FISHING FOR HUMAN PERCEPTIONS IN COASTAL AND ISLAND MARINE RESOURCE USE SYSTEMS
2nd Edition

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FISHING FOR HUMAN PERCEPTIONS IN COASTAL AND ISLAND MARINE RESOURCE USE SYSTEMS, 2nd Edition

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Early morning on a coastal seaweed farm on Rote Island, East Nusa Tenggara, Savu Sea, Indonesia.
Image: Hauke Reuter (ZMT).

Human perceptions, decision-making and (pro-) environmental behaviour are closely connected. This Research Topic focuses on bringing together perceptions and behaviour for sustainable coastal and island marine resource use systems. Management and governance of (large and small-scale) coastal marine resource use systems function in highly complex social and ecological environments, which are culturally embedded, economically interest-led and politically biased. Management processes therefore have to integrate multiple perspectives as well as perception-driven standpoints on the individual as well as the decision-makers' levels. Consequently, the analysis of perceptions has developed not only as part of philosophy and psychology but also of environmental science, anthropology and human geography. It encompasses intuitions, values, attitudes, thoughts, mind-sets,

place attachments and sense of place. All of these influence human behavior and action, and are collected or are available within the respective marine resource use system, which may support the livelihood of a large part of the local population. Management and governance are not only about mediating between resource use conflicts or establishing marine protected areas, they deal with people and their ideas and perceptions. Understanding the related decision-making processes on multiple scales and levels hence means much more than economically assessing the available marine resources or existing threats to the associated system. Over the past decade, there has been a growing inter- and transdisciplinary international community becoming interested in research which integrates perceptions of coastal and inland residents, local and regional stakeholder groups, as well as resource and environmental managers and decision-makers. By acknowledging the importance of the individual perspective and interest-led personal views, it became obvious how valuable and important these sources of information are for coastal research. An increase of research effort spent on the link between perceptions and behaviour in marine resource use systems is thus both timely and needed. By offering a diversity of inspiring and comprehensive contributions on the link between perceptions and behaviour, this Research Topic aspires to critically enlighten the discourse and applicability of such research for finding sustainable, locally identified, anchored and integrated marine resource use pathways.

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EDITORIAL
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Editorial: Fishing for Human Perceptions in Coastal and Island Marine Resource Use Systems

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Keywords: perceptions, marine resource use, qualitative research, decision-making process, coastal communities, stakeholder interactions

Editorial on the Research Topic

Fishing for Human Perceptions in Coastal and Island Marine Resource Use Systems

This Research Topic focuses on bringing together human perceptions and activities for sustainable coastal and island marine resource use systems. The initial idea of this topic formed by an increasing awareness that human perceptions, individual decision-making and (pro-) environmental behavior are much closer connected than so far acknowledged by academia and the scientific research community in general. Management and governance of (large and small-scale) coastal marine resource use systems function in highly complex social and ecological environments, which are culturally embedded, value-driven, economically interest-led and politically biased. Local action is not least framed by mental contribution and attribution of coasts as places for living, recreation and resource use. Mental constructs of coasts and marine resources as valuable areas can, in some cases, lead to the protection and preservation by initiatives of collective action, and in other cases, it is difficult to mobilize local communities to adapt and to engage in environmental management strategies (Ratter et al., 2016). Management processes therefore ought to integrate multiple perspectives as well as perception-driven standpoints on the individual as well as the decision-makers' levels. Consequently, the analysis of perceptions has developed not only as part of philosophy and psychology but also of environmental science, anthropology and human geography. It encompasses intuitions, values, attitudes, thoughts, mind-sets, place attachments and sense of place. All of these influence human behavior and action, and can be collected or are available within the respective marine resource use system. Often, these systems support the livelihood of a large part of the local population.

The 12 articles in this Research Topic have been authored by 48 researchers from 10 different countries, presenting critical insights from across the globe—from small islands in the South Pacific to Sri Lanka, China, South Africa, Norway or Uzbekistan. The institutions from the submitting authors range from Universities to think tanks, to research centers, or Non-Governmental Organizations—and the authors themselves were at very different stages in their career (from very early to senior researcher). The diversity of the professional backgrounds (Geography, Environmental Psychology, Ecology, Sociology, and Anthropology) shows in essence that researching perceptions in (not only marine) natural resource use systems does not have

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a distinctive disciplinary boundary. All of the articles are interdisciplinary, and many also have transdisciplinary approaches, employing mainly qualitative approaches (partly in combination with quantitative methods), to face the challenge of uncovering, exploring and analyzing the perceptions of a variety of stakeholders in marine resource use systems, from traders to conservation managers.

The stories told by these articles are indeed just as diverse, from cases of individual meaning-making and highlighting the power of individual perceptions (Beyerl et al.; Siriwardane-de Zoysa and Hornidge) to collective action around the status of fishery resources (Leenhardt et al.) or the persistence of destructive fishing practices (Katikiro and Mahenge). Some of the articles showcase methods for perception research, such as the Q-methodology (Hagan and Williams) or stakeholder-informed modeling (Koenigstein et al.), allowing to quantify these "qualitative subjectivities" in ways readable for machines as well as human decision-makers. All articles have a critically high level of contextuality, and show how perceptions can have an impact on decision-making processes within the science-stakeholder "entanglement." The roles of perceptions in understanding and optimizing the usefulness of management measures, conservation projects and bridging organizations for better and more sustainable conservation solutions are among the less hidden examples (Berdej and Armitage; Beyerl et al.; Hagan and Williams). Understanding aspects of leadership—perceived and factual—responsibilities and legitimacies (of persons or activities and functions; Katikiro and Mahenge; Rohe et al.; Sutton and Rudd), very clearly show the requirement of in-depth research on perceptions. Oftentimes, these aspects of leadership, the complexities and confusions linked to it and individual decisions (Gorris), are often based on very tangible/conventional matters such as economic benefit (Fabinyi et al.; Gorris), but are also tightly linked to aspects of transparency, lack of trust (including perceived and real threats; Katikiro and Mahenge), and enforcement (Gorris; Rohe et al.). One aspect that may not be underestimated, but still under-researched, is the role of local (individual and subjective as they may be) perceptions on the transformation and governance of larger coastal areas (Katikiro and Mahenge; Kitolelei and Sato) and even more distant environments (Fabinyi et al.). The articles also show that a strong perception-based impact exists across all levels of such processes, from the individual resource-user, to larger societal and professional networks.

This Research Topic show-cases the need for a larger recognition in academia that management and governance are not only about mediating between resource use conflicts or establishing marine protected areas. Moreover, they deal with people and their ideas, knowledge and perceptions (Bennett and Dearden, 2014; Wyles et al., 2014; Bennett, 2016; Gelcich and O'Keeffe, 2016; Ratter et al., 2016; Hoshino et al., 2017). And understanding the related decision-making processes on multiple scales and levels means indeed more than economically assessing the available marine resources or existing threats to the associated system. The editors trust that this Research Topic adds substance and visibility to the growing body of research and literature that presents an integration of perceptions of island, coastal and inland residents, local and regional stakeholder groups, as well as resource and environmental managers and decision-makers.

In conclusion—by acknowledging the importance of the individual perspective and interest-led personal views, it becomes obvious how valuable and important these sources of information are for coastal research. An increase of research effort and academic discourse spent on the link between perceptions and behavior in marine resource use systems is thus both timely and needed, and is in fact observable by the increasing number of perception-related publications. The challenges to find, to analyse and to publish studies on perceptions remains, but by raising their academic profile, authors of articles such as published in this Research Topic should find a different, more visible platform—for a publication- and dialogue-based sharing of questions and findings. By fishing for a diversity of inspiring and comprehensive contributions on the link between perceptions and behavior, this Research Topic shall critically enlighten the discourse and applicability of such research for finding sustainable, locally identified, anchored and integrated marine resource use pathways.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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REVIEW
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Complexities and Uncertainties in Transitioning Small-Scale Coral Reef Fisheries

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Coral reef fisheries support the development of local and national economies and are the basis of important cultural practices and worldviews. Transitioning economies, human development, and environmental stress can harm this livelihood. Here we focus on a transitioning social-ecological system as a case study (Moorea, French Polynesia). We review fishing practices and three decades of effort and landing estimates with the broader goal of informing management. Fishery activities in Moorea are quite challenging to quantify because of the diversity of gears used, the lack of centralized access points or markets, the high participation rates of the population in the fishery, and the overlapping cultural and economic motivations to catch fish. Compounding this challenging diversity, we lack a basic understanding of the complex interplay between the cultural, subsistence, and commercial use of Moorea's reefs. In Moorea, we found an order of magnitude gap between estimates of fishery yield produced by catch monitoring methods ($\sim$2 t km^{-2} year^{-1}) and estimates produced using consumption or participatory socioeconomic consumer surveys ($\sim$24 t km^{-2} year^{-1}). Several lines of evidence suggest reef resources may be overexploited and stakeholders have a diversity of opinions as to whether trends in the stocks are a cause for concern. The reefs, however, remain ecologically resilient. The relative health of the reef is striking given the socio-economic context. Moorea has a relatively high population density, a modern economic system linked into global flows of trade and travel, and the fishery has little remaining traditional or customary management. Other islands in the Pacific in similar contexts in Polynesia such as Hawaii, that continue to develop economically, may have small-scale fisheries that increasingly resemble Moorea. Therefore, understanding Moorea's reef fisheries may provide insight into their future.

Keywords: social-ecological systems, small-scale fisheries, coral reef fisheries, transitioning economy, catch monitoring, fishery yield, complexity, resilience

INTRODUCTION

Coral reef fisheries are vital to millions of people dwelling along the world's coasts (Johnson et al., 2013; Teh et al., 2013; Cinner, 2014). They support the development of local and national economies by providing food, income, and employment, and also are the basis of important cultural practices and identities. Yet the coral reefs upon which these fisheries depend are some of the globe's most threatened coastal systems (Mumby and Steneck, 2008). Until recently, coral reefs worldwide demonstrated the capacity to return to coral dominance following perturbations that cause landscape-scale loss of coral, such as cyclones and bleaching (Jackson, 1992; Pandolfi and Jackson, 2006). In the past two decades, however, a growing number of studies have documented cases where major perturbations cause long-lasting and potentially irreversible ecosystem shifts, one of the most common being a shift from a coral-dominated to a macroalgae-dominated state (Hughes, 1994; Shulman and Robertson, 1996; Hobbs et al., 2006; Rogers and Miller, 2006; Bruno et al., 2009). The dynamics of these state shifts are fundamental to understanding long-term sustainability of coral reefs and the fisheries that depend on them, yet the interacting human and ecological dynamics, including fisheries, that underpin coral reef resilience are poorly understood (Hughes et al., 2003, 2005, 2010).

Most coral reef fisheries are small-scale fisheries in that they involve simple technologies and are either subsistence-based, or supply small local markets, or roadside sellers. Despite their limited technological and economic scope, small-scale fisheries have been identified as a primary threat to coral reefs (Newton et al., 2007). Some studies suggest small-scale coral reef fisheries are experiencing declining fish biomass and size (Cinner J. E. et al., 2009) but the extent, magnitude, and variability of overexploitation is generally not well-documented (Jacquet and Pauly, 2008), and even the number of people involved in such fishing is poorly known (Teh et al., 2013). This paucity of understanding and uncertainty is attributable to the inherent complexity of small-scale coral reef fisheries. They evolve within locally specific social and ecological conditions, making them highly diverse. Variability arises from the diverse set of technologies used for harvesting marine resources, multiple overlapping social, economic, and cultural motivations for fishing, heterogeneous modes of governance, varied stakeholder organization, and complex interactions with other marine-use sectors and governance structures.

Here we explore the complexity of coral reef fisheries using Moorea, French Polynesia, as an example. Moorea presents an interesting case study in that economic development and intense exposure to globalization have not undermined the capacity of its coral reefs to recover from perturbations. Extensive, long-term ecological research on Moorea suggests that its reefs are quite resilient to disturbances (Done et al., 1991; Adjeroud et al., 2009; Adam et al., 2011, 2014; Trapon et al., 2011; Lamy et al., 2015, 2016; Galzin et al., 2016). Many Pacific islands have shown declines in the critical adaptive capacities that underpin resilience to environmental variability when they are more exposed to the pressures of globalization and global markets, have higher population densities, and widespread coastal development (Pauly and Chua, 1988; Brewer et al., 2012). Interestingly, Moorea enjoys a higher standard of living than most Pacific islands while its reefs have demonstrated high resilience to environmental perturbation. This may suggest that higher levels of socioeconomic development may reduce dependence on coral reefs and associated human impact (Cinner J. et al., 2009) or may reflect other social or ecological characteristics of the system.

We describe Moorea's small-scale coral reef fishery by documenting fishing practices and reviewing uncertainties associated with estimates of effort and landings over the last three decades. Fishing activities on Moorea are widely dispersed, both spatially around the island and temporally throughout the day and the night, making the collection of accurate catch data challenging. Existing statistical data provided by the Territorial government cannot be used for this purpose because they do not effectively assess non-commercial fishing, the most widespread fishing practice on the island. Moreover, we lack a basic understanding of the complex interplay between the cultural, subsistence, and commercial use of Moorea's reefs. Filling these gaps in our knowledge of Moorea's fishery will help enhance the development of marine resource management initiatives that seek long-term sustainability of reef fisheries and foster ecosystem resilience.

THE SOCIAL-ECOLOGICAL CONTEXT

The island of Moorea is surrounded by a barrier reef, broken by 11 passes, enclosing a 49 km^2 lagoon, whose width varies from 500 to 1500 m, with depths of 0.5–30 m (Bell and Galzin, 1984). The island has a marine spatial management plan (Plan de Gestion de l'Espace Maritime, PGEM) initiated in 2004, the first in French Polynesia. The PGEM has four objectives: (1) rational use of resources and sustainable development; (2) managing conflicts for space in the lagoon; (3) controlling pollution and physical damage to marine environments; and (4) protecting marine ecosystems and endangered species. Although the PGEM was carefully developed over a 10 year consultation process, certain segments of the fishing community voiced opposition when it was implemented in 2004 (Aubanel et al., 2013), and it continues to be a source of tension and controversy (Walker, 2001; Gaspar and Bambridge, 2008; Walker and Robinson, 2009).

The uses of Moorea's coral reefs have fundamentally changed over the last 100 years. Moorea gradually transitioned during the late nineteenth century from a subsistence economy based on small-scale gardening and fishing to an economy that by the 1940s was based on cash cropping of vanilla and copra. In the 1960s, French military activities drove a burgeoning economy and employment opportunities that drew migrants from other parts of French Polynesia to the capital city, Papeete (Henningham, 1992; Salvat and Pailhe, 2002). These economic changes in French Polynesia influenced Moorea's social-ecological system in several important ways. With regular ferry service established between Moorea and Tahiti, residents of Moorea were able to commute to jobs in Papeete. Moreover, many Papeete residents moved to nearby Moorea or visit the island on weekends and occasionally fish there. Most notably,

however, was rapid growth in tourism that progressively became the mainstay of Moorea's economy. In 2011, Moorea was the most visited island in French Polynesia with over 70,000 tourists visiting the island's 22 major hotels and 48 smaller "pensions de famille" (ISPF, 2001). The transition to a tourism-led economy has sustained a level of economic prosperity in French Polynesia, and it continues to be one of the wealthiest Pacific Island nations with a USD 15,272 per capita GDP (Baudchon et al., 2008). An economy that was once dominated by small-scale food production and subsistence fishing was replaced with tourism and service sectors as well as some export-oriented non-indigenous agriculture, such as pineapple. In addition, fishing became just one of many marine-focused activities that include scuba diving and beach and boating activities, each exerting different pressures on the coral reefs and lagoon ecosystem.

