

1 **Alternative seafood networks during COVID-19: Implications for**  
2 **resilience and sustainability**  
3

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33  
34 **Keywords: COVID-19, direct marketing, fisheries, resilience, seafood, systemic shock, trade**

## 35 **Abstract**

36

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

## 47 **1. Introduction**

48

49 Seafood is among the most traded food commodities in the world. In 2018, 38% of the global fish  
50 supply was exported at a value of US\$164 billion (Food Agricultural Organization of the United  
51 Nations, 2020). By value, this represents an inflation adjusted increase of 168% in the last 40 years.  
52 Multiple factors are contributing to the continued growth and globalization of the seafood system,  
53 including neoliberal trade policies that incentivize export of seafood and advancements in  
54 technological capacity that enable wide distribution of highly perishable products (Anderson et al.,  
55 2010). The expansion of seafood trade has resulted in a range of socioeconomic benefits, including  
56 increased employment opportunity and food security (Asche et al., 2015). However, it also makes the  
57 seafood system more vulnerable to systemic shocks that disrupt the flow of product and the  
58 livelihoods that depend on it (Cottrell et al., 2019). The global financial crisis of 2007-2008, for  
59 example, resulted in an estimated 7% decline in seafood exports worldwide, including a 9% decline  
60 in the United States and Canada (US\$632 million) (Food Agricultural Organization of the United  
61 Nations, 2010). A decade later, the seafood system again faces a systemic shock, this time due to the  
62 COVID-19 pandemic (Love et al., 2020). Shocks like these are becoming an increasingly common  
63 feature of food systems, including those associated with seafood (Cottrell et al., 2019), and this is a  
64 trend that can be expected to continue, given the challenges presented by rapid climate breakdown  
65 (Rockstrom et al., 2020). Such disturbances will continue to have major implications for the well-  
66 being of the 60 million people worldwide who are directly employed by fisheries and aquaculture as  
67 well as the millions more who are involved in the interconnected processing, distribution, and service

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

71

### 72 **1.1. Alternative seafood networks as a source of systemic resilience**

73

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

79

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

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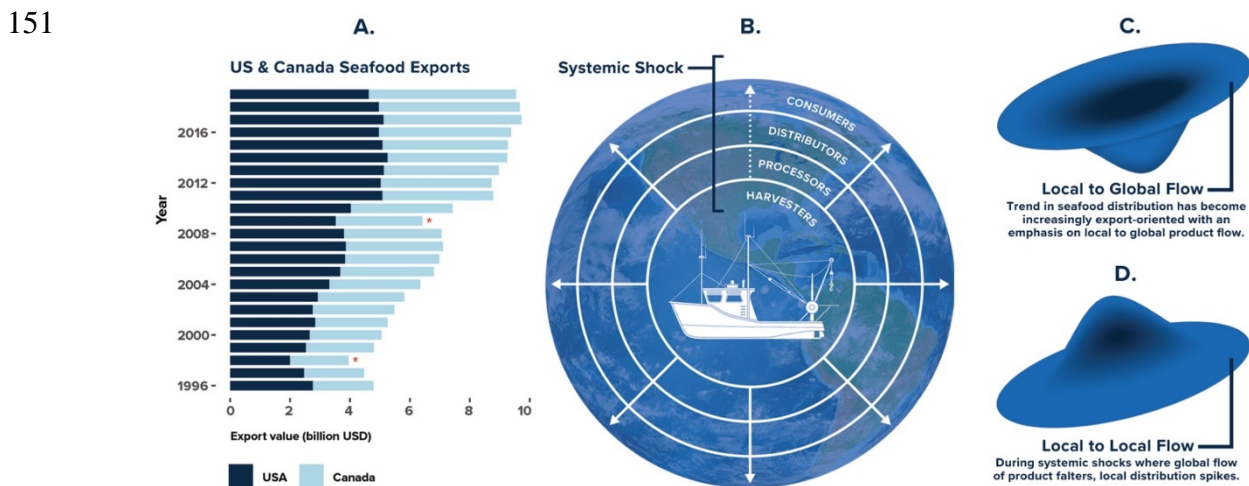
96 To explore this dynamic, we draw on data from the United States and Canada during the early  
97 months of the COVID-19 pandemic. COVID-19 initially impacted seafood trade by altered consumer  
98 behavior in China, the largest importer of seafood worldwide (Love et al., 2020). The impacts of  
99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

