that, while expenditures on fish and fish products were the largest component of costs for the longfin squid processing sector, economic impacts calculated by the CFSI I/O Model are the result of value-added expenditures. Purchases of fish from harvesters by processors thus contribute to the economic impacts associated with the harvesting sector but not that of the processing sector.

Vessels targeting longfin squid reported the majority of revenues being disbursed to captain and crew (53.57%; Table 2). Other major expenditures included fuel and lubricants (14.36%), vessel and engine repairs (7.12%), insurance (5.19%), and packaging and other materials used for on-board processing of catch (3.55%). Profits represented a small share of vessel revenues on average (0.76%) but were highly variable, possibly a result of differing levels of vertical integration with the processing sector. There was greater variability in expenditure shares across vessels as compared to that found across processors (coefficient of variation > 1 for 15 out of 29 non-null expenditure categories), which may reflect diversity in production (fresh and frozen-at-sea) or vessel ownership. When compared to vessel expenditure share data used within the CFSI I/O Model, vessels targeting longfin squid allocated greater shares of revenues to their crew and captains, spent more on packaging, and spent less on groceries, vessel and engine repair, and capital expenditures (Table A2).

The processing sector was found to sell the majority of their product to wholesalers and distributors (31.87%; Table 3). Export (28.27%) and restaurant or food service markets (24.21%) were also important. A small amount of product went on to additional processing (8.73%) or was sold to groceries or retail markets (6.83%), while a minimal amount was sold to final consumers (0.08%). Product distribution was reasonably variable across processors, with distribution to additional processing and export markets being especially heterogeneous (coefficient of variation > 1). Longfin squid processors were found to distribute product differently compared to the processing and dealer sector included in the CFSI I/O Model, exporting more product or sending it on to additional processing, restaurants or the food service sector, while distributing less to wholesalers and groceries or retail markets (Table A3). Limited product distribution data was obtained from vessels. Processor-owned vessels indicated nearly all of their landings went on to be processed at their facilities, though a small amount might be sold to wholesalers or final consumers. Subsequent estimation of economic impacts assumed vessel product distribution as described in the CFSI I/O Model (Table A3) was a reasonable representation for landings by independent vessels (75% of landings). Landings by processor-owned vessels (25% of landings) were assumed to be distributed to processors (98.5%), wholesalers or distributors (1%), and final consumers (0.5%).

Economic Impacts

From 2013-2017, average (real) annual ex-vessel revenues for all US longfin squid landings were $31.87 million. Revenues were distributed across Rhode Island (56% total average revenues), New York (18%), New Jersey (11%), Massachusetts (9%), Connecticut (5%), Maryland (<1%), North Carolina (<1%), and Virginia (<1%). Combined, the longfin squid fishery, under average landing conditions, was estimated to have produced 2,539 full-time jobs, $99.74 million in total income, and $243.56 million in total economic output across all sectors (Table 4). This total amount of economic activity corresponds to an output multiplier of 7.64 (i.e., every dollar in landings leads to $7.64 in total economic output).

Total economic impacts were spread across industry sectors. Unsurprisingly, due to high levels of employment and strong local demand, restaurants were responsible for 54% of total employment impacts and 42% of total income and output impacts. The harvesting sector, which is also labor-intensive and the primary industry, was meanwhile responsible for 24% of total employment impacts, 34% of total income impacts, and 36% of total output impacts. Economic impacts associated with seafood processors accounted for 9%, 8%, and 9% of total employment, income, and output impacts, respectively. Given that expenditures and product distribution for longfin squid harvesters and processors were not assumed to vary geographically, state-level impacts reflected the distribution of ex-vessel revenues.

Discussion

The US longfin squid fishery lands a valuable product and supplies large domestic and international markets. Though by volume US longfin squid landings have been dwarfed by landings of California market squid (*Doryteuthis opalescens*), price per kg of longfin squid is two to four times that of market squid and fishery revenues are closer in magnitude (e.g., from

2000 to 2017, longfin squid landings on average represented 21% of the volume yet 78% of the value of annual market squid landings). Despite its economic importance regionally and nationally, information on the longfin squid industry and associated markets is relatively limited.