One important outcome of these transformations was very high population growth, a portion of which was due to immigration from other islands. Census figures indicate that Moorea's population grew from 5058 to 16,893 between 1971 and 2012 (ISPF, 2013)—an annual growth rate of 2.39%, which is higher than the rate for French Polynesia as a whole (1.57%). The effect these demographic changes have had on Moorea's fishery is unknown, but throughout the region fishing pressure appears to be linked to the number of local inhabitants although the relationship is poorly understood (Russ and Alcala, 1989; Jennings and Kaiser, 1998).

FISHING CATEGORIES

Fishing has formed the backbone of Polynesian societies since their initial colonization of the region (Oliver, 1974) and continues to be an integral part of the subsistence economy and Polynesian identity. Today, Moorea's coral reefs directly support two fundamental livelihoods on the island: fishing and tourism. In strict economic terms fishing-based incomes are dwarfed by tourism-based incomes, which stem mostly from tourist accommodations and reef-based recreational activities. A recent economic assessment estimated that recreational activities stemming from Moorea's reefs provided approximately 27 M€/year while fishing activities provided 4M€/year including 2.8 M€ value placed on fish not sold but consumed within the fisher's household (Pascal and LePort, 2015). These figures, however, do not capture recreational fishing activities nor the high cultural value of reef fishing in Polynesian society (e.g., enjoyment, identity, prestige, worldview; Cinner, 2014).

Polynesian fishing activities can be lumped roughly into three categories: oceanic fisheries, coastal fisheries, and reef (or lagoon) fisheries. Reef fisheries are described as all activities involved in exploiting biological resources and carried out on the fringing and barrier reefs, channels, passes and *hoa* (small passes not always connected to the ocean) and down to the limits of coral growth (80–100 m depth; Galzin et al., 1989). According to Yonger (2002), Brenier (2009), and Leenhardt (2009) and our own observations, fishing is ubiquitous on Moorea with three broad categories of fishers: commercial fishers, subsistence fishers, and recreational fishers (**Table 1**). The latter term encompasses fishers not motivated by market imperatives or hunger, but cultural factors. The fisher population is composed of 69% recreational, 20% subsistence, and 11% commercial fishers but the categories are not mutually exclusive (Leenhardt, 2009; Brenier et al., 2014). Over half of the adult population fishes, with the vast majority of households having at least one person who fishes. While subsistence fishers are all Moorea residents, a certain number of commercial and recreational fishers come from the nearby Society Islands, mainly Tahiti (Leenhardt, 2009). It should be noted that nearly 70% of the people who fish on Moorea are recreational fishers, yet none of the catches from this category of fisher appear in the fisheries data collected in market surveys (**Figure 1**). Moreover, recreational fishing may account for 58% of the catches in the lagoon (Yonger, 2002), yet, a percentage of those catches are never recorded because they are directly destined for home consumption or shared among family or other community members. In addition, roadside sellers reported keeping a very small part of their catch on average for household consumption.

CAUGHT SPECIES

A diverse suite of species is targeted by fishing in Moorea's reefs. More than 40 genera of fishes can be found sold by the roadside. Three groups are caught most frequently: Iihi (soldierfish, *Myripristis* spp.), Paati (parrotfish, mixed species smaller than 50 cm; mostly *Scarus* spp. and *Chlorurus* spp.), and Ume (unicornfish, *Naso* spp.; **Table 2**).

FISHING GEAR TYPES

The wide diversity of species caught in part reflects the many fishing techniques that are employed, each adapted to specific suites of organisms. Given the many different techniques, individual fishers often use a multifaceted approach, using several techniques depending on their preferences and resources, on the frequency of fishing, season, weather conditions, target species, and time of day. The main gear types used in the lagoon are spear guns, lines (handlines, hook-and-line), nets (gillnets or nets with pot traps), harpoons, beach seines, and trolling (Yonger, 2002; Leenhardt, 2009; Brenier et al., 2014). Although a wide variety of fishing methods are used, spearfishing dominates the (commercial) roadside catch: sellers reported that a large majority of biomass had been taken by spear gun with the remainder split equally between hook and line and net fishing. Spearfishing occurs both during the day and at night with battery-powered torches. Night spearfishing is very effective, providing high yields per fishing trip. It accounts for about 29% of lagoon fish production in the Windward Islands (which include Moorea) as compared to 18% in the Leeward Islands (SPE, 2007). Night spearfishing is very selective but can lead to local overexploitation of stocks because most targeted species (80%) are non-migratory and tend to be confined to a specific habitat during the night (Lecaillon et al., 2000). Line fishing is done directly from the coastline or from small vessels

TABLE 1 | Classification and characteristics of fishers on Moorea.

Commercial fisher	Subsistence fisher	Recreational fisher
Two to five fishing trips per week	One to three trips per week	One to four trips per month
Sells catch	Some of the catch is sold and some is kept for home consumption	Catch is for home consumption
Fishing is the main source of income for the year	Fishing is a supplementary form of income	Fishing is primarily a recreational activity

FIGURE 1 | Reef fish sold along the roadside on Moorea. Boards in background are used by scientists to estimate sizes (Images: R. Madi Moussa).

powered by oars or 2–25 hp outboard motors. The different line fishing techniques include trolling, bottom longlining, fishing with artificial lures, using lines with one or more hooks, and fishing with natural and live bait. Nets can take a wide variety of forms: gillnet fishing; beach seine net fishing (used seasonally on bay floors to catch bigeye scad, *Selar crumenophthalmus*); funnel net fishing that includes a wire net that targets parrotfish, trevallies, surgeonfish, and goatfish; and cast nets and scoop nets, which are used to catch flying fish. Fish traps are widely used in the Tuamotu and Leeward Islands, where they can account for 90% of catches (Galzin et al., 1989), but are not used in Moorea's lagoon.

YIELD ESTIMATES

A variety of studies in the past three decades have attempted to assess fish production (Galzin, 1985) or reef fishery yields (Aubanel, 1993a; Yonger, 2002; Brenier et al., 2014) on Moorea (**Table 3**). As in other coral island settings, quantifying reef fisheries yield has proven to be a particularly difficult exercise for many reasons. Fishing is often done at night (with or without a boat), is widely dispersed, uses many different types of gear, and landings and sales do not take place at specific sites but rather anywhere along the coast, often on private stretches of coastline (**Figure 1**). Research methodologies used between the times of Galzin (1985) and Brenier (2009) have also evolved considerably. Over a period of three decades, five different studies attempted to evaluate Moorea's lagoon fishery yield, and only two studies used the same methodology (Aubanel, 1993a; Vieux, 2002), leading to a wide range of production estimates for Moorea's coral reefs. Yield estimates based on catch data provide relatively low figures (from 0.7 to 2.2 t km^{-2} $year^{-1}$), while, by contrast, data from consumption surveys or participatory surveys estimate fishing yields an order of magnitude higher (from 20 to 25 t km^{-2} $year^{-1}$).

Monitoring Catches, Landings, and Sales

Built in 1987, the Paopao market was once the single official point of sales where all fishers from the north side of the island were supposed to sell their fish. The centralized fish market was the result of a regulation that prohibited the sale of fish at roadside stands, although compliance with the law was low and eventually the Paopao market ceased to operate (Aubanel, 1993a). Galzin et al. (1989) estimated catches based on the tax the township levied on the fish sold at the Paopao market. Aubanel (1993a) estimated production and total catch based on fish sold both at roadside stands and at the Paopao market. These estimates were made by counting tuis, a string from which a collection of fish are hung, often of different species and sizes, and the unit by which fish are offered for sale (**Figure 1**). Vieux (2002) used the same protocol counting only roadside tuis (the market was closed by that time) to assess potential changes in total catch.

There were some methodological weaknesses of these assessments that most likely led them to underestimate fishery production. The tax-based approach (Galzin et al., 1989) did not account for non-market based sales (roadside sales and direct sales based on contracts), that were estimated afterwards to

TABLE 2 | Relative abundance (percent) of important fished taxa sold by the roadside on Moorea since 1991.

Tahitian name	Scientific name	1991 (Oct)	1992 (Mar)	2002 (June–July)	2007 (Jan–Sept)	2008 (Jan–Feb)	2012 (Jan–Mar)	2014–2015 (June–May)
Marava	*Siganus argenteus*	20	10	4	4	2	2	4
Vete	*Mulloidichthys vanicolensis*	16	10	2	2	1	1	0
Pahoro/Paati	*Scarus* spp. or *Chlorurus* spp.	26	19	10	26	17	33	41
Ume	*Naso unicornis*	8	20	13	31	33	5	4
Ume Tarai	*Naso lituratus*	1	14	23	7	10	4	1
Iihi	*Myripristis* spp.	NA	NA	22	7	8	10	11
Other	Other	29	28	26	24	28	45	39

Data from: Galzin et al., 1989; Aubanel, 1993b; Vieux, 2002; Yonger, 2002; Brenier, 2009; Kronen et al., 2009; Madi Moussa, 2010.

TABLE 3 | Yield estimates per surface area unit by type of survey.

Yield (t km^{-2} year^{-1})	Type of data	Source
24.5	Participatory surveys	Brenier, 2009
28.14	Socioeconomic surveys	Kronen et al., 2009
22.9	Direct consumption surveys	Yonger, 2002
1.01–2.2	Fish sold on roadside	Vieux, 2002
0.7–1.4	Fish sold on roadside	Aubanel, 1993a
1.2–1.4	Extrapolation of fishing data	Galzin et al., 1989

be about 60% of the total catch (Vieux, 2002). Yield estimates based solely on roadside surveys (Aubanel, 1993b; Vieux, 2002) were most likely underestimated for the same reasons. However, and although done 10 years apart, those two assessments based on roadside surveys led to similar yield figures. Surprisingly, the tax-based study done 10 and 20 years earlier, respectively, led to estimates in the same range, suggesting that the market oriented reef catches were similar for the various fishing/selling categories. Although the spatially dispersed nature of landings makes quantifying fish catches difficult, monitoring roadside sales can be an excellent way of discerning spatial patterns of fishing pressure (fish are typically sold in roadside stands near to where the fish were caught) as well as the species and sizes of the fish sold (**Figure 1**; Madi Moussa, 2010).

Consumption Surveys

An analysis of seafood consumption can be a good alternative for indirectly assessing fishery production (Paddon, 1997; Gilbert, 2006; Labrosse et al., 2006). This method requires a well-defined study area with low quantities of imported or exported reef and lagoon fish. On Moorea, catch exports are limited to recreational fishers who come from Tahiti on the weekends and the importation of fish is negligible, with only small amounts of pelagic fish from Tahiti or the Tuamotu Islands being brought to the island (Leenhardt, 2009; Brenier et al., 2014). On Moorea, annual consumption is nearly 110 kg per inhabitant (Yonger, 2002), far above the 23 kg per inhabitant that is the average annual consumption for the Pacific Islands region (Labrosse et al., 2006; Kronen et al., 2010). The gap between estimates in Moorea and other Pacific Island countries is intriguing and encourages consideration of possible methodological biases. Studies either sampled 5% of Moorea's household population (Yonger, 2002) or concentrated on a village and sampled 12% of its households (Kronen et al., 2010). However these two studies led to similar estimates. We believe a potential source of discrepancy with other similar studies in the region may be due to the fact that residents of Moorea consider leftovers to be a new individual meal (Gilbert, 2006). The one-off nature of the surveys also creates considerable uncertainty in the annual estimates, which were extrapolated from average weekly estimates. The methodology also assumed that eating habits and fishery production remain stable over time (Gilbert, 2006). Fish sizes were generally estimated with gauges, while size and weight conversions were calculated using biometric ratios. Size and weight ratios were not always calculated in a precise manner. In fact, length-weight relationships did not exist for the species studied, so relationships for similar species were used (Gilbert, 2006). Although the information collected from households was quantitative it involved substantial uncertainty because it relied on the short-term memory of the person interviewed and his or her ability to convert an image or a memory into a physical size (Gilbert, 2006).

Despite the drawbacks mentioned above, indirect studies based on household seafood consumption surveys offer a good alternative for studying fishery production in small-scale fisheries. In contrast to methods based on landings and sales monitoring, household consumption surveys take into account the catches of all types of fishers, including recreational fishers. They also have been conducted more frequently over the past few years (Yonger, 2002; Lagadec, 2003; Léopold et al., 2004; Kuster et al., 2006).

Participatory Methods

Participatory monitoring of reef fisheries through household surveys can be designed to collect data on consumption and fishing activities from large sample groups and can produce reliable data (Au et al., 2000; Nicholson et al., 2002). On Moorea, fishery production was estimated using surveys by schoolchildren (Brenier, 2009). Surveys consisted of questionnaires designed to gather general information (i) on the household's general fishing activities and fish consumption (including how often

fish was eaten, origin of the fish eaten, number of boats and fishers in the household) and (ii) on the number of fishing trips of one fisher in the household over a 2-week period (to cover one spring tide period and one neap tide period) along with (iii) the names, sizes and number of fish eaten at meals over the previous 3 days. These surveys involved 4.4% of total household population and the questionnaire return rate was 68%. The fisher population was estimated at 77 fishers per km^2, with 1916 ± 530 motorboats and 481 ± 68 fishing trips per km^2 each month (Brenier, 2009). If this calculated fishing pressure is accurate, it is quite high considering that 5 fishers per km^2 is the upper limit at which coral reef resources can be safely exploited (McClanahan et al., 2002).

PERCEPTIONS OF STOCK STATUS

Perception surveys can also serve as a good indicator of fish stock status. On Moorea, perception surveys show mixed results with some indicating that Moorea has experienced a decline in the abundance and size of target fish species, increased scarcity of giant clams, decreased live coral cover, and increased cover of macroalgae (Brenier, 2009), while others suggest heterogeneity in perceptions between communities, with respondents from Afareaitu reporting more marine resource degradation than in southern Ha'apiti and Papetoai. Over the past decade, fishers in most districts report that they are still catching as many fish, yet most agree that their fishing effort has increased (Leenhardt, 2009), although there is some variation between districts. The varied perceptions about the health of fished stocks emphasize the difficulty of using such metrics to infer stock status. Responses are consistent with reefs that are either fully exploited or somewhat overexploited but show no evidence of collapse despite the heavy use.

DISCUSSION

Coral reef fisheries are multifaceted, and when fishers can fish for pleasure, identity, to eat or to sell, yields are very difficult to assess and large uncertainty is common. For instance, in Moorea's reef fisheries, there is considerable uncertainty on the magnitude of the catch or even the status of the stocks being fished. Over a period of 30 years, several studies have attempted to assess fishery production in Moorea's reefs, with nearly every study using a different methodology. Two approaches have yielded an order of magnitude gap between the estimates: ∼2 t km^{-2} $year^{-1}$ using catch-monitoring methods vs. ∼24 t km^{-2} $year^{-1}$ using consumption or participatory socioeconomic consumer surveys (**Table 2**). Market surveys are unable to capture many kinds of fishing activity (e.g., recreational fishing, fishing for household consumption, and contract fishing for private clients), so we expect that methods based on these surveys would underestimate fishery production. Methods involving socioeconomic surveys might potentially give more accurate fishery production estimates as they apply to all fish consumed on the island regardless of source, but they rely on recollections of fish recently consumed, rather than on direct observation, introducing other forms of uncertainty.

Similar to many small-scale coral reef fisheries, fishery activities in Moorea's lagoon are quite challenging to monitor and quantify because they vary greatly and are quite dispersed. While estimates of actual production are uncertain, the potential sustainable productivity of Moorea's lagoon fisheries is completely unknown. In fact, there may not be any reliable guidelines for the sustainable yield of many of these fish species, as their biomasses have been shown to change by a factor of five or more over time scales as short as a few years during rapid ecological transitions (Adam et al., 2011, 2014). At present, these variations in biomass are not predictable - some are driven by pulse disturbance events (Adam et al., 2014), and there is no infrastructure for monitoring stock status that would permit dynamic estimation of sustainable yield.

