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Title: An Overview of Retail Sales of Seafood in the United States, 2017-2019

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Abstract

While a large number of studies have investigated seafood consumption in various markets, surprisingly little is known about the types of seafood sold in retail outlets or their product forms. in the United States. This is particularly true for fresh seafood, which is generally regarded as the most valuable product form of seafood. In this paper a unique dataset on retail in-store seafood sales that includes information about three main product forms (fresh, frozen and shelf-stable products) was analyzed. Fresh seafood is important, as it makes up 43% of sales revenue. Moreover, some species are almost exclusively sold fresh, with trout and lobster as prime examples. Fresh also includes the greatest diversity of species, and as such, is the most likely product form for new producers to succeed. National sales are dominated by a few species, with salmon and shrimp accounting for a large portion of the fresh (27%) and frozen categories (43%), respectively, and tuna dominating the shelf-stable category (75%). There are also a large number of species with mostly small market shares. There are few differences in regional sales patterns for the main species, with notable exceptions such as whitefish in New England and crawfish in Louisiana and Texas. The degree of urbanization and income level appear as important drivers for seafood sales.

1. Introduction

Seafood consumption in the United States (U.S.) has gradually increased for decades, and includes a mixture of wild-caught and aquacultured species, from both domestic and imported sources (Love et al., 2020; Shamshak et al., 2019). As U.S. fish stocks are generally well-managed at or near maximum sustainable yield and aquaculture production in the U.S. is limited, most of the increase in consumption originates from imports (Gephart et al., 2019; Shamshak et al., 2019). Readily available data on domestic landings, some aquaculture production, and trade enables estimates of availability (Kroetz et al., 2020; Shamshak et al., 2019), however, information on where seafood is consumed — both in terms of food sourcing and sub-national data, and in which product categories — is highly limited, particularly at the species level. Love et al. (2020) recently found that about two-thirds of expenditures on seafood occurs away from home, primarily at restaurants, while seafood purchased for at home consumption makes up a much larger share by weight (56% at home vs 31% at restaurants and 13% at other outlets) (Love et al., 2020). Moreover, these shares vary significantly by species and region. For instance, 52% of shrimp consumption occurs at home compared to 70% of salmon and 77% of tilapia consumption (Love et al., 2020), and per capita consumption in Atlantic coastal regions is twice that of the Midwest (Love et al., 2020). The origin and product forms of purchased seafood are important to understand growth opportunities for the seafood industry — in particular in the specific market segments where domestic landings compete with typically lower priced imports — and how different parts of the seafood market respond to shocks or other sources of instability and natural variation.

This paper uses U.S. retail sales data from Nielsen, a retail measurement company, to shed light on retail purchases as a proxy for seafood consumption patterns of fresh and shelf-stable seafood across the entire U.S. and by region. Earlier research has used retail sales data to provide an overview of sales trends for frozen seafood products with a focus on potential competitors for U.S. catfish producers (Dey et al., 2017), and a number of studies investigated demand for specific groups of products (Singh et al., 2014, 2012; Surathkal et al., 2017). These and other similar studies did not evaluate fresh seafood and few analyzed shelf-stable products, with the exception of one study on canned tuna and salmon (Wessells and Wallström, 1999).

The gap in the literature on fresh seafood is important since this product category constitutes a large and valuable share of the market, and some species like trout, lobster, halibut, crab and salmon are predominantly sold as fresh, making these species difficult to study with previous work focused on retail sales data for frozen products. U.S. retail sales of seafood favors frozen (42% of total) over fresh product categories (35%) by volume, but by value, fresh makes up a larger share (43% of total) compared to frozen (39%). The shelf-stable category makes up the remainder of seafood sales (23% by volume and 18% by value). Fresh products, therefore, have a significantly higher unit value than frozen and shelf-stable products. For most species, fresh is the most valuable product form for the producers, and it is a product form where closer proximity to markets should be a benefit for local fishers and fish farmers. Fresh products are highly perishable, which highlights the importance of efficient logistics— features that favor large fisheries producers and aquaculture (Asche and Smith, 2018).

Seafood consumption levels differ among regions, and retail sales data can help explore these trends. For example, demand, price elasticity, and substitution of frozen fish vary considerably across 52 U.S. markets (Singh et al., 2014). Using dietary recall data, seafood consumption was influenced by region, proximity to the coastline, and population density (Love et al., 2020; US EPA, 2014). It is unknown whether this regional variation is in the product category mix, species mix, or a combination of both. Transportation cost is in itself an argument for why fresh seafood should be more available along the coast, particularly for domestic fish. On the other hand, if logistics are sufficiently good to inland areas, this should not matter much. Love et al. (2020) indicated that seafood consumption was higher in urban areas, suggesting that some combination of logistics, market size, consumer demand, and/or household income may impact consumption (Love et al., 2020).

Our analysis provides the most current and detailed characterization of the U.S. retail seafood market. National patterns in seafood sales are described by product type and species, and retail sales patterns are compared across regions. In the next section the dataset and methods used to structure it are presented. Then comes a detailed discussion of national and regional retail sales patterns before offering conclusions based on these findings.

2. Data

2.1. Nielsen retail scanner data

Nielsen retail scanner data (eXtended All Outlet Combined, xAOC, product, New York, NY) contained national and state-level annual sales at the unique product code (UPC) level for January 1, 2017 to December 31, 2019. The UPC provides a unique number for each product, much like a barcode. Nielsen sampled 237 store brands and 109,695 individual stores (e.g., grocery, convenience, drug, club, big box, military, pet, and dollar stores) and then made national-level and state-level sales projections (Table 1), which is collectively called "retail sales" in this manuscript. State-level projections were available for 31 states where Nielsen collects data, which were selected because they contain major metropolitan markets and provide good regional coverage. The dataset that was purchased does not contain UPC-level retail sales by store brand, so for example, we were not able to disaggregate sales from grocery stores versus big box stores, or one grocery store chain from another.

2.2. Data cleaning and processing

Retail sales volumes were converted to kilograms from ounces (and in a few cases from pints), adjusted revenue ($), and unit price ($/kg). Data were deflated using the Consumer Price Index (CPI-U series, non-seasonally adjusted) and adjusted to 2019 for annual inflation. Regional price indices were used for state-level data. The Nielsen department category "seafood" was renamed "fresh", and the "grocery" category was renamed "shelf-stable", and the "frozen" category was not renamed. The majority (>90%) of products in the "fresh" category were sold as random weight (i.e., by the pound), which suggests they were truly fresh. Missing weights were imputed using the average unit price of a similar item and matched using a concatenation term. Data were analyzed using R (v 4.0.2) programming (R Core Team, 2021) in R.Studio (v. 1.3).

3. Results

3.1 National results

An average of 813,700 metric tons/yr of seafood was purchased at the retail level, generating $12.2 billion in retail revenue annually (Table 2). Retail seafood are grouped into three main product categories: fresh, frozen and shelf-stable products. The frozen product category made up the majority of sales by volume, while the fresh product category made up the most sales by revenue (Table 2).

