Alternative seafood networks during COVID-19: Implications for resilience and sustainability

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Abstract

Export-oriented seafood trade faltered during the early months of the COVID-19 pandemic. In contrast, alternative seafood networks (ASNs) that distribute seafood through local and direct marketing challenges were identified as a "bright spot". In this paper, we draw on multiple lines of quantitative and qualitative evidence to show that ASNs experienced a temporary pandemic "bump" in both the United States and Canada in the wake of supply chain disruptions and government mandated social protections. We use a systemic resilience framework to analyze the factors that enabled ASNs to be resilient during the pandemic as well as challenges. The contrast between ASNs and the broader seafood system during COVID-19 raises important questions about the role that local and regional food systems may play during crises and highlights the need for functional diversity in supply chains.

1. Introduction

Seafood is among the most traded food commodities in the world. In 2018, 38% of the global fish supply was exported at a value of US$164 billion (Food Agricultural Organization of the United Nations, 2020). By value, this represents an inflation adjusted increase of 168% in the last 40 years. Multiple factors are contributing to the continued growth and globalization of the seafood system, including neoliberal trade policies that incentivize export of seafood and advancements in technological capacity that enable wide distribution of highly perishable products (Anderson et al., 2010). The expansion of seafood trade has resulted in a range of socioeconomic benefits, including increased employment opportunity and food security (Asche et al., 2015). However, it also makes the seafood system more vulnerable to systemic shocks that disrupt the flow of product and the livelihoods that depend on it (Cottrell et al., 2019). The global financial crisis of 2007-2008, for example, resulted in an estimated 7% decline in seafood exports worldwide, including a 9% decline in the United States and Canada (US$632 million) (Food Agricultural Organization of the United Nations, 2010). A decade later, the seafood system again faces a systemic shock, this time due to the COVID-19 pandemic (Love et al., 2020). Shocks like these are becoming an increasingly common feature of food systems, including those associated with seafood (Cottrell et al., 2019), and this is a trend that can be expected to continue, given the challenges presented by rapid climate breakdown (Rockstrom et al., 2020). Such disturbances will continue to have major implications for the well-being of the 60 million people worldwide who are directly employed by fisheries and aquaculture as well as the millions more who are involved in the interconnected processing, distribution, and service

sectors (Rotz and Fraser, 2015). As such, systemic shocks like the COVID-19 pandemic provide an important opportunity to study food system resilience and learn from segments of it that exhibit shock-tolerant.

1.1. Alternative seafood networks as a source of systemic resilience

As seafood systems become increasingly globalized, evermore product flows out and away from the places where it is caught. Yet during systemic shocks, food systems – including those associated with seafood – can become "deadlocked" (Garnett et al., 2020). Such paralysis, even if temporary, represents a problem for a system that is inherently reliant on being able to efficiently move seafood over long distances.

Local and regional seafood systems are not immune to shocks, including but not limited to those caused by extreme weather events (Marín et al., 2010) and anthropogenic catastrophes (Cockrell et al., 2019). Furthermore, these place-based systems are not fully decoupled from global seafood systems (Bronnmann et al., 2020; Farrell et al., 2020). Nevertheless, key distinctions between them exist in terms of their relationship and geographic orientation to consumers. In particular, what local and regional seafood systems lack in their overall geographic domain and market potential, they make up in their direct connection and proximity to consumers (Stoll et al., 2020). This "relational" orientation between harvesters and consumers sets local and regional seafood systems apart from their global counterparts. Since ASN are not fully dependent on long or complex supply chains to function, the physical and social connectedness associated with ASN may also help to insulate them from the deadlock caused by systemic global shocks. We therefore propose that there is likely an inverse, yet complementary, relationship between global and local seafood systems during periods of systemic shock. Specifically, we anticipate that during these episodes of systemic shock, we will see a temporary re-localizing phenomenon unfold (Fig. 1), one which contributes important systemic resilience to regional food systems and the seafood industry at large.

To explore this dynamic, we draw on data from the United States and Canada during the early months of the COVID-19 pandemic. COVID-19 initially impacted seafood trade by altered consumer behavior in China, the largest importer of seafood worldwide (Love et al., 2020). The impacts of COVID-19 subsequently propagated worldwide. The first cases of COVID-19 were observed in the United States and Canada in early January of 2020. On March 11 the World Health Organization

declared the spread of the COVID-19 virus a global pandemic and forced government stay-at-home orders in North America. Less than two weeks later, on March 21, the US-Canada and US-Mexico borders were closed to non-essential traffic and protective health measures were widely adopted in both countries. Social distancing and other public health measures immediately altered consumer behavior, with the restaurant and food services sector particularly hard hit (White et al., 2020). In March 2020, for example, the US Farm Bureau reported a 27% increase in grocery store sales compared to the previous year and a 25% decrease in restaurant and other food establishments (U.S. Farm Bureau, 2020). Nearly all segments of the seafood system were impacted in some way by COVID-19 (Love et al., 2020; Sorensen et al., 2020; White et al., 2020). Examples include delayed fishing seasons, outbreaks in processing plants, and depressed prices due to reduced global demand. The focus of this research is on a segment of the seafood system called alternative seafood networks (ASNs). ASNs are an umbrella term that describes a range of seafood distribution models that serve local and regional food systems and deliver seafood directly to consumers. The literature also refers to ASN as direct marketing arrangements (Stoll et al., 2015), community supported fisheries (Bolton et al., 2016), and relational seafood supply chains (Stoll et al., 2020). Like Alternative Food Networks in the agricultural sector, which emerged in response to perceived problems in food systems, ASNs emerged in the seafood industry as a way address a range of economic, social, and environmental issues (Witter, 2020; Witter and Stoll, 2016) and help small-scale fishers earn higher prices for their catch by capitalizing on growing consumer demand for local, traceable, and sustainable seafood (Brinson et al., 2011; Campbell et al., 2014; McClenachan et al., 2014; Stoll et al., 2015).

