

Do community supported fisheries (CSFs) improve sustainability?



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ABSTRACT

Community supported fisheries (CSFs) have emerged recently and expanded rapidly in the United States and Canada as an analog to community supported agriculture, and have been proposed as a way to reduce the environmental impacts associated with seafood production, distribution, and consumption. Here, we test the hypothesis that CSFs are more sustainable than industrial fisheries by comparing these systems across a range of sustainability metrics: carbon footprint, sustainability of target stocks, and associated environmental impacts. We find that consuming seafood distributed by local CSFs reduces the average seafood carbon footprint by more than two orders of magnitude; the mean distribution distance for CSF products was 65 km, compared to an average distance of 8812 km for industrially supplied seafood consumed in the United States. There was no difference in the sustainability of target species as measured by mean trophic level, sustainability rating, or current stock biomass status (*B/BMSY*). However, CSFs do distribute a subset of highly abundant stocks not targeted by industrialized fisheries, which has a strong potential to increase local fisheries sustainability. Finally, we delineate five ways in which CSFs may reduce environmental impacts associated with fisheries and identify current examples of these practices, including marketing species that would otherwise be discarded and encouraging fishers to experiment with lower impact fishing gear. Challenges remain to the widespread use of CSFs, but increased attention to local food systems should result in environmental benefits for fisheries and marine ecosystems.

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1. Introduction

Local food movements have emerged across the globe as a way of reducing environmental impacts associated with food systems, promoting community connectivity, increasing the profit margin to small-scale food producers, and improving the quality of food for local consumers (Cone & Myhre, 2000; Ericksen, 2008; Weber and Matthews, 2008). One prominent example is the community supported agriculture (CSAs) model, in which consumers pay in advance for shares of locally produced food (Brown and Miller, 2008). This direct marketing approach first developed in the U.S. in the 1980s and CSAs currently number approximately 2500 (Campbell et al., 2014). In coastal regions, community supported fisheries (CSFs) have followed the CSA model: consumers

purchase a share of the catch of locally landed fish and invertebrates, thereby decreasing the financial risk to fishers while providing consumers a more transparent supply chain and fresh local seafood (Brinson et al., 2011; Fig. 1A and B). CSFs have emerged recently and expanded rapidly. The first was established in 2007, and CSFs in the U.S. and Canada now number more than 30, delivering seafood to more than 125 locations. These CSFs primarily source seafood from local, small-scale fisheries (Local Catch, 2013).

While CSFs are primarily intended to promote the economic viability of local fisheries and seafood producers, many conservation benefits of CSFs have been proposed. Seafood distributed locally through CSFs should reduce the carbon footprint of the distribution chain as compared to industrialized fisheries for global markets by shortening the distance from boat to plate (Fig. 2; Witter, 2012). CSFs may also diversify catch and reduce harvesting pressure on single, high value species by making species more equally valuable (NCSPC, 2012) and by encouraging consumers to eat locally plentiful fish that are underrepresented in supermarkets, whose offerings are controlled by larger suppliers (Greenaway, 2012). The