A feature that has received particular interest in recent decades is the increased use of private labels (i.e. store brands) in retail seafood sales (Roheim et al., 2007; Sogn-Grundvåg et al., 2019). The importance of brand-name products varies by department (Table 3). By both revenue and volume, most fresh products do not list a company. This is because most (85% by revenue) of fresh products are sold as random weight items and are not packaged. In contrast, frozen products were mostly branded (45% by revenue) and private label (54%) products. Shelf-stable products were mostly sold as branded products (88% by revenue) with the remaining sold under a private label (12%). Hence, private labels have the strongest impact for frozen seafood, while the traditional brands are holding up well for shelf-stable products. Internationally there is a trend towards centralized packing outside of the store, which includes fresh seafood (Landazuri-Tveteraas et al., 2018), and industry contacts indicate that this is also the case in the U.S. The data provide no evidence, however, that this is leading to branding of fresh seafood in a similar fashion as for terrestrial meats (Asche et al., 2018), with the exception of smoked products.

Exploring the national data by species suggests that sales are highly concentrated among a few species groups, but that there is important variation between product categories. Shrimp, salmon, tuna, crab, and tilapia species groups made up 75% of retail sales by revenue and 71% of retail sales volume (Figure 1). It is also interesting to note that three of the species groups have large aquaculture components, shrimp, salmon and tilapia, while tuna and crab are primarily wild caught. Moreover, all are predominantly imported. Shamshak et al. showed that five species groups (shrimp, salmon, tuna, tilapia and catfish) made up over 70% of U.S. seafood consumption (Shamshak et al., 2019), largely mirroring imports and global production (Garlock et al., 2020a). Notably, crab replaces catfish in the top-5 retail sales, while catfish has greater overall consumption.

The relative importance of the product category varies significantly by species. Many species are mostly sold fresh (Figure 2). For example, more than 90% of the total sales of lobster and trout were sold fresh. Lobster is the highest value species group in the U.S. based on ex-vessel value, and trout is the second largest finfish species farmed in the U.S. (NMFS, 2020). In addition, more than 73% of salmon sales, the second most consumed species in the U.S., are fresh. Other species like whiting (87%), flounder (77%), shrimp (75%), pollock (69%) and tilapia (69%) are primarily sold as frozen. Tuna (95%) and anchovies and sardines (98%) were predominantly sold as shelf-stable products, and oysters (42%), clams (39%), herring (36%), and salmon (15%) also had large shelf-stable components.

The fresh category was generally more expensive than frozen or shelf-stable categories (Table 4). For example, there was a $5.70/kg premium for fresh salmon compared to frozen salmon. While this is partly due to costlier logistics, it supports arguments that fresh and unprocessed fish are the most valuable (Anderson and Bettencourt, 1993; Asche and Smith, 2018; Roheim et al., 2007). The distribution of sales by unit price is plotted next. Fresh and frozen products generally ranged from $5/kg to $20/kg with fresh skewing more expensive, while shelf-stable seafood was more tightly focused in the $5 to $10/kg range (Figure 3). The most affordable products were frozen whiting ($6.29/kg), frozen pollock ($7.93/kg), frozen tilapia ($8.00/kg), shelf-stable salmon ($11.54/kg) and shelf-stable tuna ($11.43/kg) (Table 4).

Given that there are a large number of species available at retail outlets, it is of interest to investigate if there are some species that dominate, causing a product form to be highly concentrated within a few species. One way to measure concentration in a market is a Herfindahl index (HHI), which is the sum of squared market shares S_i of the products in a market, i.e. HHI=$\sum_i S_i^2$. The index takes values between 0 and 1, where it is close to zero if there is little concentration and it takes the value 1 if a market consists of only one product. In an antitrust context, a market is regarded as highly concentrated if the index has a value higher than 0.25. The Herfindahl index was 0.169 for fresh seafood, 0.315 for frozen seafood, and 0.575 for shelf-stable seafood. Market concentration was similar at the regional level as at the national level. While the antitrust threshold of 0.25 does not necessarily transfer to the number of species, the index does suggest that both the shelf-stable and the frozen categories are highly concentrated. This is not a surprise given the high market share of canned tuna, however, it was surprising that the frozen market is so highly concentrated in a few species. Shrimp, tilapia, and salmon make up 65% of total frozen seafood sales, and none of the traditional whitefish species (cod, haddock, pollock) are represented. The lower degree of concentration in the fresh seafood category makes this a potentially easier category to enter into if a firm is competitive on other attributes. This most likely reflects the importance of locally caught species to a large extent, although Garlock and colleagues show that the market for smaller local species can also be dominated by imports (Garlock et al., 2020b). The combination of high prices and low concentration in the fresh seafood market creates an opportunity for U.S. fisheries or aquaculture producers of new species since the market seems to be relatively open and willing to pay for quality.

3.2 Regional results

Little prior work has explored regional patterns of different forms of seafood sales, particularly in the fresh seafood category. To fill this gap, a multivariate linear regression was conducted for the sales shares (S_j) of the three product categories (j) using 2019 cross-sectional data by state for the 31 states represented in the dataset. States were grouped into four regions: East Coast (Connecticut, Georgia, Maryland, Massachusetts, New Jersey, New York, North Carolina, South Carolina,Virginia), West Coast (California, Oregon, Washington), Gulf Coast (Alabama, Florida, Louisiana, Mississippi, Texas), and Inland (Arizona, Colorado, Illinois, Indiana, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nevada, Ohio, Pennsylvania, Tennessee, Wisconsin). In addition to regional dummies (D_i) for West Coast (base category), East Coast, Inland and Gulf regions, the regression contains variables for average household income in the state (*HHI in $*), the percentage urban population (*Urban*), total population (*Pop*) (Census Bureau, n.d.),and total seafood commercial landings (lbs), which includes some aquaculture production (*Landings*) (NOAA Fisheries, n.d.), and an error term e_j. The regression equation is given as:

$$S_j = a + \sum_i b_i D_i + c_1 HHI + c_2 Urban + c_3 Pop + c_4 Landings + e_j$$

The results of these multivariable regressions are reported in Table 5, and bivariate regression for each explanatory variable in Appendix Table A2. In the equations for fresh and frozen seafood, the models have good explanatory power with an R^2 over 0.8, while the equation for shelf-stable is much lower at $R^2 = 0.47$, although an F-test indicates that the parameters are still jointly statistically significant at a 5% level with a p-value of 0.032.

