Title: India's seafood consumers demonstrate the need for a seafood commons

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ABSTRACT

The requirement of institutions to sustain seafood supplies that come from marine commons has been discussed in scientific literature for decades. Thus far, the focus has been on regulating the most direct contact with the resource - fish harvests. This has been extremely warranted, given the increasingly technological forms of fishing, high rates of exploitation, etc. Despite strict regulations across several regions and countries, like the EU, USA and NZ, achieving ecological sustainability has had limited success - they may have seen recovery of fish stocks in their own waters often as resulting a result of spatial fixes to feed seafood demand, like increasing harvests within Exclusive Economic Zones of African and Asian nations, as well as increasing harvests in international waters (case in point: Chilean Sea Bass). Clearly limiting fishing alone cannot achieve the ultimate goal of equitable and ecologically sustainable fisheries.

Some types of resource users may asymmetrically contribute to resource exploitation, but they may often be overlooked, particularly if they are slightly further up the supply chain. In the case of seafood, the role of consumers in making "responsible" choices has been recognized by multiple organizations, like SeaFood Watch, Marine Stewardship Council etc. Yet their participation in the processes of creating marine commons, i.e. commoning, have never been given serious attention.

Using data on ~500 seafood consumers who identified as being interested in ecological sustainability from India, we examine the extent to which consumption can facilitate or hamper fisheries management. We contrast this with data from seafood restaurants. We find that the selective consumption of seafood does not support the types of commons initiatives that are created by fishermen in India. Instead selective consumption drives economic, ecological and social declines in marine fisheries. Therefore we propose the concept of a seafood commons - one in which seafood consumers are seen as resource users who disproportionately affect fisheries management across the globe through the demand for seafood that they create.

1. INTRODUCTION

Tropical, nearshore fisheries are characterized by a huge diversity of species, habitats, fishing vessels and gear relative to temperate fisheries (Johannes, 1998), and very little scientific information is available about such tropical resources. This limited knowledge is due to low sampling efforts (Menegotto & Rangel, 2018), and high costs involved in tropical fish stock assessments (Mohamed & Veena, 2016). Yet these tropical, nearshore ecosystems also generally score lower in terms of ocean health and contribution to human well being (Halpern et al, 2012) because unlike temperate fisheries, they continue to be extracted with rising trends in catches of large and small pelagic species (FAO, 2018). At this rate of extraction, primary production in tropical oceans is estimated to decline by approximately 11% by 2100 (Kwiatkowski, 2017), disrupting marine ecosystems and consequently risking the livelihoods of 40.3 million people directly engaged with capture fisheries, and the food security of 3.2 billion people significantly dependent on seafood (FAO, 2018). In this context fisheries management is crucial, but scientists remain conflicted on which approach to management best suits developing countries that adjoin most of these tropical nearshore waters. Hilborn (2017) notes that marine ecologists (e.g. Hastings, Gaines & Costello, 2017) advocate the use of spatial closures like Marine Protected Areas (MPA) rather than the fisheries scientists' techno-economic approach to reduce fisheries bycatch and manage mixed stocks of fish with different life histories. Social and interdisciplinary scientists, like Johannes (1982), recommend rules of thumb gleaned from traditional ecological knowledge to be much more effective at achieving ecological sustainability under tropical conditions and suggests ecosystem-based and community-based management. The main point of contention is managing the diversity and abundance of multi-species fisheries, where there is limited capacity to target or manage species individually, while trading-off against both short and long term profits (Hilborn et al, 2012). Other research suggests that even if such regimes are successful, they are extremely vulnerable to changing consumer preferences, since such socio-ecological systems are linked to globalizing markets (Baumgärtner et al, 2011). This is an often missed, but crucial step, since demand for seafood is increasing exponentially and consistently outstripping supply, suggesting that the development of fisheries is demand driven across most of the world (Cai & Leung, 2017).