ASNs exist worldwide and were identified as a “bright spot” in both high- and low-income countries during the early months of the COVID-19 pandemic (Bennett et al., 2020; Gephart et al., 2020; Loring et al., 2020; OMalley, 2020). For example, in the northeast, United States, Smith et al. (Smith et al., 2020) found that 60% of the 258 fishers they surveyed reported adapting to local and direct seafood sales during the pandemic. Similarly, in a global survey of more than 150 fishing organizations from 21 countries, Pita et al. (2020) found that 48% of respondents had shifted to direct to consumer sales through ASNs. Even some multinational corporations pivoted towards local and direct models of seafood distribution (Cooke Aquaculture, 2020).

In this paper, we present multiple lines of quantitative and qualitative evidence to show that ASNs experienced a short-term pandemic “bump” in both the United States and Canada in the wake of

supply chain disruptions and government mandated social protections. We then analyze the factors that enabled ASNs to be resilient during the early months of the pandemic and discuss the implications for seafood systems. We frame our analysis of ASNs around the concept of systemic resilience, which describes the ability of actors in a complex system to effectively respond and recover from shock and surprise (Walker:2012tu; Ungar, 2018). Generally, systemic resilience involves some sequence of actions through which agents (people, firms, or industries) adapt to new circumstances and secure the resources required for recovery (Ungar, 2018). Response diversity, flexibility, and social capital and learning are among the primary system properties known to confer systemic resilience (Carlisle, 2014; Leslie and McCabe, 2014). Systemic resilience also operates at multiple levels (Berkes and Ross, 2013); people may draw resilience from larger social networks or the state, and they may also, through their actions, contribute resilience to those higher levels. Here, we are particularly interested in the individual and structural circumstances that enabled or inhibited local agents' ability to adapt to the new societal and supply chain challenges created by COVID-19, effectively allowing the inverse pattern of response noted above. Our findings have important implications both for how we understand the role of heterogeneity in food systems, particularly with respect to the scale and organization of production and distribution of food, as well as for policy options for enhancing the systemic resilience of seafood systems moving forward.

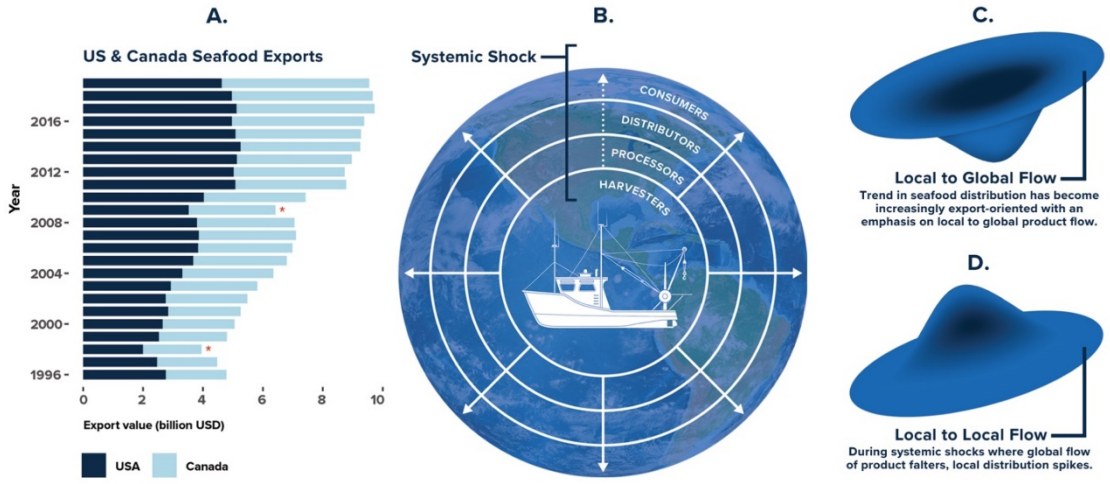

Figure 1. (A) Fisheries in the United States and Canada have become increasingly trade-oriented, but in the last 25 years, multiple systemic shocks have caused global trade to drop sharply, including during the ongoing COVID-19 pandemic (United Nations, 2020). Asterisks correspond to global recessions. (B) Systemic shocks impact all levels of the food system, from producers to consumers, and can lead to "deadlock" in the system. (C) Globalization in the seafood system leads to a local-to-global pattern where product is distributed out and away from the places where it is caught, creating a void of seafood. (D) During the early months of COVID-19 pandemic, however, global seafood supply chains faltered, leading to greater dependence on local food systems and a surge or "bump" in local and direct distribution.

2. Methods

This study uses mixed methods to examine changes experienced by ASN practitioners during the early month of the COVID-19 pandemic. In gathering and analyzing data for this study, we also included a mixed authorship team, composed of academic and practitioner knowledge holders. This team was composed deliberately and recruited with intentions to conduct research with, instead of on, ASNs, and in recognition that knowledge emerges from society and the specific relationships we, as researchers, have to people and the environment. Adding non-traditional authors to our writing team represents a small way to acknowledge the important contributions that practitioners have had on our thinking, ability to collect critical data, and integral support to the research process. This decision also reflects our philosophy that shared authorship is also about distributing the privilege and legitimacy that comes with publishing.