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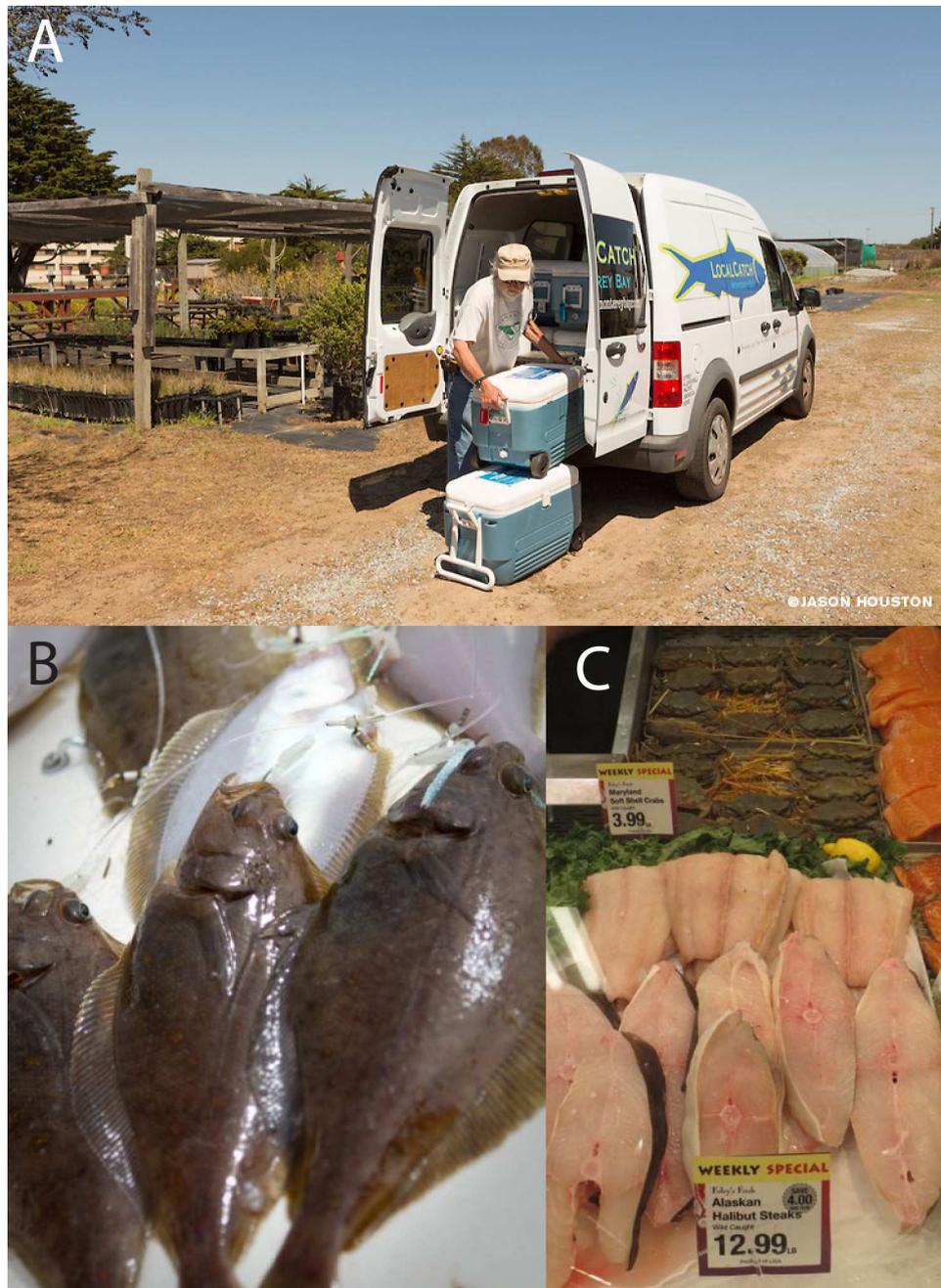


Fig. 1. (A) Community supported seafood distribution, Local Catch Monterey Bay (Photo credit: Jason Houston). (B) Sand-dabs, an example of locally abundant species with limited market distributed by Local Catch Monterey Bay CSF (Photo credit: Alan Lovewell). (C) Seafood distributed in supermarkets, which was used for comparison in this analysis.

CSF model may also encourage fishers to use less destructive fishing methods such as hook and line gear (Witter, 2012), as their practices are more transparent to consumers who are concerned with the environmental effects of their consumption patterns (NCSPC, 2012). Finally, CSFs may result in more active involvement of fishers in management by encouraging interest in advancing sustainability in their local fisheries by developing local rules or protocols that improve on those imposed by state or federal managers (Brinson et al., 2011).

To date, the small body of research on CSFs has focused on social and economic aspects of these systems (e.g., Brinson et al., 2011; Witter, 2012) and comparisons to CSA models (Campbell et al., 2014), such that the potential sustainability benefits of CSFs have yet to be evaluated empirically. Broadly, research on fisheries

sustainability has included analyses of the sustainability of target stocks, including quantification of declines in total global catch and the mean trophic level of fisheries (Pauly et al., 2002), as well as progress toward achieving management targets like maximum sustainable yield (MSY) (Worm et al., 2009). Researchers have also called attention to fisheries' impacts on the environment through habitat destruction, bycatch, and alterations of ecological interactions (Dayton et al., 1995), and more recent concern over global change has prompted analyses of carbon footprint of particular fisheries and seafood distribution systems (Iribarren et al., 2010; Winther et al., 2009; Vázquez-Rowe et al., 2010). While the literature on fisheries sustainability is broad and varied, little attention has been paid to the sustainability implications of local food movements and direct marketing efforts (Walker et al., 2013). Here, we

