Effects of COVID-19 on US fisheries and seafood consumption

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Abstract

In the United States, the seafood sector could be hit hard by responses to COVID-19, given the seasonal nature of many fisheries and its global position as a top importer and exporter of seafood. Because of policy actions being considered, early indicators are needed. Synthesizing almost 200 news articles, we document the most commonly reported effects of COVID-19 actions on seafood: the closing of processing centers, shortened fishing seasons, and loss of revenue. Using landings and trade data, we show that catches and imports of fresh seafood declined substantially relative to the previous year (40 and 37% respectively), while frozen products were less affected. Google search trends and seafood market foot traffic data suggest that consumer demand for seafood from restaurants dropped by as much 30% during lockdowns, with recovery varying by state. Our synthesis of open-access datasets and media reports shows widespread, but heterogeneous, fallout across the seafood sector, implying that policy-makers should focus support on states and sub-sectors most affected by COVID-19: fishery-dependent communities, processors, and fisheries that focus on fresh products.

Keywords: Fisheries, Aquaculture, COVID-19, Shocks, Pulse disturbance

Introduction

The COVID-19 global pandemic has forced many governments to shut down various parts of their economies, including businesses and restaurants, to promote social distancing in order to reduce infection rates (Hale et al. 2020; White & Hébert-Dufresne 2020, Althouse et al. 2020). COVID-19 itself, and responses to it, have the potential to affect the seafood sector in multiple ways (FAO 2020, Bennett et al. 2020). During both fishing, and especially processing, seafood

workers and observers often work long hours in tightly confined working conditions (Syron et al. 2018), which could facilitate the spread of the disease as it has already in meat processing facilities (Gephart et al. 2020). Social distancing policies could also reduce seafood demand, given that 65% of U.S. spending ($69.6 billion in 2017) on seafood is in restaurants (Love et al. 2020), and this could have the cascading effect of lowering overall seafood prices since restaurants pay premium values for seafood. Conversely, as supply chains are disrupted in other industries (e.g. meat processing), fisheries could potentially gain market share. Thus, COVID-19 has the potential to temporarily, and perhaps permanently, shift consumer demand and production of seafood. The varied impacts of COVID-19 present a natural experiment to understand how shocks affect the entire seafood supply chain, including fisheries, aquaculture, consumers, and ecosystems.

The U.S. is the world's top importer and fourth largest exporter of seafood products (US Census Bureau 2020). In addition, the U.S. seafood sector is heterogeneous between states in terms of production, processing, and demand, each with its own sub-sectors (NMFS 2018). Production includes aquaculture and both commercial and recreational fisheries, all of which varies by state. For instance, Alaska itself accounts for 58% of all U.S. commercial fisheries landings, but other states like Massachusetts have higher value for seafood landed (NMFS 2018). In addition, the seafood pipeline also includes processing, distribution, and consumer demand. Each of these sub-sectors will likely be affected differently by the fallout from COVID-19, especially given differences in responses to the pandemic across U.S. states (Hale et al. 2020; White & Hébert-Dufresne 2020, Althouse et al. 2020).

While there is evidence that shocks to seafood production may be becoming more frequent through time (Cottrell et al. 2019), shocks are a common feature of seafood systems (Gephart et al. 2016; Gephart et al. 2017). The seafood shocks have been due to fish stock collapses, aquaculture diseases, natural disasters, and oil spills along with the most disruptive caused by wars and state dissolution, where impacts may reach across multiple sectors influencing the interdependencies among them (Cottrell et al. 2019; Gephart et al. 2017). Though similar in this way, COVID-19 is more like a "black swan" event (Anderson et al. 2017) with unpredictable, large, and synchronous impacts felt throughout entire food supply chains, across multiple sectors, and at local and global scales. With the COVID-19 crisis continuing and potential future waves considered probable, understanding consumer responses and capacity for adaptive responses from industry during the initial epidemic may help direct aid and highlight islands of resilience for the seafood industry in the U.S.