2.1. Co-authorship

To acknowledge the different, but complementary ways in which researchers and practitioners create and disseminate knowledge, authorship on this manuscript was based on intellectual contribution rather than the particular tasks each author completed for the research (e.g., writing, revising, etc.) (see Castleden et al. (2010)). Our team included 14 individuals who are involved in ASNs in a professional capacity (including one with a dual role in academia) (hereafter referred to as "practitioners") and three researchers who do not have a financial interest in ASNs (hereafter referred to as "researchers"). The researcher sub-team was responsible for the initial conception of the paper, primary data collection, analysis, and drafting the manuscript. The practitioner sub-team provided website analytics data and feedback on the results and multiple drafts of the manuscript. By assembling this mixed authorship team, we acknowledge the important role practitioners often play in enabling research and create space for those with grounded experiences to confirm that their lived experiences are represented appropriately.

2.2. Quantitative Analysis

Our quantitative analysis of ASNs were based on daily website traffic data, Google search term analysis, and SafeGraph foot traffic data. Daily website traffic for 8 ASNs in the United States and Canada was collected for the time period of January 1, 2019 to June 30, 2020. Businesses were selected purposefully to ensure geographic coverage across the United States and Canada and to

account for the different types and scales of direct producer-to-consumer seafood models (see: Bolton et al. (2016) for a typology of ASNs). Because they are a non-random sample, results are intended to show a qualitative trend. Data were downloaded from Google Analytics and Squarespace Analytics (n = 8) and analyzed in R (Version 3.6.1). Data were normalized to allow for business-to-business comparison using a z-score calculation ($z = (x-\mu)/\sigma$), where x represents the raw data, μ represents the population mean, and σ represents the population standard deviation. Change in consumer interest was calculated on a year-over-year basis for 2019 and 2020. Google search term data associated with seafood and food systems were analyzed for a 5-year period from June 2016 to July 2020.

We also analyzed 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 also includes some restaurants and direct-to-consumer businesses. Following White et al. 2020, 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. The number of businesses fluctuated over time as well, so we normalized visits by the number of businesses included each day. This resulted in an average number of visits per business per day.

2.3. Qualitative Analysis

Thematic networks are used to organize salient themes and provide structure in the depiction of those themes and how they were derived (Attride-Stirling, 2001). Though similar to methods of qualitative analysis found in grounded theory (Corbin and Strauss, 2008), thematic networks are not intended to "discover the beginning of arguments or the end of rationalizations" (Attride-Stirling 2001, pg 388), but are rather a technique for organizing text and developing rationalizations and their significance (ibid). Thematic networks are constructed using three 'levels' of data organization: basic themes, organizing themes, and global themes.

In total, 48 semi-structured interviews were conducted with 16 people via telephone or online video conferencing between March and August of 2020. Interview participants were solicited via recruitment through the Local Catch Network listserv and other similar outreach channels. All participants were selected due to their involvement in an ASN. Interviews were recorded and transcribed, then analyzed using NVIVO qualitative analysis software.

To develop basic themes, we followed the analytical steps laid out by Attride-Stirling (2001) and began by reducing the text via a presence/absence coding scheme. We focused the presence/absence on factors that supported or hindered resilience in ASNs. Once all transcripts were coded, codes were refined to consolidate any redundancy and clarify code definitions. Next, codes were organized around emerging themes, then refined to clarify discrete boundaries between ideas. Next, the identified themes were organized into coherent groupings, resulting in organizing themes of several social and structural factors. We further consolidated those themes into key organizing themes of structural and response diversity, which fit best under a global theme of resilience. To connect empirical evidence from the interviews to the global theme, we linked exemplifying pieces of interview text to the thematic network at the basic coding level (Supplement 1). It is important to note that in the present approach to thematic coding, prevalence of occurrence of individual codes does not imply relative importance, and hence is not reported here.

To develop the policy recommendations table, we posed the following question to the practitioner authors: what social, political, economic, environmental, regulatory, and/or cultural changes are needed to institutionalize the short-term "pandemic bump" that CSFs have observed and lead to transformative change in the seafood system? We collected twenty-seven responses to this question, and synthesized responses thematically.

3. Results

3.1. Alternative seafood networks during systemic shock

Our research shows that the COVID-19 pandemic drove a temporary spike in demand for local and directly sourced seafood in the United States and Canada, at a time when many other segments of the broader food system were disrupted (Garnett et al., 2020; Love et al., 2020). To make our case, we draw on four lines of quantitative and qualitative evidence: Google search term data, website analytics data, SafeGraph foot traffic data, and in-depth interviews with practitioners involved in ASNs. We find that Google searches for terms related to local and direct seafood distribution surged in the beginning of March. For example, from mid-March until the end of June, the searches for terms like "direct seafood" (not shown) (88%), "seafood delivery" (209%), and "local fish" (4%) (not shown) all increased and then started to return to normal during the summer (Fig. 2). This pandemic "bump" is also reflected in Google searches for terms related to the local food system more broadly

such as “local food” (+47) and “community supported agriculture” (+124%) (not shown), but not general terms like “seafood” (-6%) (Fig. 2). These results are consistent with website analytics data across the United States and Canada. Across a geographically distributed but non-random subset of ASNs (n = 8), we find no statistical year-over-year difference in ASN website traffic in January or February 2020 compared to the previous year. However, corresponding with the implementation of government ordered health measures related to COVID-19, there is a significant year-over-year increase from March to June (p-value < 0.001) (Fig. 2).

The mean number of people visiting approximately 3,000 fish and seafood markets in the United States decreased by 30% in 2020 as COVID-19 cases started increasing (Fig. 3a), although this also varies by state (White et al. 2020). There was some recovery starting in mid-April, but foot traffic never reached levels seen in the previous year (Fig. 3a). Although a small sample size (n=23), ASNs that are listed on the Local Catch Network (https://finder.localcatch.org/) did not experience a sharp decline and followed a very similar pattern to 2019 (Fig. 3b). In combination, the website analytics, Google trends data, and foot traffic data, suggest that ASNs were potentially more robust to COVID-19 pandemic restrictions given their prior focus on local and direct seafood distribution.