For fresh seafood, the sales share is lower in all regions relative to the West Coast, and it is lowest in the Inland region. The sales share of fresh seafood increases with household income and percent urban population, but is independent of the states' total population and seafood commercial landings. All the coefficients that are statistically significant in the equation for fresh seafood are also significant in the equation for frozen seafood, but with the opposite sign. Hence, the sales share of frozen seafood is higher in the other three regions than in the West Coast, and also higher in states with lower household income and less urbanization. The sales share of shelf-stable is independent of all variables. Hence, there are regional differences in sales for fresh and frozen, but not for shelf-stable seafood. Moreover, sales of fresh seafood increases with household income indicating that wealth matters, and it increases with degree of urbanization, indicating that logistics and infrastructure matter. It is also notable that on average, total commercial fisheries landings do not have a significant impact on sales. This is not too surprising given the high share of imports. Another way to visualize the shift between fresh and frozen sales is to plot sales proportion by product category and state (Figure 4). This plot also shows that the frequency of shelf-stable sales remains fairly constant across all states.

Given that there were regional sales for fresh and frozen categories, regional preferences were explored by species group. Fresh species sales (Figure 5a) had more state-to-state variability than frozen (Figure 5b) or shelf-stable species (Figure 5c). This makes sense if logistics limit distribution of some fresh products. Some products had large variation in price from state-to-state, such as fresh and frozen halibut, fresh and frozen lobster, fresh and frozen oysters, fresh anchovy, fresh whiting, frozen trout, and frozen herring (Table 4). In some cases, lower prices were observed close to production centers for halibut, lobster, flounder, and oysters, while the highest prices of fresh lobster were far from production sites in inland states (data not shown). The top species-product category combinations — fresh salmon, frozen shrimp, and shelf-stable tuna — acted more like food commodities as they were widely consumed in all states with little variation in price (Table 4).

With a few notable exceptions, the variation in species purchased by region is low. There are strong cultural traditions for certain species, however, that may impact seafood sales in some regions. Fresh and frozen shrimp, catfish, and crawfish made up a larger share of seafood sales in

Louisiana than in other states (Figure 5). The same was true for the following species-state pair: fresh catfish in Mississippi, Missouri, Texas, and Illinois; fresh cod, lobster, and haddock in Massachusetts and Connecticut; and canned salmon in many southern states (Figure 5). Quantity of top species groups consumed by a state relative to other states is presented in Figure 6. Northeast states consumed more fresh and frozen haddock, flounder, clams and scallops, and fresh lobster compared to other states (Figure 6a, 6b). Maryland, Virginia, North and South Carolina, and Georgia consumed more frozen whiting (Figure 6b); Minnesota, New York, and Wisconsin consumed more fresh and shelf-stable herring (Figures 6a, 6c); and California, Florida, and Texas consumed more of all seafood types due to their larger population size (Figure 6b, 6c).

4. Conclusions

The U.S. retail sector has a wide diversity of seafood species, product categories, brands, and regional sales, which makes it both complex and interesting to study. Purchases are highly focused on a handful of commodity products sold through mainstream supply chains with national distribution. Despite the diversity in seafood, which is a function of natural diversity in aquatic life (Metian et al., 2020), the retail sector is fairly homogeneous and does not reflect the full diversity of species caught and farmed in U.S. waters. Sales for fresh seafood vary by region, as well as by household incomes and urban population percentage. This suggests that better logistics and infrastructure in urban areas support fresh seafood distribution, and high incomes allow consumers to purchase fresh products that are often at higher price points than frozen products. The opposite was true for frozen seafood, which was associated with lower household income and lower share of urban population. Shelf-stable seafood had no association with region, income or urbanization. The Nielsen dataset does not provide insights into other food sources such as food service or self-caught seafood, however other studies have done so (Love et al., 2020).

Retail sales data including the fresh category has not been available previously, so this study sheds new light on a major component of the seafood market. Fresh products made up the majority of retail seafood revenue and many top species are sold mainly fresh. Atlantic salmon is one of the largest products sold as majority-fresh and an example of an industry that can produce, process, and globally distribute large quantities of perishable fish (Asche et al., 2018). Fresh salmon has a higher degree of price transmission to retail than processed or packaged salmon (Asche et al., 2018) and firms have decided that selling fresh seafood is more profitable. As such, 84% of Atlantic salmon imports are fresh, including 77% of Chilean Atlantic salmon (48,000 metric tons/yr) by air freight and 99.8% of Canadian Atlantic salmon (57,000 metric tons/yr) by truck (US Census, n.d.). An argument has been made that farmed salmon producers opened up Midwestern markets for fresh seafood (Anderson, 2002; Anderson et al., 2019) with their better logistics and pin-bone out fillets.

The fresh category also has low market concentration and higher unit prices, which makes it an appealing market for domestic fisheries and aquaculture products with enough quantity and sufficient logistics. Farmed trout is an excellent example of the ability of domestic producers to capture market share in the fresh category. While the total value of U.S. aquaculture production of food fish may have fallen 2.2% from 2013 to 2018, domestic trout production increased 5.9% over the same period (USDA, 2019). The success of domestic farmed trout has received little attention, it is almost exclusively sold as fresh, and available all over the country.

Decisions about which product category to market have a bearing not only on sales but also on their underlying supply chains, as well as environmental sustainability and food waste. Fresh seafood spoils faster than frozen or shelf-stable forms, and requires different modes of transport, including by air when the distance to market is large, which has a larger environmental footprint (Ziegler et al., 2013). Consumers have different strategies related to food acquisition and meal planning for fresh seafood compared to more stable forms. Retail is the main outlet where consumers access seafood in the U.S. (Love et al., 2020), and seafood is wasted at higher rates at the retail and consumer stages than in other parts of the supply chain (Love et al., 2015), making this an important avenue for waste prevention. Fresh seafood waste is thought to be higher than frozen or shelf-stable seafood waste (Buzby et al., 2009; Muth, 2011), but more work is needed to characterize waste by product category. Reducing seafood waste is critical because there are higher environmental costs of wasting seafood and meats than other foods due to their larger environmental footprint (Conrad and Blackstone, 2020). There is also an economic argument for reducing waste — wasted seafood costs more for consumers than other foods (Conrad, 2020). By examining the most common product categories and species consumed fresh at retail, this study can help inform the targeting of interventions for seafood waste among consumers and retail seafood managers.

Lastly, regional markets for seafood were explored with mixed findings. In the regression an association between average domestic commercial seafood production and retail sales was not found. This can be explained by the fact that imports represent such a large share of the market, and also by the fact that the U.S. is a major seafood exporter (Gephart et al., 2019; Shamshak et al., 2019). At the species group level, however, there were examples of regional markets, such as states that consume a larger share of a particular species, or where price was influenced by distance to market. It is unknown if products with regional markets were majority import or domestic, however. There is a growing body of work on domestic seafood sold via direct sales (O'Hara, 2020; Stoll et al., 2015). More work is needed to account for origin and production within the retail supply, both analytically and through traceability, including product labeling and mislabeling (Kroetz et al., 2020; Roheim et al., 2018). The serious mislabeling issues associated with seafood as documented by (Kroetz et al., 2020) increases the importance of this issue, particularly since generic categories like whitefish are increasingly important in the international seafood trade (Anderson et al., 2018; Asche et al., 2009). The importance of a few globally sourced species also facilitates addressing market shocks. For instance, during the COVID-19 pandemic, U.S. retail seafood sales are up significantly from the previous year, and up more in frozen and shelf-stable than fresh, while restaurant sales are down (Love et al., 2021).