Many data sources across the fisheries and seafood sectors are not reported for months or years after they were initially collected (Gephart et al. 2019). However, policy decisions have to be made on much shorter time scales. Therefore, we examined five early signals of the effects of COVID-19 on U.S. fisheries and seafood: news articles, Google trends, business foot traffic,

available fish landing data, and seafood imports and exports by product category. These data sources span multiple spatial and temporal scales as well as the entire seafood pipeline, from production to consumer demand.

Methods

Media reporting on COVID-19 and U.S. seafood

We examined two sets of news article databases. First, we used GDELT, a searchable database that continuously compiles media from around the world (https://www.gdeltproject.org/). We used the search terms "(covid OR coronavirus) AND (seafood OR fishery OR fisheries OR aquaculture) AND [list of all state and territory names]" to compile all articles from January 1st, 2020, to September 1st, 2020 for the U.S. We then removed duplicate titles and summarized the total number of articles. We also pulled individual state count data using the same search terms and a single state name. We also assembled a database of a partial collection of news articles focused on responses to the COVID-19 pandemic affecting various parts of the fisheries and seafood sectors (Gephart et al. 2020). We coded each article for geographic location, the supply chain sector involved, the type of production, and the specific impact and species groups involved. This resulted in a total of 196 news articles focused on the U.S. (Gephart et al. 2020).

Fisheries landings data

Landings data are often not publically available for months or years. However, for heavily-managed Alaskan fisheries (Hilborn et al. 2020), halibut and sablefish fisheries have data updated weekly at https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports. We used data for the first 32 weeks of each year from 2017-2020.

Import and export data

U.S. monthly seafood trade data (Customs Value, USD) comes from the U.S. Customs and Border Protection (US Census Bureau 2020). All HS 6-digit codes within the 03 chapter we included for July 2018 to June 2020 to calculate year-over-year changes in imports and exports. All frozen product forms were grouped together, as were all live, fresh or chilled products. Dried, salted, brined, prepared meals, fish meal and oils, and other miscellaneous preparations were excluded.

Foot traffic data

We use foot traffic data from SafeGraph, a data company that aggregates anonymized location data from numerous applications in order to provide insights about physical places. We examined data specific to fish and seafood markets (NAICS code 445220), which includes some restaurants. We filtered out businesses that were mislabeled as seafood markets and those with less than 300 days of foot traffic data since the start of 2019. We followed SafeGraph's

recommendations on normalizing data by dividing the number of daily visits by the number of devices present.

Google trends

On August 19 2020, United States search trend data were extracted from Google Trends in the *Food and Drink* category for keyword *web search terms* of "seafood restaurant", "seafood recipe", "seafood delivery", "sushi take out" and, for comparative food system context, "bbq restaurant". We compared daily search patterns of the past five years during the time frame of January 1st to August 19th, standardizing within each year. A simple loess smoother, with 95% confidence intervals (Google Trend ~ Year), was fit to each year.

Results and discussion

Media reporting on COVID-19 and U.S. seafood

As early as January 2020, news articles focused on decreased international demand for some U.S. seafood products (e.g., farmed geoduck, Maine lobster) caused by the lockdown in China during the initial COVID-19 outbreak, followed by increased domestic demand for frozen and shelf stable products (e.g. canned tuna) as the outbreak spread in the U.S. and elsewhere (Fig. 1). Other commonly-reported effects of COVID-19 on the U.S. seafood industry include restrictions on travel of seasonal laborers, shifts in consumer demand, fishing seasons being cut short, aquatic farmers delaying outplanting, processing centers closing, and seafood workers contracting COVID-19 (Fig. 1). There have also been several reports of industry adaptation on the commercial side, including direct-to-consumer marketing (e.g. https://finder.localcatch.org/) and community supported fisheries programs, reducing the complexity of the supply chain. Media reporting on these effects has varied across the U.S. with New York, California and Washington receiving more coverage (Fig. 1). In addition, news articles have tended to focus on fisheries production and fresh seafood. Although most news articles were not species-specific, the species groups that were most commonly referenced were marine fishes, diadromous fishes (most notably salmon), and crustaceans (Fig. 1). Lastly, The National Oceanic and Atmospheric Administration (NOAA) has cancelled many research cruises and has waived requirements for fisheries observers on all of its boats, which will limit data availability for future assessments of the status of commercially fished species, with some redeployment of observers in the Northeast starting August 14th (Gephart et al. 2020).