Interview data with ASNs further corroborate our findings. A total of 48 interviews were conducted with 16 ASNs. In total, 15 of 16 ASNs (93%) reported a major increase in demand for their products through both in-person and online outlets. As one respondent observed:

> In the beginning I think a lot of us were nervous that we weren’t going to be able to get rid of [our product] … And then the thing was for a couple of weeks, people started kind of panic buying in the beginning, and it was like ‘Oh no, we actually can’t keep up with what people are wanting’. But then once it started to level out we’ve been able to get rid of everything” (Participant 1, April 28, 2020).

Although ASNs are optimistic that demand for local and directly sourced seafood will be sustained, some ASNs began reporting a decline in the initial “bump” in demand in June and July as retail locations reopened more broadly.

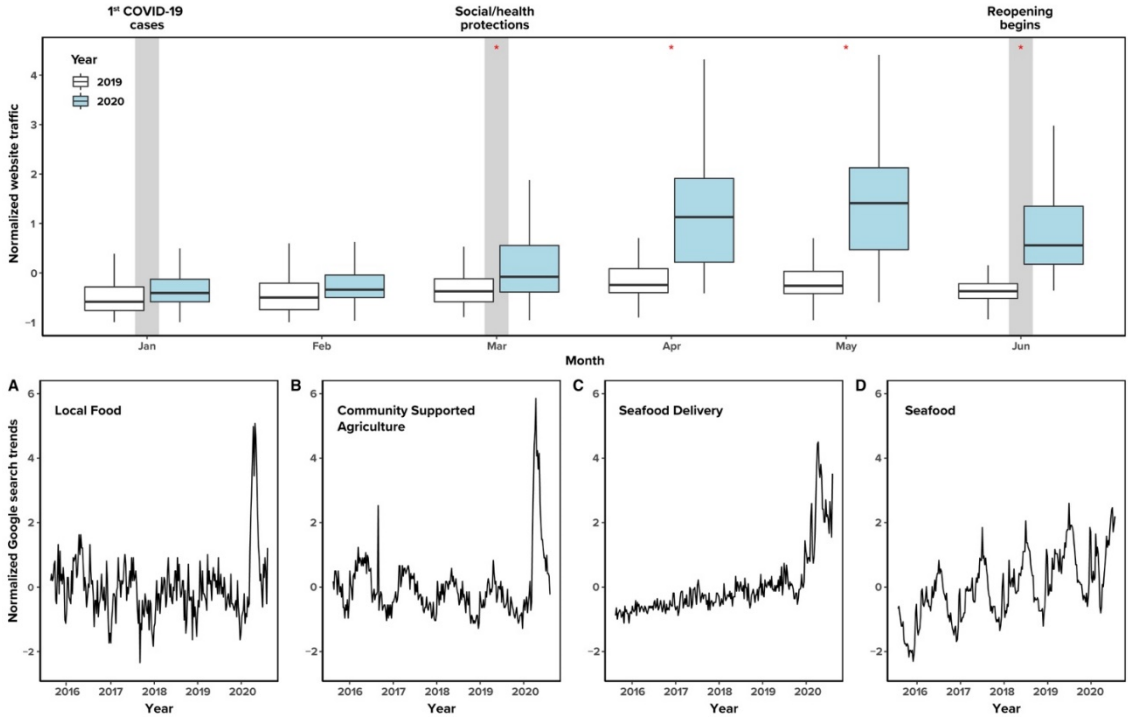

Figure 2. (Top) Google Analytics web traffic data for select alternative seafood networks (n=8). Asterisks denote a statistical difference between years. (Bottom) Google search trends for example phrases related to local food systems and direct producer-to-consumer sales White et al. (2020) similarly describe an increase in web searches for the term "seafood recipes" (A-C). Note that a similar pattern does not exist for the more general term "seafood" (D).