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

122  
123 ASNs exist worldwide and were identified as a “bright spot” in both high- and low-income countries  
124 during the early months of the COVID-19 pandemic (Bennett et al., 2020; Gephart et al., 2020;  
125 Loring et al., 2020; OMalley, 2020). For example, in the northeast, United States, Smith et al. (Smith  
126 et al., 2020) found that 60% of the 258 fishers they surveyed reported adapting to local and direct  
127 seafood sales during the pandemic. Similarly, in a global survey of more than 150 fishing  
128 organizations from 21 countries, Pita et al. (2020) found that 48% of respondents had shifted to direct  
129 to consumer sales through ASNs. Even some multinational corporations pivoted towards local and  
130 direct models of seafood distribution (Cooke Aquaculture, 2020).

131  
132 In this paper, we present multiple lines of quantitative and qualitative evidence to show that ASNs  
133 experienced a short-term pandemic “bump” in both the United States and Canada in the wake of

134 supply chain disruptions and government mandated social protections. We then analyze the factors  
 135 that enabled ASNs to be resilient during the early months of the pandemic and discuss the  
 136 implications for seafood systems. We frame our analysis of ASNs around the concept of systemic  
 137 resilience, which describes the ability of actors in a complex system to effectively respond and  
 138 recover from shock and surprise (Walker:2012tu; Ungar, 2018). Generally, systemic resilience  
 139 involves some sequence of actions through which agents (people, firms, or industries) adapt to new  
 140 circumstances and secure the resources required for recovery (Ungar, 2018). Response diversity,  
 141 flexibility, and social capital and learning are among the primary system properties known to confer  
 142 systemic resilience (Carlisle, 2014; Leslie and McCabe, 2014). Systemic resilience also operates at  
 143 multiple levels (Berkes and Ross, 2013); people may draw resilience from larger social networks or  
 144 the state, and they may also, through their actions, contribute resilience to those higher levels. Here,  
 145 we are particularly interested in the individual and structural circumstances that enabled or inhibited  
 146 local agents' ability to adapt to the new societal and supply chain challenges created by COVID-19,  
 147 effectively allowing the inverse pattern of response noted above. Our findings have important  
 148 implications both for how we understand the role of heterogeneity in food systems, particularly with  
 149 respect to the scale and organization of production and distribution of food, as well as for policy  
 150 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.

## 152 **2. Methods**

153

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

164

### 165 **2.1. Co-authorship**

166

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

179

### 180 **2.2. Quantitative Analysis**

181

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

186 account for the different types and scales of direct producer-to-consumer seafood models (see: Bolton  
187 et al. (2016) for a typology of ASNs). Because they are a non-random sample, results are intended to  
188 show a qualitative trend. Data were downloaded from Google Analytics and Squarespace Analytics  
189 (n = 8) and analyzed in R (Version 3.6.1). Data were normalized to allow for business-to-business  
190 comparison using a z-score calculation ( $z = (x-\mu)/\sigma$ ), where x represents the raw data,  $\mu$  represents  
191 the population mean, and  $\sigma$  represents the population standard deviation. Change in consumer interest  
192 was calculated on a year-over-year basis for 2019 and 2020. Google search term data associated with  
193 seafood and food systems were analyzed for a 5-year period from June 2016 to July 2020.  
194 We also analyzed foot traffic data from SafeGraph, a data company that aggregates anonymized  
195 location data from numerous applications in order to provide insights about physical places. We  
196 examined data specific to fish and seafood markets (NAICS code 445220), which also includes some  
197 restaurants and direct-to-consumer businesses. Following White et al. 2020, we filtered out  
198 businesses that were mislabeled as seafood markets and those with less than 300 days of foot traffic  
199 data since the start of 2019. We followed SafeGraph's recommendations on normalizing data by  
200 dividing the number of daily visits by the number of devices present. The number of businesses  
201 fluctuated over time as well, so we normalized visits by the number of businesses included each day.  
202 This resulted in an average number of visits per business per day.