Adding to the complexity is the fact that Moorea's reefs have been subjected to several large perturbations in the past four decades, including in 2008–2010 (Adjeroud et al., 2009; Trapon et al., 2011; Adam et al., 2014; Lamy et al., 2015, 2016). In all cases, the coral community on the fore reef displayed high resilience to perturbation -returning to pre-disturbed coral cover (∼40–50%) within about a decade without undergoing a shift to high cover of macroalgae (Adjeroud et al., 2009; Trapon et al., 2011; Adam et al., 2014; Lamy et al., 2016) due in large part to herbivorous fishes preventing the establishment of macroalgae on the fore reef (Adam et al., 2011, 2014). Following the recent disturbances, the relative abundances and biomass of species targeted by Moorea's fishers changed, with several key groups of herbivores experiencing large increases.

The complexity of Moorea's coral reef fishery, in many ways, is representative of other small-scale coral reef fisheries around the world. A wide diversity of fish is caught with at least five major gear types and fishing occurs during day or night without any regular schedules or formalized protocols. Moorea's fishery, however, becomes more place-specific when we consider the socio-economic context and the motivations that underlie why people fish. Unlike many other small-scale coral reef fisheries in the Pacific and around the world, French Polynesia is a relatively rich country. For this reason Moorea households are not dependent on marine resources for protein or their livelihoods to the same extent as in poorer countries where necessity motivates the harvesting of marine resources. For this reason, only a small percentage of Moorea households identify fishing as their primary source of income or livelihood. Instead, fishing is vitally important for its non-material benefits. The primary motivation for fishing on Moorea is related to an important cultural factor: eating fresh reef fish. For Moorea's inhabitants the consumption of fresh reef fish is as fundamental to their identity as speaking the Tahitian language. It is pivotal to culturally important events such as Church gatherings, birthdays, Sunday feasts, and other events and continues to dominate the local diet. For these reasons, the three categories of fisher—subsistence, commercial, and recreational—that are frequently cited in the literature on small-scale fisheries do not fully capture

the nature of fishing on Moorea. Culturally motivated fishing, although most similar to recreational fishing, translates into fishing behavior that cannot easily be analyzed within a cost-benefit or profit maximization model where the economic value generated by the activity forms the core of the analysis. To more deeply comprehend fishing on Moorea the non-material benefits related to the Polynesian lifestyle and identity must be considered.

Given the social and ecological complexity of Moorea's lagoon fisheries, any attempt to understand their dynamics will likely require integrated methods that consider both systems simultaneously. More integrated fieldwork is required to better evaluate the sustainability of the existing fisheries, in which social science techniques are paired with ecological field surveys to understand how fishing behavior depends on ecological state, livelihood opportunities, non-material benefits, cultural cohesion, and personal identity.

CONCLUSIONS

Understanding Moorea's lagoon fisheries is a major challenge, but also an opportunity. In important ways, Moorea may provide a window into the future of many other islands in the Pacific. Although the influence of globalization and economic development will inevitably vary across the Pacific, many Pacific Island nations are undergoing socio-cultural and economic changes similar to Moorea in that their population densities are increasing, their economies are modernizing and becoming more linked to global flows of trade and travel, and their fisheries are no longer managed through traditional marine tenure practices. If other island nations in the Pacific undergo similar changes, their small-scale fisheries may increasingly come to resemble Moorea's, where fishers are less dependent on the marine environment for subsistence or income and more motivated by non-material factors that sustain personal and cultural identity. Despite these changes on Moorea, its reefs are still superficially healthy with high coral cover and abundant fish. We acknowledge Moorea is unique in that it is economically and geopolitically linked to France, but studying Moorea's system might yield insight into how the processes of globalization can be effectively and sustainably navigated both ecologically and socially in similar contexts in Polynesia such as Hawaii.

AUTHOR CONTRIBUTIONS

PL wrote the first draft and all authors contributed substantially to revisions.

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Stakeholder-Informed Ecosystem Modeling of Ocean Warming and Acidification Impacts in the Barents Sea Region

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Climate change and ocean acidification are anticipated to alter marine ecosystems, with consequences for the provision of marine resources and ecosystem services to human societies. However, considerable uncertainties about future ecological changes and ensuing socio-economic impacts impede the identification of societal adaptation strategies. In a case study from the Barents Sea and Northern Norwegian Sea region, we integrated stakeholder perceptions of ecological changes and their significance for societies with the current state of scientific knowledge, to investigate the marine-human system under climate change and identify societal adaptation options. Stakeholders were engaged through personal interviews, two local workshops, and a web based survey, identifying the most relevant ecosystem services potentially impacted and developing an integrated system dynamics model which links climate change scenarios to the response of relevant species. Stakeholder perceptions of temperature-dependent multiannual fluctuations of fish stocks, interactions among fish, marine mammal, and seabird populations, and ecological processes such as primary production are represented in the model. The model was used for a discourse-based stakeholder evaluation of potential ecosystem changes under ocean warming and acidification scenarios, identifying shifts in ecosystem service provision and discussing associated societal adaptation options. The results pointed to differences in adaptive capacity among user groups. Small-scale fishers and tourism businesses are potentially more affected by changing spatial distribution and local declines in marine species than industrial fisheries. Changes in biodiversity, especially extinctions of polar species, and ecosystem functioning were a concern from an environmental conservation viewpoint. When considering potential additional impacts of ocean acidification, changes observed in the model projections were more uniformly valued as negative, and associated with an increased potential for conflicts among user groups. The stakeholder-informed ecosystem modeling approach has succeeded in driving a discussion and interchange among stakeholder groups and with scientists, integrating knowledge about climate

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change impacts in the social-ecological system and identifying important factors that shape societal responses. The approach can thus serve to improve governance of marine systems by incorporating knowledge about system dynamics and about societal uses and values.

Keywords: participatory modeling, marine ecosystem services, marine systems, climate change adaptation, ocean acidification, Barents Sea

INTRODUCTION

Under global climate change, the oceans are undergoing profound changes. Ocean warming, acidification (decreasing pH values), deoxygenation (insufficient oxygen levels), and other physical and chemical changes are anticipated to affect marine species, drive changes in marine ecosystem structure and dynamics, and impact the productivity of marine ecosystems and the provision of ecosystem services to human societies (Pörtner et al., 2014; Gattuso et al., 2015). Ocean warming is already observed to lead to poleward shifts in the spatial distribution of marine organisms, facilitating species invasions into regional ecosystems, and causing local or regional extinctions by exceeding the thermal tolerance limits of organisms (Poloczanska et al., 2013). Ocean acidification, the decrease in water pH via increasing solution of atmospheric CO_2, is anticipated to impact different organism groups in marine ecosystems (Kroeker et al., 2013). Increased mortality and structural damages observed in laboratory experiments with early life stages of fish under future ocean pH values cause concern about the future of fish stocks (Munday et al., 2010; Denman et al., 2011).

Nevertheless, considerable uncertainty compounds the analysis of ecosystem-level effects of multiple climate change drivers, and their interactions with anthropogenic impacts and human uses (Gattuso et al., 2015; Riebesell and Gattuso, 2015). Ecological models are increasingly playing an important role in an integrated assessment of these effects in marine social-ecological systems (Perry et al., 2010; Osterblom et al., 2013). A wide range of human uses and activities will be affected by climate change impacts on marine systems (Allison and Bassett, 2015). Economic and nutritional dependence on marine resources, and vulnerability toward change differs strongly among countries (Allison et al., 2009). While societies have a range of options to adapt to changes in marine living resources, e.g., increase of exploitation efforts or economic diversification, these depend on economic, social and cultural conditions (Perry et al., 2011; Haynie and Pfeiffer, 2012). The ecosystem services concept (Millenium Ecosystem Assessment, 2005) can serve as a framework for assessing changes in societal benefits provided by marine ecosystems, like food provision from fisheries and aquaculture, carbon uptake and climate regulation, bioremediation, and nutrient cycling, or recreation and cultural services (Beaumont et al., 2007). To improve the scientific basis for quantifying changes in the provision of these services and important trade-offs among services, assessment methodologies must be equipped to capture the multidimensional nature of the value of ecosystems, to enable better informed individual and institutional decisions and improve governance mechanisms (Daily et al., 2009; Kittinger et al., 2014). Since ecosystem services are ultimately defined by society and governance decisions should be more effective when supported by affected societal groups, there is strong rationale for stakeholder participation as an integral part of ecosystem assessment processes.

We present a regional case study on climate change impacts on ecosystem service provision in the Barents Sea and Northern Norwegian Sea area. In Norway, the oceans play an important economic and cultural role. The fisheries sector with a production of 2.3 million tons of fish and 12.800 employees in 2011 makes the country the world's second-largest seafood exporter after China (FAO, 2013), divided between industrial off-shore fishing, aquaculture mostly of Atlantic salmon, and small-scale coastal fisheries. Main capture fish species are Atlantic cod (*Gadus morhua*), Atlantic herring (*Clupea harengus*), capelin (*Mallotus villosus*), Atlantic mackerel (*Scomber scombrus*), saithe (*Pollachius virens*), and other whitefish. Norway's national fisheries management is generally seen as well-regulated, science-driven, internationally cooperative and sustainable (FAO, 2013, 2014). Fishers participate in management via national and regional fisheries associations and provide catch information (Johnsen, 2013; Jentoft and Mikalsen, 2014). In recent years, good management and favorable environmental conditions under ocean warming have facilitated large fish stock sizes such as of Barents Sea cod (Eide et al., 2013; Kjesbu et al., 2014). Nevertheless, future climate change represents a considerable challenge for Norwegian fisheries management (Harsem and Hoel, 2012), and recent integrated, ecosystem-based coastal zone management plans recognize important knowledge gaps with regard to the impacts of climate change and ocean acidification (Hoel and Olsen, 2012).

The Barents Sea is projected to experience rapid ocean warming in the next decades, which together with a reduced extent of Arctic sea ice is already leading to pronounced changes in ecological community composition, spatial distribution and biomass of fish stocks, and thus, fisheries provision (Hollowed and Sundby, 2014; Fossheim et al., 2015; Kortsch et al., 2015). At the same time, Arctic and subarctic areas will be affected by the strongest pH changes expected worldwide until the end of the century, with Arctic waters becoming corrosive to some shell-producing organisms. Thus, changes in food web structure and also direct impacts on fish stocks are expected, but still subject to high scientific uncertainty (AMAP, 2013). The comparatively simple food web in the Barents Sea is expected to be more vulnerable to impacts on certain keystone or bottleneck species than ecosystems with higher species diversity (Wassmann et al., 2006; Duarte et al., 2012).

We constructed an ecological model of the expected impacts of ocean warming and acidification on marine ecosystem services in the Barents sea region, based on input from potentially affected stakeholder groups (Costanza and Ruth, 1998; Voinov and Bousquet, 2010). We incorporated stakeholder input regarding which ecosystem elements and processes to include in the model, and used stakeholder perceptions to assess which human uses and societal groups may be impacted by environmental changes in the region. Thus, stakeholders served as representatives of society, to integrate local knowledge and concerns, identify relevant ecosystem elements and services, evaluate projected changes under scientific uncertainties, and identify societal adaptation options (Walker et al., 2002). This integrated social-ecological systems approach is applied with the aim of increasing resilience of marine-human systems and improving adaptive capacity (Hughes et al., 2005), to discover governance options for a more sustainable use of marine resources under climate change.

MATERIALS AND METHODS

Stakeholder Consultation

For an initial compilation of potential ecosystem changes under climate change in the focus area, the scientific literature was screened for an overview of the problem (reviews on regional ecosystems and on climate change and ocean acidification impacts, reports of expert groups, news, and outreach products produced by regional scientific institutes). To compare these findings to relevant topics of concern for the users, internet-based news portals aimed at regional stakeholders, archives of newspapers of general interest and for user groups (e.g., fisheries magazines) were screened for recent prominent topics. Ten interviews with regional scientific experts with a background in marine ecology, governance of marine resources and areas, oceanography, ecosystem modeling, fisheries science, and other disciplines, further helped to identify potentially affected ecosystem services and stakeholders. Interviews with 25 stakeholders of potentially affected groups from Norway and Russia were conducted in different locations in Norway (Oslo, Bergen, Tromsø, Bodø, Lofoten Islands, Finnmark, Svalbard) or via email between March and September 2013. Stakeholders included representatives from fishing associations and aquaculture companies, individual small-scale fishers, tourism operators (hotels/camps, sport fishing, whale watching), non-governmental organizations (including environmental conservation and indigenous Sami groups), and governmental agencies (Fisheries and Environmental Directorates). The personal interviews aimed at identifying (1) the general socio-economic situation of participants, (2) perceptions and concerns about regional ecosystem impacts of climate change, (3) the communication between science, politics and stakeholders about expected impacts, (4) societal impacts and adaptation options to climate change, and (5) management options and political adaptation strategies (Supplemental File S1: Interview questionnaire). Participants were also asked for their personal opinion on further potentially affected societal groups, to open up the investigation to ecosystem services and user groups not initially identified.

The most frequently mentioned ocean uses, climate-related concerns, and ecosystem interactions from stakeholder interviews which could be linked to elements of the marine ecosystem, were compiled to form the basis of the model (**Table 1**). A model-building workshop with stakeholders was held in Bergen, Southern Norway in October 2013, where stakeholders were introduced to the topics of the research project and the current state of scientific knowledge about climate change impacts on marine ecosystems. A draft of the model structure based on the identification of relevant ecosystem services and elements from the interviews was presented. Stakeholder comments on the model structure and requests for further elements and services to be included were collected to inform further model development (Koenigstein and Goessling-Reisemann, 2014).

Integrative System Dynamics Model

A system dynamics model (Costanza and Ruth, 1998) was developed in the modeling software STELLA 9.1, and later converted to STELLA Professional 1.0 (www.iseesystems.com). Its structure was based on the most relevant ecological elements and processes that can be linked and quantified using empirical biological results. Graphical icons for species and ecosystem services were designed and integrated into the model interface to make the model structure more easily accessible to stakeholders. The model was based on a multi-species population structure, with biological processes governing population dynamics of the integrated species, and interactions among species represented by predation and consumption (**Figure 1**).

The model structure incorporates the marine species of high importance to the various stakeholder groups, and the most commonly mentioned biological processes. Some ecologically similar species were aggregated to groups ("other baleen whales," seals, "other seabirds") to limit model complexity, and/or combined in modules (tooth whales, baleen whales, seabirds) in the model interface. Aggregate representations of lower trophic levels (one phytoplankton and three zooplankton groups) were used to base the biomass flow through the food web on a primary production process, integrating stakeholder concerns about primary production and the ecosystem services of carbon uptake and export (**Figure 1A**). Due to the importance of fish stock recruitment in stakeholder concerns, fish populations were divided into two to four life stages and embedded in a self-enhancing feedback of reproduction and recruitment processes.

Ocean warming and acidification were incorporated as changes in fish and zooplankton consumption and growth, based on physiological thermal growth windows (Pörtner and Farrell, 2008) and assuming an increasing loss of metabolic energy under acidification reaching up to 10% of the total energy uptake (**Figure 1C**). Driver scenarios for temperature and pH were incorporated based on IPCC (Intergovernmental Panel on Climate Change) ensemble earth system model projections for the Barents Sea under the RCP (Representative Concentration Pathway) 8.5 ("business-as-usual") emission scenario (AMAP, 2013; Bopp et al., 2013; Collins et al., 2013). Temperature was additionally adjusted to undergo seasonal fluctuation and an inter-annual oscillation with a period of 8 years (**Figure 1B**),

TABLE 1 | Stakeholder concerns and observations with regard to climate change impacts on marine ecosystems, from personal interviews with stakeholders from the fisheries sector (F), tour providers and other tourism businesses (T), and environmental and other non-governmental organizations (E), ranked by sum over sectors (seven participants for each sector, one additional aquaculture representative for the fisheries sector).