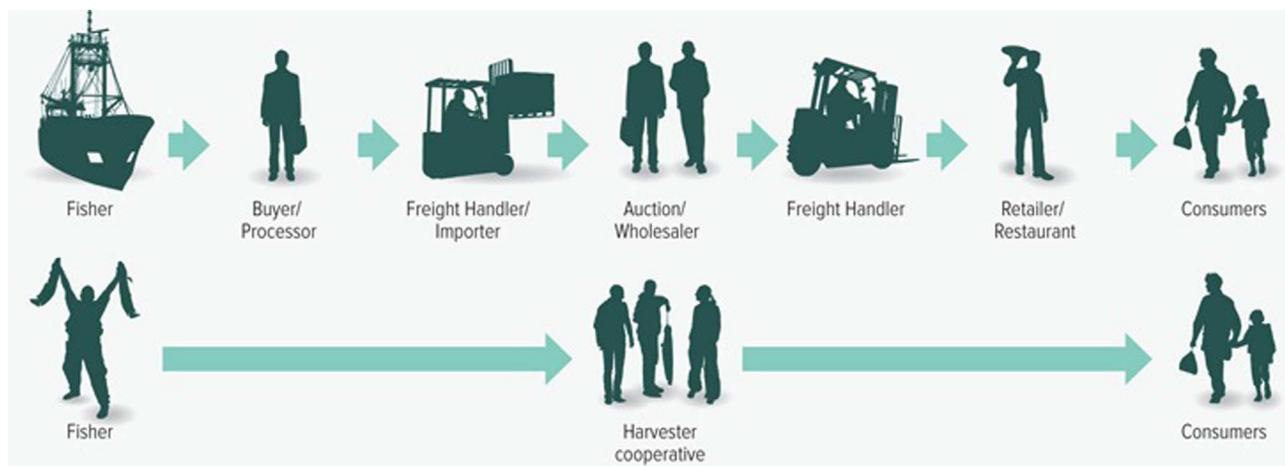


Fig. 2. A schematic of the seafood distribution chain for industrial seafood products and CSFs. Used with permission from K. Lowitt from Nelson et al. (2013).

assess the sustainability of CSFs relative to industrialized fisheries for three types of sustainability: carbon footprint, sustainability of target stocks, and associated environmental impacts. Our goal is to quantify sustainability differences that currently exist and explore how CSFs are implementing innovative practices to reduce environmental impacts through both supply-side (seafood production) and demand-side interventions (consumer awareness of sustainable seafood).

2. Methods

We obtained information from 15 CSFs located in New England, California, British Columbia, and North Carolina. We focused on CSFs in these regions because they represented four distinctive geographic areas that all have some of the highest concentrations of CSFs in North America (Local Catch, 2013). Data were obtained directly from CSF representatives, as well as from information published online by individual CSFs. For each CSF, we requested information on numbers of subscribers, size of shares, fish stocks targeted, gear used, and the distance of distribution sites from the landing site. For privacy reasons, we grouped all data by region.

We quantified the carbon footprint associated with distributing seafood through CSFs by calculating the mean distance from the landing sites to the distribution sites, for all CSFs together and for CSFs within each region. We then calculated a minimum potential travel distance for all seafood consumed in the United States using import data obtained from the National Oceanic and Atmospheric Administration (NOAA). We used data on edible fishery products (excluding reduction fisheries) imported in 2011, the most recent data available (NOAA, 2012). For each exporting nation ($n = 44$), we chose a fixed point (the capital city) and calculated the distance to a fixed point in the United States. Each distance was then weighted by total imports in kilograms from that nation. For domestically produced seafood products, we used an arbitrary conservative distance of 549 km, which was the maximum port-to-consumer distance shipped by the CSFs, and weighted this distance by the total U.S. domestic landings of edible fishery products, reduced by the total U.S. exports of these products (NOAA, 2012). This method underestimates the travel distance for industrial seafood products but provides a minimum potential distance to which we could compare CSF seafood.

We assessed the sustainability of target stocks using three independent measurements, which we compared to seafood available for purchase in supermarkets in communities served by CSFs. We visited 10 supermarkets in California, New England, Vancouver, and North Carolina and recorded each seafood product available

for sale, its country of origin, and whether it was wild caught or farmed (Fig. 1C). For both CSFs and supermarket seafood, we aggregated species by region to eliminate redundancies, and compiled data on our three sustainability measurements. These were: (1) trophic level, (TL) which we obtained from FishBase (Froese and Pauly, 2013) or estimated from published diet information, (2) sustainability ranking as reported by the Blue Ocean Institute Seafood Choices database (BOI, 2013), and (3) status of the stock measured as current biomass relative to target biomass (e.g., $B/BMSY$, B/B_{target}) for the subset U.S. and Canadian stocks that had available stock assessments, which we obtained from regional Fisheries Management Councils (U.S.), state management agencies (U.S.), or the Department of Fisheries and Oceans (Canada). These biomass values indicate stock health, with values of 1.0 and greater indicating that stocks are at or above the target biomass, and values < 0.5 indicating overfished status (Murawski, 2000). Directly comparing CSF and supermarkets for stock status allowed us to test the hypothesis that CSFs encourage consumers to eat fish that may be locally plentiful but underrepresented in supermarkets.