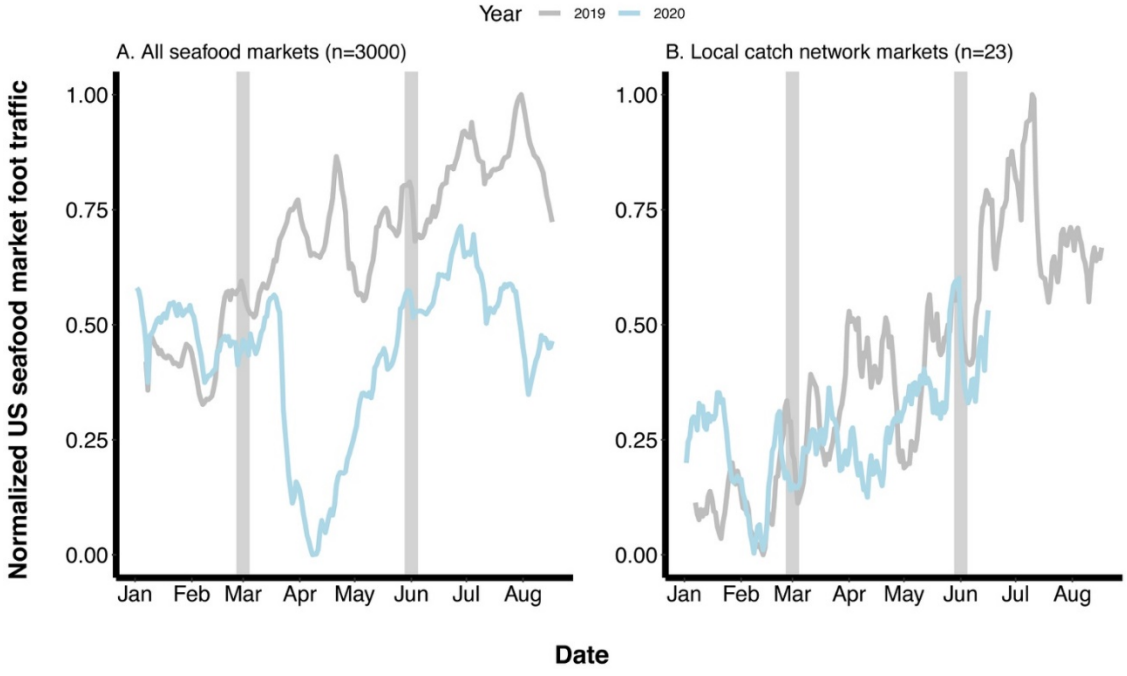

Figure 3. Rolling mean of normalized seafood market foot traffic for (A) all seafood markets in the US and (B) only those seafood markets found in the Local Catch Network (https://finder.localcatch.org/). As in figure 2, the vertical grey bars designate the initial introduction of social-distancing guidelines and reopenings.

3.2. Resilience of ASNs during systemic shock

ASNs identified multiple drivers and determinants that contributed to their resilience during the early months of the COVID-19 pandemic (Figure 4 and Supplement 1). We identified two primary factors influencing ASNs resilience: structural factors and response diversity. Structural factors are generally fixed or hard-to-change features of society, such as infrastructure and policy, which help or hinder people in their ability to enact diverse responses (Loring et al., 2011). In contrast, response diversity describes features at the individual and societal levels that enable people to enact a variety of existing and new strategies (Leslie and McCabe, 2014).

With respect to response diversity, ASNs drew upon social networks and personal psychological resilience to respond to the pandemic. ASNs in particular identified inter-harvester relationships and relationships to higher-level organizations such as fisheries co-ops, as essential to maintain seafood distribution. Relationships were also viewed as being important for facilitating new markets. For example, ASN harvesters who live away from the fishing grounds in the off-season were able to develop new markets in places that were otherwise not served by their fishery. ASNs emphasized the positive psychological value that they derived from their relationships with consumers during the early months of the pandemic, especially at a point in time when such interactions have been limited in daily life (Fig. 4).

This emphasis on relationships is closely coupled with the underlying philosophies that shape ASNs and was key to informing how they operated during the pandemic. For example, ASNs often prioritize sustainable food systems, human and community health, and well-being alongside profitability (Witter and Stoll, 2016). These topics are often tightly coupled, but during the early months of the pandemic, ASNs grappled with the tradeoffs between the need to provide seafood and the risks associated with contracting or spreading the virus, particularly to rural and remote fishing communities. As one ASN operator explained, “I do feel like I have a right to get to our fishing boat and go catch fish. And as fishermen we are essential workers. But do I want to exercise that right? Do I want to put my kids on an airplane, fly myself and my partner and my kids up [to Alaska where we fish] and be a vector for this town that I love so much?" (Participant 2, April 27, 2020).

Setting appropriate price points and managing consumers’ fears and anxiety about committing to a subscription or share-based model ASNs during times of economic uncertainty was also a challenge. ASNs reported being oriented around providing high quality seafood products for reasonable prices,

but faced declining disposable income in their consumer bases as people struggle with financial security during the pandemic.

With respect to structural factors, study participants identified many circumstances that support or reduce resilience (Fig. 4), such as having access to diverse supply chain configurations (e.g., distribution methods, consumer-harvester interaction interfaces, consumer bases), diversified fishing portfolios containing multiple species and fishing seasons, and an established online presence by which to be recognized and sell seafood products. Participants also identified specific circumstances that inhibited or made more difficult their efforts to adapt to pandemic-induced challenges such as limited options to transport seafood products, closed or restricted fishing seasons, lack of processing infrastructure and freezer space, or lack of a well-established online retail system and brand.

One structural challenge to ASN resilience was the loss of fresh retail markets (e.g., restaurants) due to the pandemic. Though many ASN saw a dramatic increase in demand from individual consumers, adapting to serve those markets came at a cost. To remain in business, ASN were forced to pivot their consumer base away from restaurant-based markets and other retail locations facing closures, such as farmers markets. These closures created an overall decline in demand and drop in price, resulting in the closure or delay of some fisheries (e.g., Great Lakes). In some places it also caused a loss of processing capacity when large processors temporarily closed due to a lack of product to process. As one ASN owner described,

> Having that really direct connection takes out a lot of variability or uncertainty. You know the more hands you put in the middle the more uncertainty there is. Right? The more, you know, you just don't know for example if this processor or that processor is going to shut down. Or if you're dealing with wholesalers or distributors in between you just don't know, you can't control those things. The direct relationship between the fishing family and the end consumer builds trust, builds flexibility on the part of the customer" (Participant 9, April 22, 2020).

Other structural resilience challenges arose due to price uncertainty from large-scale processors, to whom many ASN sold the excess of their catch, though the rising demand from new individual customers acted as a buffer for some ASN models. Processing capacity and availability, either within the ASN or through a larger commercial processor, became tenuous as processing spaces closed their doors or limited their intake - a challenge for small ASN with no privately-owned processing space.

Similarly, accessing appropriate retail space such as docks or other physical locations that allowed for social distancing and sanitation measures was also critical for ASN to maintain sales.