Species of interest and/or concern				
	F	***T***	***E***	**Σ**
Atlantic cod	7	5	5	17
Mackerel	6	5	5	16
Kelp/Seaweeds	2	1	4	7
Herring	6		1	7
King crab	2		3	5
Capelin	3		1	4
Atlantic Halibut	1	2	1	4
Haddock	2		2	4
Shellfish (mussels, scallops, etc.)	2	1	1	4
Zooplankton	2		1	3
Sea urchins		1	2	3
Blue whiting	3			3
Lobster	0	1	1	2
Shrimps	2			2
Atlantic salmon			2	2
Seabass	1		1	2
Saithe	1		1	2
(Cold water) corals	1		1	2
Dolphins and pilot whales		2		2
Minke whales	1	1		2
Orcas		2		2
Redfish	1	1		2
Seabirds		1	1	2
Seals		1	1	2
Sperm whales		1	1	2
Total: marine mammals	1	7	2	10
Total: fish	30	14	20	64
Total: benthic organisms	12	4	12	28

General ecosystem observations				
	F	***T***	***E***	**Σ**
Feeding interactions/competition	8	3	3	14
Fish larvae/spawning/stock recruitment	5	5	2	12
Natural fluctuations in abundance	5	2	2	9
Primary production	4	1		5
Phenology/migration patterns	2	1	2	5
Local fish declines in fjords			3	3
Regime shifts			2	2
Fish size	1	1		2
Fish more distant to coast		1		1
Observations and concerns linked to climate change				
Fish stock abundance or productivity changes	6	4	4	14
Distribution range shifts	7	2	4	13
Ocean warming	6	2	3	11
Immigrating species	4	3	3	10
Ice melting/ice coverage	4	1	3	8
Sea level rise/wave height		4	3	7
Ocean acidification	3		2	5
Oceanic currents	2		1	3
Threatened Arctic species		1	2	3
International disputes	3			3
Habitat reduction		1	1	2
Snow melt		2		2
Increased precipitation and nutrient influx			2	2
Harmful algae blooms			2	2
Extreme weather events	1		1	2
Milder winters	1			1
Fish migrations to deeper waters	1			1
Anoxia in fjord depths			1	1

Number of instances mentioned across interviews for species of interest or concern (only species mentioned more than once), general ecosystem observations, and observations or concerns explicitly linked to climate change impacts (detailed interview questions given in Supplemental File S1).

mimicking the natural fluctuations linked to the North Atlantic Oscillation (Ottersen et al., 2001) as mentioned in the stakeholder interviews. Marine mammal and seabird populations were modeled without direct effects of warming or acidification, as empirically observed changes are mostly indirectly caused through food web changes (Sandvik et al., 2005; Simmonds and Isaac, 2007). Fishing was incorporated as an additional biomass extraction process for fish and minke whales (*Balaenoptera acutorostrata*), defined as fixed relationships between stock sizes and landings in the following year, based on past quota agreements. Details of model parameterization, calibration and validation will be described in a separate publication, as we focus on the incorporation of stakeholder perceptions into the model and their assessment of the results here. The graphical interface of the model included dynamic displays of the states of the relevant biomass compartments and other indicators in the model over time, grouped in combined graphs aimed at each of the three stakeholder groups in the model valuation workshop (**Figure 1D**).

Model Evaluation and Identification of Adaptation Options

A web-based online survey was prepared to evaluate the relative importance of socio-economic framing factors identified in the interviews, created in a Norwegian and an English version using the platform Limesurvey by the provider Limeservice (www.limeservice.com). This served to prepare input for the discussions in the second workshop and helped the creation of framing scenarios at a later time. Factors already included in the model (e.g., ocean temperature or marine organism abundances) were not surveyed.

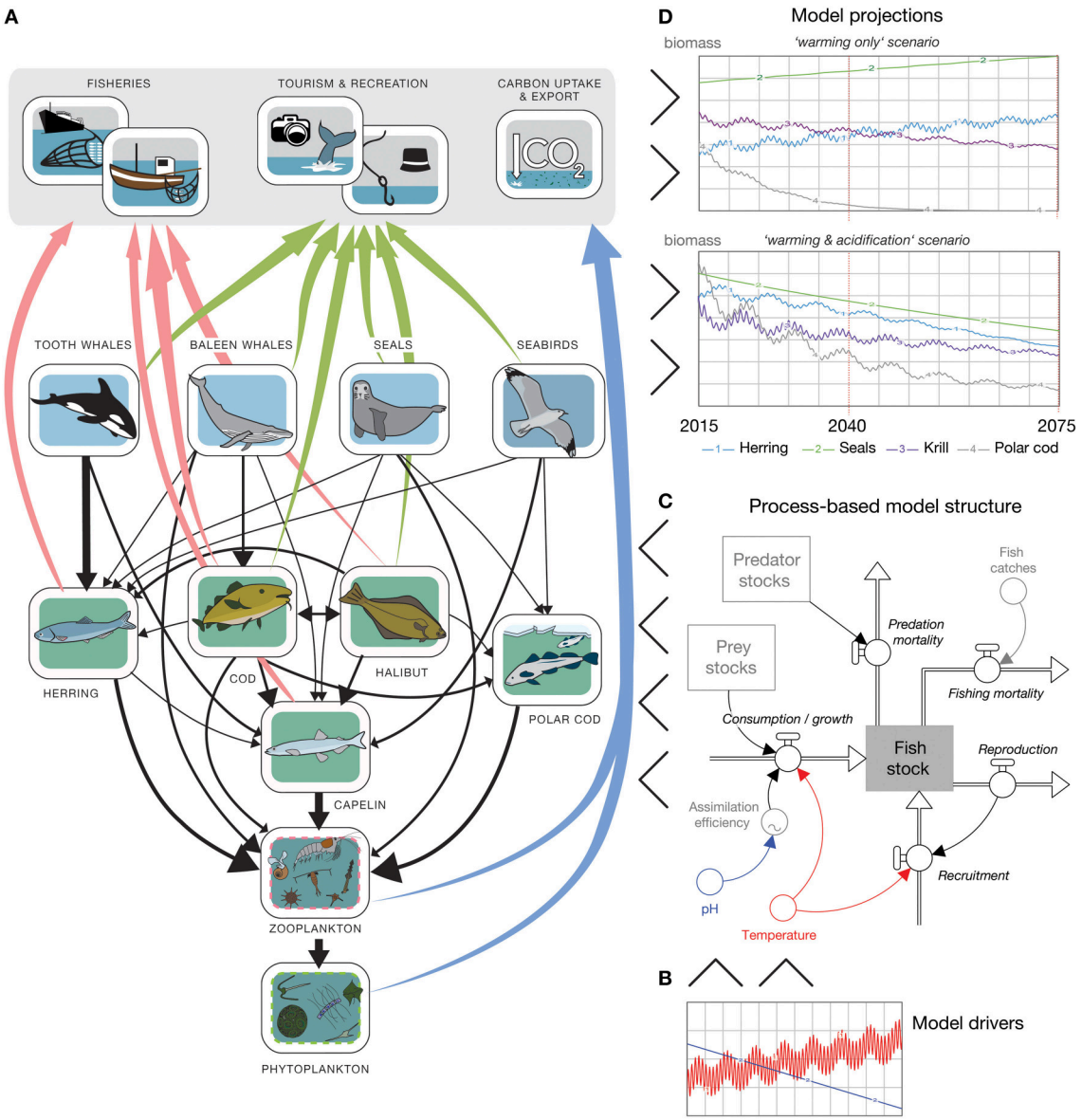

FIGURE 1 | Structure, drivers, and exemplified projections of the developed system dynamics model. (A) Top-level interface of the model, with modules of the most relevant species interacting in the marine food web, and links to provided ecosystem services (gray shaded top row). Thin black arrows mark predation on other species in the food web, wide colored arrows mark connections to the ecosystem services fisheries (pink), tourism (green), and carbon uptake and export by primary production and plankton mortality (blue). Icon design for organism and ecosystem services by Leonard Rokita, Bremen. **(B)** Temperature and pH over model time frame as drivers of the model, affecting biological processes. **(C)** detailed structure of the species included in the model in system dynamics notation, based on biomass flows (thick arrows) which determine the state of each fish stock and the dynamic links to other stocks in the model (boxes), and are influenced by the environmental drivers temperature and pH, and by fish catches (circles, thin arrows). **(D)** examples for resulting model projections under "warming only" and "warming and acidification" scenarios (different biomass scales), which qualitatively reproduce natural fluctuations and were evaluated by stakeholders at two time points, the model years 2040 and 2075 (red dotted lines).

A second stakeholder workshop for model valuation was held in Tromsø, Northern Norway in June 2015 with representative stakeholders from fisheries, tourism and environmental conservation. Structure and functioning of the parameterized model was explained, model assumptions and scientific uncertainties discussed, and model runs performed under two scenarios, driven by ocean warming alone, and warming and acidification combined, respectively. At two time points in the simulation—the year 2040 and at the end of the simulation in the year 2075—model runs were stopped and stakeholders asked to discuss the developments in stock levels and ecosystem indicators in groups by sector. Stakeholders agreed on a rating in terms of the significance for their business and interests on a scale of +5 to −5, where: +5 refers to a high preference, i.e.,

the best imaginable event for participants' business or interests; 0 is neutral, and −5 is catastrophic for economic survival or the stakeholders' main interests.

Then, stakeholders were asked to decide whether they needed to change their business, take organizational decisions or other steps to adapt to the projected ecosystem changes. Groups discussed and proposed possible adaptation options for their sector. Finally, general societal adaptation options were discussed among all stakeholders, and common policy recommendations developed among the participants of the different sectors. During this process, stakeholders had access to all model variables and indicators (dynamics of species abundance and processes, biodiversity and ecosystem indicators, etc.), which together reflect the complexity of the underlying ecosystem.

RESULTS

Stakeholder Perceptions and Concerns

Marine species most often mentioned by stakeholders with regard to ecosystem changes in the interview series were the fish species Atlantic cod, mackerel and herring, as well as kelp and seaweeds, king crabs, and followed by other fish species (**Table 1**). Stakeholders exhibited a high level of ecological knowledge in their observations and concerns about marine organisms. The most prominent environmental changes linked to climate change were distribution range shifts of fish and other marine species, changes in fish abundance or productivity of fish stocks, an increased occurrence of newly immigrated species such as mackerel, and the factor which was attributed as the main cause of these changes, ocean warming. When describing their observations and/or concerns, stakeholders frequently mentioned ecological processes, mainly feeding interactions, e.g., among herring, cod and capelin, fish stock spawning and recruitment, and inter-annual environment-related fluctuations and variability of fish stocks. Ocean acidification as a relatively newly discovered additional factor was known to fewer stakeholders, but was incorporated as a model driver as it was a central topic of the project, and because it could be linked to warming effects via physiological mechanisms. Upon presentation of scientific results from laboratory experiments on ocean warming and acidification at the workshops, acidification was perceived as an additional concern, but uncertainty with regard to effects in the ecosystem was recognized.

A compilation of stakeholder statements and backgrounds on the topics in the interviews and the first workshop was published in an open-access report (Koenigstein and Goessling-Reisemann, 2014). Based on these interview results and discussions at the model-building workshop, the ecosystem elements and services of highest relevance to stakeholders, and which were suitable for integration in a foodweb-based model consistent with ecological knowledge, were selected to represent ecosystem service provision in the model. These were the commercially harvested fish stocks Atlantic cod, herring, capelin and halibut, as well as minke whales for food provision via fisheries. Mackerel, which was regularly mentioned in interviews as a newly immigrated fish species in Northern Norway, was not integrated because data on feeding interactions is not yet available. For tourism and recreation services, baleen whales (Humpback whales, *Megaptera novaeangliae*, and fin whales, *Balaenoptera physalus*), sperm whales (*Physeter macrocephalus),* killer whales (*Orcinus orca*), Atlantic puffin (*Fratercula arctica),* and other seabirds, as well as Greenland halibut (*Reinhardtius hippoglossoides*) and Atlantic cod stocks relevant for sports fishing were integrated. To represent a potentially threatened Arctic species dependent on sea ice, and because experimental data on warming and acidification impacts was available, Polar cod (*Boreogadus saida)* was also included. Lower trophic levels (phyto- and zooplankton) integrated primary production and food availability for fish. These elements thus represent the ecosystem services of food provision to industrial and small-scale fisheries, tourism and recreation as income-generating and cultural services (sports fishing, tours for whale, sea lion, and seabird watching, and other nature-related activities), and regulating and supporting services by carbon uptake via primary production and carbon export via sequestration. Species diversity (Shannon index) was incorporated as an indicator of ecosystem state on demand of stakeholders from the environmental sector in the model valuation workshop.

In the interviews, the most prominent socio-economic concern unrelated to climate change was pollution by oil drilling, mining sewage, dumping, or other sources, followed by fish market prices and labor availability. In the web-based survey conducted to gain additional insights on socio-economic factors and to prepare the valuation workshop, participants (12 completely answered surveys) rated sustainability-oriented management of resources, oceanographic changes, fish price, global economic growth and fishing quota as the most important external factors for their business or interest, with differences in importance among sectors (**Figure 2**).

Stakeholder Valuation of Model Projections

Stakeholder valuations of model projections in the second workshop differed markedly among stakeholder groups (Supplemental File S2: stakeholder valuations). Stakeholders noted that their valuations of the model projections depend on the trend displayed up to the stop in simulation time, i.e., the same stock level was rated more negatively when stock levels had been descending to this level as opposed to when they had ascended. The full development was only revealed after the simulation restarted to complete the run, reflecting uncertainty about the future in decision making in real life.

Projected changes in the warming-only scenario included increases in most fish stocks, orcas and "other seabirds," and decreases in sperm whales, seals, krill, and carbon export associated with zooplankton mortality. This scenario was rated as positive for fisheries, but as negative by tourism stakeholders due to decreased sperm whale levels, and caused concern for environmental conservation due to declines in species diversity and the collapse of Polar cod (**Table 2**). In the "warming and acidification" scenario, most species showed declines due to the energetic loss under ocean acidification incorporated in the model. Stakeholders from the fisheries sector viewed the projections for 2040 as "economically painful," given locally strong socio-economic impacts for fishers, and possible conflicts

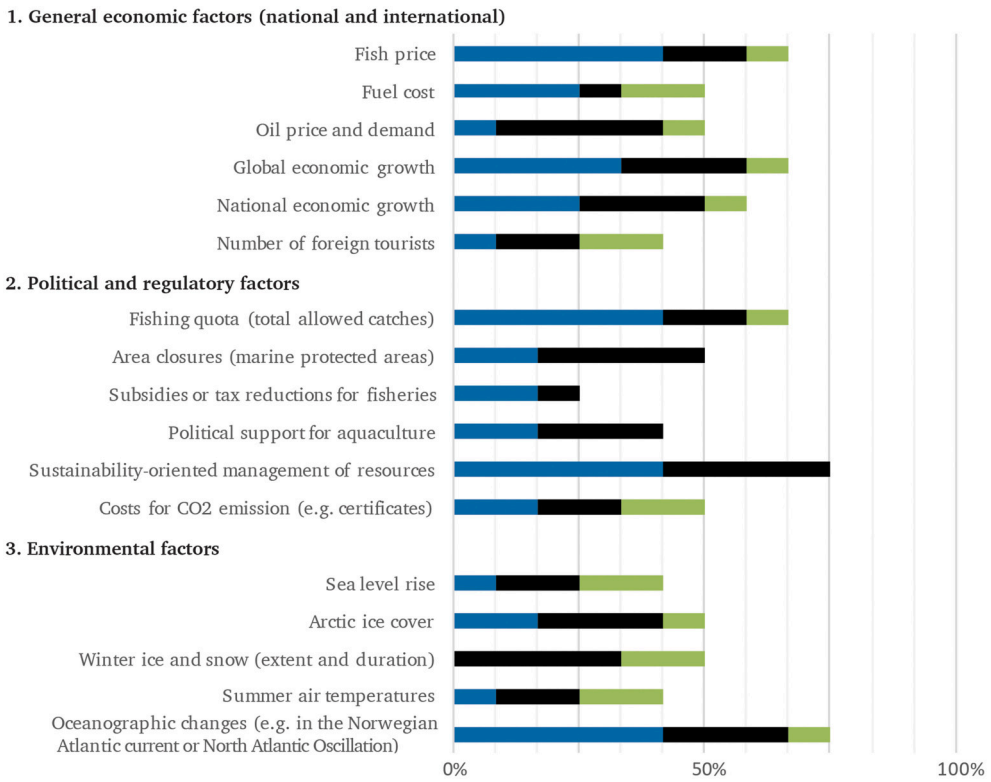

FIGURE 2 | Importance of selected economic, political and regulatory, and environmental framing factors for the business or interest of regional stakeholders (percentage of stakeholders denoting factors as "important") from a web-based survey, *N* = 12. Colors indicate self-designated sectors of participants: fisheries (blue, five participating stakeholders), environmental conservation (black, four persons) and tourism (green, three persons).

between large vessels and small-scale fishers. Further decreased stocks and the collapse of the Atlantic cod stock toward the end of the simulation in the year 2075 were perceived as leading to strong socio-economic impacts and a challenge for fisheries policies. At the model valuation workshop, present stakeholders from the fisheries sector noted that haddock, saithe, and the increasingly immigrating mackerel were also important species for regional fisheries (or expected to become important in the future), and should be added to the model.