Finally, we interviewed a subset of CSF representatives from each of the four regions to determine fishing practices with respect to overfished stocks ($B/BMSY < 0.05$) and stocks that we defined as highly abundant ($B/BMSY = 2.5$), as well as associated environmental impacts not revealed by quantitative sustainability statistics. These included marketing of products that would otherwise be discarded as bycatch, fisheries that involved less impactful gears than are typically used, and utilization of abundant local resources that displace a less sustainable option. In total, we interviewed representatives of 8 of the 15 CSFs in our study.

3. Results

In our four regions, CSFs ranged in size from 100 to > 1000 subscribers. Share size ranged from 12 to 182 lb of seafood products per year, with a median annual share size of 48 lb. The focus of CSFs varied, ranging from those that targeted single species in a particular season to those that included > 20 species as part of a year-round business. Cumulatively, the highest number of species was offered by California CSFs, with a total of 47 species, followed by 25 each in New England and North Carolina, and 7 in British Columbia.

3.1. Distance

On average, seafood from CSFs traveled two orders of magnitude less than seafood originating from industrial seafood supply systems. The mean distance from landing to distribution site for

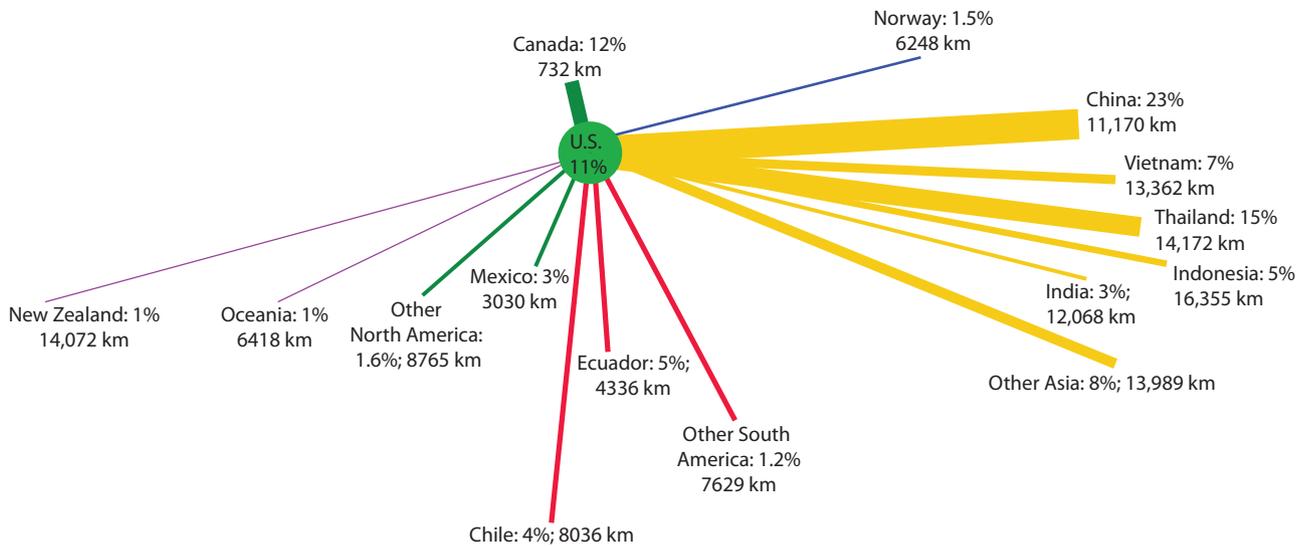


Fig. 3. Distance traveled by seafood imported into US for human consumption. Blue: Europe, Orange: Asia, Red: South America, Green: North America, Purple: Oceania. The width of each line represents relative quantity of total seafood and distance is a straight-line distance from a fixed point within that country. Data from NOAA (2012).

CSFs across all regions was 64.6 km (SE 9.6, range 0–549 km). The longest distance was traveled by seafood in North Carolina, with a mean distance of 313 km, due to the fact coastal CSFs primarily serve the inland cities of Durham and Raleigh. The shortest distance was in British Columbia, where both surveyed CSFs have landing sites that are the same as the distribution sites; CSFs land their catch on wharfs in Vancouver and Victoria where members pick up their shares. California and New England had similar mean distribution distances of 36 and 51 km, respectively.

In contrast, the average weighted straight-line distance traveled by seafood products consumed in the US was 8812 km (Fig. 3). U.S. production of edible seafood products represented 11% of total domestic consumption (0.27 million metric tons), and imported products represented 89% of total domestic seafood consumption (2.4 million metric tons). Chinese seafood represented the largest quantity consumed in the U.S. (23%), followed by Thailand (15%) and Canada (12%).