203

### 204 **2.3. Qualitative Analysis**

205

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

213

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

219

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

232

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

238

### 239 **3. Results**

240

#### 241 **3.1. Alternative seafood networks during systemic shock**

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



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

259

260 The mean number of people visiting approximately 3,000 fish and seafood markets in the United  
261 States decreased by 30% in 2020 as COVID-19 cases started increasing (Fig. 3a), although this also  
262 varies by state (White et al. 2020). There was some recovery starting in mid-April, but foot traffic  
263 never reached levels seen in the previous year (Fig. 3a). Although a small sample size (n=23), ASNs  
264 that are listed on the Local Catch Network (<https://finder.localcatch.org/>) did not experience a sharp  
265 decline and followed a very similar pattern to 2019 (Fig. 3b). In combination, the website analytics,  
266 Google trends data, and foot traffic data, suggest that ASNs were potentially more robust to COVID-  
267 19 pandemic restrictions given their prior focus on local and direct seafood distribution.

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

271

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

277

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

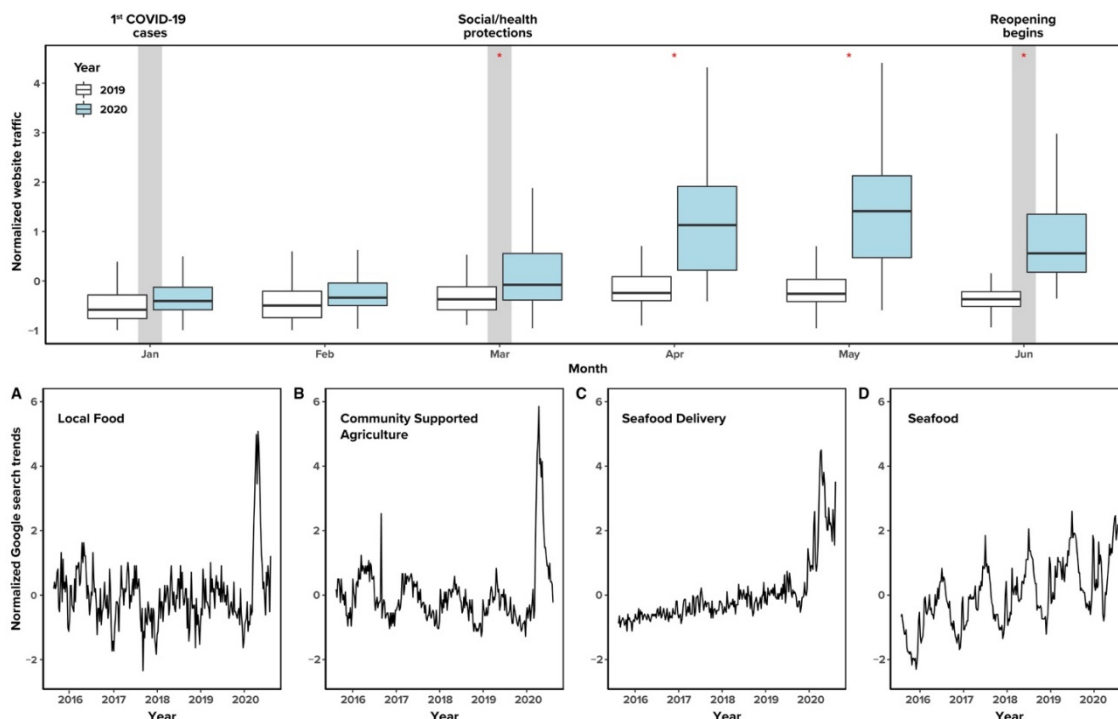
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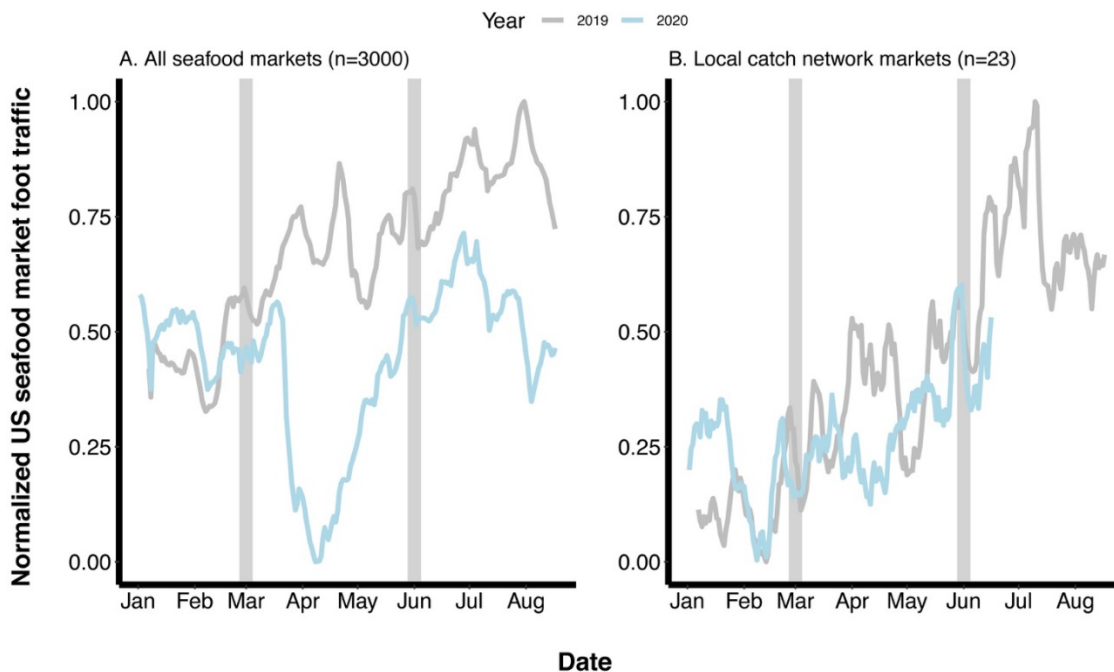
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**Figure 2.** (Top) Google Analytics web traffic data for select alternative seafood networks (n=8). Asterisks denote a statistical difference between years. (Bottom) Google search trends for example phrases related to local food systems and direct 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.