ASN operators also identified physical infrastructure and available workforce as critical to their ability to adapt to new buying and selling strategies, keep their workforce and customers safe, and rapidly scale their business model in response to increasing demand. Many ASN operators described having an online marketing presence, usually through social media, a dedicated website, or app, and a developed brand as essential to accommodating social distancing requirements and accessing new consumers. Unsurprisingly, ASN operators also noted the absence of physical infrastructures such as those described above as a hindrance to resilience. Difficulty in finding local employees (or the secondary barrier of processors not having enough employees, and thus closing) and working around COVID-19 distancing and sanitation concerns (e.g., insufficient space, etc.) were significant challenges that limited ASN ability to adapt to new production and sales conditions. As one harvester described,

> "I'm always a really big fan of selling whole fish. One of our infrastructure struggles is finding processors. We've had our favorite one shut down and he didn't reopen, so for us not knowing the market is one thing but getting it processed for high demand would actually be a challenge. So at that point I would really encourage my customers to buy whole fish" (Participant 3, May 5, 2020).

Some ASN identified the problem of lack of access to fishing grounds, or feeling unsafe to travel to their fishing grounds. Those who could access the fishing grounds identified geographic access to markets as a challenge for those harvesting in remote areas who faced increased logistical barriers to getting their product to markets when transportation and travel became restricted. Secondary to challenges of access were challenges around maintaining a steady supply of product, particularly for those ASN who were unable to return to their harvesting grounds or missed important fishing seasons/openers. Here, ASN often relied upon the aforementioned strong social networks between harvesters to maintain their seafood supply chains (e.g., accessing seafood through their co-op). As an ASN owner-harvester said, "It's really been helpful that the co-op is providing me with basically it's like fish on tap, where I can go back and get more if I run out" (Participant 2, May 17, 2020).

With respect to response diversity, ASNs drew upon social networks and personal psychological resilience to respond to the pandemic. For instance, ASNs identified building and maintaining strong

inter-harvester relationships, and between harvesters and higher organizational levels such as fisheries co-ops, as essential to supporting the supply and distribution of ASN products. ASNs also highly valued the positive social and psychological impact of their relationships with consumers, and highlighted the opportunity for face-to-face interactions (e.g., during curb-side pickups or home deliveries), especially during COVID-19 where such interactions have been limited in daily life.

ASNs also identified relationships to place as important in both developing new markets and selling place-based products. For example, ASN harvesters who live away from the fishing grounds in the off-season were able to develop new markets in places that were otherwise not served by their fishery. Their personal connection to their home area and their fishery was important to connecting consumers to the value and origin of their product. Harvesters also reported feelings of satisfaction through connecting with their customers and sharing with them a nutritionally and emotionally valuable food product. This factor linked closely to ASNs having core underlying philosophies that inform their business decisions and offered flexibility in considering what an ASN should achieve and how a sustainable business model should look during the pandemic. For example, prioritizing sustainable food systems and human and community health and well-being alongside profitability.

Conversely, social and emotional tolls of dealing with the uncertainty of the COVID-19 pandemic's impact on their fisheries and markets, and worries about risks and responsibilities of contracting or spreading the virus, particularly to rural and remote fishing communities, hindered many ASNs. Setting appropriate price points and managing consumer fears/anxiety of commitment to a subscription or share-based model ASNs during times of economic turmoil has also been a challenge. As one harvester said:

> We've actually dropped the prices on a lot of things. I know like tuna and spa went from being like $14.00, $15.00 to now everything is like $10.00/lbs and some of the whole fish is cheaper, whole or a couple dollars less fillet, just again people are I think wanting to move stuff but also make sure that people are able to buy because as much as we're struggling, so are the people that are supporting us (Participant 9, May 11, 2020).

ASNs reported being oriented around providing high quality seafood products for reasonable prices, but faced declining disposable income in their consumer bases as people struggle with financial security during the pandemic.