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Declaration of Interest
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Tables and Figures

Table 1. Nielsen retail scanner study data footprint

Type of store	Brands (n)		Individual store locations (n)		
	sampled	not sampled	sampled	not sampled	% sampled by Nielsen
Grocery stores	113	26	16,480	4,610	78.1%
Convenience stores	86	38	35,925	5,842	86.0%
Drug stores	12	10	20,011	473	97.7%
Club and big box stores	10	1	7,369	546	93.1%
Pet stores	9	16	4,397	817	84.3%
Military stores	5	-	1,011	-	100.0%
Dollar stores	2	3	24,502	45,736	34.9%
Total	237	90	109,695	58,024	65.4%
Total excluding pet, drug, and dollar stores	214	65	60,785	10,998	84.7% [a]

[a] Nielsen sampled 60,785 stores where U.S. seafood sales occur (~85% of all locations) and made projections for the remaining ~15% of stores.

Table 2. Average U.S. retail seafood sales by product category according to Nielsen, 2017-2019.

Product category	Annual revenue billion $ (st dev)	% of total	Annual volume 1,000 metric tons (st dev)	% of total
Fresh	5.30 (0.14)	43.3%	288.9 (8.39)	35.4%
Frozen	4.80 (0.08)	39.1%	341.6 (7.60)	42.0%
Shelf-stable	2.14 (0.01)	17.5%	184.2 (2.81)	22.6%
Total	12.2 (0.23)	100%	813.7 (13.4)	100%

Table 3. Brand use by product category for U.S. retail seafood, Nielsen 2017-2019

Brand	Sales by revenue [a]			Sales by volume [a]		
	Fresh	Frozen	Shelf-stable	Fresh	Frozen	Shelf-stable
No company listed	84.8%	0.4%	0.0%	85.8%	0.3%	0.0%
Branded	10.2%	45.2%	87.7%	9.8%	48.2%	82.1%
Private label	5.0%	54.4%	12.3%	4.5%	51.5%	17.9%

[a] see Table 1 for total revenue and volume

Table 4. Average unit price ($/kg) by species and product category, Nielsen 2017-2019.

Species group	Unit price $/kg (st dev) [a]		
	fresh	frozen	Shelf-stable [b]
halibut	44.07 (6.52)	53.35 (6.40)	-
scallops	33.08 (3.39)	27.83 (1.66)	-
lobsters	26.86 (6.25)	51.8 (5.37)	-
tuna	22.64 (2.27)	14.34 (1.86)	11.43 (0.99)
salmon	22.37 (1.88)	16.67 (1.11)	11.54 (1.91)
haddock	21.60 (3.19)	16.36 (1.19)	-
trout	20.66 (1.57)	21.8 (10.49)	-
shrimp	19.39 (2.17)	17.55 (1.04)	-
flounder	18.89 (5.47)	10.7 (0.84)	-
crab	18.77 (2.52)	20.73 (3.12)	-
cod	17.48 (1.90)	13.52 (0.78)	-
anchovy	16.84 (9.98)	10.14 (2.27)	12.56 (1.58)
oysters	16.26 (5.33)	24.57 (9.51)	16.03 (2.10)
whiting	15.00 (4.85)	6.29 (0.46)	-
herring	12.56 (1.33)	15.46 (6.23)	14.01 (1.94)
tilapia	12.31 (2.31)	8.00 (0.45)	-
catfish	12.12 (1.58)	9.17 (0.84)	-
crawfish	11.35 (1.75)	12.96 (3.38)	-
pollock	9.52 (1.12)	7.93 (0.73)	-
clams	9.38 (2.43)	12.81 (1.97)	9.62 +/- 0.8

[a] unit price based on the average and standard deviation of 31 U.S. states

[b] only the main shelf-stable species are reported

Table 5. Parameter estimates for multivariable regressions on product form shares by state.

Dependent variable	Fresh share		Frozen share		Shelf-stable share	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Intercept	0.045	(0.466)	0.661*	(<0.001)	0.294*	(<0.001)
East Coast[a]	-0.069*	(0.011)	0.078*	(0.004)	-0.009	(0.590)
Inland[a]	-0.107*	(<0.001)	0.095*	(0.001)	0.012	(0.476)
Gulf[a]	-0.068*	(0.026)	0.089*	(0.004)	-0.021	(0.255)
HH income	<0.001*	(0.005)	>-0.001*	(0.028)	-0.000	(0.235)
Percent urban	0.003*	(0.002)	-0.002*	(0.018)	-0.001	(0.115)
Population	<0.001	(0.809)	>-0.001	(0.655)	<0.001	(0.756)
Landings	>-0.001	(0.348)	<0.001	(0.879)	<0.001	(0.216)
R^2	0.873		0.829		0.467	