Fisheries landings data

Only limited landings data are available since the start of the pandemic, of which Alaskan halibut (*Hippoglossus stenolepis*) and sablefish (*Anoplopoma fimbria*) are easily available at a weekly level (see *Methods*). Prior to June, landings of halibut declined 40%, whereas sablefish was in line with previous years (WebFigure 2); likely reflecting processing differences since almost all sablefish catch is frozen, while 60% of halibut is sold fresh (and for 30% higher prices than

frozen product) (NMFS 2018). Thus, demand for sablefish should be more reliable for processors given the ongoing pandemic. This is also in line with news articles on increased demand for frozen seafood products, including Alaskan pollock (*Gadus chalcogrammus)* (Gephart et al. 2020). Research in the Northeastern U.S. shows a similar complicated picture of commercial fisheries (Smith et al. 2020). Some stocks had landings in line with previous years whereas others that are targeted for exporting (e.g. monkfish) larger declines in both landings and price (Smith et al. 2020).

Import and export data

Given the importance of the United States in the global seafood trade (Gephart and Pace 2015), disruptions to trade were among the earliest COVID-19 impacts felt outside of China. We compared year-over-year import and export value changes to identify changes in trade. Prior to January 2020, seafood imports stayed within 5% of the previous year's value, but increased by 7-11% year-over-year in January and February 2020. This increase may be explained by shipments originally heading to China being redirected to the U.S. market (Gephart et al. 2020). Live, fresh, and chilled imports then fell to 37% below the previous year's value by April 2020, while frozen products were only 3.5% below 2019 levels (Fig. 2).

Possibly due to the trade war with China, exports of live, fresh and chilled products were generally lower than the previous year from April 2019 to September 2019 (-5 to -29% year-over-year). Coincident with the onset of COVID-19, exports sharply dropped to 29-43% below the previous year's value in February-April 2020, (Fig. 2). Exports of frozen fish were also generally below the previous year's values for most months of 2019 and at similar levels in January and February 2020, before a sudden drop to 20% below the previous year in March 2020. Frozen exports, however, returned to 4% over the previous year's value in April 2020. In other words, domestic and foreign demand for frozen US seafood remained high early in the pandemic (Gephart et al. 2020).

Foot traffic data

The mean number of people visiting 2,800 U.S. fish and seafood markets decreased by 30% in 2020 as COVID-19 cases started increasing (Figs. 3f, WebFigure 1). In total, 39 of the 41 states with sufficient data saw a decline in seafood market foot traffic from March 2019 to March 2020 (WebFigure 1). These widespread effects have been most pronounced in coastal areas. Some areas, particularly in the Southeast and Pacific Northwest have seen some recovery since June 2020 (WebFigure 1).

Google trends

Although data across sectors are generally sparse early in a pandemic, Google search trends can provide insight into consumer demand and interest (Bento et al. 2020). Google searches related to seafood in the U.S. increase on weekends and through the course of the year before peaking in

mid-summer (Fig. 3). In 2020, searches for "seafood restaurant" dropped over 50% starting around March 1, well before the health impacts of the virus started sweeping across the U.S. This is not surprising given preemptive stay-at-home orders in some states, and the fact that 70% of spending on seafood in the U.S. is in restaurants (Love et al. 2020). However, searches started rebounding in late April as individual states started reopening (Fig. 3a). During the same time period, searches for seafood delivery, takeout, and recipes continued to increase; although still at low relative magnitude, (Figs. 3b-d), this change may presage a new move towards different forms of local demand. Indeed, seafood restaurant and sushi take out searches have returned to comparable levels of previous years, while delivery and recipe are slightly higher.