Within these fisheries, some information, such as the fact that bottom trawling is overwhelmingly responsible for marine ecosystem degradation (Flaherty & Karnjanakesorn, 1995; Lobo et al, 2010) is available. Yet information about small-scale fisheries, even though they employ 98% of the world's fishers (Mohamed & Veena, 2016) is poor . This lack of information is transferred down supply chains, with consumers lacking both awareness and interest, especially in Asia (Jacquet & Pauly, 2007). In the absence of useful signals, such as price or quality, that can

translate stresses from marine ecosystems through supply chains, trade and supply chains form a further obstacle in information transfer to consumers (Crona et al, 2016). In tropical marine systems where biodiversity and means of harvest are so diverse, informing consumers about sustainable seafood choices becomes even more complex. Particularly in India, where state fisheries legislation is poorly enforced (Karnad, Gangal & Karanth, 2014) and much of the management occurs through community based and commons regimes at the local scale (Bavinck, 2001; Bavinck et al, 2013; Karnad, 2017a), sustainable seafood consumption is rendered even more difficult.

In this context, we set out to examine seafood consumption among ecologically sensitive consumers who self-identify as interested in sustainability. We attempt to delineate the role of consumer demand in supporting ecologically sustainable fisheries management. In this regard, we have two hypotheses:

i) High consumer knowledge on ecological sustainability results in ecologically sustainable seafood consumption practices. This is because information on sustainability alters consumer attitudes, changes their behaviour and makes them rationally acting.

ii) Low-priced restaurants serving seafood have wider range of seafood options. High-end restaurants catering to selective markets selectively use high-value species, and this makes diverse low-value species easily available

2. METHODS

2.1 *Study Area*

India is among the top ten countries in terms of marine capture production, and Indian marine fisheries contribute to 4.54% of the world total (FAO, 2018). India has 263 finfish species, 15 penaeid species (e.g. prawn, shrimp) and 8 cephalopod species (e.g. squid) that constitute a total of 286 commercially important seafood species among around 1470 species that are harvested (Sathianandan, 2013).

Yet multiple studies discuss lack of information about India's seafood harvest (e.g. Worm et al, 2009; Costello et al, 2012) and a lack of knowledge about seafood consumption. Nationally, 5.6% of women and 4.8% of men consume fish daily (IIPS & ICF, 2017). Therefore we surveyed seafood eaters from "high value markets" in India. These markets were represented by urbanised and upward-income groups with access to commercial restaurants and fishmarkets.

2.2 *Survey*

The study used an online questionnaire circulated between June and October 2018, and consisted of both open- and closed-ended questions. The questionnaire was

administered by posting on the electronic mailing list of Young Ecologists Talk and Interact (YETI), using the database of seafood eaters interested in sustainability held by InSeason Fish, personal communication with students of natural and environmental sciences at Ashoka University, and snowball sampling involving seafood enthusiasts and environmentally conscious individuals. Respondents replied opportunistically, generally self selecting for interest in sustainable seafood. The questionnaire took 3 minutes to complete.

The questionnaire had 30 questions spread over three sections consisting of a) consumption preferences and patterns, b) knowledge about seafood and seafood sourcing, and c) personal and background information.

Ethics

Informed consent was obtained from all respondents for all methods described above. Participants were informed of the objectives of the study, the absence of financial incentives or benefits from participation, the voluntary nature of the information provided, and the strict confidentiality of responses. The identity of respondents, including details such as their names and contact information were not recorded, unless permission was provided.

2.3 *Restaurant Data*

Data on seafood restaurants was collected independently of survey data using the online database of Zomato, a restaurant and food search service. 100 restaurants were selected from each of the four major metropolitan cities of India, namely, Bengaluru, Chennai, New Delhi and Mumbai. These restaurants were categorized by price into high (> ₹1500 for a couple, henceforth 'high-end'), medium (₹500-1000 for a couple, henceforth 'mid-range') and low (< ₹500 for a couple, henceforth 'low-priced') Observations on diversity of seafood species, type of cuisine, and use of non-native (exotic) and threatened species in restaurants were made based on information displayed on respective restaurant menus.

2.4 *Data analysis*

All responses were entered into MS Excel; open ended responses were categorized and coded. Percentages were analyzed using R *v. 1.0.44* (RStudio Team, 2016). 39 species and 7 seafood types, viz. "caviar", "black caviar", "roe", "cod roe", "flying fish roe", "salmon roe" and "ink" were identified as exotic because they weren't locally produced but imported. 4 species were identified as threatened based on data from the IUCN Red List of Threatened Species. These include seerfish (most commonly Narrow-barred Spanish Mackerel (*Scomberomorus commerson*); near threatened), Yellowfin Tuna (*Thunnus albacares*; near threatened), Bluefin Tuna (*Thunnus thynnus*; endangered) and shark (generic, but with high chances of being

species like Scalloped Hammerhead (*Sphyrna lewini*; endangered), or Common Thresher Shark (*Alopias vulpinis*; vulnerable).