* statistically significant at the 5% level

[a] Reference category is West Coast

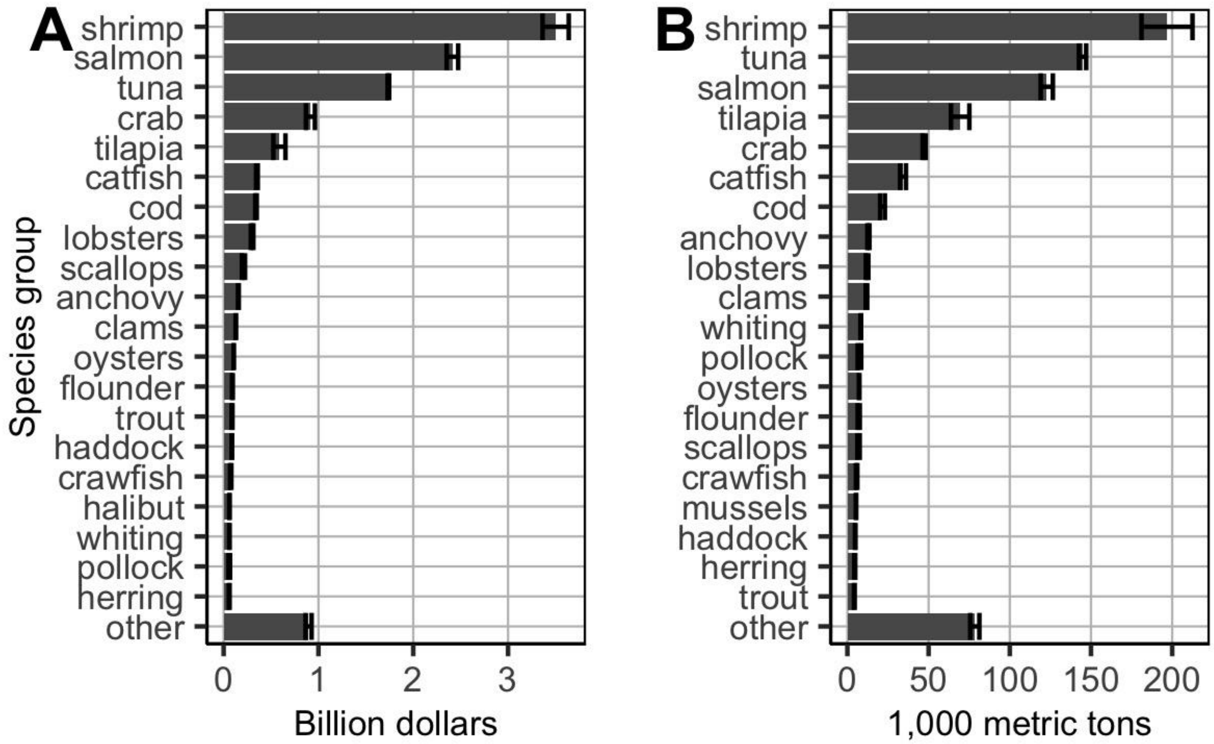


Figure 1. Annual sales of the top-20 retail seafood species groups by A) revenue (billion dollars) and B) volume (1,000 metric tons) in the U.S., Nielsen 2017-2019. Standard deviation error bars provided. “Other” is a combination of all other species groups. See Appendix Table A1 for values reported in this figure.

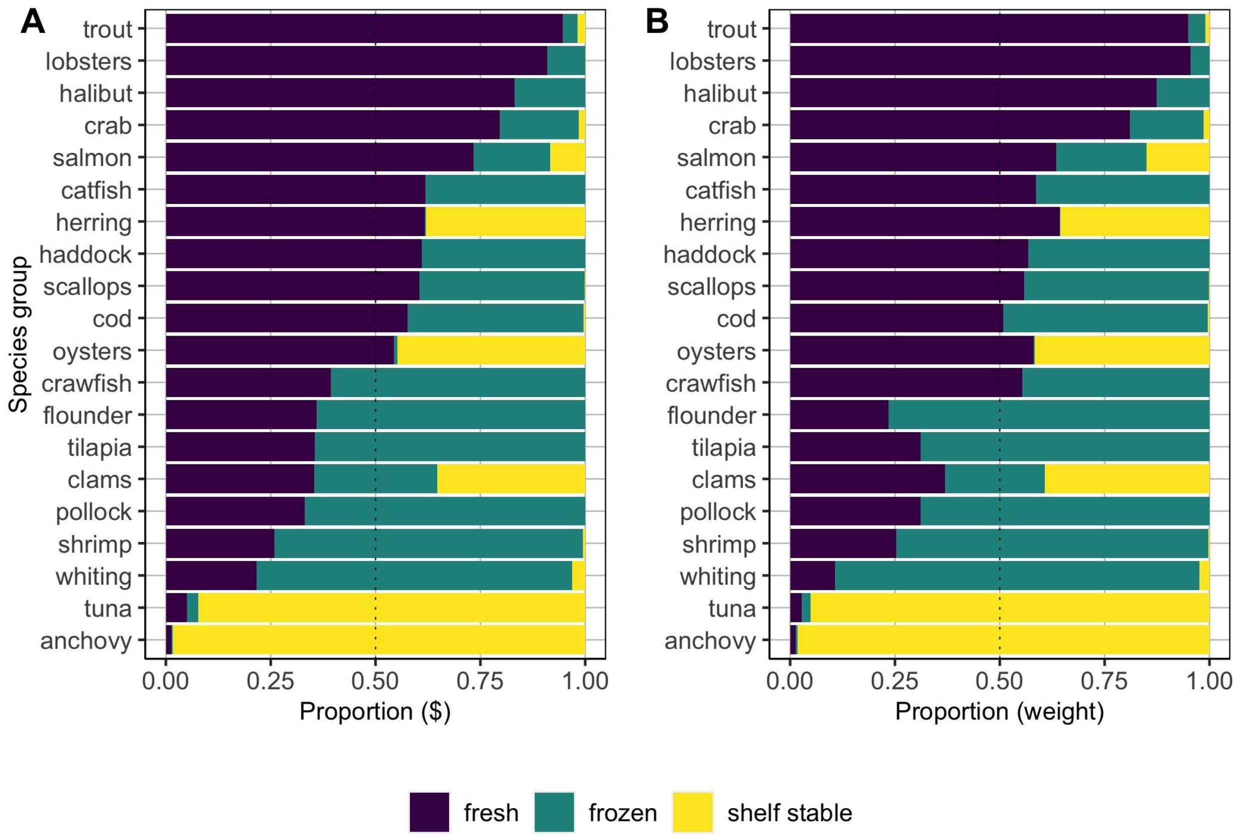


Figure 2. Average sales proportion by (A) revenue and (B) quantity for species and product categories in U.S. retail seafood, Nielsen 2017 - 2019. Dotted vertical line at x = 0.5 for comparison purposes.

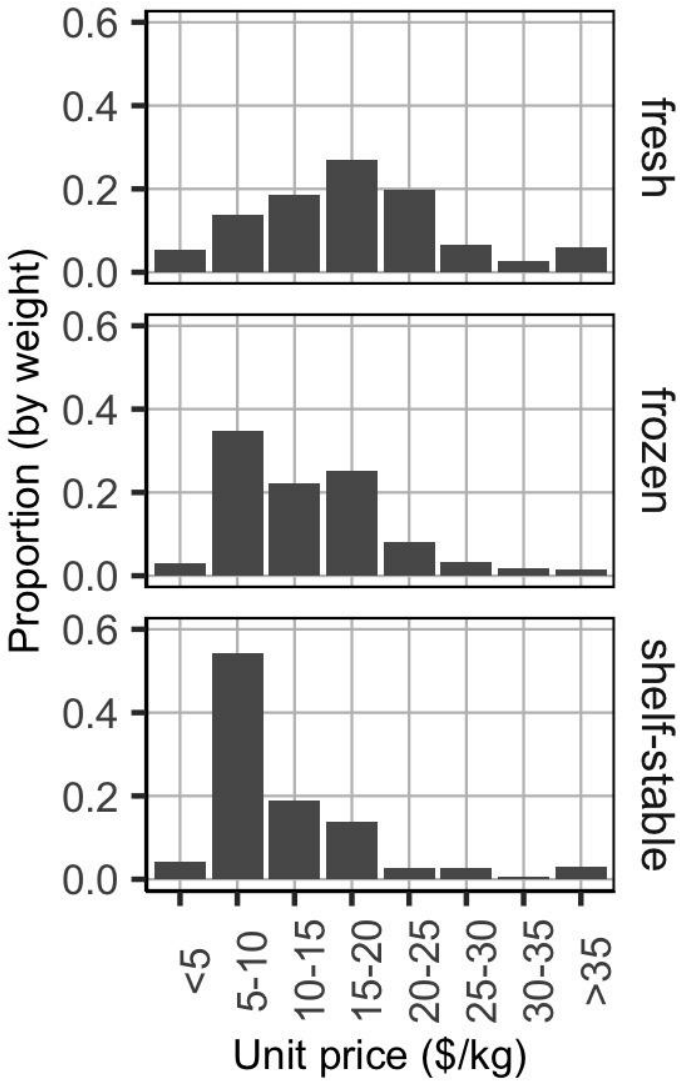


Figure 3. Average sales of (A) fresh, (B) frozen, (C) shelf-stable seafood sales quantity by unit price in U.S. retail seafood, Nielsen 2017-2019. See Appendix Figure A1 for a similar plot based on revenue.