Data provided by industry participants was used to generate economic impact estimates by updating an existing commercial fishery input-output model (CFSI I/O Model, see Kirkley 2009). While cost data from the harvesting sector had previously been collected (Georgianna et al. 2001), this study is the first to document expenditures and product distribution for the processing sector, including processor-owned vessels. Economic impacts depend on industry expenditures and product distribution, implying that large changes in industry structure and operation would lead to changes in associated impacts. In this study, it was assumed that 75% of landings were made by independent vessels and 25% by processor-owned vessels, and that 50% of landings were frozen at sea while 50% were fresh. The fleet of freezer trawlers has reduced in recent years, and frozen-at-sea landings are perhaps now a smaller component of the total (e.g., 30-40%). Additionally, this analysis produced economic impact estimates using average landing conditions and assuming geographic homogeneity in expenditures and product distribution. Economic impact estimates provided here should therefore be interpreted as average impacts at the national level, rather than impacts expected in a particular year or state. Continued collection of socioeconomic data from both the harvest and post-harvest sectors is necessary to refine existing models as well as to assess downstream impacts of changes in fisheries management or exogenous conditions (e.g, Guldin and Anderson 2018, Guldin et al. 2018).

Total economic output impacts were estimated at $243.56 million and suggest that each dollar of longfin squid landings leads to an additional $6.64 dollars in economic activity. Both within this study, and in national figures, restaurant and retail sectors dominate employment and value-added impacts. As seafood generally, and longfin squid in particular, may be viewed as substitutable with other protein sources, inclusion of restaurant and retail sectors may inflate impact estimates (Steinback and Thunberg 2006). Including only the harvest, processing, and wholesale sectors yields economic impact estimates of 1,032 full-time jobs, $53.64 million in total income, and $132.90 million in total economic output. National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act specifies that fisheries occurring in federal waters should be managed for optimum yield, producing the greatest overall societal benefit. Economic benefits are typically interpreted as surplus value in a welfare context, and often differ in magnitude and distribution when compared to economic impacts. Understanding the economic linkages within and across US commercial fisheries nevertheless enables managers and decision-makers to quantitatively consider tradeoffs in employment and distributional impacts when evaluating policy options or responses to exogenous change.

Acknowledgements

This work was supported by the National Science Foundation Industry/University Cooperative Research Center SCeMFiS (Science Center for Marine Fisheries) through membership fees and under the direction of the Industry Advisory Board. SCeMFiS administrative support is provided by NSF award #1266057. We thank K. Almeida at The Town Dock, M. Lapp at Seafreeze Limited, J. Kaelin and M. Viall at Lund's Fisheries Inc., C. Lee at Sea Fresh USA Inc., and participating vessel captains who provided data and insight into their operations as well as the industry more broadly. PhD student Shelby White assisted with preparation of this report. Conclusions and opinions expressed herein are solely those of the author.

References

Anderson, J.L., Anderson, C.M., Chu, J., Meredith, J., Asche, F., Sylvia, G., et al. 2015. The Fishery Performance Indicators: A Management Tool for Triple Bottom Line Outcomes. *PLoS ONE*,10(5): e0122809. doi: 10.1371/journal.pone.0122809.

Arkhipkin, A.I., Rodhouse, P.G., Pierce, G.J., Sauer, W., Sakai, M., Allcock, L., et al. 2015. World squid fisheries. *Reviews in Fisheries Science & Aquaculture*, 23(2): 92-252. doi: 10.1080/23308249.2015.1026226

Brodziak, J.T. 1995. Long-finned squid. In: Conservation and Utilization Division, Northeast Fisheries Science Center, editors. Status of the fishery resources off the northeastern United States for 1994. NOAA Technical Memorandum. NMFS-NE-108. p. 112-113. https://www.st.nmfs.noaa.gov/tm/ne_image/ne108image.pdf

Buresch, K.C., Gerlach, G., and Hanlon, R.T. 2006. Multiple genetic stocks of longfin squid *Loligo pealeii* in NW Atlantic: stocks segregate in shore in summer, but aggregate offshore in winter. *Marine Ecology Progress Series*, 310: 263-270. doi: 10.3354/meps310263

Georgianna, D., Elper, B., and Schmidek, J. 2001. The Cost of Fishing for Squid in Northeastern United States. University of Massachusetts Dartmouth. Prepared for NMFS, U. S. Department of Commerce.