3. RESULTS

3.1 *Respondent characteristics*

We surveyed a total of 563 respondents, of whom 531 were retained because they met our criteria of being Indian seafood consumers. The 531 entries were chosen after eliminating 5 duplicate entries, 14 entries with unspecified locations, 8 foreign nationals who weren't residents of India, 2 entries that didn't consume seafood, and 3 entries that mentioned vegetarian food preferences. All respondents had access to the survey and were capable of reading English, suggesting that they belonged to a middle-class and upwards income group; 53.86% of respondents were either employed, self-employed or affiliated to academia, and students constituted 28.63% of the respondents.

Most (79.85%, n=531) of respondents ate seafood at home and sourced it from a fishmarket (71.37%). A significant proportion also ate seafood at restaurants (56.5%), out of which 19.59% ate seafood only at restaurants, and 36.91% ate seafood at both home and restaurants. A minority of people ate seafood at hostel, work etc. (<1%). 8.85% of respondents did not specify their seafood sources and <1% mentioned "angling" as a means of sourcing. Details of respondent characteristics are available in Table 1.

Table 1: Characteristics of seafood consumers interviewed in India

Respondent characteristics	Percentage of respondents (n = 531)
Age in years	
Below 20	11.11
20-29	48.96
30-39	20.53
40-49	11.11
50-59	5.65
Above 60	2.64

Profession	
Student	28.63
Employed	25.61
Self-employed	14.88
Academia	13.37
Unemployed	3.01
Retired	1.69
Education	
Diploma	3.20
Graduate	32.77
PhD	4.90
Post-graduate	48.40
School	10.73
Source of seafood	
Fishmonger	27.31
Fish Market	71.37
Supermarket	15.44
Online Retail	8.47
Retail Store	10.36
Beach	16.01
Type of fishing gear thought to be used for seafood	
Trawl	53.67
Line Caught	23.73
Gill Net	30.13
Spear Fishing	8.10

Purse Seine	20.34
Bag Net	17.33
I don't Know	38.61
Number of seafood species	
Less than 10	4.52
11 to 30	18.46
31 to 50	22.03
51 to 100	25.42
100 to 200	12.05
More than 200	17.51

3.2 *Respondent seafood consumption patterns*

On average respondents (n=531) ate 6.11 number of species (ranging from 0 to 23) and were willing to try 2.48 additional species (ranging from 0 to 8). Table 2 provides a list of species that are either preferred, willing to be tried, or both. The most preferred seafood was prawn (80.98%), followed by pomfret (67.61%), crab (53.30%), mackerel (52.73%) and seerfish (47.65%). Taste (90.40%) was the most significant reason for choice of preferred seafood, but respondents also noted that their preferred seafood was easily available (46.89%) and suited their cuisine (37.10%). Most (92.09%) respondents preferred Indian cuisine for seafood consumption, ranking it higher than continental (31.07%) and Thai (28.06%).

Respondents were most willing to try species like solefish (39.36%), halibut (38.42%) and emperor (37.85%).

Table 2: Seafood consumption and availability across seafood consumers and restaurants

Seafood Type	Preferred / Willing to Try / Both	Consumer choice (%) (n = 531)	Restaurant availability (%) (n = 400)
Prawn	Preferred	80.98	87.50
Pomfret	Preferred	67.61	36.50
Crab	Both	P = 53.30 (W <1)	56.75
Mackerel	Preferred	52.73	26.00
Seerfish	Both	P = 47.65 (W <1)	36.25
Solefish	Both	W = 39.36 (P <1)	6.75
Halibut	Both	W = 38.42 (P <1)	1.50
Emperor	Willing to try	37.85	0.75
Squid	Preferred	35.03	44.75
Sardine	Both	P = 34.65 (W <1)	6.50
Trevally	Both	W = 30.13 (P <1)	0.75
Silverbelly	Willing to try	29.94	1.00
Anchovy	Preferred	29.38	20.00
Indian Salmon	Preferred	28.81	13.25
Tuna	Preferred	28.44	20.25
Bombay Duck	Preferred	27.31	12.50
Goatfish	Willing to try	25.99	1.25
Red Snapper	Preferred	25.61	12.25
Lobster	Both	P = 23.16 (W <1)	26.75
Shark	Preferred	17.7	10.00
Barramundi	Preferred	17.33	22.00
Atlantic Salmon	Preferred	14.69	0.50