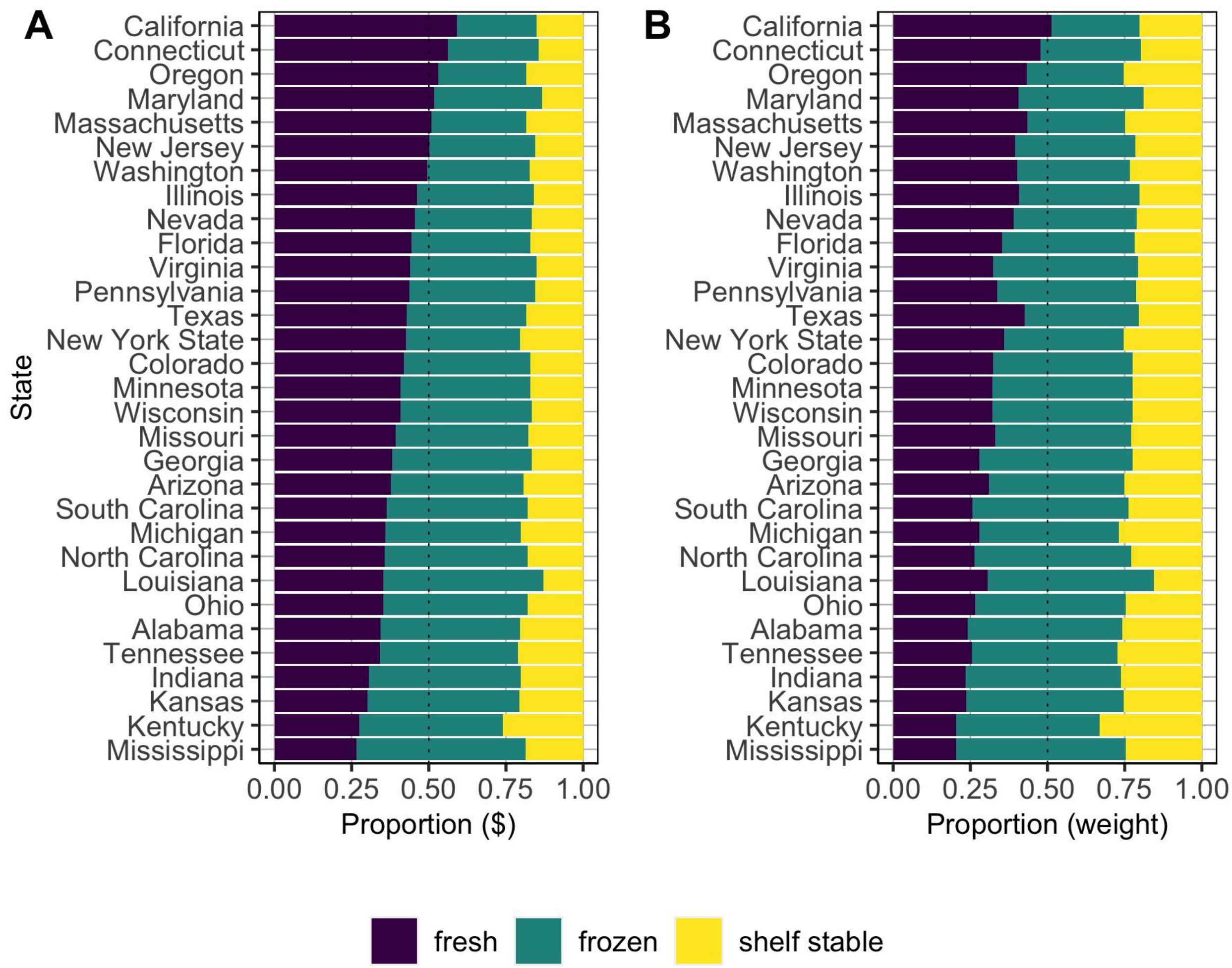
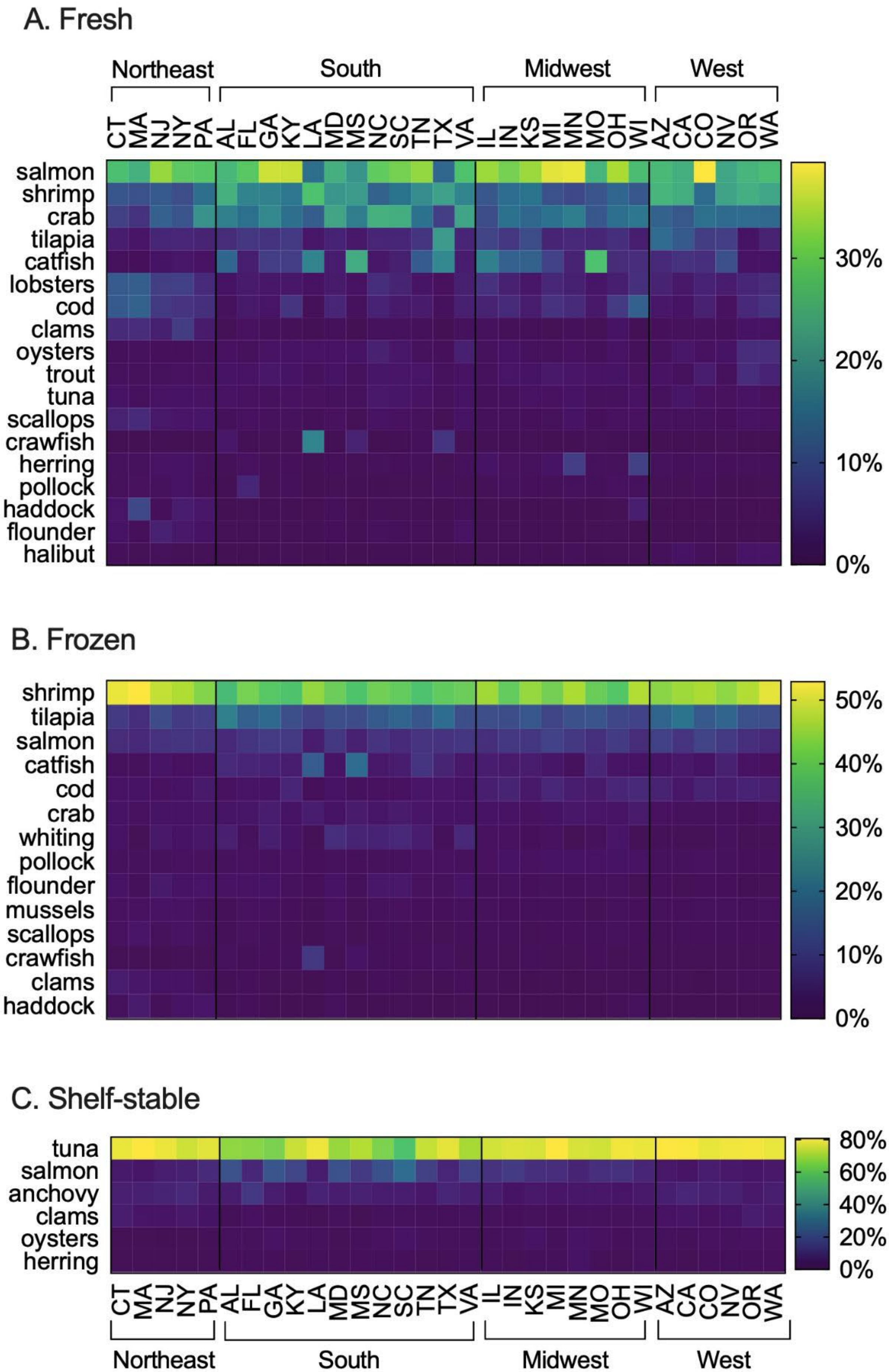