### 290 **3.2. Resilience of ASNs during systemic shock**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

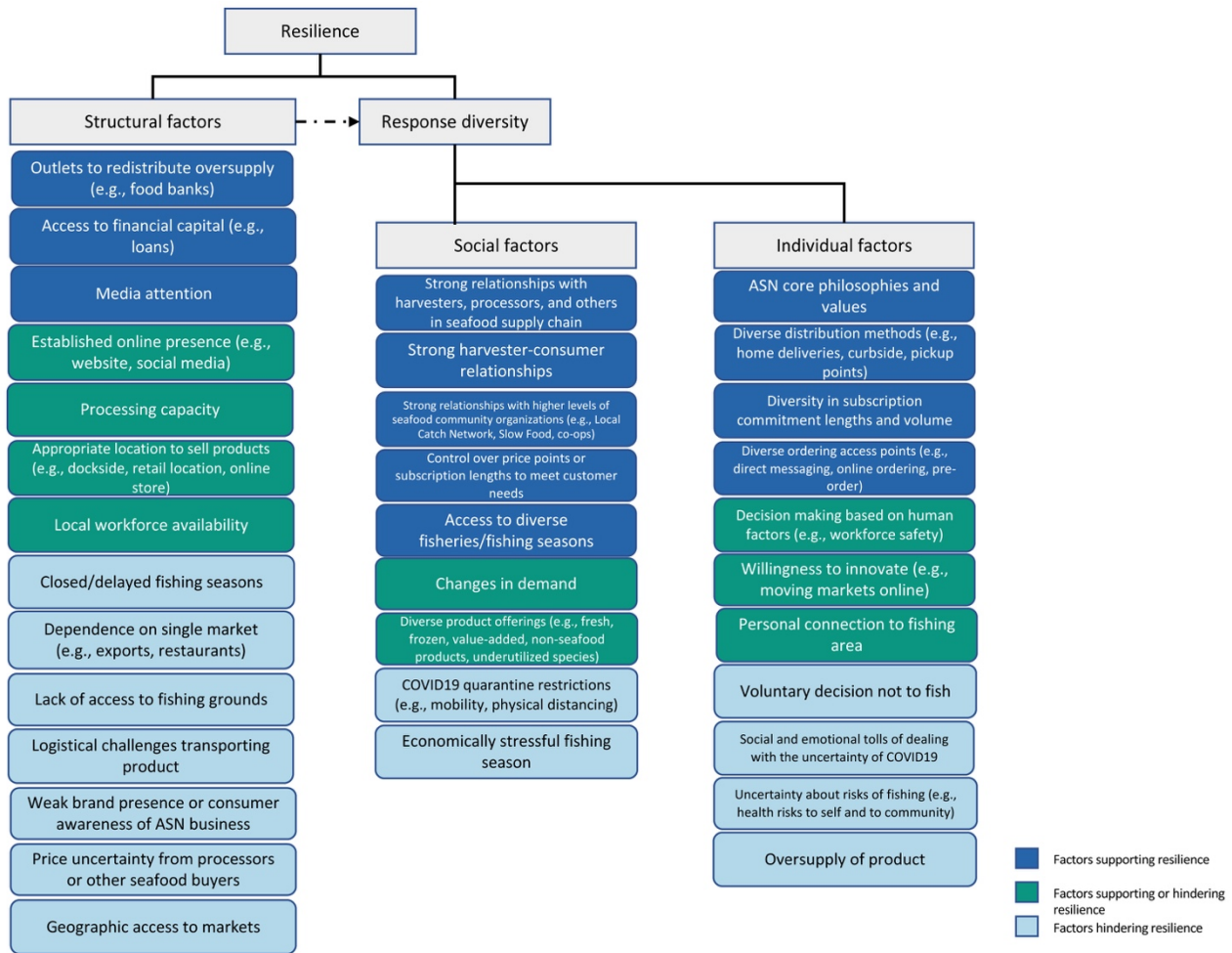
384 ASNs also identified relationships to place as important in both developing new markets and selling  
385 place-based products. For example, ASN harvesters who live away from the fishing grounds in the  
386 off-season were able to develop new markets in places that were otherwise not served by their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

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

400  
401 We've actually dropped the prices on a lot of things. I know like tuna and spa went from  
402 being like \$14.00, \$15.00 to now everything is like \$10.00/lbs and some of the whole fish is  
403 cheaper, whole or a couple dollars less fillet, just again people are I think wanting to move  
404 stuff but also make sure that people are able to buy because as much as we're struggling, so  
405 are the people that are supporting us (Participant 9, May 11, 2020).

406  
407 ASNs reported being oriented around providing high quality seafood products for reasonable prices,  
408 but faced declining disposable income in their consumer bases as people struggle with financial  
409 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.