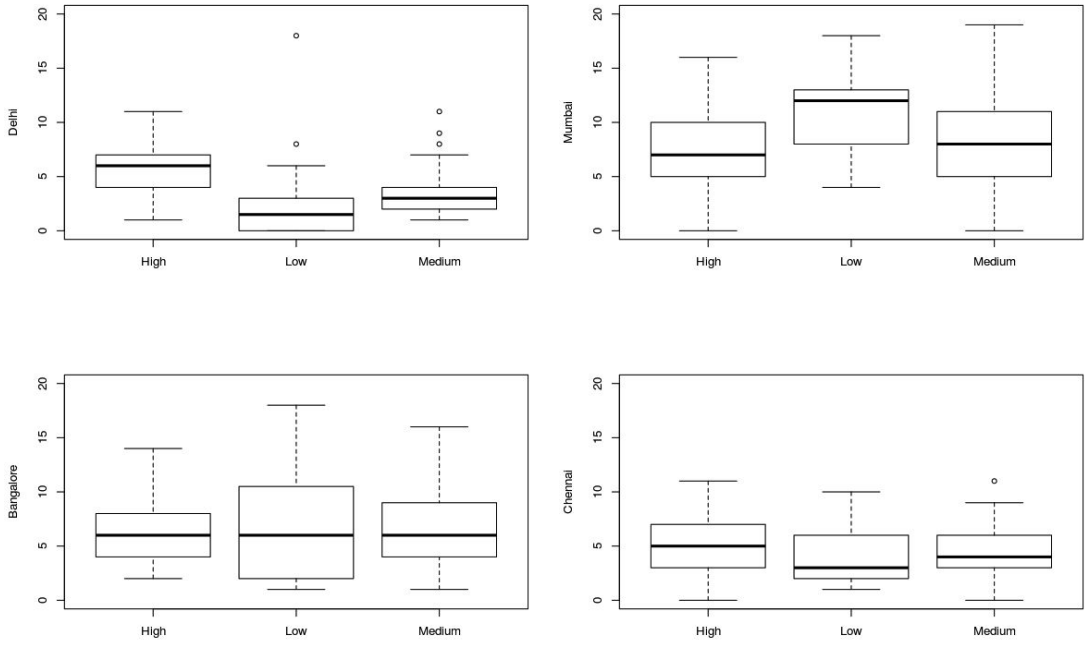
Ribbonfish	Both	W = 11.29 (P <1)	0.00
Threadfin Bream	Both	P = 8.85 (W <1)	2.25
Barracuda	Preferred	8.66	0.25
Abalone, Alaskan Salmon, Basa, Butterfish, Caviar, Pufferfish, Ray	Willing to try	<1	
False Trevally, Grouper, Hilsa, Mahi Mahi, Mullet, Oyster, Pink Perch, Rock Perch, Scallops, Shellfish, Skate, Swordfish, White Sardine	Preferred	<1	
Catfish, Clam, Eel, Mussels, Pearl Spot, Shrimp	Both	<1	

3.3 *Seafood availability in restaurants*

Restaurants surveyed (n=400) served an average of 6.85 species (ranging from 0 to 28). A large number of restaurants served seafood varieties that were preferred by consumers, e.g. squid was preferred by 35.03% (n=531) of respondents and was available in 44.75% (n=400) of restaurants. Species that were willing to be tried by consumers weren't significantly represented in restaurants, e.g 29.94% of respondents were willing to try silverbelly but it was available only in 1% of restaurants (Table 2).

There were no significant differences in native seafood diversity across restaurants of the four metropolitan cities & three price categories (Figure 1). While use of exotic species was observed most (70.25%) in high-end restaurants and least (5.26%) in low-priced restaurants, restaurants with Asian (62.50%) and Western (59.38%) cuisine accounted for highest use of exotic species compared to Indian (6.48%) restaurants.

Figure 1: Native seafood diversity in high-end, mid-range and low-priced restaurants in four Indian metros (clockwise from top left) - Delhi, Mumbai, Chennai & Bangalore.