3.2. Sustainability of target stock

There were no statistically significant differences in the mean trophic levels (TL), Blue Ocean Institute sustainability ranking, or stock status, either between CSF fisheries and fish sold in supermarkets, or among CSFs in the four regions (Table 1; Fig. 4). The mean TL for CSF-sold seafood was 3.52, compared to 3.29 for supermarket seafood and the mean BOI rankings were identical (2.28). The median *B/BMSY* values were 1.00 for supermarket seafood and 1.15 for CSF seafood; half of stocks sold in supermarkets and two-thirds (66%) of stocks sold as part of CSFs had biomass values at or above

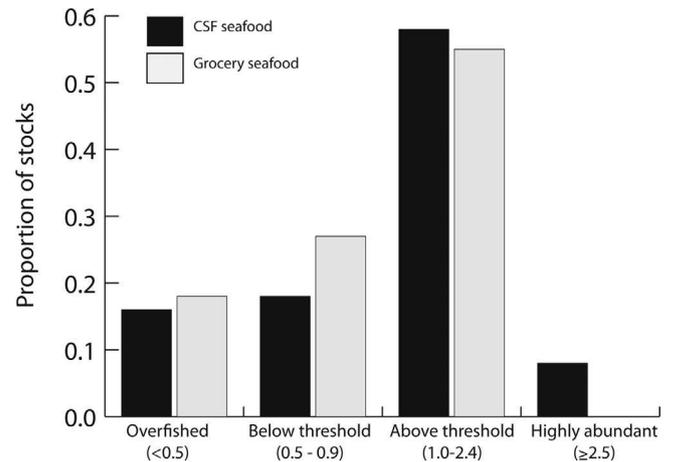


Fig. 4. The stock status of fisheries targeted by CSFs and sold in supermarkets. Values refer to *B/BMSY*, or proxy (e.g., *B/Btarget*).

the target for that stock. There were no significant differences in these values among regions, with all CSFs having median biomass levels exceeding the management target for sustainability (range 1.04–1.44).

One notable difference between CSFs and supermarket seafood was the presence of highly abundant stocks in seafood distributed by CSFs (Fig. 4). We defined highly abundant stocks as those whose current biomass is 250% or more of the identified target biomass for that stock (*B/BMSY* = 2.5). Five out of the 62 stocks with assessments available were highly abundant: three in California and two in New England (Table 2). The northern California stock of Pacific halibut (*Hippoglossus stenolepis*) had the highest abundance relative to its

Table 1

Differences in sustainability rankings among seafood products available for purchase in supermarkets and through CSFs. (TL—trophic level; BOI—Blue Ocean Institute). Median *B/BMSY* is for US and Canadian stocks only. Biomass values (*B/BMSY*) indicate stock health, with values of 1.0 and greater indicating that stocks are at or above the target biomass, and values <0.5 indicating overfished status.

	Mean TL (SD)	Mean BOI Index (SD)	Median <i>B/BMSY</i>
All Grocery	3.29 (1.04)	2.28 (0.56)	1.00
All CSFs	3.52 (0.87)	2.28 (0.48)	1.15
British Columbia CSFs	3.44 (1.04)	2.61 (0.32)	1.44
California CSFs	3.58 (0.80)	2.23 (0.44)	1.32
New England CSFs	3.42 (0.88)	2.10 (0.51)	1.25
North Carolina CSFs	3.53 (0.97)	2.48 (0.46)	1.04

Table 2

Highly abundant stocks targeted by CSFs (*B/BMSY* or proxy = 2.5).

Species	<i>B/BMSY</i> or proxy	Region
Pacific halibut (<i>Hippoglossus stenolepis</i>)	10.2 (Northern stock)	California
Dover sole (<i>Microstomus pacificus</i>)	3.4	California
Atlantic herring (<i>Clupea harengus</i>)	3.3	New England
English sole (<i>Parophrys vetulus</i>)	2.9	California
Lobster (<i>Homarus americanus</i>)	2.5 (George's Bank stock)	New England

Table 3
Overfished stocks targeted by CSFs (B/BMSY or proxy < 0.50).

Species	B/BMSY or proxy	Region
Atlantic cod (<i>Gadus morhua</i>)	0.08 (George's Bank) 0.19 (Gulf of Maine)	New England
Gray sea trout (<i>Cynoscion regalis</i>)	0.13	North Carolina
Pacific bluefin tuna (<i>Thunnus orientalis</i>)	0.18	California
Winter flounder (<i>Pseudopleuronectes americanus</i>)	0.29 (Gulf of Maine)	New England
Pacific sardines (<i>Sardinops sagax</i>)	0.34	California
White hake (<i>Urophycis tenuis</i>)	0.35	New England
Spotted seatrout (<i>Cynoscion nebulosus</i>)	0.37 (range: 0.21–0.52)	North Carolina
Sheephead (<i>Semicossyphus pulcher</i>)	0.40	California
Witch flounder (<i>Glyptocephalus cynoglossus</i>)	0.41	New England