Figure 4. Average proportion of sales by A) revenue and (B) volume for states (n = 31) and product categories in U.S. retail seafood, Nielsen 2017-2019. Dotted vertical line at x = 0.5 for comparison purposes.



A. Fresh
Northeast
South
Midwest
West
CT MA NJ NY PA AL FL GA KY LA MD MS NC SC TN TX VA IL IN KS MI MN MO OH WI AZ CA CO NV OR WA
salmon
shrimp
crab
tilapia
catfish
lobsters
cod
clams
oysters
trout
tuna
scallops
crawfish
herring
pollock
haddock
flounder
halibut
30%
20%
10%
0%
B. Frozen
shrimp
tilapia
salmon
catfish
cod
crab
whiting
pollock
flounder
mussels
scallops
crawfish
clams
haddock
50%
40%
30%
20%
10%
0%
C. Shelf-stable
tuna
salmon
anchovy
clams
oysters
herring
80%
60%
40%
20%
0%
CT MA NJ NY PA AL FL GA KY LA MD MS NC SC TN TX VA IL IN KS MI MN MO OH WI AZ CA CO NV OR WA
Northeast
South
Midwest
West

Figure 5. Average proportion of sales within a state of (A) fresh, (B) frozen, and (C) shelf-stable seafood, Nielsen 2017-2019. Calculations are based on all species groups, however, only the top-20 species groups are presented for simplicity.

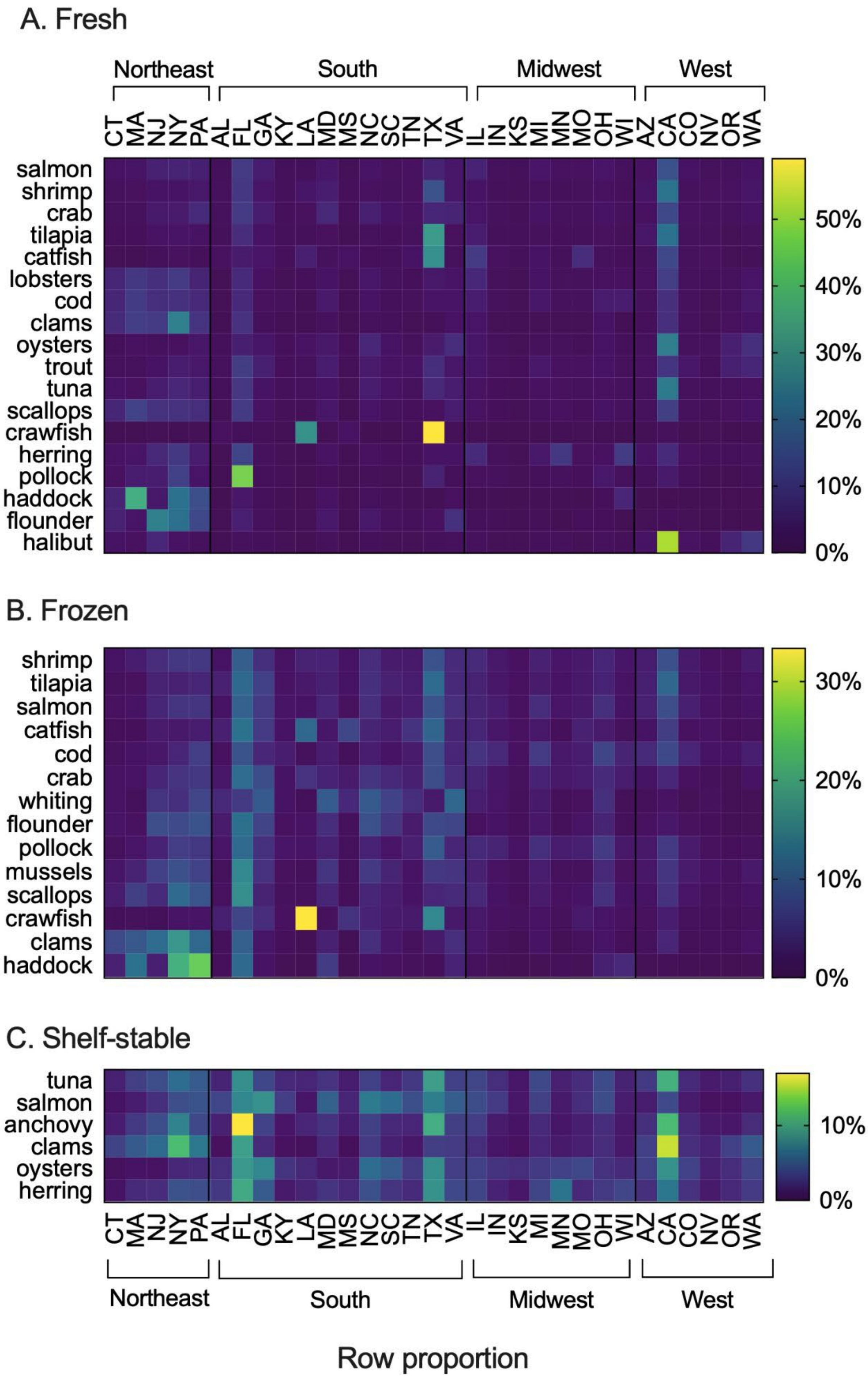

A. Fresh
Northeast
South
Midwest
West
CT MA NJ NY PA AL FL GA KY LA MD MS NC SC TN TX VA IL IN KS MI MN MO OH WI AZ CA CO NV OR WA
salmon
shrimp
crab
tilapia
catfish
lobsters
cod
clams
oysters
trout
tuna
scallops
crawfish
herring
pollock
haddock
flounder
halibut
50%
40%
30%
20%
10%
0%
B. Frozen
shrimp
tilapia
salmon
catfish
cod
crab
whiting
flounder
pollock
mussels
scallops
crawfish
clams
haddock
30%
20%
10%
0%
C. Shelf-stable
tuna
salmon
anchovy
clams
oysters
herring
10%
0%
CT MA NJ NY PA AL FL GA KY LA MD MS NC SC TN TX VA IL IN KS MI MN MO OH WI AZ CA CO NV OR WA
Northeast
South
Midwest
West
Row proportion