Conclusions

The COVID-19 pandemic is a rare socio-economic shock in terms of global scale and extent of supply chain disturbance across all sectors, including seafood. In the U.S., social distancing measures that have led to widespread restaurant closure and reduced seafood market foot traffic, have driven greater public dependence on seafood deliveries and home-cooking. Such changes in consumer demand have profoundly affected seafood production, with landings, as well as imports and exports, changing in favor of frozen products. However, given the inherent heterogeneity between seafood sub-sectors and state-level differences in COVID-19, these changes have not been felt equally across the U.S. These immediate responses and distribution changes are important in highlighting weak spots in seafood supply chains (such as fresh products or products with long supply-chains being more disruption-prone), but also hide other aspects of exposure or adaptive capacity in the face of seafood shocks for different communities. Some states, notably in the Southeast and Pacific Northwest have seen faster recoveries in terms of seafood market demand (WebFigure 1). Fishery-dependent communities have been, and will likely continue to be, hit especially hard by the fallout from COVID-19. For example, several Native American communities have been particularly affected with loss of revenue from canceled recreational guide trips and commercial fisheries (Gephart et al. 2020). This has cascading effects as many businesses in these communities exist in large part because of the fishery.

With such varied responses, only time will tell the full extent of COVID-19 on U.S. fishing and seafood industries. A combination of human responses, combined with species life history, will determine the timescale of these effects and whether or not they are temporary or cause longer term shifts in consumption, fishing patterns, and fishery status. It is clear that we need better, and more timely reporting of both fisheries landings and aquaculture data for rapid policy interventions (Gephart et al. 2019; Froehlich et al. *in review*). In addition, our work shows how using non-traditional indicators (e.g. seafood market foot traffic) can help inform science and policy when other data sources are not available.

The varied responses by seafood sub-sectors and states also suggest priorities for government interventions. Amid the COVID-19 pandemic, there were three significant actions by the federal government. First, in direct response to fallout from COVID-19, the CARES relief act directed $300 million to the seafood industry, though the distribution of these funds from NOAA has reportedly been extremely slow, particularly for aquaculture (Gephart et al. 2020; Virginia Tech 2020). The federal government also purchased seafood directly, including 20 million pounds of shrimp (< 1% total annual harvest) from Gulf of Mexico fishers (Gephart et al. 2020). Lastly, and somewhat independent, an expansive May 7th Executive Order was introduced to promote fisheries and aquaculture regulatory reform and increases in production (Gephart et al. 2020). While deregulation of wild fisheries was highlighted—Magnuson-Stevens Fishery Conservation & Management Act and Marine Mammal Protection Act remaining intact—the clear emphasis was on overhauling current and future aquaculture oversight and planning. Most notably, the National Oceanic and Atmospheric Administration (NOAA) was identified as the lead agency for marine and offshore expansion. Given the disruption and uncertainty, future interventions and funds for the U.S. seafood sector should focus on fishery dependent communities, improving processing infrastructure and safety, supporting systems that focus on fresh seafood products, and more broadly data collection and management to create a system which can more readily respond and distribute relief more quickly. The implementation of these various governmental policies, combined with the continued and possible future interventions to COVID-19, will ultimately determine the long-term effects on the U.S. seafood industry.

Data and Code Availability

Except for the SafeGraph foot traffic data, all data and code used in this paper are available at https://github.com/eastonwhite/COVID19_US_Fisheries with the news article code at https://github.com/rahulAgrBej/seafoodGDELT.

Acknowledgments

E.R.W. was supported in part by the COVID-19 Rapid Research Fund from the Gund Institute for Environment at the University of Vermont. H.E.F. recognizes support from the University of California, Santa Barbara. T.A.B. was funded in part by the Richard C. and Lois M. Worthington Endowed Professor in Fisheries Management. J.K.B. was supported by a Natural Sciences and Engineering Council of Canada Discovery Grant and E.W.R. Steacie Fellowship. RSC acknowledges funding from the National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara.