management target, with a $B/BMSY > 10$, or more than 1000% of the target. In four out of five cases, targeting highly abundant stocks for local consumption as part of CSFs marked a new phase of the fishery following collapse. In California, the three highly abundant stocks distributed by CSFs historically were targeted by a fishery dominated by larger trawl vessels. This fleet was declared a federal disaster in 2000, and a subsequent vessel buyback reduced it by approximately half with many of the remaining permits acquired by The Nature Conservancy (TNC). The fishery transitioned to an individual transferable quota (ITQ) catch share program in 2011 and gear and area restrictions were adopted (Gleason et al., 2013). TNC emphasized local marketing, and some of the vessels remaining in the fishery now market their fish through CSFs. In New England, Atlantic herring (*Clupea harengus*) were targeted historically as a bait fishery, but there has been recent interest in resurrecting this fishery for human consumption (see Section 3.3). American lobster (*Homarus americanus*) is an active commercial fishery in New England, but the highly abundant George's Bank stock represents the smallest contribution to the overall fishery (McKown et al., 2009). High lobster biomass has been attributed both to effective management, as well as fishing-induced depletion of predatory groundfish species (Steneck et al., 2011).

Not all stocks targeted by CSFs are robust. In total, 21 stocks (34% of stocks with assessments available) fell below their biomass targets ($B/BMSY < 1.0$) and 10 stocks (16%) were below the overfished threshold ($B/BMSY < 0.5$) (Fig. 4; Table 3). The percentage of overfished stocks is nearly identical to that of supermarket fish, of which 18% were below $B/BMSY < 0.5$, and similar to the overall stock status of federally managed fish in the United States, of which 21% are overfished (NOAA, 2011). While this study did not consider the relative abundance of seafood products within CSFs, interviews with CSF representatives suggested that these overfished stocks may represent a small proportion of the total seafood caught and

distributed. For example, the Pacific bluefin tuna included in this list (Table 3) represents one individual that was caught and distributed two years prior to this study.

3.3. Reducing associated environmental impacts

Through our interviews, we identified five ways in which CSFs reduce environmental impacts associated with fisheries that are not apparent from stock assessment data or other sustainability metrics (Table 4). Bycatch utilization represented a common type of reduction in environmental impact, as CSFs can market locally abundant species that are caught incidentally and often discarded. For example, pink salmon (*Oncorhynchus gorbuscha*) in British Columbia are caught in small volumes in the coho salmon (*Oncorhynchus kisutch*) troll fishery, but do not have significant value and are therefore considered bycatch. However, they are marketed in small volumes through a CSF. Similarly, octopus (*Octopus vulgaris*) in British Columbia is a bycatch of the prawn trap fishery and has been typically sold only as bait. The CSF network provides a local food outlet for this species, which brings fishers a 50% increase in ex-vessel price. In New England, Jonah crab (*Cancer borealis*) has increased in abundance over the last decade, due in part to fisheries-mediated declines in urchins and an ecological phase shift that favor these crabs (Steneck et al., 2013). This species is caught incidentally in the lobster trap fishery and has had limited market, but has been distributed through CSF networks. In California, CSFs distribute Pacific grenadier (*Coryphaenoides acrolepis*), which is caught incidentally in the trawl fishery. Catches of grenadier are currently incidental and small, but this species has been recognized as having potential for overfishing due to slow growth (Abbot, 2005). Thus, while utilization of bycatch typically represents an immediate environmental benefit, in some cases, the development of a directed fishery would not be sustainable. Finally, CSFs have helped

Table 4
Methods by which CSF fisheries reduce environmental impacts associated with fisheries.

Impact reduction	Examples (region)
1. Develop market for bycatch and waste products	Jonah and rock crabs (bycatch, New England) Pink salmon and octopus (bycatch, British Columbia) Sheepshead (bycatch, North Carolina) Grenadier (bycatch, California) Fish heads (waste product, British Columbia) Flounder roe (waste product, New England)
2. Create markets for underutilized, abundant species	Atlantic herring (New England) Ridgeback prawns (California) Sand dabs (California)
3. Create local demand for product otherwise exported or imported	Longspine and shortspine thornyheads (California) Jonah and rock crabs (New England)
4. Use of lower impact gear	Sand dabs (development of targeted hook and line fishery, California) Coho salmon (vessel changes to reduce fuel usage while trolling, British Columbia) Mixed species trawl fishery (use of trawl nets with reduced roller gear, California)
5. Education and collaboration	Walking Fish CSF: business model developed with input from Duke University Local Catch Monterey Bay: sustainability plans developed with collaboration with the Center for Ocean Solutions at Stanford University Port Clyde Fresh Catch: marketing and promotional assistance from the Island Institute, a local non-profit

to reduce waste by meeting demand for otherwise disposable products, such as fish heads or roe. In British Columbia, fish with heads intact are desired by CSF members, and the allocation of these as part of CSFs reduces both processing and waste. Similarly, in New England, flounder roe, a highly perishable product, is distributed as part of the CSF shares.