Adaptation Options

Continued adjustment of fishing quota and intensified regulation of stock management were proposed as an adaptation option to climate change effects for fisheries in the interviews and the valuation workshop. Stricter quotas in times of declining stocks, potentially aided by a diversification of quotas and the regulation of by-catches may support a recovery of stocks. Larger vessels can also respond by moving further out to open waters, following moving fish stocks. In the valuation workshop, switching fisheries to other species (e.g., crab, mackerel, mollusks) was viewed as an additional option for reducing economic losses. Also, in the opinion of the stakeholders, increased fines for illegal fishing and catch limitations for tourist fishing may become necessary. Increased research on and investment in aquaculture as an alternative for food provision was discussed as a further adaptation option with explicit mention of sustainable and multi-species aquaculture, including species such as seaweeds and sea urchins, depending on market demand and cultural acceptance, and research into zoo- and phyto-plankton as a food source.

The tourism sector would also suffer from local collapses of small-scale fisheries, and generally decreased fish stock levels. One of the suggested adaptation options was to change marketing, focusing less on marine animals and more on cultural heritage and landscapes, and possibly on winter business to make use of the modest declines projected for orcas, and strengthen networking with small-scale fishers. The potential impacts of aquaculture on tourism and the possible use of aquaculture facilities as a tourist option could be explored. Stakeholders from environmental conservation called for an extension of marine protected areas, e.g., for nursery grounds of polar cod and whales, to mitigate ecological impacts of warming and acidification, and a stricter regulation of additional anthropogenic stressors, e.g., pollution by the deposition of mining wastes in fjords.

Commonly agreed policy recommendations of the participants of the second workshop for the projected warming and acidification scenarios were to explore the potential of increased seaweed farming and other alternative aquaculture food. For this, creating training and education, and conserving local economies by appropriate government strategies and incentives would be necessary. Abandoning the consumption

TABLE 2 | Stakeholder concerns about socio-economic impacts on their business or interest, and societal and personal adaptation options to climate change impacts, from personal interviews with stakeholder from the fisheries sector (F), tour providers and other tourism businesses (T), and environmental and other non-governmental organizations (E), ranked by sum over sectors (Σ), seven participants for each sector (one additional aquaculture representative for F).

	F	*T*	*E*	*Σ*
SOCIO-ECONOMIC CONCERNS AND OTHER IMPACTS ON BUSINESS				
Oil drilling pollution	5	1	1	7
Garbage dumping and other/unspecified pollution	3	2	1	6
Fish market prices	5			5
Mining discharges pollution	1		3	4
Labor market	3		1	4
Ecological impacts of aquaculture	1		2	3
Increasing aquaculture activity	1	1		2
Bad weather		2		2
Unfair distribution of fishing rights			2	2
Heavy metals/seafood health effects	1		1	2
General economic situation		1		1
Seismic exploration		1		1
CO_2 storage	1			1
ADAPTATION OPTIONS TO CLIMATE CHANGE IMPACTS				
Quota adjustments	6	4	1	11
Increase vessel search area	4	2		6
Protected areas/local management	1	1	2	4
New technologies	2		1	3
Reduce or compensate CO_2 emissions	2		1	3
Change target species	2			2
Move business to other location		1		1
Change profession		1		1

Number of instances mentioned across interviews (detailed interview questions given in Supplemental File S1).

of seagull eggs, seals and whales may be advisable, and would necessitate some cultural changes. Under the projected strong stock declines, renegotiations of fishing rights and quotas may become necessary. This would call for the respective political will and actions for conflict resolution among fisheries in Norway.

DISCUSSION

Integration of Stakeholder Perceptions about Climate Change and Ocean Acidification Impacts

All interviewed stakeholders reported plausible climate change effects on marine species, thus their personal accounts substantiated recent scientific results (Fossheim et al., 2015). However, many participants also pointed to the great variability in marine ecosystems in the region, especially fish stocks, which makes it difficult to distinguish environmental fluctuations from long-term change, and thus increases uncertainty about climate-related trends (Johannesen et al., 2012). Because of the high importance of ecological processes and species interactions for stakeholders in the initial interview series, the ecosystem model was based on the foodweb interactions among pelagic and demersal species in the Barents Sea (Bogstad et al., 2015), explicitly integrating the biological processes of interest (Koenigstein et al., 2016). This enabled the incorporation of a large fraction of the species of interest to the stakeholders into the model, and also allowed us to incorporate fishing quotas as the most important adaptation option and anthropogenic driver initially identified in the interviews. However, this choice of model structure came at the expense of being unable to consider spatially explicit distribution shifts and benthic species such as macroalgae, shellfish, or echinoderms. These are often restricted to coastal and fjord habitats and undergo highly localized conditions, e.g., with regard to freshwater influx or hypoxia. In comparison to mental models or other probabilistic models often used in participatory modeling, the deterministic ecosystem model developed here resolves to some degree the emergent behavior of the ecosystem under different conditions, and enables the integration of scientific knowledge, assessing dynamic trade-offs in effects among species and among biological processes under future climate change conditions (see subsection "Towards ecological realism...").

The main non-climate related concern was pollution, caused by oil and gas exploration, residues from mineral mining along the coasts, or shipping. For whale watching companies, noise pollution from shipping and seismic exploration was a prevalent concern. Due to high scientific uncertainty and highly localized ecological impacts, these concerns could not be incorporated into the model. Also, as aquaculture is not directly linked to marine

foodwebs, and was not often mentioned as a factor or concern by the stakeholders in the interview phase, the aquaculture sector was not further considered at this point. Melting of the Arctic sea ice and sea level rise, although of high relevance in the interviews, were also not incorporated due to unclear links to the marine organisms in the model. The scenario-based incorporation of pollution, sea ice and aquaculture is planned for a future extension of the model.

Although impacts of marine ecosystem changes on tourism are far less prominently covered in the scientific literature and the media, the relevance of shifts in marine food ecosystems was immediately obvious to most interviewed stakeholders from the tourism sector. Worldwide, biodiversity loss and reduced aesthetic value of landscapes are expected to impact tourism under climate change, among a range of other factors (Simpson et al., 2008). Tourism in our study region is to a high degree dependent on certain locally abundant species (sperm whales, cod, halibut, seals), thus pointing to highly localized climate change impacts on tourism and recreation, and to the necessity for a detailed assessment of local conditions. Biodiversity and cold-water coral reefs were also mentioned as threatened by climate change, and valuation studies point to a very high willingness-to-pay of the Norwegian public to conserve cold-water coral reefs (Aanesen et al., 2015). Stakeholders of all sectors had agreed in the model-building workshop on conserving the protected status of coral reef areas (e.g., prohibition of trawl fisheries) and not including reefs in the model, putatively reflecting the cultural and existence value of this reefs, but also low economic importance of these areas for fisheries.

Adaptation Options for Stakeholders to Projected Ecosystem Changes

Stakeholder valuations and discussions at the valuation workshop showed that small-scale fisheries and tourism businesses have less, or more constrained adaptation options for the ecological changes projected by the model (cf. **Table 3**). For instance, small-scale fishers often cannot follow moving fish stocks far away from the coast, or have the funds to invest in different gear. The commercially relevant whale-watching and other tour activities in the area are heavily dependent on the sighting probability of certain species (e.g., sperm whales). Adaptation options for sightings decreasing below a critical level would entail drastic changes in the character of tourism activities, with probable reductions in customer numbers and income.

Fishing quota adjustments were seen as the primary adaptation option by fisheries and tourism stakeholders. However, small fishing boat owners, often located in more remote areas and with a partial income from sports fishing tours, perceived quota adjustment as less likely to be a sufficient measure for climate change impacts than stakeholders organized in fisheries associations. In a situation with reductions in several co-used fish stocks, as projected under the combined warming and acidification scenario, suggested adaptation options ceased to be sector-exclusive, and conflicts were expected to increase among industrial, small-scale, and sports fishing, when catch efforts would be increasingly concentrated on the remaining stable species (e.g., halibut). Conflict potential among and within sectors led to the recognition of the need for increased cooperation and networking among user groups. Increased investment in aquaculture was a heavily discussed adaptation option at the valuation workshop, which is very relevant worldwide in the context of securing food provision under overfishing of many fish stocks (FAO, 2014). Yet, there was a range of concerns from stakeholders with regard to the ecological impacts of aquaculture (pollution from nutrients and antibiotics, escaped individuals and parasites, spatial use conflicts). Also, the viability of this option depends on economic factors and the continued provision of small pelagic fish by capture fisheries for fish meal production. Stakeholders agreed on the need for increased research on ecological impacts and more sustainable methods of aquaculture production.

Environmental conservation stakeholders adopted a broader view on ecosystem functioning, asking for inclusion of a biodiversity indicator during the valuation workshop, and thus brought a precautionary aspect into the discussion. Declines in zooplankton and phytoplankton biomass levels were also negatively rated by stakeholders from the fisheries sector, reflecting concerns about indirect impacts on fish stocks. The discussion among different stakeholder groups was also shaped to some extent by implicit societal values, as e.g., the high cultural importance of the Atlantic cod fishery in Northern Norway and the significance of marine species for the coastal indigenous Sámi were mentioned. In the discussion of societal adaptation options, a focus on options which were undisputed among the workshop participants was observed, while options which would have more potential for conflicts (e.g., total catch bans or area closures for certain uses) were avoided topics. The group evaluation approach thus reproduced certain factors and constellations which govern societal decision-making, e.g., implicit valuing, social agreement, and power balances among stakeholders.

These results point to considerable differences in adaptation capacities to climate change impacts among stakeholders in the Northern Norwegian Sea and Barents Sea region, with less resilient small-scale fishers and tourism businesses. Potential food-web mediated impacts e.g., on whales and seabirds or lower trophic levels would thus lead to governance-relevant trade-offs among fish provisioning and other ecosystem services. As model development is ongoing and valuations are based on a preliminary, not finally validated version of the model, projections and societal adaptation options at this stage should be regarded as describing possible paths of system behavior. As framing and limiting conditions for stakeholder decisions have been identified during the valuation workshop, stakeholder decisions will be transferrable to validated projections as these become available.

Toward Ecological Realism in Assessments of Climate Change Impacts on Ecosystem Services

The participating stakeholders' main ecological concerns and the most relevant ecosystem services have been integrated into the developed ecosystem model, considering the scientific knowledge

TABLE 3 | Projected ecological impacts of climate change and ocean acidification for which a need for adaptation measures was recognized among 18 stakeholders during a model valuation workshop.

	Impact	Stakeholder rating (2040/2075)	Adaptation option	Condition/drawback
"WARMING ONLY" SCENARIO				
Fisheries	Increased fish stock levels (decreases in capelin 2075)	+4/+3	None (continue good fisheries management)	–
Tourism	Declines in sperm whales and seals, robust fish stocks, increases in orcas	–2.5/–3	Increase tour/search distance	Customer acceptance, increased fuel consumption
Conservation	High biomasses, but decreasing species diversity and polar species	–3/–4	Protect nursery areas (e.g. of polar cod and whales)	Political will
	Decreases in krill and carbon export	–3/–4	–	–
"WARMING AND ACIDIFICATION" SCENARIO				
Fisheries	Fish stock declines/cod stock collapse, zooplankton declines	–2.5/–4	Stricter catch regulations	Social quota redistributions
			Switch target species	Adaptation of catch gear and vessels
			Increased investment in aquaculture	Research on ecological impacts and market acceptance, conflict with fisheries
Tourism	Fish stock declines	–2/–3	Strengthen networks/cooperation with fishers	Resolution of conflicts with fishers
	Decreases in mammals and seabirds	–3/–5	Change tour focus	Customer acceptance for less ecological attraction
Conservation	Decreases in fish, mammals, zooplankton, and biodiversity	–4/–5	Area closures	Use conflicts
			Stricter regulation of other stressors	Economic impacts

Relevant aspects of impacts, with stakeholder rating on a scale from +5 to –5, adaptation options suggested by stakeholder groups, and conditions or potential drawbacks given for these adaptation options. Stakeholder rating +5 reflects an extremely beneficial effect on stakeholder group, –5 reflects a catastrophic effect.

on interactions among ecosystem elements and processes, and helping to build trust in the model. Importantly, this model structure also enables the assessment of indirect ecological climate change impacts (e.g., on marine mammals and seabirds relevant for tourism), thus exploring possible trade-offs among ecosystem services. The process-based structure of the developed model thus enables a more realistic representation of biodiversity (Queirós et al., 2015) and improves the potential for integrating empirical data into climate change projections (Koenigstein et al., 2016).

Models used in ecosystem service assessment are usually highly simplified in order to be easily understandable, and it is a challenge to communicate scientific uncertainty (Ruckelshaus et al., 2013). Our stakeholder-informed ecosystem model development represents an intermediate approach between participatory modeling of stakeholder perceptions without a direct empirical basis of ecosystem behavior, and the use of models e.g., in fisheries management, where a pre-developed model is often brought to the stakeholders and explained by scientists. The model developed and used here reproduces the inter-annual variability in ecosystem dynamics and interdependent fluctuations in fish populations observed by the stakeholders, which are governed by climatic fluctuations linked to the North Atlantic Oscillation (Ottersen et al., 2001; Dalpadado et al., 2012). The reflection of their perceptions in the model enabled the participants to "play" with it during the workshop, exploring effects that were in some cases not expected by the model developers, and finding their own explanations for model behavior. Importantly, it was understood and accepted that the model is not a scientifically proven prediction of the future, but has a range of internal uncertainties e.g., in parameter ranges and structural reliability, and depends on uncertain external parameters with regard to climatic and economic factors. The observed influence of the displayed trend in model projections on stakeholder valuations indicates that stakeholders implicitly extrapolate model trends (and fluctuations) into the future, incorporating the perceived uncertainty into their decision.