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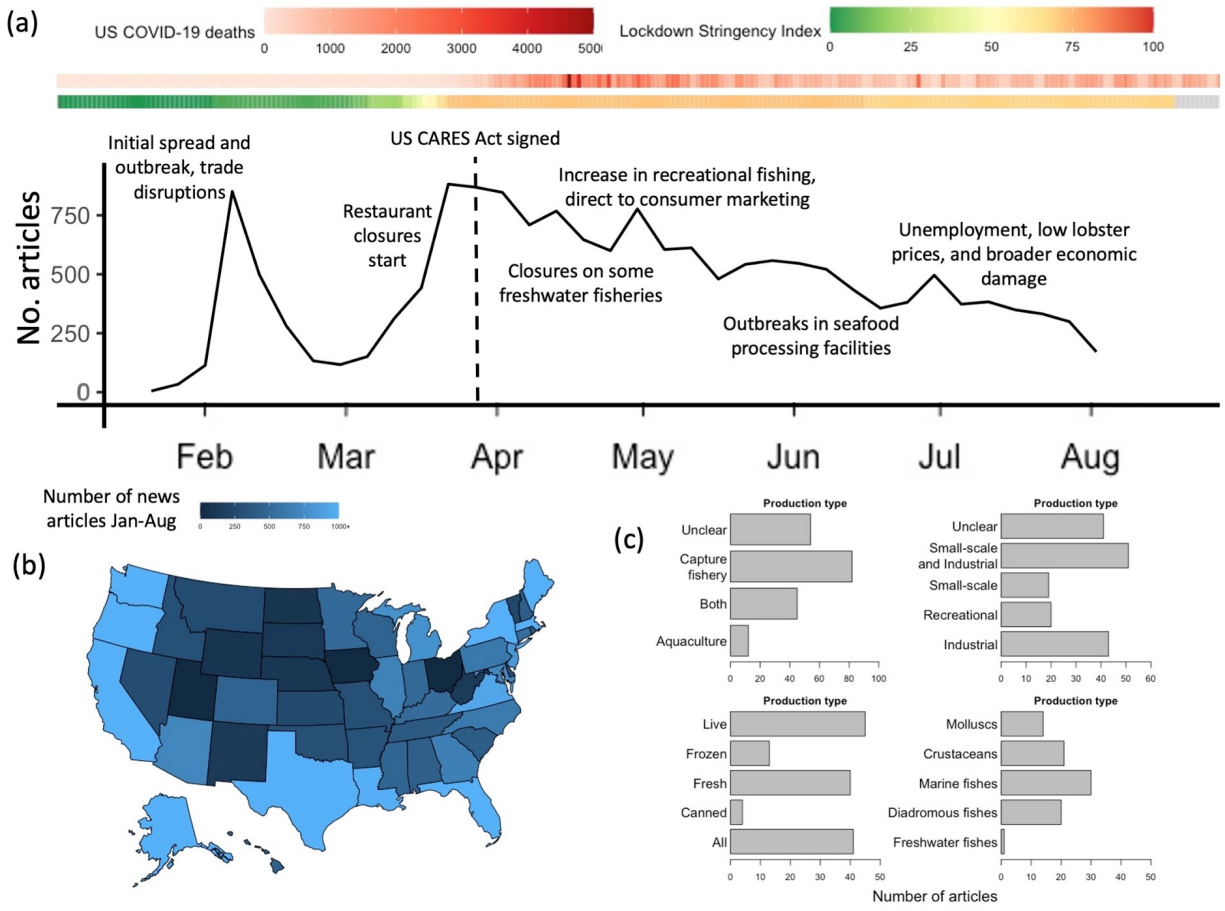


Figure 1. COVID-19 and associated media reports on seafood impacts in the U.S. (a) Timeline of key events in the US seafood industry related to COVID-19 along with the government lockdown stringency index ("17 indicators aggregated reporting a number between 1 and 100 to reflect the level of government action", Hale et al. 2020), COVID-19 related deaths per day in the US, and the number of news articles published per day with particular search terms (see *Methods*). (b) Distribution of COVID-19 and seafood news articles for each individual state since the start of the pandemic. (c) Distribution of impacts by production type, production scale, product form, and species groups affected. An impact is defined as explicitly reported on in a news article.