A second way that CSFs have helped increase sustainability is by creating markets for locally abundant fish and invertebrates that previously lacked local demand. As for bycatch species, these stocks have the potential to displace less sustainable options currently in the market. In California, ridgeback prawns (*Sicyonia ingentis*) can be locally abundant, but have a limited potential in long distance markets (Owens, 2006). The CSF model of minimizing time from catch to consumption reduces this risk and creates a new market for these stocks. California CSFs also distribute Pacific sand dabs (*Citharichthys sordidus*), a small flatfish in high local abundance with a limited market (Fig. 1B). In New England, Atlantic herring (*Clupea harengus*) are a low trophic level and locally abundant fish that have been targeted primarily as bait for the lobster fishery; currently almost none of the catch enters the market for human consumption. However, herring were historically canned, smoked, dried, or pickled and distributed as part of a directed fishery. Resurrecting local food markets for species such as herring has the potential to increase sustainability by recreating seafood distribution and consumption patterns that existed prior to industrialized fisheries.

Third, CSFs have helped create local market for seafood products that are currently shipped overseas and have provided a local substitute for products supplied from international markets. For example, both longspine and shortspine thornyheads (*Sebastolobus altivelis* and *Sebastolobus alascanus*) are caught in California and distributed by CSFs. There is strong demand for these fish in Asia, but they have not been popular in the U.S. Local marketing displaces the energy costs for transportation and freezing required for the export market, and because the fresh market commands a higher price, fewer individuals need to be caught to return the same profit. Conversely, local utilization of products that have direct imported analogues, such as Jonah and rock crab meat in New England, means that less of this product must be imported.

Fourth, some CSFs incentivize the use of fishing gear with reduced environmental impact. In New England, some of the fishers who supply CSFs use a larger mesh size than required by law and have experimented with trawls with reduced twine size, which are easier to pull through the water, reducing fuel consumption. In California, CSF suppliers use trawls with reduced roller weights, in order to impart less impact on benthic habitats. California CSF fishers have also expanded hook and line fisheries, such as for sand dabs, which effectively eliminate benthic disturbance. In British Columbia, the salmon trolling practiced by CSF fishers is already known as a low-impact fishery. Some CSF fishers have taken further steps to reduce fuel usage, including mounting stabilizers and using an upgraded, more efficient diesel engine.

Finally, CSFs can promote social dimensions of sustainability through demand-side interventions such as education for consumer awareness and cross-sector collaborations. Many CSFs include member education efforts as part of their service, including information about the status of local fisheries stocks, fishing methods, seafood processing and distribution, community events, and recipes from local chefs. Though the effect of these efforts is unknown, these practices are intended to increase consumer awareness of sustainable seafood and the overall traceability of seafood systems, helping shift local demand toward more sustainable species and practices. CSFs have also enabled collaborations among fishers, academic institutions, and non-profit organizations, which enhances communication among groups that may not typically interact. For example, two of the CSFs in our study had direct

connections to universities, and one had a direct connection with a local nonprofit (Table 4). While these collaborations may not be typical of CSFs, it demonstrates the potential for CSFs to foster such connections.

4. Discussion

A diversity of approaches has been taken to assess the sustainability of seafood systems, but there is a relative paucity of literature assessing direct marketing efforts, which limits comparison of our results with other efforts. For example, the carbon footprints of particular fisheries have been analyzed to determine the relative contributions of different stages of seafood production and distribution (Winther et al., 2009), differences among coastal, offshore, and deep-sea fisheries (Iribarren et al., 2010), and the fuel intensity of different gear types (Vázquez-Rowe et al., 2010). However, research has not differentiated between types of seafood distribution systems, nor to our knowledge has a comprehensive analysis of the carbon footprint of seafood systems been undertaken. In our comparison of the sustainability of CSFs and industrial seafood supply systems, we found a decrease of two orders of magnitude in distribution distance for CSF seafood, which represents a substantial decrease in carbon footprint. While our work only focuses on distribution, not carbon footprint associated with harvesting, previous work has suggested that energy use associated with transportation of internationally distributed seafood is one of its major environmental impacts, with processing, freezing, packaging, and transportation representing up to 80% of the total carbon output (Winther et al., 2009). In coastal communities, the CSF model has the potential to greatly minimize these impacts. Furthermore, fisheries products inherently can have a lower greenhouse gas emission cost than meat products due to lack of inputs such as fertilizer inputs for feed growing (Weber and Matthews, 2008). Therefore, if fish are processed and distributed locally, they may represent one of the lowest energy-intensive animal protein sources available.