A focus on ecosystem services during model development helped to limit model complexity to ecosystem elements that can be linked to societal uses. The ecosystem service concept promises to improve the participation of stakeholders in the management and conservation of marine areas and resources (Kittinger et al., 2014; Leenhardt et al., 2015). However, ecosystem services have been criticized as being too simplistic and too much focused on monetization (Norgaard, 2010; Silvertown, 2015), and cultural services are often not considered in ecosystem service assessments (Chan et al., 2012). We

addressed these issues through the use of a process-based ecosystem model, taking into account ecological complexity and variability, and dynamic trade-offs among ecosystem services. Cultural and ethical values were implicitly considered in the discourse-based valuation, which should improve the perceived legitimacy of the derived recommendations (Wilson and Howarth, 2002).

Altogether, our approach to combine stakeholder consultation and ecosystem modeling has been successful in conveying scientific backgrounds and associated uncertainties of climate change processes to stakeholders, motivating stakeholders to participate in the evaluation of impacts and the identification of societally acceptable adaptation options. In a next step, insights on environmental and socio-economic framing factors gained in this study will be integrated into consistent scenarios, and stakeholders will again be involved in finding adaptation options under these scenarios using an extended and validated version of the model. This forms a methodological basis for developing adaptation strategies under scientific uncertainties, that are informed both by knowledge about ecosystem dynamics and by societal uses and values. Characterization of societal responses in connection with the identified properties of the social-ecological system (e.g., species composition, ecological dynamics, human uses and user groups) can yield insights for research in situations with lower data availability and lower level of knowledge of stakeholders, where a comparably high model detail may not be possible.

CONCLUSIONS

Our integrative ecosystem model was designed to consolidate the dynamic simulation of climate change impacts with stakeholder perceptions and concerns. By reflecting the complexity of the biological processes underlying ecosystem dynamics, individual scientific results of ocean warming and acidification research can be integrated and communicated, interactions and uncertainties discussed with affected stakeholders, and trust gained in long-term projections under climate change. Stakeholder-informed ecosystem modeling and discourse-based evaluation are thus useful tools for ecosystem service assessments with multiple user groups, investigating trade-offs and balancing interests under multiple system drivers. Integrative models of intermediate complexity, like the one developed in this work, have the potential to improve understanding of regional social-ecological systems, and help to identify options for adaptive governance of marine systems under climate change and human use.

AUTHOR CONTRIBUTIONS

SG conceptualized the work program. SK conducted and evaluated the interviews, SG and SK conducted and evaluated the stakeholder workshops. SK, MR, and SG conceptualized, developed and validated the simulation model. SK drafted the manuscript, MR and SG contributed to the manuscript and reviewed the final version.

ETHICS STATEMENT

All human participants took part voluntarily and gave oral or written informed consent to participate. They also consented to the use of their statements for the study after anonymization. The purpose and background of the study and the planned use of the results were made transparent prior to interviews, surveys and workshops. The confidentiality of personal information and the right to omit uncomfortable questions or withdraw from the interview at any stage were provided.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fmars.2016.00093

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Bridging for Better Conservation Fit in Indonesia's Coastal-Marine Systems

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Efforts to improve the fit between conservation initiatives (e.g., marine protected areas, no-take zones) and the dynamic social dimensions of coastal-marine systems remain underdeveloped. We empirically illustrate here how opportunities to enhance "conservation fit" are influenced by bridging organizations that serve to (1) better align conservation initiatives with characteristics of the social context that influence conservation outcomes (e.g., institutions, culture, values, local practice), (2) foster coordinated and adaptive approaches to conservation that are reflective of multiple perspectives and knowledge, and (3) better connect people and conservation actions across jurisdictional and geographical boundaries. Qualitative methods were used in this research, including semi-structured interviews, observation of key events and meetings, and literature review. We draw from three coastal-marine conservation cases in Bali, Indonesia, that exemplify different approaches to bridging for conservation fit: the Bali MPA Network, the Nusa Penida MPA, and the East Buleleng Conservation Zone. Our synthesis of these cases identifies different strategies used by bridging organizations to deal with conservation fit issues, including their capacity to integrate actors and perspectives using flexible approaches, actualize hybrid forms of decision-making, build capacity and leadership, and foster cross-scale conservation and scale-bridging social networks. We also examine the limitations of bridging organizations and offer direction for future research for coastal-marine conservation in Indonesia specifically, and the Coral Triangle region generally. More broadly, this analysis contributes new insights on emerging forms of governance designed to deliberatively fit conservation initiatives to coastal-marine social-ecological systems experiencing rapid change.

Keywords: bridging organizations, conservation, Coral Triangle, fit, governance, Indonesia, marine protected area, social-ecological system

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INTRODUCTION

The success of marine conservation in southeast Asia's Coral Triangle (CT) requires modes of governance that deliberately fit conservation initiatives to underlying social dimensions. Insufficient consideration of social dimensions in conservation initiatives has contributed substantially to limited progress in this regard. To this end, we investigate the issue of "conservation fit," which we refer to here as the dynamic alignment of the governing system for conservation and

the social dimensions of a system that influence the outcomes of conservation policy and practice.

Governance is an umbrella term that refers to the "...integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society..." (Biermann et al., 2009, p. 4). For our purposes, governance describes the interactions of different actors and networks that formulate and implement conservation. By social dimensions we refer to the multilevel patterns of interaction between actors and organizations, their values, interests and social customs, and the processes and instruments that drive, support or constrain the practice of conservation (*sensu* Galaz et al., 2008; Meek, 2013; Epstein et al., 2015). This characterization recognizes that governance systems affect, are affected by, and are also a part of the broader suite of social dimensions that make up coastal-marine social-ecological systems.

To examine the issue of conservation fit, we focus on the role of bridging organizations, which are entities that connect social actors or groups through some form of bridging process (Crona and Parker, 2012). These organizations link actors and actions to facilitate coordinated, integrated responses in contexts where resources or capacity are limited. However, few studies have explored their role in developing, implementing and adapting conservation initiatives, or their influence on conservation outcomes (e.g., Jamal et al., 2007; Schultz and Lundholm, 2010; Jacobson and Robertson, 2012; Bodin et al., 2014). Building on previous work in the region (Berdej and Armitage, 2016), this paper empirically demonstrates that bridging organizations can help to better align conservation initiatives with their social context, foster appropriate processes and instruments to pursue coordinated and adaptive conservation, and better connect people and conservation actions across scales and levels. However, as this paper also shows, bridging organizations are not without their limitations, and we identify a number of constraints or barriers that require further consideration.

Our focus here is on the congruence of the governing system for conservation and the other crucial social dimensions of a system that influence overall conservation effectiveness—what we term "conservation fit." The concept builds on critiques of conservation initiatives that point to a lack of meaningful engagement with, and integration of, social dimensions such as socioeconomic or cultural context, stakeholder relations, knowledge diversity, or the multiplicity of political scales and domains of action (see CT: Clifton, 2009; Foale et al., 2013; Fidelman et al., 2014; von Heland et al., 2014). Where there is insufficient consideration (or "poor" fit)—as in cases where new conservation policies and rules are introduced without attention to local or indigenous legacies (Majors, 2008), or where trade-offs between biodiversity conservation and development are overlooked (Foale et al., 2013), problems of ineffective and inefficient conservation often result. As such, the concept of conservation fit is a useful frame to understand why certain conservation initiatives may not work as intended and how they might be strengthened via bridging organizations.

Enhancing conservation fit in the CT is challenging because of the immense diversity of actors and interests across geographical and jurisdictional scales, and the differing socio-political, cultural and economic contexts (e.g., Mills et al., 2010; Fidelman et al., 2012; Foale et al., 2013; von Heland et al., 2014; Cohen and Steenbergen, 2015). In Indonesia, the partial decentralization of government has afforded greater opportunity for participatory approaches in conservation, but has also contributed to political tensions between levels, governance fragmentation and conflicting government policies (Patlis, 2005; Wiadnya et al., 2011). Further, marine conservation efforts in this region are facing rapidly expanding and increasingly mobile populations, emerging markets for marine commodities, and a limited ability to enforce rules and regulations (Majors, 2008). Many scholars across the CT have stressed the importance of connecting people and conservation practice in ways that communicate knowledge and foster learning, reconcile diverse objectives and views, and which forge relations across domains and governance levels (e.g., Fidelman et al., 2012; von Heland et al., 2014; Pietri et al., 2015). However, until recently, relatively little work has explicitly investigated the influence of bridging organizations in facilitating these needs in the CT, and none has examined their role in the practice of conservation in Indonesia (see Berdej and Armitage, 2016).

In the following section, we introduce the concept of conservation fit and examine bridging organizations as an organizational strategy to foster fit. We outline three categories of conservation fit that serve to frame the analysis, and highlight their key challenges in the CT. We then present three cases from Bali, Indonesia, that illustrate the role of bridging organizations in different conservation contexts, and draw on these cases to generate insights about key strategies applied by bridging organizations to influence conservation fit. Finally, we identify a number of constraints or barriers that require further consideration, and speak to commonalities underlying successful bridging approaches that are relevant beyond the particular conservation settings we examine here, recognizing that each case reflects a slightly different social, political and ecological context.

THEORETICAL BACKGROUND

Defining the Problem of "Conservation Fit"

Our concept of "conservation fit" emerges from a broader discourse on institutional and governance fit. For example, fit has been discussed as part of institutional dimensions of global environmental change (Young, 2002; Ekstrom and Young, 2009), resilience of social-ecological systems (Folke et al., 1998/2007; Galaz et al., 2008; Epstein et al., 2015), and common pool resources (Ostrom, 2007). Much has been written on how well governing systems "fit" ecological dynamics (e.g., Folke et al., 1998/2007; Ekstrom and Young, 2009), and, more recently, on the fit between governing systems and social dynamics (e.g., Brown, 2003; Meek, 2013; Pittman et al., 2015). However, exactly what constitutes a good fit and how such fit can be achieved remains a research puzzle

Abbreviations: CI-I, Conservation International Indonesia; CT, Coral Triangle; CTC, Coral Triangle Centre; CTI-CFF, Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security; RC-I, Reef Check Indonesia.

(Ekstrom and Young, 2009; Bodin et al., 2014). In particular, limited understanding of the conditions and implications of fit for the practice of marine conservation is a gap in the literature.

Conservation initiatives should be more effective in the long-term where the governance system is aligned with, and responsive to, the complexity and dynamism of the social system (e.g., Brown, 2003; Christie et al., 2003; Christie, 2004, 2011; Shackeroff et al., 2009; Ban et al., 2013; Kittinger et al., 2014; von Heland and Clifton, 2015). Our concept of fit responds to calls for more participatory and pluralistic conservation approaches that allow for learning and adapting (Berkes, 2007; Armitage et al., 2012), clarify hard-choices and trade-offs (Hirsch et al., 2011), and which seek social legitimacy and ethical imperatives in conservation (Brechin et al., 2003; Mascia, 2003)—all of which have been difficult to actualize in practice, as detailed below.

A "poor" fit, as mentioned, can undermine the effectiveness of conservation initiatives by resulting in inadequate understanding of contentious social issues, unintended negative consequences, missed opportunities for positive change, and an incomplete understanding of the system (Christie et al., 2003; Christie, 2011). Situations of "poor" fit (or misfit) can arise, for example, where governance underplays community norms and livelihood needs (Clifton, 2009; Ferse et al., 2010), or is unable to account for diverse worldviews and belief systems (Majors, 2008; Clifton and Majors, 2012). Alternatively, a "good" fit should contribute to the salience of conservation by generating meaningful benefits, improving perceived legitimacy and sense of ownership, and by reducing the probability of negative impacts. Positive examples include cases where conservation initiatives are hybridized with local or customary practice (Cinner and Aswani, 2007), social networks are built to connect local management to higher-level policy-making (Cohen et al., 2012), or where governance learning networks are created to bridge cultural and jurisdictional boundaries (Pietri et al., 2015).

Improved conservation fit alone may be necessary, but not sufficient for conservation success. Even where conservation initiatives are compatible with social dimensions, they may not adequately provide for ecological dimensions or "ecological fit." Although, our focus in this paper is on social dimensions, we join other authors in affirming the importance of engaging both dimensions in the context of developing and ongoing conservation initiatives (e.g., Epstein et al., 2015). There is also no "ideal" conservation fit since social systems and the factors that influence them differ and are constantly changing. Instead, fit is a means to an end, not an end in itself. For analytical purposes, we distinguish three general categories of conservation fit associated with: (1) aligning conservation initiatives with characteristics of the social context (e.g., institutions, culture, values, local practice), (2) enabling governance processes and instruments to bring together and meaningfully engage actors, their interests, norms and knowledge to pursue coordinated and adaptive conservation, and (3) effectively linking conservation initiatives and social actors across scales and levels (**Table 1**). We make no claim to have articulated all social dimensions influencing conservation policy and practice at this point. Rather, these categories are reflective of the main issues from the literature on fit theory, and which are derived from applicable cases and lessons-learned from across the CT.

Attempts to identify strategies to expand the inclusion of social dimensions in conservation in the CT have been plentiful (e.g., Lowry et al., 2009; Mills et al., 2010; Green et al., 2011; Foale et al., 2013; Weeks et al., 2014a,b; Berdej and Armitage, 2016), and a number of relevant conceptual frameworks are proposed (e.g., Ban et al., 2013; Kittinger et al., 2014). All are useful when discussing issues of conservation fit. However, there is limited practice-based guidance on how to move from recognition of the need for greater inclusion of social dimensions to actual operationalization of best practices in different contexts. Practice-based strategies to grapple with conservation fit issues (via e.g., trade-off analysis, ecosystem-based management, integrated coastal zone management) have been slow to emerge and face a range of implementation barriers (e.g., Folke et al., 1998/2007; Christie, 2011; Hirsch et al., 2011; Kittinger et al., 2014). In the next section we introduce bridging organizations as one potential way to help actualize the conditions and processes necessary to enhance conservation fit.

Bridging Organizations for Fit

Bridging organizations can help to improve conservation fit by taking on a number of roles and responsibilities. A bridging organization, as mentioned, is defined as an entity that connects diverse actors or groups through some form of strategic bridging process (Crona and Parker, 2012). These organizations come in many shapes and sizes, as well as levels of formalization. Brown (1991) argued that bridging organizations are central players in an increasingly multi-sectoral paradigm and hold a critical role in liaising actors to solve problems that neither would have been able to solve on their own. These organizations can provide an arena for knowledge co-production, trust building, sense making, social learning, vertical, and horizontal collaboration, and conflict resolution (e.g., Hahn et al., 2006; Olsson et al., 2007; Berkes, 2009; Schultz and Lundholm, 2010; Crona and Parker, 2012). Furthermore, they can fill technical and financial gaps by linking experts and expertise across levels of society, and by mobilizing ideas, resources and leadership.

Inherent in bridging different social actors is often a need to overcome some degree of mistrust. Hence, consensus building and conflict resolution are important features in governance, but can be difficult to establish and maintain (Folke et al., 2005). Bridging organizations can facilitate depoliticized arenas that contribute to lowering institutional and cultural barriers between stakeholder groups and aligning their interests (Crona and Parker, 2012). Kowalski and Jenkins' (2015) case study on the science-policy interface of ocean management showed that bridging organization leadership coordinated collective action and resolved group issues within and among scientific and policy communities. Developing neutral space is advantageous for dealing with the ambiguity of multiple objectives, entrenched

TABLE 1 | Categories of conservation fit and their key challenges in the Coral Triangle based on literature review[(a)].