Figure 6. Average proportion of sales across states of (A) fresh, (B) frozen, and (C) shelf-stable seafood, Nielsen 2017-2019. Calculations are based on all species groups, however, only the top-20 species groups are presented for simplicity.

Appendix

Table A1. U.S. retail seafood sales by species group, 2017-2019.

Species group	Annual revenue (billion $)	St dev	Annual volume (1,000 metric tons)	St dev
shrimp	3.502	0.138	196.8	15.67
salmon	2.413	0.061	122.8	3.753
tuna	1.738	0.008	144.8	2.228
crab	0.915	0.047	47.3	0.944
tilapia	0.588	0.064	69.4	5.668
other finfish	0.501	0.016	55.6	2.147
catfish	0.351	0.008	34.3	1.807
cod	0.341	0.008	21.6	1.447
lobsters	0.300	0.013	12.1	0.747
scallops	0.209	0.016	6.87	0.701
anchovy	0.155	0.004	12.94	0.638
clams	0.128	0.002	11.7	0.459
oysters	0.105	0.001	7.27	0.147
flounder	0.092	0.004	6.98	0.645
trout	0.088	0.005	4.26	0.216
haddock	0.087	0.002	4.81	0.125
crawfish	0.074	0.007	5.69	0.418
halibut	0.061	0.002	1.56	0.073
whiting	0.061	0.001	8.24	0.203
pollock	0.060	0.008	7.41	1.081
herring	0.059	0.004	4.52	0.297

swordfish	0.055	0.001	2.05	0.017
other seafood	0.045	0.004	3.73	0.267
mussels	0.043	0.000	5.33	0.079
snapper	0.042	0.005	2.02	0.380
mahi mahi	0.038	0.008	1.71	0.450
octopus	0.030	0.001	2.14	0.054
perch	0.022	0.001	1.50	0.006
sole	0.022	0.000	1.02	0.052
sea bass	0.021	0.002	0.53	0.116
mackerel	0.021	0.002	3.80	0.186
grouper	0.015	0.001	0.52	0.090
roughy	0.014	0.001	0.54	0.043
surimi	0.012	0.001	1.12	0.144
caviar	0.006	0.000	0.066	0.008
multiple seafood types	0.004	0.000	0.24	0.009
conch	0.003	0.001	0.12	0.022
shark	0.002	0.000	0.14	0.012
not food	0.001	0.000	0.13	0.016

Table A2. Bivariate regressions for each dependent independent variable, except for the regional dummies, of which one regression was run with a constant term for all of the dummy variables.

Dependent variable	Fresh share			Frozen share			Shelf-stable share		
	Coefficient	*p*-value	R^2	Coefficient	*p*-value	R^2	Coefficient	*p*-value	R^2
East Coast[a]	-0.085*	(-0.07)	0.438	0.092*	(-0.018)	0.471	-0.008	(-0.648)	0.180
Inland[a]	-0.160*	(-0.07)		0.142*	(<0.001)		0.018	(-0.272)	
Gulf[a]	-0.172*	(-0.001)		0.167*	(<0.001)		0.006	(-0.754)	
HH income	<0.001*	(<0.001)	0.646	>-0.001*	(<0.001)	0.580	<0.001*	(-0.003)	0.280
Percent urban	0.006*	(<0.001)	0.630	-0.005*	(<0.001)	0.574	-0.001*	(-0.004)	0.255
Population	<0.001*	(-0.04)	0.142	>-0.001*	(-0.039)	0.144	>-0.001	(-0.318)	0.036
Landings	<0.001*	(-0.034)	0.151	>-0.001*	(-0.041)	0.140	>-0.001	(-0.203)	0.057

* statistically significant at the 5% level

[a] Reference category is West Coast

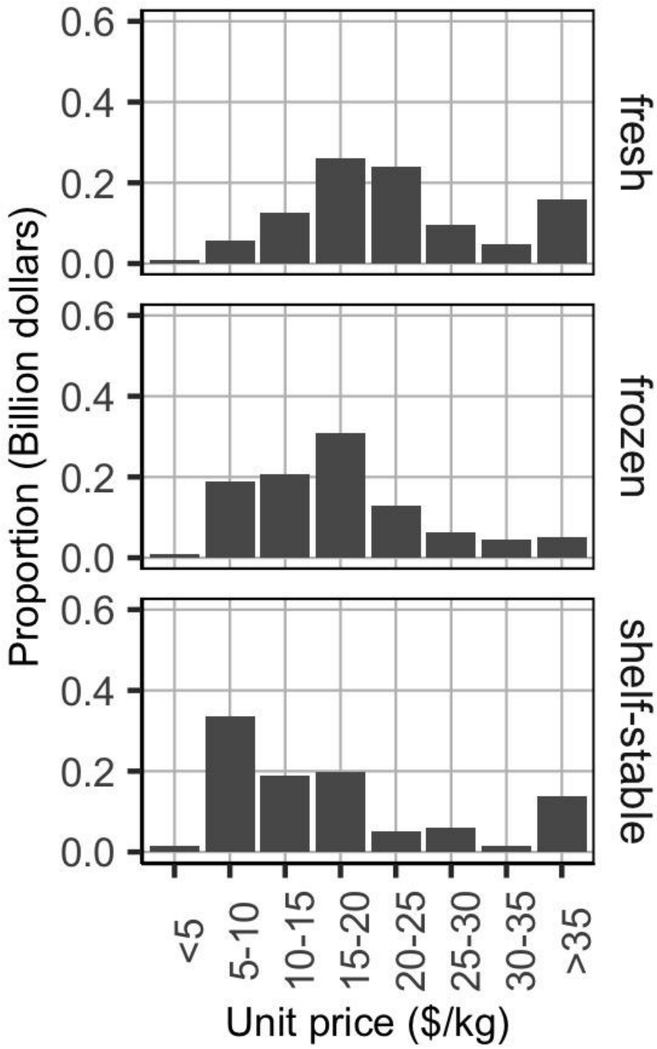


Figure A1. Average proportion of fresh, frozen, and shelf-stable seafood revenue by unit price in U.S. retail seafood, 2017-2019