In terms of stock status and overall sustainability of the target stock, we found that CSFs distribute highly abundant stocks not available through industrial seafood systems (Fig. 4; Table 2), suggesting that there is potential to improve sustainability if these seafood products are substituted for less sustainable options. Our interview results also provide empirical evidence of many of the proposed associated environmental benefits to CSFs, confirming that CSFs are helping to create new markets for locally abundant stocks that would otherwise not be marketable due to issues of scale and distance, and that many are experimenting with lower impact gear types (Table 4). On average, we found that CSF fisheries stocks are not significantly more sustainable than those entering the industrial supply chains as measured by our three metrics of stock status (Table 1). However, our stock assessment comparison was limited to U.S. and Canadian stocks, which represent a small percentage (23%) of total U.S. consumption. Therefore, this metric may underestimate the total difference between the stock status of CSF seafood and supermarket seafood, as many foreign stocks that supply U.S. markets lack adequate management (Worm et al., 2009).

Not all stocks targeted by CSFs are stable, with several overfished stocks targeted and distributed through CSFs (Table 3), which limits their ability to improve community based marine conservation. It is important to note that the goal of all CSFs is not to promote sustainability; as with all fisheries, many fishers that supply CSFs simply fish within the limits of the fishery and the quota allocated established by management agencies. As well, CSFs operate within a broader social and governmental context, such that efforts to improve sustainability may be diluted if effective management is lacking (Campbell et al., 2014). The ability of the CSF model to

contribute to improving marine conservation therefore requires on a broader suite of policies that support robust and diverse fisheries (Alden, 2011). The overall status of fisheries stocks is of fundamental concern for supporting small-boat fleets and associated local markets, both for CSFs and other small-scale fisheries, which are often overlooked in planning for fisheries sustainability (Jacquet and Pauly, 2008).

The recent fisheries adaptation of the “locavore” movement, which began with agricultural products, holds potential for seafood systems, and many similarities exist between the CSA and CSF models (Campbell et al., 2014). CSFs are employing innovative approaches to reduce environmental impacts through both supply-side (seafood production) and demand-side interventions (consumer awareness of sustainable seafood). On the demand side, many CSFs are educating consumers about stock status, sustainable harvesting techniques, and a diversity of locally abundant, but unfamiliar species. The dynamic between consumer demand and the CSF model is ongoing, and local variants will continue to develop to address the desire for short distribution chain and utilization of locally abundant species. For example, some CSF representatives noted that lack of choice can act as a consumer deterrent, and are developing alternative modes of local distribution for consumers who want local and sustainable seafood but are not fully committed to the CSF model. The SLO Fresh Catch CSF in San Luis Obispo created a mobile device application that provides real-time landings information, which allows consumers to select and order products that can then be distributed through the CSF network (<http://phondini.com/fishline/>). These adaptations may reduce the ability of CSFs to introduce consumers to unfamiliar species, but potentially reduce waste by increasing consumer choice. Globally, the traceability of seafood has become a key dimension of seafood sustainability, and substantial efforts have been directed toward efforts to increase transparency, such as through ecolabeling (Gutiérrez et al., 2012; Jacquet et al., 2010). CSFs also seek to enable transparency, albeit in a localized market, through efforts to engage with and educate CSF members and their community.

Sustainable local fisheries are of increasing concern among the myriad stakeholders involved in seafood production, conservation, and fisheries assessment (Alden, 2011; Smith, 2008; Smith et al., 2010). The CSF model creates alternative economies and holds much potential to generate positive social and environmental impacts in coastal communities. While CSFs still supply a fraction of the seafood consumed in the U.S. and Canada, the rapid proliferation of this model signifies the growth potential in local seafood businesses. Further, the median annual share size for the CSFs in our study was 48 lb, which if shared among a family of four, is roughly equivalent to the US average per capita seafood consumption of 15 lb (NOAA, 2012). As CSFs increase in numbers and scale, it is feasible that these models may supply a larger percentage of the seafood consumed, particularly in economically diverse coastal communities that include both a active fishing community and a substantial consumer base.

Our results show that in aggregate, CSFs are decreasing the distance from boat to plate and targeting highly abundant local stocks. Additionally, many are developing innovative approaches to simultaneously enhance local economies and food security in coastal communities, and achieve conservation and sustainable fisheries goals. The development of novel markets and local/regional seafood supply systems holds much promise to enhance adaptive and locally driven management of coastal fisheries. In order to assess the full range of these impacts, there is need for more comprehensive sustainability assessments that take into account social, economic, environmental sustainability dimensions, to evaluate the effectiveness of CSFs and other seafood businesses in strengthening local economies, food security and environmental stewardship efforts.

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