59.21% of low-priced restaurants served threatened species compared to 23.97% of high-end restaurants. Restaurants catering to coastal cuisine accounted for highest use of threatened species (96%) while Asian and Western had the least use (11.61% and 12.5% respectively). Low-priced restaurants accounted for most usage of seerfish (55.26%) and sharks (21.05%) which are native threatened species. Coastal restaurants were the highest users of these species (~94% and ~36% respectively).

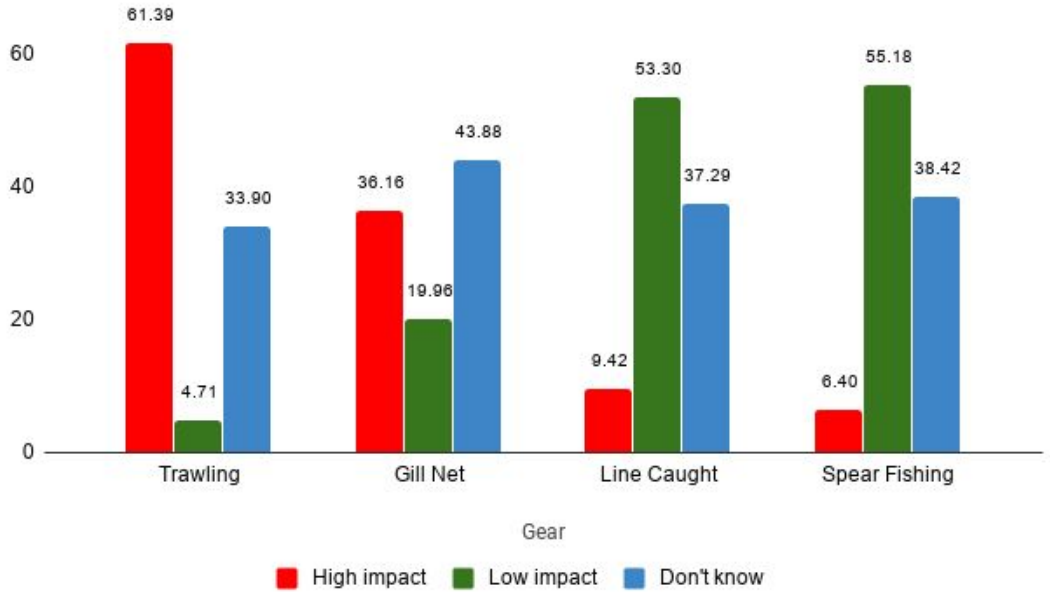
3.4 *Knowledge and attitudes*

92.66% of respondents (n=531) were willing to buy seafood from ecologically sustainable sources and 58% were interested in receiving further information about sustainable seafood. 53.67% of respondents had knowledge that their seafood was trawl-caught and 30.13% mentioned the use of gill nets but a sizeable proportion (38.61%) didn't know the gear used to catch their seafood. <1% mentioned gear like "fish traps", "poles", "jiggs", "cast nets" and "shore seine".

61.39% of respondents stated that trawling had ecologically high impacts while 53.30% and 55.18% mentioned that line-caught and spear fishing methods had low impacts respectively (Figure 2). On an average, 38.37% of respondents didn't know the ecological impacts of the four methods mentioned, viz. trawling, gill net, line caught and spear fishing.

Respondents' knowledge on the diversity of edible seafood species available in India was varied. 4.52% mentioned there were less than 10 edible species, 25.42% mentioned it was in the range of 51-100, and 17.51% mentioned there were more than 200.

Figure 2: Seafood consumers' characterization of ecological impacts from different fishing methods



DISCUSSION

This paper shows that seafood consumers are critical stakeholders in sustainable fisheries management regimes, since they exert a significant pressure on fisheries to supply a limited set of species, irrespective of the ecological consequences of doing so. Despite being ecologically sensitive and self-selecting for interest in sustainable seafood, middle and upper class urban respondents in India ate only ~2%, and were willing to try <1%, of the edible seafood species available in India. Most respondents consumed seafood at home or at restaurants, and source seafood from fishmarkets. Diversity of native seafood was observed to be similar across price ranges from high-end to medium-range and low-priced restaurants although there was a descending trend in use of native threatened species from low-priced to high-end restaurants, and in exotic (non-native and imported) species from high-end to low-priced restaurants.