Guldin, M. and Anderson, C.M. 2018. Catch shares and shoreside processors: A costs and earnings exploration into the downstream sector. *Marine Resource Economics*, 33(3): 289-307. doi: 10.1086/698200.

Guldin, M., Warlick, A., Errend, M.N., Pfeiffer, L., and Steiner, E. 2018. Shorebased processor outcomes under catch shares. *Coastal Management*, 46(6): 587-602. doi: 10.1080/08920753.2018.1522490.

Hendrickson, L.C. 2017. Longfin inshore squid (*Doryteuthis* (*Amerigo*) *pealeii)* Stock Assessment Update for 2017. US National Marine Fisheries Service: Woods Hole, MA. https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/59073cc9be65945087783a84/1493646537724/Doryteuthis_update_April_2017.pdf

Jacobson, L.D. 2005. Essential Fish Habitat Source Document: Longfin Inshore Squid, *Loligo pealeii*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-193: Washington DC. https://nefsc.noaa.gov/publications/tm/tm193/tm193.pdf.

Kirkley, J. 2009. The NMFS Commercial Fishing & Seafood Industry Input/Output Model (CFSI I/O Model). Prepared for the National Marine Fisheries Service (NMFS). Virginia Institute of Marine Science. https://www.st.nmfs.noaa.gov/documents/Commercial%20Fishing%20IO%20Model.pdf

Mid Atlantic Fisheries Management Council (MAFMC). 2018. MSB AP Informational Document – April 2018. Prepared by Jason Didden. http://www.mafmc.org/council-events/2018/may-2018-ssc-meeting. Accessed October 17, 2018.

National Marine Fisheries Service (NMFS). 2018. Fisheries Economics of the United States, 2016. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-187, 243 p. https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016.

Serchuk, F.M. and Rathjen, W.F. 1974. Aspects of the distribution and abundance of the long-finned squid, *Loligo pealei*, between Cape Hatteras and Georges Bank. *Marine Fisheries Review*, 36(1): 10-17.

Steinback, S.R. and Thunberg, E.M. 2006. Northeast Regional Fishing Input-Output Model. NOAA Tech Memo NMFS NE, 188, p.54. https://www.nefsc.noaa.gov/publications/tm/tm188/tm188.pdf.

U.S. Bureau of Labor Statistics. Producer Price Index for All Commodities. FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/PPIACO. Accessed August 9, 2018.

Tables

Table 1. Average expenditure shares as a percent of total revenues for longfin squid processors (n = 4). Standard deviations in parentheses.

Expenditure Category	Revenue Share	
Supplies		
Containers, packaging supplies	1.78%	(0.67%)
Fish, fish products	63.90%	(10.29%)
Ice	0.17%	(0.13%)
Other non-fish ingredients	0.67%	(0.64%)
Miscellaneous supplies	0.84%	(0.92%)
Fixed and general expenses		
Accounting, legal	0.35%	(0.12%)
Ads, promotion	1.13%	(1.44%)
Bank fees and services, interest	0.49%	(0.35%)
Broker fees	0.21%	(0.17%)
Communications	0.02%	(0.04%)
Custom processing	0.85%	(1.13%)
Employee benefits/health insurance	0.24%	(0.31%)
Equipment lease, depreciation	1.14%	(1.12%)
Freight, shipping costs	4.02%	(0.95%)
Insurance	0.62%	(0.36%)
Maintenance and repairs, equipment	0.71%	(0.37%)
Office supplies	0.41%	(0.19%)
Offload fees	0.29%	(0.37%)
Real estate	0.68%	(0.63%)
Taxes: payroll taxes/FICA	0.30%	(0.17%)
Taxes: property/local taxes	0.12%	(0.08%)
Travel, entertainment	0.36%	(0.17%)
Truck/vehicle costs	0.48%	(0.34%)
Utilities: electricity	1.25%	(0.84%)
Utilities: natural gas	0.01%	(0.01%)
Utilities: propane	0.02%	(0.03%)
Utilities: waste & sewer	0.29%	(0.42%)
Utilities: water	0.03%	(0.04%)
Warehousing, cold storage	1.59%	(0.99%)
Other expenses	0.50%	(0.50%)
Wages	10.35%	(2.52%)
Profit	6.23%	(8.52%)
Total revenue	100.00%	