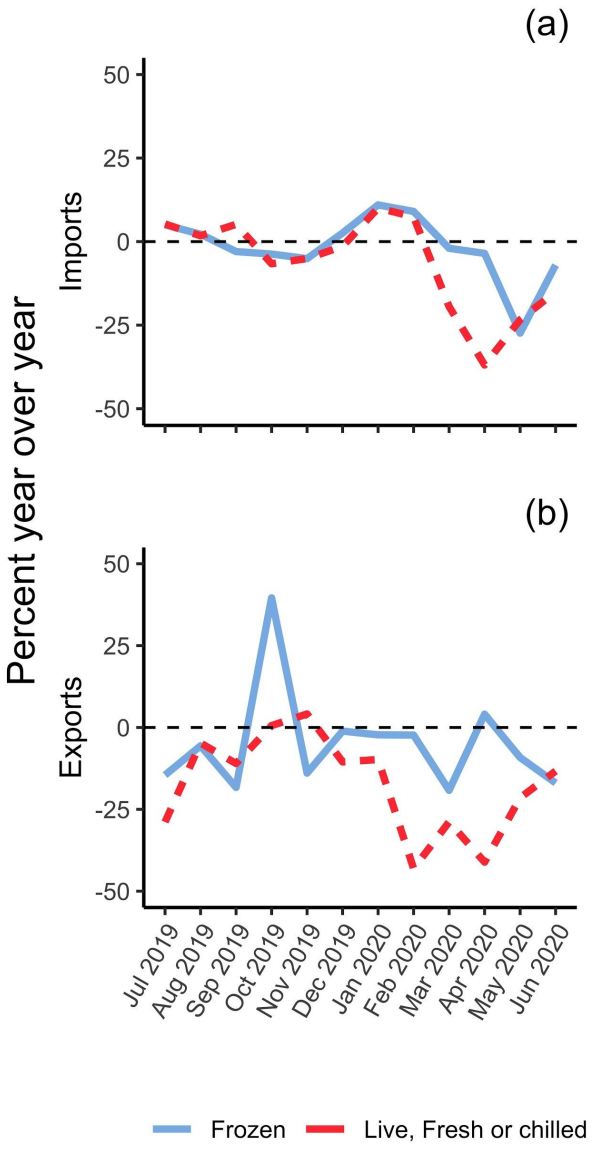


Figure 2. U.S. Seafood Imports and Exports. Monthly U.S. imports and exports of frozen or fresh (live, fresh, or chilled) seafood as a percent change since the previous year.