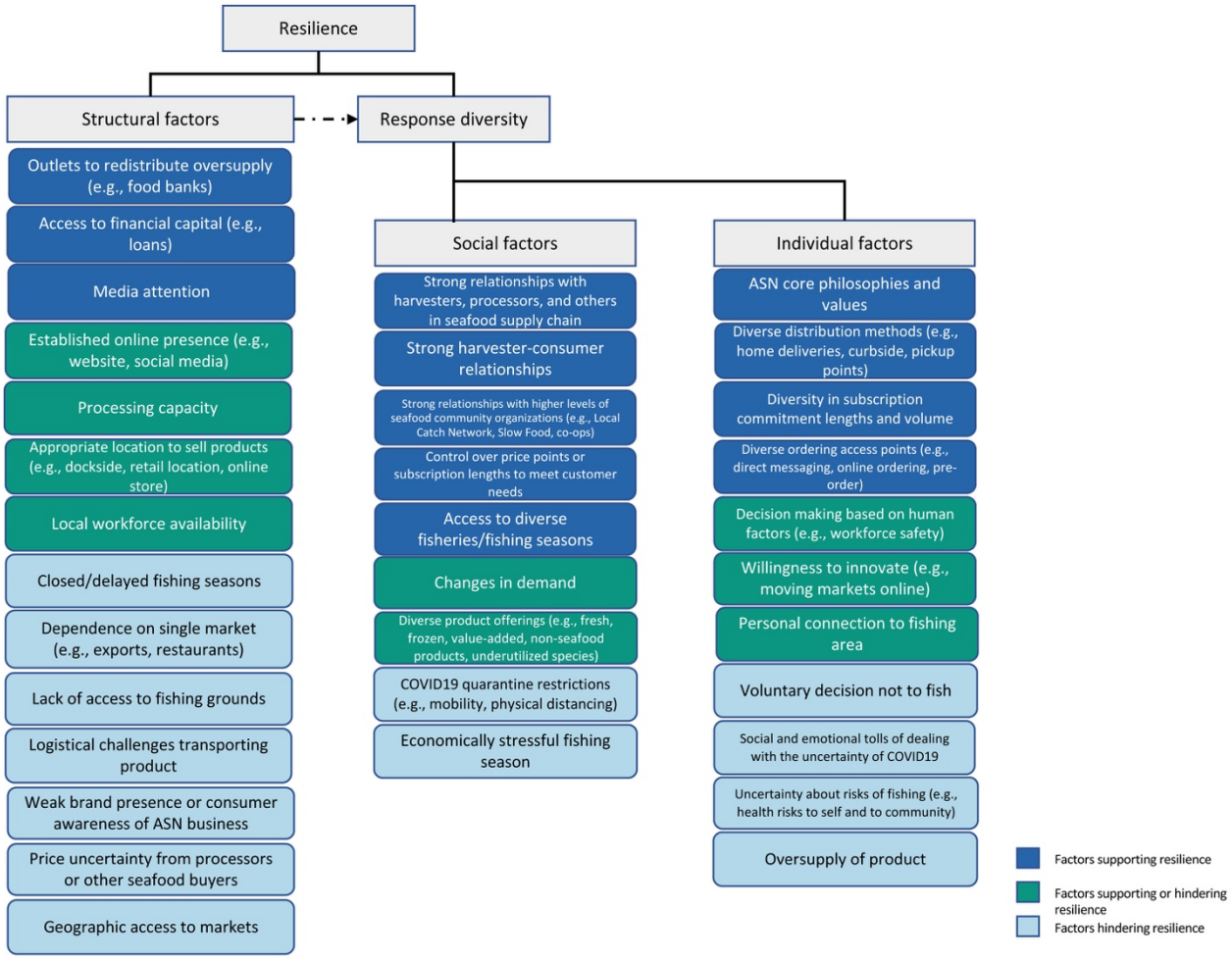

Figure 4. Structural and response factors that supported or hindered ASN resilience during the COVID-19 pandemic. Factors in dark blue were identified as being important to supporting ASN resilience across research participant contexts. Factors in green were either supportive or hindering ASN resilience depending on the context of individual ASNs. Factors in light blue were identified as hindering ASN resilience across research participant contexts.

3.3. Strengthening Alternative Seafood Networks

ASN operators identified several key barriers to ASN development and growth, notably a lack of appropriate infrastructure such as docks or other unloading areas, reliable postal services, or seafood processing locations. Others identified challenging regulatory environments that make it difficult to obtain appropriate permits, licenses, or other permissions required to direct-market seafood to local consumers or retailers. Underlying these challenges was also a reported lack of state/provincial or federal recognition of ASNs and small-scale fisheries and the role they provide to local food security. Table 1 provides a synthesis of policy changes to address these challenges identified during interviews.

[Table 1]

4. Discussion

Our research documents a temporary re-localization in the seafood system during the early months of the COVID-19 pandemic, in which demand for local and directly sourced seafood spiked abruptly. To date, ASNs have been described as an important strategy for small- and mid-size seafood operations to build firm-level resilience (Kittinger et al., 2015; Stoll et al., 2020). However, the relative shock-tolerance that ASNs exhibited during the COVID-19 pandemic also suggests that they may also contribute to the "systemic resilience" of the broader seafood economy. That is, ASN participants may be uniquely capable of mobilizing the necessary response diversity that allows producers and consumers to circumvent supply chain deadlocks during times of stress. Indeed, it is worth noting that the pattern of re-localization during shocks that we document in this paper is not a new phenomenon. For example, in 1917, during World War I, the Canadian Ministry of Agriculture encouraged citizens to establish "victory gardens" as part of the tactical strategy to increase food sovereignty and win the war. Woodrow Wilson, president of the United States between 1913 and 1921, launched a similar campaign. More contemporary examples also exist. For example, Gomez and Lien (2017) have previously observed that the global financial crisis of 2007-2008 played a critical role in catalyzing local food distribution in southern Europe. Similarly, during the 2007-2008 global financial crisis, the iconic lobster fishery in Maine, which had been becoming progressively more globalized (Stoll et al., 2018), pivoted their efforts towards local and domestic seafood distribution. Likewise, this pattern of food systems localization has also been reported to us anecdotally for multiple Latin American locales during the pandemic, including Puerto Rico (Marco Hanke, *pers. comm.* 17 August, 2020, Chile (Marah Hardt, *pers. comm.* 06 July 2020), Mexico (Ines Lopez, *pers. comm.* 31 August, 2020), and the Caribbean Islands (Felicity Burrows, *pers. comm.* 21 July 2020).

Some of the drivers and determinants of resilience observed here match with findings of other research, including the importance of existing infrastructure, experience with alternative fisheries and marketing strategies, and a willingness to be flexible on the part of individual operators (Hamilton et al., 2003; Huntington et al., 2017). Particularly noteworthy, we believe, is the apparent role of psychological resilience and agency at the individual level, e.g., fishers' commitment to fishing and