Our study shows that seafood consumption in India does not reflect the reality of Indian marine fisheries. Consumption of ~6 species suggests that a very targeted fishery is supplying this demand, which in turn can be managed using species based

management practices. Species based management practices are well developed in several developed countries and are increasingly successful (Branch et al, 2011). But India's fisheries are not targeted, because fishermen use indiscriminate fishing gear such as bottom trawls or drift gill nets, and consequently catch hundreds of species that are not valued in these markets (Lobo et al, 2010; Karnad, Gangal & Karanth, 2014) or maybe threatened (Karnad, Sutaria & Jabado, 2019). Scientists across the world have recognized limits to and socio-economic costs of single-species management (Pikitch et al, 2004). Using a greater diversity of species can reduce pressure on vulnerable species (Zhou et al, 2010) and managing fisheries within the wider context of ecological, economic and social networks that they participate in is crucial to success (Pikitch et al, 2004; Halpern et al, 2012; St. Martin 2001).

Our hypothesis that high consumer knowledge about ecological sustainability produces ecologically sustainable seafood consumption practices was clearly disproved. Despite being aware of the high ecological impact of trawling many respondents believed that they ate seafood that was trawl caught. This suggests that dominant approaches to involving consumers in marine sustainability issues, such as eco-labeling, seafood guides and campaigns (Olson, Clay & da Silva, 2014), will have limited impact on consumer behaviour. The disconnect between seafood consumers' knowledge and behaviour was also seen in other studies (e.g. Verbeke et al, 2007), and more broadly suggests that assumptions on consumers being rational actors, whose decisions are informed by knowledge, need to be questioned (Berg & Gornitzka, 2012). Yet approaches based on improving consumer information cannot be completely discounted, because as Berg and Gornitzka (2012) explain, consumer attention is limited in this era, and often overwhelmed by too much information. Hence, what appears irrational could be explained by the different types of information retained by individuals based on their own individual contexts. Such different types of knowledge may produce the diversity of consumption behaviour and its potential paradoxes with information received. In our case, consumption of trawl-caught seafood despite perceptions of harmful impacts of trawling, could be due to a combination of availability, familiarity only with a limited set of species that are trawl-caught and so on. Although a considerable number of respondents reported this association of ecological harm with trawl fishing, it is extremely significant to note that one-third of respondents didn't know the impacts of different fishing methods. This lack of knowledge, along with most respondents not knowing about India's seafood diversity suggests large differences in individual knowledge about seafood and sustainability. Seafood is more easily accessible to consumers (D. Karnad pers observation), even in non-coastal areas, and perhaps sustainability recommendations that include aspects of seafood diversity might translate better from knowledge on consumption behaviour.

Our next hypothesis that low-priced restaurants serve a greater diversity of seafood due to the easy availability and low price of species that were not most preferred by high-end restaurants was also disproved. However, many restaurants across the price spectrum had included dishes where the type or species of seafood used was not specified. Our study is limited by the fact that we were unable to classify these generic seafood species. The seafood varieties listed on restaurant menus weren't significantly different across price ranges. There are several factors that might explain this. Firstly this could be due to consumer preference. Since consumer demand was for a select group of species, restaurants choose to highlight these species on their menus (Reddy et al, 2014). This could also contribute to further specialization of consumer demand, since respondents suggested that familiarity and preference of taste, as well as easy availability of those varieties is what drew them to those varieties in any case. An additional factor could be the growing indirect markets for species that are not valued for human consumption. Termed “non-target” or “bycatch” these edible species being caught in indiscriminate fishing gear such as bottom trawlers are increasingly being converted to fishmeal (Cashion, 2017). The fishmeal industry is in fact continuing to keep bottom trawlers profitable in India (Lobo et al., 2010). Consequently availability of diverse, lower priced seafood for low-priced restaurants may be limited.