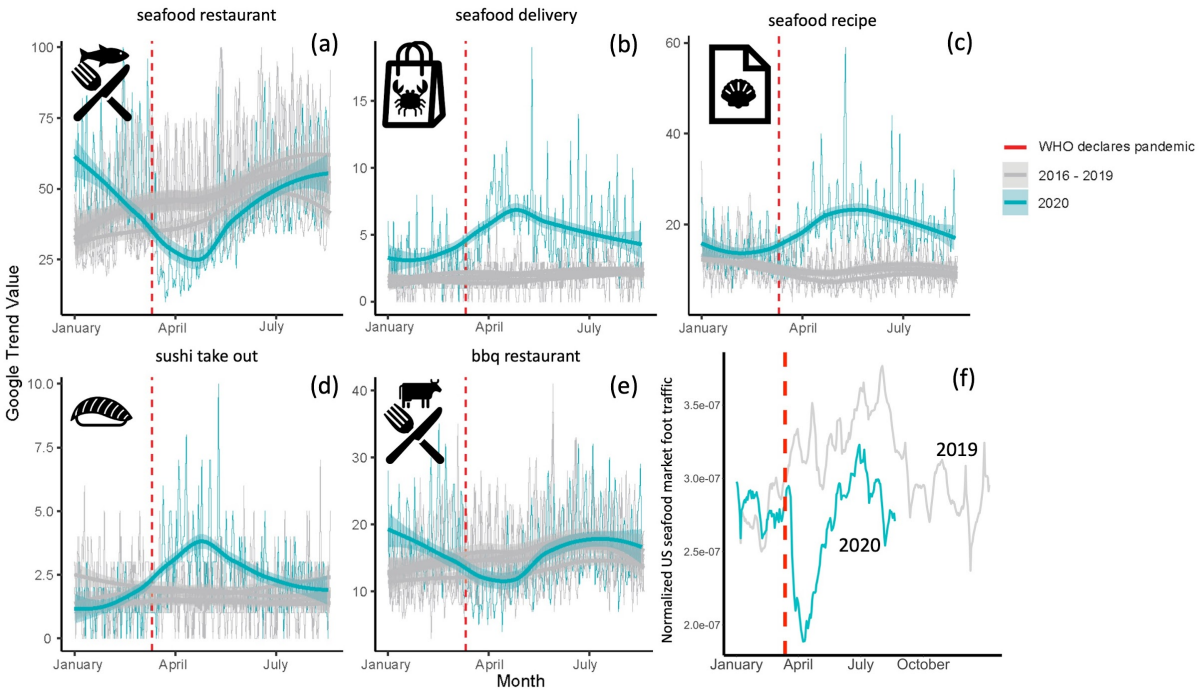
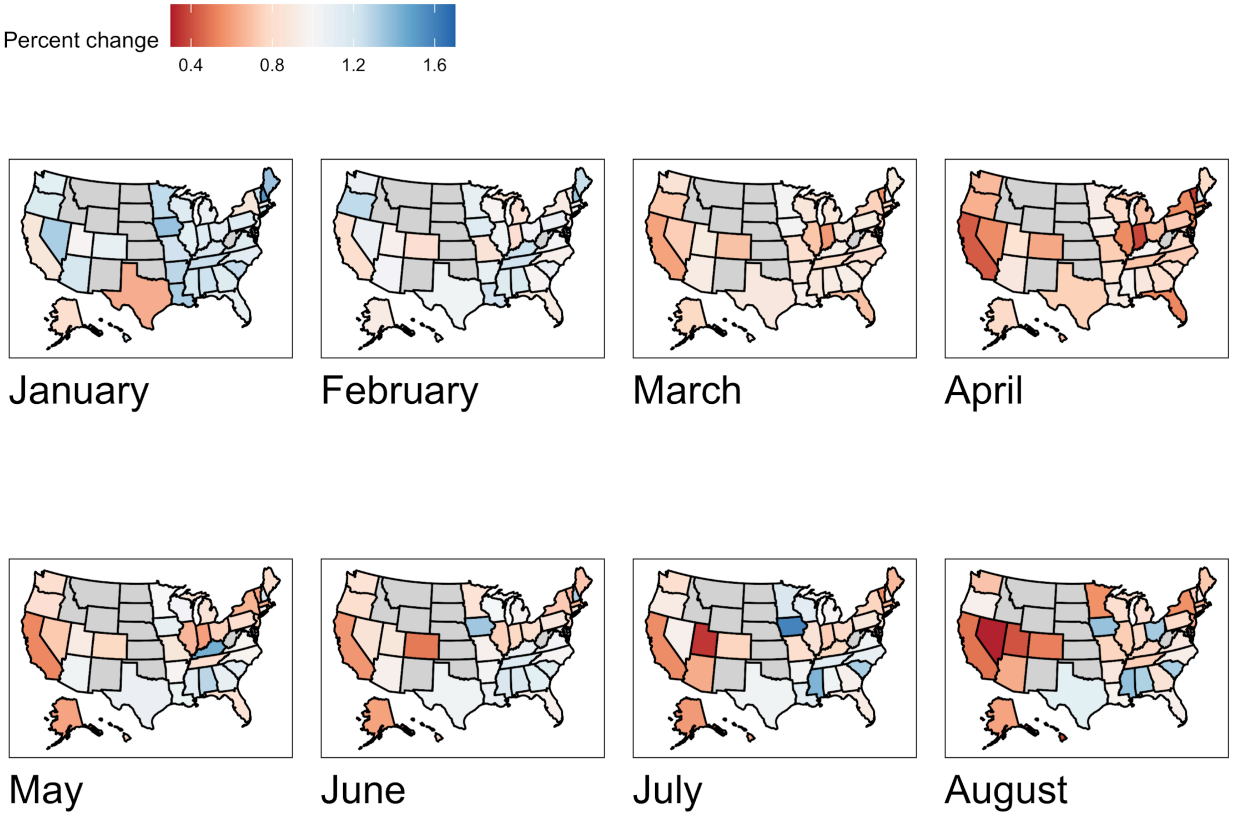