Table 2. Average expenditure shares as a percent of total revenues for longfin squid vessels (n = 12). In calculating averages, data was weighted assuming 50% of landings were fresh (n = 9), 50% of landings were frozen (n = 5), 75% of landings were by independent vessels (n = 3), and 25% of landings were by processor owned vessels (n = 9). Standard deviations in parentheses.

Expenditure Category	Revenue Share	
Equipment purchases		
Electronics	0.13%	(0.41%)
Fishing nets	0.15%	(0.32%)
Fishing tackle, reels, other gear	1.04%	(0.95%)
Safety equipment	0.05%	(0.07%)
Miscellaneous hardware	2.15%	(1.12%)
Equipment repair & maintenance		
Electronics	0.09%	(0.20%)
Fishing gear, nets	2.39%	(1.05%)
Vessel & engine	7.12%	(2.94%)
Trip expenses		
Bait	0.00%	(0.00%)
Fuel & lubricants	14.36%	(2.87%)
Groceries, food, & supplies	0.90%	(1.65%)
Ice	1.26%	(0.99%)
Offloading/non-crew labor costs	1.19%	(0.45%)
Packaging and other materials	3.55%	(1.97%)
Fixed and general expenses		
Accounting	1.14%	(0.36%)
Bank fees and services	0.21%	(0.67%)
Capital expenditures (boats)	1.64%	(3.48%)
Communications	0.55%	(0.23%)
Dues/Association Fees	0.11%	(0.18%)
Insurance	5.19%	(1.17%)
Licenses, permits	0.17%	(0.21%)
Monitoring/enforcement	0.07%	(0.21%)
Moorage	0.40%	(0.35%)
Real estate	0.00%	(0.00%)
Taxes	0.18%	(0.52%)
Travel	0.10%	(0.09%)
Trucking/shipping	0.02%	(0.06%)
Utilities: electricity	0.08%	(0.12%)
Utilities: natural gas	0.00%	(0.00%)
Utilities: propane	0.00%	(0.00%)
Utilities: waste & sewer	0.00%	(0.00%)
Utilities: water	0.00%	(0.00%)
Vehicle costs	0.07%	(0.09%)
Other expenses	1.36%	(3.67%)
Crew & captain shares	53.57%	(9.19%)
Profit	0.76%	(4.80%)
Total	100.00%	

Table 3. Average product distribution for longfin squid processors (n = 4). Standard deviations in parentheses.

Distribution Sector	Product Distribution	
Exports	28.27%	(30.10%)
Final Consumers	0.08%	(0.21%)
Groceries / Retail Markets	6.83%	(5.15%)
Processors (2nd processing)	8.73%	(18.82%)
Restaurants / Food Service	24.21%	(18.30%)
Wholesalers / Distributors	31.87%	(25.96%)
Total	100.00%	

Table 4. Economic impacts associated with the US longfin squid fishery. US totals assuming average 2013-2017 ex-vessel revenues shown. Total impact column is the sum of direct, indirect, and induced impacts.