Fit category	Explanation	Key challenges	CT-related references and examples [(b)]
Aligning with social context	Governance should strive to align with the dynamic socio-political, cultural and economic characteristics of the social system in shaping conservation initiatives	Identifying and integrate patterns of resource use, norms, interests, and priorities How to ensure appropriate and fair incentives for conservation (economic, social, political) How to merge existing informal/customary management systems and science-based conservation Valuing and incorporating local expertise and stakeholder/traditional knowledge systems	Cinner and Aswani, 2007; Majors, 2008; Clifton and Majors, 2012; Cohen and Steenbergen, 2015; Glaser et al., 2015
Use of appropriate governance processes and instruments	Need to foster appropriate collaborative and adaptive processes and instruments in developing, implementing and adapting conservation initiatives	Broadening meaningful stakeholder engagement and deliberation Need to foster capacity for (local) stewardship, empowered governance, and strong leadership Identifying and negotiating trade-offs btw objectives for e.g., biodiversity, fisheries, food security Platforms are needed for knowledge exchange & fostering learning networks Mechanisms are needed for conflict resolution	Cohen et al., 2012; Fidelman et al., 2012; Foale et al., 2013; Pietri et al., 2015
Linking across scales and levels	Social actors and actions for conservation should be connected, coordinated and supported across scales and levels of governance	Overcoming scale-dependency to allow for multi-lateral actions, and cross-scale/multi-level linkages Resolving jurisdictional and functional overlaps btw governance units at different levels Fostering social networks needed to e.g., leverage resources, expertise and capacities across scales and levels	Lowry et al., 2009; Mills et al., 2010; Green et al., 2011; Rosen and Olsson, 2013

[(a)] *This list is not intended to be inclusive of all issues of fit in the CT.*
[(b)] *Many of the authors and examples listed here are applicable to multiple fit categories simultaneously.*

conflicts, and for navigating power differentials among social actors.

Important contributors to successful conservation often include government and intermediary non-governmental organizations (NGOs), as well as local actors such as community groups, civil society organizations, and customary decision-making bodies. By building linkages to external social actors, bridging organizations help those at the local level to cross geographical and political scales in ways that would have otherwise been difficult, if not impossible. Hahn et al. (2006) showed how a bridging organization linked local actors with other levels of governments to generate legal, political and financial support in a wetlands landscape in Sweden. Through bridging, communities and others are able to gain access to non-local expertise and resources, including technical and financial resources, sources of technology, donors, and alternative trading networks (Folke et al., 2005). Such access can enable capacity building for more engaged or empowered involvement in conservation (e.g., Jamal et al., 2007).

However, the literature also suggests a need for a more sophisticated understanding of the influence of bridging organizations on social interactions and social networks for governance generally (Crona and Parker, 2012), and for conservation governance specifically (Berkes, 2007; Jacobson and Robertson, 2012). Despite an increased scholarly interest in bridging organizations, few have empirically addressed their function and implications in conservation contexts (e.g., Hahn et al., 2006; Jamal et al., 2007; Jacobson and Robertson, 2012). This investigation builds on our recent work in the region, in which we report that bridging organizations contribute in several ways to positive governance outcomes by nurturing social networks and interactive processes (Berdej and Armitage, 2016). Here, we seek to further examine their capacity to deal with issues of conservation fit. We also expand the discussion of bridging organizations to assess the different ways through which they develop, implement, and adapt conservation initiatives to fit a broad range of social dimensions associated with conservation of coastal-marine systems (e.g., cultural context, local politics, knowledge systems, multiplicity of scales and levels).

MATERIALS AND METHODS

Research Context and Sites

The Coral Triangle (CT) comprises marine waters of Indonesia, Philippines, Malaysia, Papua New Guinea, Solomon Islands, and Timor-Leste. The region is globally regarded for its extraordinary marine biodiversity (Allen, 2008) and its exceptional importance to local economies and societies (CTI Secretariat, 2009). As part of efforts to address marine resource decline, the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) was established in 2009—a collaboration among the six nations to better manage the region's coastal and marine resources. The CTI-CFF sets out a diverse set of goals for the region, from an ecosystem approach to management of fisheries to climate change adaptation. The establishment and effective management of marine protected areas (MPAs) are seen as a key conservation tool in this regard, and comprise the CTI-CFF's third goal.

Each of the CT nations has unique ecological, socio-cultural and governance arrangements for defining and establishing MPAs and other conservation initiatives. In Indonesia, the Government has committed to establish 20 million hectares (or 6.5% of territorial waters) of marine conservation area by 2020. MPAs here are declared and administered by national, provincial, and regency or municipal governments, and take on a number of forms (see White et al., 2014). In addition, there are a growing number of community-based conservation areas. Of the 15.7 million hectares of MPAs already designated, however, the majority of MPAs (>85%) offer little to no protection due to budgetary constraints, governance weakness, lack of marine management capacity, and political will (Burke et al., 2012; White et al., 2014). As stated above, these challenges are compounded by a deficit of understanding and incorporation of the social dimensions of conservation (Clifton, 2009; Foale et al., 2013; Fidelman et al., 2014; von Heland et al., 2014).

Our research focused on three cases across Bali, Indonesia (**Table 2**). Cases were selected based on literature review and consultations with Indonesian partners and other experts using geographic and thematic criteria of relevance (e.g., Indonesia, marine, conservation, bridging, coastal-resource management, sharing, learning). Additional details on rationale for selection of bridging organizations can be found in Berdej and Armitage (2016). The use of the term MPA in our cases refers to a type of Indonesian conservation strategy entitled "Kawasan Konservasi Perairan" (literally translated to "aquatic conservation area"), whose definition encompasses both marine and freshwater areas that are managed by a zoning system.

Data Collection and Analysis

Data was collected over eight-months in 2013–2014, with a follow-up visit in January-February 2015. A case study approach (Yin, 2003) was used and included semi-structured interviews ($n = 53$ Nusa Penida, $n = 54$ East Buleleng, $n = 20$ Bali MPA Network), participant observation of key meetings ($n = 5$) and a literature review. Interviewees included individuals from government ($n = 17$), NGOs ($n = 12$), resource user groups ($n = 19$), other community groups ($n = 11$), traditional bodies ($n = 3$), private sector businesses ($n = 14$), universities ($n = 1$), and other ($n = 1$). Some of these organizations were affiliated with more than one study site. A combination of snowball sampling and purposive (or judgmental) sampling methods (Hay 2010) were used to identify participants. Snowball sampling is a technique whereby the current participant nominates subsequent participants (Hay, 2010). The approach is helpful to identify "hidden populations" or key individuals that might have otherwise not been known. Purposive sampling occurs where the researcher purposefully identifies individuals from the population based on her/his own knowledge and judgment.

Themes covered in interviews included basic organization details, affiliations and relationships, conservation management and implementation processes, interactions and perceptions of bridging organizations, and constraints and barriers. Interviews were conducted face-to-face in English or Bahasa Indonesia with the aid of a local research assistant. The majority of interviews were recorded by handwritten notes, given that a digital voice recorder was deemed inappropriate to the context. Key public meetings were observed related to each of the cases on the topics of marine planning and MPA socialization. A literature review was conducted to complement and validate data collected, and focused on thematic areas stated above. Documents included annual reports, policy briefs, copies of presentations and newspaper articles.

Data analysis was framed around the three conservation fit categories outlined in the previous section (**Table 1**). These categories were developed from a review of relevant literature on fit theory, and using applicable cases and lessons-learned from across the CT. Analysis of qualitative data from the field (including interviews, participant observation and some document collection) was carried out using an inductive approach to provide insights into emerging patterns of strategies used by bridging organizations. These findings were sorted and grouped, and then linked to one of the three conservation fit categories. We acknowledge that the use of pre-defined categories may overlook or restrict other themes. To counter this, we intentionally chose broad categories to allow for findings to emerge as unrestrained as possible from the raw data, while also linking them to the theoretical base driving the research.

This research was carried out with approval from the Office of Research Ethics at the University of Waterloo (Ethics Approval Number 17930). All participants gave verbal consent prior to conducting interviews. An information sheet explaining the purpose of the research and how data would be used was read and/or translated verbally to participants. Participants were made aware of their right to withdraw participation from research at any time.

CASE STUDIES

We introduce three cases below that are illustrative of the diverse ways bridging organizations can influence conservation fit in Bali. This section is organized by case, as opposed to fit

TABLE 2 | Study site summaries.

	Location	Type of conservation initiative	Management status	Active bridging organization(s)
Bali MPA Network	Across all regencies, Bali Province (head office in Denpasar)	MPA Network	Initiated (2011)	Conservation International Indonesia
Nusa Penida MPA	Klungkung regency	Regency-level MPA	MPA established (finalized March 2014)[(a)]	Coral Triangle Center
East Buleleng Conservation Zone	Buleleng regency (Tejakula sub-district)	Local marine management areas & regency-level MPA	LMMAs established (2008–2009) MPA declared (August 2011)[(a)]	Reef Check Indonesia & The Indonesian Nature Foundation

[(a)] *The difference between an "established" MPA and a "declared" MPA is the state of its spatial zoning and management plans.*

category, to give the reader a more holistic understanding of the conservation setting and of how bridging organizations are situated therein. Each sub-section briefly outlines the context, followed by an introduction of the bridging organization or organizations, and an overview of their roles and responsibilities. Results are synthesized according to each of the fit categories of our framework in the section that follows.

Toward a Bali MPA Network—Crossing Scales, Crossing Boundaries

Context

The province of Bali is located in the westernmost end of the Lesser Sunda Islands, covers almost 565,000 hectares, and comprises the main island of Bali and a series of satellite islands. High marine biodiversity is documented in the area (Mustika et al., 2012), and important habitats include coral reefs, mangrove forests and seagrass beds. There are over four million people in the province, spread across eight administrative regencies and the capital city of Denpasar. Coastal and marine resources are a cornerstone of Bali's economies and societies, supporting livelihoods such as fisheries, ornamental fish collection, mariculture (e.g., shrimp, fish, seaweed) and a burgeoning marine tourism industry.

Partial decentralization, as mentioned earlier, has led to fit challenges associated with poor coordination between levels of government, policy inconsistencies, and non-conformities in the licensing, policing and use of coastal-marine resources between regencies (see Patlis, 2005). The inequitable distribution of assets and access to these resources has fueled ongoing conflicts between villages, between regencies, and between sectors. Together, these have hindered efforts to address pressures from overfishing and destructive fishing practices, marine litter and nutrient run-off, and the rapid development of coastal areas and watersheds (Mustika et al., 2012). In this context, the environmental NGO Conservation International Indonesia has emerged as a key player in the movement toward coordinated, cross-scale conservation practice.

Conservation International Indonesia (CI-I)

Since 2010, Conservation International Indonesia has been a driver behind the development of a Bali MPA Network (hereafter "Network"; Indonesian: Jejaring Kawasan Konservasi Perairan). CI-I has been active in Indonesian seascapes in general since 2004 with a mission of "building upon a strong foundation of science, partnership and field demonstration, [to empower] societies to responsibly and sustainably care for nature, our global biodiversity, for the well-being of humanity" [CI-I (Conservation International Indonesia), 2015: website]. In Bali it has taken on a number of roles and responsibilities, including: biological monitoring to inform Network design; identification and engagement of partners; coordination of activities related to Network planning; and facilitated development of a management planning document (hereafter "Blueprint").

To initiate planning for the Network, CI-I and its partners facilitated a multi-stakeholder workshop in 2010 and together identified 25 sites across Bali for possible inclusion. Site selection was informed by some 66 representatives from government, universities, NGOs, private sector, and community and traditional leaders in attendance from across the province. Marine Rapid Assessments were then carried out by CI-I in each of the proposed sites with data collected about marine biodiversity, coral reef community structure, and current condition of coral reefs and related ecosystems (see Mustika et al., 2012). This was combined with earlier assessments (Allen and Erdman, 2008) and used to inform the evolving design of the Network. Included was the recommendation of nine of the 25 sites for priority as MPAs due to their high ecological, economic and cultural value.

The Network was formally initiated in 2013 through a memorandum of understanding signed by all ten heads of marine affairs and fisheries agencies in Bali—comprising nine regency agencies and one provincial agency. Its overall visions is "the creation of harmony and synergy between national, provincial and regency governments in Bali in the management of aquatic resources, with strong support and participation of the community and other institutions, and for the sustainable enhancement of social, economic and cultural benefits" (Gunawan and Dewantama, 2014, p. 7 translated). In practice, the Network is intended to foster cross-boundary coordination to synergistically align all aquatic-related efforts of regencies with the province, while at the same time, respecting the autonomous rights of regencies to manage programs in their territorial waters (CI-I staff, personal communication 2014).

A multi-stakeholder, multi-agency task force was established for Network planning, comprising 28 representatives from provincial and regency government (including tourism, environment, planning, and marine and fisheries agencies), existing parks and reserves, traditional councils, and NGOs (see Bali Gov. Decree, 2013). The task force is chaired by the head of the Bali Ministry of Marine Affairs and Fisheries, and network members have described the role of CI-I as project lead and coordinator. Other groups such as local governments and civil society organizations are not members of the Task Force. However, they are expected to contribute to individual working groups on policy-making, spatial planning, and funding as part of the ongoing planning process (which has yet to begin; see Gunawan and Dewantama, 2014).

The MPA Network is based on the principle of "One Island, One Management" through which Bali is viewed as a singular ecosystem comprised of terrestrial, marine and aerial space that requires integrated, cross-scale management to deal with conservation challenges. This has been described as a "*...need to manage as an island instead of eight or nine separate entities within the island...[where regencies] have to sit down together to talk about general issues and the environment*" (anonymous personal communication 2014). Objectives are set for ecological and social connectivity to "...braid cooperation between MPA mangers in Bali for more effective, efficient, comprehensive and sustainable management and conservation" (Gunawan and Dewantama, 2014, p. 21 translated). This is a means for actors to share their experiences, lessons learned and capacities.

Three pillars inform the ideology the Network—scientific evidence, rule of law, and culture. A series of Balinese "local wisdoms" have been adopted, including: "Nyegara Gunung" (translates to "ridge to reef" that signify the integration of mountains and sea), "Tri Hita Karana" (a philosophy on sustainability emphasizing interrelation and harmony of human, God and nature), and "Sad Kerti" (six strategies to maintain the balance of nature that are comprised of soul, human, forest, lake or fresh water, sea and the universe). In practice, this translates to a fixed inclusion of local and cultural values, as well as cultural seascapes, in the design and implementation of MPAs. The inclusion of Balinese wisdoms is also intended to uniformly strengthen the "*cultural sovereignty of Balinese in conservation*" (CI-I staff, personal communication 2014).

To support coordination and operation of the Network, a Blueprint document was created to provide consistency in approaches and laws in the planning of aquatic areas across Bali, as well as in setting minimum standards of compliance. These guidelines are to serve in part as reference in developing protected areas (marine or terrestrial) at the level of regency, and include ecological, socio-economic and governance considerations (see Gunawan and Dewantama, 2014).

Still, there are numerous challenges facing the actualization of the Bali MPA Network. Cooperation from governments and stakeholders remains problematic given conflicting interests, high turnover of government staff that inhibits relationship-building, and a general lack of trust between groups. An NGO representative was careful to make the distinction between those organizations or agencies in the MPA Network that were "*happy*" to be included but rarely participate, and those who were "*enthusiastic*" in moving the process forward by actively participating (local NGO rep., personal communication 2014). Many regencies still do not have dedicated staff, nor sufficient budget, for MPA planning and implementation. In addition, concern has also been raised about the possibility of conflict where the "One Island, One Management" idea could be interpreted by some as an attempt by the province to regain power over coastal-marine decision-making (national NGO rep., personal communication 2014).

Nusa Penida MPA—Pluralism and Multiple-Use in Conservation

Context

The Nusa Penida MPA is located southeast of the Balinese coast comprising three islands: Lembongan, Ceningan, and Penida. Its 46,000 inhabitants are distributed across 16 administrative and 46 customary village divisions. Major livelihood activities include capture fisheries (≈850 local fishers in 40 fishers' associations), seaweed production (≈308 ha of farms), and marine tourism (over 200,000 tourists per year; Ruchimat et al., 2013). The area is well known among divers for its large charismatic species such as the ocean sunfish (*Mola mola*) and manta ray (*Manta birostris*).