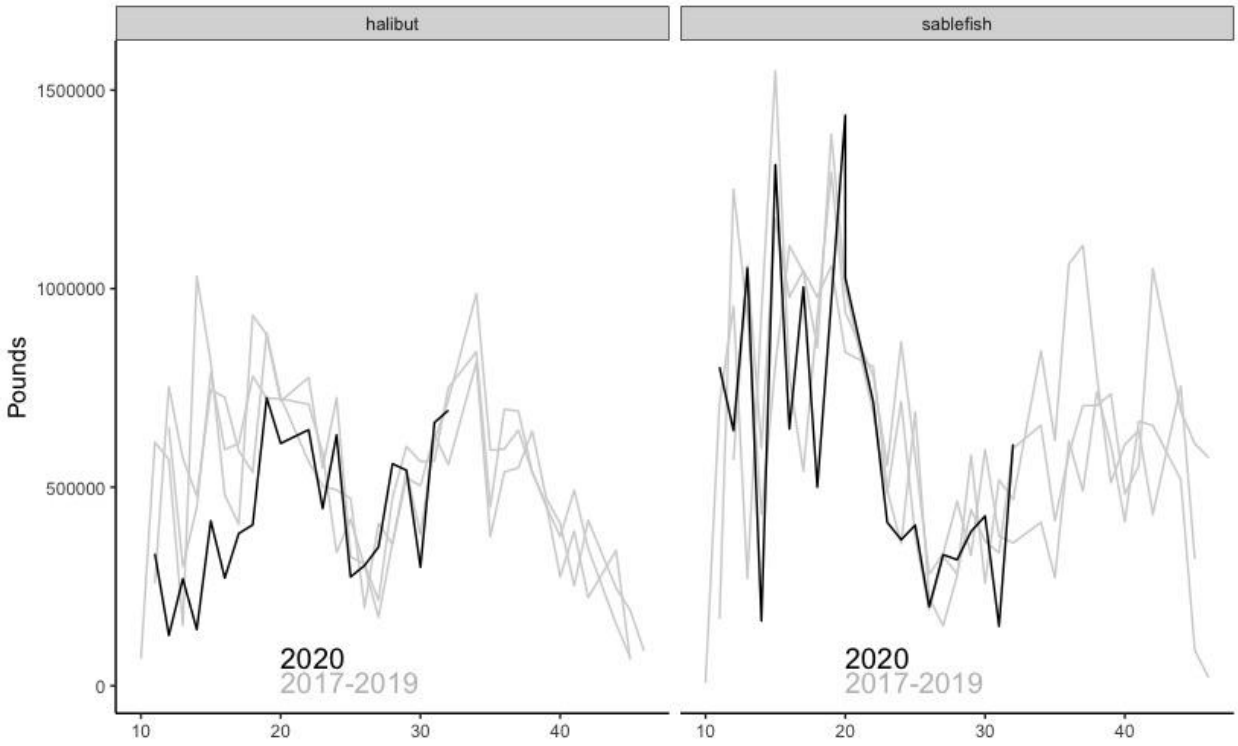
Figure 3. U.S. seafood consumer demand. Previous and current relative Google trends for several search terms: (a) seafood restaurant, (b) seafood delivery, (c) seafood recipe, (d) sushi take out, and (e) bbq restaurant (as a control). Each year was fit with a simple loess smoother (solid lines) with corresponding 95% confidence intervals. Panel (f) is the rolling mean of normalized (see methods) foot traffic data for all US fish and seafood markets.

Supplementary materials for this manuscript include the following:

WebFigure 1. State-level monthly mean of normalized (see *Methods*) foot traffic data for fish and seafood markets for the beginning of 2019 and 2020.



WebFigure 2. Alaskan weekly landings (pounds) for halibut (*Hippoglossus stenolepis*) and sablefish (*Anoplopoma fimbria*) for 2020 (black line) and past years (grey lines). Data is updated at https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports



WebFigure 3. State-level monthly number of news articles published for search terms "(covid OR coronavirus) AND (seafood OR fishery OR fisheries OR aquaculture) AND [list of all state and territory names]".