The use of native threatened species of sharks and seerfish was highest in low-priced and coastal (among cuisines) restaurants, and the reason could be attributed to the cultural use of these species in food along with consumers’ affordability of this cultural experience. High-end restaurants are the greatest users of exotic non-native species catering to a niche market that favours high-value seafood that isn’t local. Although this prevents the use of native threatened species like sharks, the perceived effects on consumer awareness on not consuming threatened seafood species has a single-species focus and doesn’t enable the use of diverse low-value species. Although nascent, guidance on ethical consumerism in restaurants (Fabinyi & Liu, 2014) would have a positive effect on seafood diversity and sustainability only if affective characteristics such as taste influence a behavioural shift towards consumers’ willingness to try diverse seafood. Sustainable seafood initiatives in India such as InSeason Fish (2016), are taking steps towards improving traceability and making threatened species and sustainable fishermen more visible directly to seafood consumers by bypassing traditional markets and supply chains. Additional initiatives that can change seafood trade structures (Crona et al, 2016) are also required to improve opportunities for consumers to access sustainable seafood

Most respondents depended on fishmarkets as their primary source of seafood. Markets are observed to be hierarchical, and the level of interaction between consumers and vendors increases down the hierarchy - this relationship can be valued socially (Wang, 1999). Since respondents in the study preferred fishmarkets

overwhelmingly in comparison with supermarkets and online retail, it is tacit that these fishmarkets were local. This augurs well for sustainability fisheries as a food system that is driven by local markets and not produced by corporations (Johnston, 2008) but despite the opportunity for interactions with fish vendors, respondents in the survey did not explore the diversity of seafood species that would be available in these markets. Fish vendors especially in small-scale fishmarkets operate under variable social and economic conditions, and the fish that is sold is an accumulation of fish stocks (Abbott et al 2007). As in the case of supply-demand of seafood in restaurants, consumers' demand for specific seafood in fishmarkets through preordained preferences such as taste restricts the seafood diversity of fishmarkets, and reinforces the easy availability of a few species.

The study found that most respondents ate seafood at home. At an individual level, Spangenberg and Lorek (2002) identify eating in the households as an important contributor to the environmental impact of households, and that conservation ought to focus on household food consumption patterns, because consumer demand increases the pressure on a few seafood species. Household sizes and incomes are important variables in determining these consumption patterns, and so seafood consumption is an indirect indicator and a useful alternative to measure fisheries production and the pressure on specific fish stocks (Leopold, Ferraris & Labrosse, 2004). The classical view of consumer preferences being 'externalities' is problematic as consumers are a part of ecological-economic systems (Baumgartner et al, 2011), and under the influence of free markets, these systems have lowered resilience and reduced potential for sustainable resource use. Therefore, rules of thumb gleaned from scientific literature on fishery management can only be applied within the context of livelihoods (Allison & Ellis, 2001) - if the market is not supportive, rules of thumb with/without legal bases will not sustain fisheries. Consumer demand is an aspect of the market that is understudied especially in the literature and management of fishery science and sustainability of fish-as-food systems, but it is observed that it has the greatest impacts on the selection and restriction of seafood species.

Overall this paper finds that even domestic, ecologically sensitive seafood consumers of Indian seafood have consumption practices that do not match the needs of sustainable fisheries management in India. Sustainable fishing practices in these communities involve catching seasonal varieties of fish, catching locally available fish rather than chasing after high value fish and managing informal fishing territories at the local scale (Karnad, 2017b). Translating this information to consumers in a way that will help them select sustainable seafood requires great increases in traceability of seafood and the visibility of fishing communities to consumers (Crona et al, 2016). Practices that can aid this process include encouraging consumers to visit fishing villages and fish landing sites, to see for themselves how their seafood is caught while developing relationships with the fishing communities. These are the kinds of

initiatives being undertaken by InSeason Fish. Such ethical economic practices can maintain ecology, resources, relationships and networks differently than neoclassical or neoliberal economics and are active processes in the creation of commons (Gibson-Graham et al, 2016). Supporting these practices require markets that are in tune with the dynamics of these fisheries, as well as the people that harvest the fish. A focus on the ways in which the formation of communities can aid the embeddedness of markets and improve the visibility of social and ecological consequences of traditional, rationalized markets should be the way forward (McCay and Jentoft 1998). Our paper suggests not only that seafood consumers perspectives should be included in fisheries management, but also that fisheries management should include supply chain and consumption management in order to create truly sustainable fisheries. In the Indian context, to achieve socio-ecological sustainability, fishing commons need to be treated from a more holistic perspective by introducing and involving seafood consumers in fisheries management at the local scale. This would require reimagining the fishing commons as a seafood commons.

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