454 to core values for fishing, in supporting the continued function of the seafood system at higher levels.
455 This is an important contribution to how we understand the role of individual coping and well-being
456 in the resilience of fisheries and the larger social-ecological systems within which they are embedded
457 (Adger, 2000). Resilience at the individual level has been discussed previously, but largely in terms
458 of people's ability to cope and maintain their own well-being during crisis (Broch, 2013; Coulthard,
459 2012). Here, we have an example of individuals contributing positive resilience, that is, the ability to
460 not just bounce back but bounce forward (Manyena et al., 2011), in a way that is transferring
461 resilience to higher levels in regional food systems and the seafood sector at large.
462
463 Troell and colleagues previously hypothesized that the aquaculture sector could add resilience to the
464 global seafood system by increasing the diversity of fished species and production locales (Troell et
465 al., 2014). While we are unaware whether any studies have tested their hypothesis for aquaculture or
466 any other subsector of the industry, here we do show that ASNs contribute to the systemic resilience
467 of the global seafood system. In part, they do by adding diversity to the production systems and
468 supply chains, and allow consumers to circumvent deadlocks in global supply chains. We also find
469 that individual agency plays an important role, agency that is empowered by fishers' psychological
470 resilience and commitment to the unique set values around fisheries that ASNs embody, values such
471 as fair access and simple supply chains. This suggests that when considering how to improve global
472 seafood systems moving forward, it is insufficient to look at diversification in production and supply
473 chains without looking at the system of values that motivate the actors making and participating in
474 those changes.
475
476 ASNs identified a number of structural and response factors that, depending on their local context,
477 helped or hindered their resilience to impacts from the COVID-19 pandemic as well as possible
478 policy options that could address some obstacles to resilience (Table 1). Those policy opportunities
479 were directed toward physical, social, socioeconomic, economic, and regulatory infrastructure. For
480 example, ASNs identified that lack of physical infrastructure, such as working waterfronts or seafood
481 processing capacity, posed a challenge to ASNs who need space to deliver their product and prepare
482 it for sale. Prioritizing investment at multiple levels to develop and support existing local-level
483 seafood infrastructure would provide appropriate locations and capacity for ASNs to scale their
484 operations to meet demand and seasonal abundance. Similarly, ASNs identified that excessive
485 regulatory 'red tape' was often challenging and expensive to navigate, creating disincentives for
486 some seafood harvesters to seek out appropriate permissions to direct-market their products. ASNs

identified that streamlining and simplifying direct-marketing permissions (e.g., permits, licenses, etc.) and the process by which they are obtained would make this process more accessible to a wider variety of seafood producers and bring direct-marketing of seafood in line with the more streamlined processes that exist for the direct sale of land-based agricultural products.

Finally, to more fully understand the role that ASNs play in the broader seafood system, better data on the sector are critically needed. At present, there is no national-level data in either the United States nor Canada to describe the number of ASNs, their geographic distribution or their total socioeconomic contribution. However, sales associated with parallel types of agricultural distribution in the United States alone are estimated to be US$9 billion, including US$2.8 billion direct to consumers (USDA, 2019). Addressing this data gap is not beyond the realm of possibility as parallel data for the agricultural sector have been collected since 1976 in the United States through the Farmer-to-Consumer Direct Marketing Act. Such data are critical to further understand the role of ASNs in shock-tolerance and the importance of functional diversity in supply chains, as demonstrated during the COVID-19 pandemic.

Conflict of Interest

JSS is the co-founder of Local Catch Network and owner of Georgetown Island Oyster Company. DC is a co-owner of the Walking Fish Cooperative. MC is a commercial fisherman and co- owner of West Coast Wild Scallops. KH is Chief Fisheries Officer with Sitka Salmon Shares. BJ is the marketing director for the Columbia River Inter-Tribal Fish Commission. JK is a commercial fisherman and co-manager for Tuna Harbor Dockside Market. EK is a commercial fisherman and the co-owner of Straight to the Plate. SK is co-founder and CEO of Wild for Salmon, Inc. AL is a co-founder and CEO of Real Good Fish. SS is the co-founder and CEO of Skipper Otto Community Supported Fishery. TS is a commercial fisherman fishmonger at Wooden Island Wild. AT is the general manager of New Hampshire Community Seafood. TY is the co-founder and director of Fishadelphia Community Seafood Program.

Author Contributions

JSS, HLH, EDS, and PAL conceived of the study. HLH, EDS, and PAL performed qualitative interviews. HLH and EDS analyzed qualitative data. JSS and ERW performed quantitative analysis. JSS, HLH, EDS, and PAL drafted the manuscript. DC, MC, KH, BJ, JK, EK, SK, AL, SS, TS, BT,

AT, ERW, and TY contributed web analytics and interview data, and reviewed and commented on the manuscript.

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Data Availability Statement

Google search term data is downloadable at https://trends.google.com/trends/?geo=US. Aggregated Google Analytics data used in this study are available upon written request to the corresponding author. Data and code for the SafeGraph foot traffic data is available at: https://github.com/eastonwhite/COVID19_US_Fisheries. Ethnographic data and information on participants are confidential, protected by research ethics protocols and cannot be shared.

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677 **List of Tables**

678 **Table 1**. Policy opportunities to strengthen alternative seafood networks.

Type of infrastructure	Action / Investment
Physical	Make local and state/provincial investments in scale-appropriate infrastructure (e.g., working waterfronts, postal service, food hubs, etc.) that is conducive for direct-sale of seafood products through multiple channels and locations.
Social	Provide affordable, accessible health care for essential food production workers in the seafood industry that reflect the seasonality of fishing.
Social / Economic	Develop fair and affordable financial tools to help young and new fishermen enter highly competitive and costly fisheries.
Economic	Establish financial incentives for domestic seafood purchasing and consumption, with priority on sustainability of stocks and fair labor practices.
Regulatory	Streamline and simplify regulatory requirements for fishermen to sell their catch directly to consumers or local retail outlets. These policies exist for land-based farmers, but are much more arduous for seafood producers.
Regulatory / Marketing	Acknowledge the diversity of domestic seafood markets (ASNs, large-scale), and expand the definition of what “local” means in terms of labeling so as to include products harvested elsewhere by local residents.
Marketing	Provide leadership at the state/provincial and federal level to highlight and promote the value of North America’s commercial fishing fleets and emphasize local, U.S./Canadian caught/raised

	seafoods (i.e., national seafood council) and consumption of local, sustainably-harvested, underutilized species.

679