Sector	Impact Category	Direct	Indirect	Induced	Total
Harvesters	Employment (jobs)	317	94	196	607
	Income (2017 US$, thousands)	17,315	6,405	9,894	33,614
	Output (2017 US$, thousands)	31,874	22,935	31,685	86,494
Processors	Employment (jobs)	150	35	47	231
	Income (2017 US$, thousands)	3,387	2,207	2,347	7,941
	Output (2017 US$, thousands)	7,451	5,949	7,524	20,924
Wholesalers	Employment (jobs)	94	47	52	193
	Income (2017 US$, thousands)	6,664	2,796	2,626	12,087
	Output (2017 US$, thousands)	8,910	8,145	8,424	25,478
Grocers	Employment (jobs)	111	10	20	141
	Income (2017 US$, thousands)	2,870	631	1,011	4,513
	Output (2017 US$, thousands)	3,270	1,707	3,239	8,215
Restaurants	Employment (jobs)	971	124	271	1,366
	Income (2017 US$, thousands)	20,380	7,548	13,655	41,582
	Output (2017 US$, thousands)	36,393	22,340	43,712	102,446
Total all sectors	Employment (jobs)	1,644	310	585	2,539
	Income (2017 US$, thousands)	50,617	19,587	29,533	99,737
	Output (2017 US$, thousands)	87,897	61,076	94,584	243,558

Table A1. Expenditure shares as a percent of total revenues for processors and dealers purchasing a variety of trawl caught species as represented in the CFSI I/O Model (termed "Other Trawl" in model documentation).

Expenditure Category	Revenue Share
Supplies	
Containers, packaging supplies	5.00%
Fish, fish products	8.00%
Ice	0.00%
Other non-fish ingredients	8.00%
Miscellaneous supplies	5.00%
Fixed and general expenses	
Accounting, legal	1.00%
Ads, promotion	0.00%
Bank fees and services, interest	4.50%
Broker fees	0.00%
Communications	1.80%
Custom processing	0.00%
Employee benefits/health insurance	0.00%
Equipment lease, depreciation	0.50%
Freight, shipping costs	6.00%
Insurance	1.70%
Maintenance and repairs, equipment	2.50%
Office supplies	0.00%
Offload fees	0.00%
Real estate	2.10%
Taxes: payroll taxes/FICA	0.00%
Taxes: property/local taxes	0.35%
Travel, entertainment	0.00%
Truck/vehicle costs	0.00%
Utilities: electricity	0.00%
Utilities: natural gas	0.00%
Utilities: propane	0.00%
Utilities: waste & sewer	0.00%
Utilities: water	0.00%
Warehousing, cold storage	0.00%
Other expenses	1.30%
Wages	38.61%
Profit	13.64%
Total revenue	100.00%

Table A2. Expenditure shares as a percent of total revenues for vessels targeting a variety of species using trawl gear as represented in the CFSI I/O Model (termed "Other Trawl" in model documentation).

Expenditure Category	Revenue Share
Equipment purchases	
Electronics	0.15%
Fishing nets	0.00%
Fishing tackle, reels, other gear	1.31%
Safety equipment	0.61%
Miscellaneous hardware	1.55%
Equipment repair & maintenance	
Electronics	0.44%
Fishing gear, nets	2.72%
Vessel & engine	12.38%
Trip expenses	
Bait	0.47%
Fuel & lubricants	13.41%
Groceries, food, & supplies	4.54%
Ice	1.39%
Offloading/non-crew labor costs	0.00%
Packaging and other materials	0.00%
Fixed and general expenses	
Accounting	0.78%
Bank fees and services	2.23%
Capital expenditures (boats)	7.43%
Communications	0.00%
Dues/Association Fees	0.00%
Insurance	4.07%
Licenses, permits	0.33%
Monitoring/enforcement	0.00%
Moorage	2.45%
Real estate	0.00%
Taxes	0.17%
Travel	0.00%
Trucking/shipping	0.00%
Utilities: electricity	0.00%
Utilities: natural gas	0.00%
Utilities: propane	0.00%
Utilities: waste & sewer	0.00%
Utilities: water	0.00%
Vehicle costs	1.57%
Other expenses	6.02%
Crew & captain shares	31.41%
Profit	4.55%
Total	100.00%

Table A3. Product distribution for vessels and processors/dealers in the CFSI I/O Model. Values correspond to the percent of total output distributed from the column sector to the row sector.

Distribution Sector	Vessels	Processors/ Dealers
Exports	35.00%	0.00%
Final Consumers	8.70%	7.60%
Groceries / Retail Markets	6.20%	23.00%
Processors / Dealers	20.00%	0.00%
Restaurants / Food Service	5.10%	17.70%
Wholesalers / Distributors	25.00%	51.70%
Total	100.00%	100.00%