411

### 412 3.3. Strengthening Alternative Seafood Networks

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

421  
422 [Table 1]  
423

#### 424 4. Discussion

425  
426 Our research documents a temporary re-localization in the seafood system during the early months of  
427 the COVID-19 pandemic, in which demand for local and directly sourced seafood spiked abruptly.  
428 To date, ASNs have been described as an important strategy for small- and mid-size seafood  
429 operations to build firm-level resilience (Kittinger et al., 2015; Stoll et al., 2020). However, the  
430 relative shock-tolerance that ASNs exhibited during the COVID-19 pandemic also suggests that they  
431 may also contribute to the “systemic resilience” of the broader seafood economy. That is, ASN  
432 participants may be uniquely capable of mobilizing the necessary response diversity that allows  
433 producers and consumers to circumvent supply chain deadlocks during times of stress. Indeed, it is  
434 worth noting that the pattern of re-localization during shocks that we document in this paper is not a  
435 new phenomenon. For example, in 1917, during World War I, the Canadian Ministry of Agriculture  
436 encouraged citizens to establish “victory gardens” as part of the tactical strategy to increase food  
437 sovereignty and win the war. Woodrow Wilson, president of the United States between 1913 and  
438 1921, launched a similar campaign. More contemporary examples also exist. For example, Gomez  
439 and Lien (2017) have previously observed that the global financial crisis of 2007-2008 played a  
440 critical role in catalyzing local food distribution in southern Europe. Similarly, during the 2007-2008  
441 global financial crisis, the iconic lobster fishery in Maine, which had been becoming progressively  
442 more globalized (Stoll et al., 2018), pivoted their efforts towards local and domestic seafood  
443 distribution. Likewise, this pattern of food systems localization has also been reported to us  
444 anecdotally for multiple Latin American locales during the pandemic, including Puerto Rico (Marco  
445 Hanke, *pers. comm.* 17 August, 2020, Chile (Marah Hardt, *pers. comm.* 06 July 2020), Mexico (Ines  
446 Lopez, *pers. comm.* 31 August, 2020), and the Caribbean Islands (Felicity Burrows, *pers. comm.* 21  
447 July 2020).

448  
449 Some of the drivers and determinants of resilience observed here match with findings of other  
450 research, including the importance of existing infrastructure, experience with alternative fisheries and  
451 marketing strategies, and a willingness to be flexible on the part of individual operators (Hamilton et  
452 al., 2003; Huntington et al., 2017). Particularly noteworthy, we believe, is the apparent role of  
453 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

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

491

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

502

### 503 **Conflict of Interest**

504

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

### 515 **Author Contributions**

516

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

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

## 522 **Funding**

523  
524 JSS received partial funding from the Oak Foundation and the School of Marine Sciences at the  
525 University of Maine. HLH, EDS, and PAL received partial funding from the Social Sciences and  
526 Humanities Research Council of Canada. ERW was supported in part by the COVID-19 Rapid  
527 Research Fund from the Gund Institute for Environment at the University of Vermont.

## 528 **Acknowledgments**

529  
530 We extend our appreciation to Mandy Marcum and Wen Xin Weng for help in accessing daily  
531 analytics data from two of the ASN. Our deep gratitude to everyone who took part in this study and  
532 shared their experiences during the difficult and tumultuous times of the COVID-19 pandemic.

## 533 **Data Availability Statement**

534  
535 Google search term data is downloadable at <https://trends.google.com/trends/?geo=US>. Aggregated  
536 Google Analytics data used in this study are available upon written request to the corresponding  
537 author. Data and code for the SafeGraph foot traffic data is available at:  
538 [https://github.com/eastonwhite/COVID19\\_US\\_Fisheries](https://github.com/eastonwhite/COVID19_US_Fisheries). Ethnographic data and information on  
539 participants are confidential, protected by research ethics protocols and cannot be shared.

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676



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.
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679