Nusa Penida is part of the Klungkung Regency, Bali Province. In addition to regency and village administrative laws, there is customary law implemented by local traditional bodies (Indonesian: *Adat*) and a Tribes' Council (Indonesian: *Majelis Alit*). This law is focused on religious and cultural activity, but can also include rules and sanctions associated with natural resources. In Lembongan, for example, customary law forbids logging of mangroves or collection of sea sand. Other regulatory bodies on the islands include a newly formed consortium of diving businesses, and separate fishers' and seaweed farmers' associations through which activities are regulated socially.

Intensive utilization of coastal resources and overlapping or competing income-generating activities in a relatively small region such as the one presented here, has posed challenges to fit, and contributed to many ecosystems becoming overexploited (see Welly, 2009). These too have fueled conflicts between various user groups (e.g., tourism and fishers, tourism and seaweed farmers). Here an NGO bridging organization has taken on the central role of facilitating the region's many stakeholders and uses in creating and managing the MPA.

The Coral Triangle Center (CTC)

The Coral Triangle Center, an Indonesian environmental NGO focused on capacity building, has been the lead facilitator of the Nusa Penida MPA since it was initiated in 2008. At the time, CTC was a subsidiary of the US-based NGO The Nature Conservancy, but became an independent foundation in 2010 and now operates in multiple sites across Indonesia. A key objective of CTC is to "...stimulate partnerships with leaders in sectors such as tourism, fisheries, agriculture, and business development, recognizing that holistic and inclusive approaches are necessary for the sustainability of coastal ecoregions and health and economy of local communities" [CTC (Coral Triangle Center), 2011, p. 2]. The major roles of CTC in the MPA include: identification and engagement of local partners; collection of

stakeholder inputs and data to inform MPA design; coordination of activities related to MPA planning; and technical advisory and training.

Preceding the declaration of the MPA, CTC coordinated a series of 33 public consultations to gather input and mutual agreement on MPA establishment—some 1200 individuals from 16 villages participated between 2009 and 2010 (CTC staff, personal communication 2014). This information would later inform MPA design. In 2010, the Nusa Penida MPA was officially declared by decree of the Head of the Klungkung Regency Government (decree no.12/2010). In an effort to better align benefits to local stakeholders with marine conservation, three objectives were established: (1) biodiversity protection, (2) sustainability of fisheries, and (3) sustainability of marine tourism. A multi-agency, multi-stakeholder working group was created and tasked with disseminating information and undertaking preparations for the MPA.

The MPA design process was informed by scientific data (biological assessments and socioeconomic surveys), policy assessments of law and regulation, and stakeholders' input. To be inclusive of the many stakeholder groups, and their interests and knowledge, CTC conducted an additional 30 public stakeholder meetings at the village and regency levels about boundaries and zoning preferences. According to CTC staff, one of its major roles is to "*bring people together*" (CTC staff, personal communication 2013)—it engaged and included stakeholders from regency (Klungkung Regency) and central governments, NGOs, community groups, tourism operators, traditional leaders, teachers, youth groups, and local fishers' and seaweed farmers' associations.

The resulting MPA zoning system consists of four maritime zones and a series sub-zones: (1) core zone for education and research purposes (469 ha), (2) sustainable fisheries zone—including traditional fisheries sub-zone (16,916 ha), temporally controlled special use sub-zone (905 ha) (see below), and seaweed farming sub-zone (464 ha), (3) utilization zone—including marine tourism sub-zone (1221 ha) and marine harbor sub-zone (35 ha), and (4) other zone—including traditional sacred sub-zone (47 ha). This zoning system integrates utilization activities and cultural perspectives alongside biodiversity conservation, and in balance.

To ensure impacts on local fishers were minimized, some 80% of MPA waters remain accessible either as prioritized fishing grounds or in multiple use zones. Existing seaweed-farming territories on each island were allocated their own zones. A desire to protect and integrate Balinese culture into planning led to the creation of a "traditional sacred zone," which limits speedboat and tourist access in waters located adjacent to an important temple on the coast. To minimize conflicts between fishers and marine tourism operators in a number of areas along the north coasts of Nusa Penida and Nusa Lembongan, "special use zones" were created to allow temporally controlled access. Between the hours of 4 p.m. and 9 a.m. fishing is permitted in these areas, however, outside of these hours only marine tourism activities are permitted.

A pluralist management unit comprised of representatives from various actor groups was formalized in 2013 to allow for representative decision-making, and is supported by a joint patrol team, and biophysical and socioeconomic monitoring teams facilitated by CTC. Team representatives include those from regency government, traditional village police, fishers' associations, the Indonesian Navy, the Indonesian Police Unit, local dive operators, the Tribe's Council, and associated NGOs and community groups. Joint patrols and monitoring are conducted monthly. In addition, CTC coordinates annual reef health monitoring surveys in 12 sites across the islands together with the Management Unit and local partners, and conducts community perception and engagement surveys every two years. These activities are meant to both build skills and capacity for local stewardship (via training and certification of locals by CTC), as well as foster learning that feeds back into the ongoing development of the MPA.

In addition to the aforementioned bodies, the process of MPA development has helped to connect several new social networks within different interests in Nusa Penida. For example, an association of local dive operators was founded to link businesses and self-regulate dive tourism practices through agreed codes of conduct. Likewise, a mangrove tourism association to connect local fishers arose out of CTC-led efforts to develop community-managed mangrove ecotourism. In addition, a memorandum of understanding was recently signed with the management unit of Nusa Penida MPA to enable CTC to use the area as an "MPA Learning Site" and living laboratory for learning exchanges and training visits among practitioners and sites across the CT region.

However, the MPA faces a number of new and ongoing challenges moving forward. Unsurprisingly, building stakeholder relationships is a work-in-progress. Some respondents made note of ongoing tensions between and within groups, particularly between on- and off-island fishers or tourism operators, and between snorkeler and dive operators. Both cultural and language barriers persist between some stakeholder groups. Concern has also been raised about the burgeoning tourism industry and the ability to regulate and enforce tourist carrying capacities on reefs given the number of informal and off-island operators.

East Buleleng Marine Conservation Zone—Scaling-Up Empowered Community Conservation

Context

The Marine Conservation Zone resides along 26 km of coastline located in northeastern Bali. This is the province's richest area for fish diversity (Mustika et al., 2012) and includes important habitat for marine life such as whale sharks, sea turtles and dolphins. Its 54,000 inhabitants are distributed across ten administrative and 60 customary village divisions that comprise the Tejakula sub-district. Coastal communities rely on fisheries (≈2000 local fishers in 47 fishers' associations), the marine aquarium trade, aquaculture (shrimp, fish, seaweed) and tourism to meet subsistence and livelihood needs [DKP (Dinas Periknanan and Kelautan, Pemerintah Kabupaten Buleleng), 2015]. According to the head of the ornamental fishers association and NGO field staff, there are less than 100 ornamental fishers in the sub-district.

Tejakula is part of the Buleleng Regency, Bali Province. Similar to Nusa Penida, coastal-marine regulations here stem from regency and village administrative laws, as well as customary law. Other regulatory bodies include fishers' and ornamental fishers' associations, and community groups responsible for Locally Managed Marine Areas (LMMAs) (Indonesian: *Daerah Perlindungan Laut*). Major challenges to fit here include intra- and inter-community tensions associated with overlapping use and access. For example, the ongoing development of beachfront hotels has meant increasing exclusion of fishers and ornamental fishers from marine spaces. Local people are highly dependent on coastal-marine systems and livelihood alternatives are limited. In addition, capacity to combat environmental threats such as coral mining and pollution, as well as destructive and illegal fishing practices, is limited. Two environmental NGOs have played central, but differing, roles in supporting a transition toward community empowered conservation practice in this region: Reef Check Indonesia and the Indonesian Nature Foundation.

Reef Check Indonesia (RC-I)

Reef Check Indonesia, a chapter of a US-based environmental NGO of the same name, has been active in the Buleleng region since 2006. The NGO embodies a philosophy of "integrated coastal and marine ecosystem management to enhance the welfare of coastal communities" [RC-I (Reef Check Indonesia), 2015: website] and was founded on three pillars of activity: science and technology, collaborative management, and education and awareness. Their main office is located in south Bali, but at the time of data collection a member of RC-I staff was also housed semi-permanently in the office of the Ministry of Marine Affairs and Fisheries, Buleleng. RC-I has taken on a number of roles in the region, including: support of LMMA planning; facilitation of traditional guards; community capacity building and training; and coordination of MPA design and development.

Between 2008 and 2009, RC-I worked together with community members and local governments in developing a series of LMMAs in villages across the sub-district, with the aim to curb illegal activities and promote sustainable resource use. LMMA zoning was guided by a mix of local knowledge and scientific data collected by RC-I on coral reef health. According to staff, this involved "*sharing sessions*" held with different organizations—such as fishers' associations, traditional authorities, community groups, local NGOs and tourism operators—to better understand and integrate their interests in conservation solutions that "*accommodate collective importance*" (RC-I staff, personal communication 2014). Zoning was undertaken on a village-by-village basis and includes categories for: core zones where extraction activities are prohibited, buffer zones where limited fishing is permitted, and utilization zones where non-destructive activities are permitted.

As well as establishing LMMAs, community-based organizations were created for each, and take on the majority of responsibility to implement, manage and monitor these spaces. The head of one such organization described its purpose as helping to create a more sustainable marine environment, while at the same time educating their community and improving community welfare (LMMA rep., personal communication 2014). In this context, RC-I has directed effort to building local capacity—it conducts training on practice and theory of marine ecology and conservation, diving skills (general and scientific), and ecological monitoring techniques (snorkeling and diving). Local fishers are taught and certified to identify and record the health of their coral reefs and fisheries, and have been actively collecting data both independently and alongside RC-I over the last 5 years (LMMA rep., personal communication 2014). Dive training has served the dual purpose of conservation and ecotourism: several LMMA organizations are also tourism dive centers.

RC-I has sought to strengthen local stewardship by inaugurating certified diver fishers into community groups called "Pecalang Segara" or "traditional guardians of the sea." The marine-based Pecalang are an extension of the terrestrial-based traditional body (i.e., *Adat*). Following training, they are tasked with undertaking surveillance and enforcement of regulations in LMMAs. According to the head of an LMMA organization, the enacting of Pecalang strengthens the community's "*cultural responsibility*" to protect the environment (LMMA rep., personal communication 2014).

In 2011, RC-I partnered with the Ministry of Marine Affairs and Fisheries, Buleleng to facilitate the designation of the East Buleleng Marine Conservation Zone, part of a regency-level MPA that would include the already-established LMMAs. The process of scaling-up began in 2013 through a series of public consultations at the village and sub-district levels to gather input and mutual agreement on MPA zones, boundaries, and allowable activities. In attendance were members from fishers' and ornamental fishers' associations, hotels and spas, government, local NGOs, community associations and others. A regency government official explained that MPA zones are meant to align with those in existing LMMAs so that one would strengthen the other (government rep., personal communication 2014).

At the time of data collection, substantial progress had been made in zoning, but finalization had yet to take place. The zoning system will include four categories: (1) core zone—for protection of ecosystems, traditional cultural sites, and research and education; (2) limited use zone—for tourism and recreational activities, as well as research and education; (3) sustainable fisheries zone—for non-destructive catch and cultivation of fish, tourism and recreational activities, as well as research and education; and (4) other zone—for specific purposes such as port harbors, rehabilitation of specific marine biota or traditional territories. Similar to the Nusa Penida MPA, this zoning system is meant to balance utilization activities and cultural perspectives alongside objectives for biodiversity conservation.

However, the creation of LMMAs and subsequent MPA has not been embraced or accepted by all. Numerous fishers and ornamental fishers voiced discontent about their exclusion or the extent of their exclusion from coastal areas. There is also persistent belief among some community members that the word "conservation" implies absolutely no use activities permitted. One business owner explained that it will be difficult for some fishermen to see the benefit of the MPA because they tend to think

short term, and MPA benefits will be a long-term gain (business owner, personal communication 2014).

The Indonesian Nature Foundation (LINI)

The Indonesian Nature Foundation has been active in the Buleleng Regency since 2008, with many of its staff having operated in the Regency since 2000. LINI is an NGO from south Bali with a mission to "...work with marginalized coastal communities to reverse the degradation of Indonesian coral reefs and raise awareness about responsible and sustainable marine resource use" [LINI (The Indonesian Nature Foundation), 2015: website]. It works most closely at the community level, particularly with the villages of Les and Penuktukan, to foster a sustainable marine ornamental fishery as part of wider conservation efforts. LINI subscribes to the idea that "*...you cannot force people to protect the environment, [rather], you have to start by helping them with livelihoods and understanding (education)*" (LINI staff, personal communication 2013). In this respect, it has taken on a number of roles, including: community capacity building and skills training on reef restoration and ornamental fishery; biological and socioeconomic data collection; identification and engagement of local partners and partnerships.

LINI has been a leader in building capacity for community-driven coral reef restoration. It trains local fishers in the production and installation of various types of artificial reef structures, including fish domes, shrimp pods, and "roti buaya" (rough logs of artificial substrate). These are made, deployed and occasionally designed by villagers themselves. With help from LINI, fishers from Les village have taken on stewardship of reef restoration in the area since 2010. As of January 2014, over 100 fish domes and 1000 shrimp pods had been installed on the reef in multiple sites in East Buleleng (ornamental fisher, personal communication 2014). These structures serve the dual purpose of encouraging coral re-growth, and providing nurseries for the marine aquarium trade to fuel local livelihoods.

Alongside reef restoration activities, LINI has sought to foster human and institutional capacity in coastal communities for a sustainable ornamental fishery, including sea and land-based aquaculture development. The gathering of ornamental fish has a rich history in the region, but it has tended to come with destructive practices such as cyanide use (e.g., Frey and Berkes, 2014). LINI delivers practical skills training about e.g., marine conservation, fish collection methods, post-harvest handling techniques, fish rearing and mariculture, and diving (general and scientific). It has assisted in the development of an ornamental fish export business by community fishers, including the building of land facilities for a fish rearing program (ornamental fisher, personal communication 2014). Construction has recently been completed on a new Aquaculture and Training Centre in Les village designed to offer skills training, research and work experience in marine conservation and aquaculture.

In addition, LINI plays an important role in collecting and distributing information across scales. It has described itself as "*...a big knowledge hub, and a trafficker of information*" (LINI staff, personal communication 2014). The NGO has established and maintained an extensive database on ornamental fish harvests, fisheries catches, supply chains, and aquaculture data from the village to regional scales. As well, it has been monitoring the progress of reef restoration by recording numbers and species of fish. This information is collected by LINI staff, community members, or with other NGOs such as RC-I. LINI works with regency government on the use of such data to inform fisheries quotas in the region.

However, despite strides in the advancement of a sustainable ornamental fishery, some concerns have been raised about its long-term viability in the region. An ornamental fisher explained that many stakeholders in the area—including some local authorities and tourism operators—continue to be suspicious of the activities of ornamental fishers (ornamental fisher, personal communication 2014). It has an unfavorable image, he explained, even though methods have changed significantly. In addition, there are far fewer ornamental fishers than pelagic fishers and, subsequently, their position in the region may not be as strong.

RESULTS: CONTRIBUTIONS OF BRIDGING ORGANIZATION TO CONSERVATION FIT

Results are organized here according to the three main categories of conservation fit outlined in our framework earlier in the paper. These include: (1) aligning conservation initiatives with characteristics of the social context (e.g., institutions, culture, values, local practice), (2) facilitating governance processes and instruments to bring together and meaningfully engage actors to pursue coordinated and adaptive conservation, and (3) effectively linking conservation initiatives and social actors across scales and levels. We identify and discuss in detail the strategies used by bridging organizations to promote and sustain aspects of conservation fit, which are summarized in **Table 3**. To this end, we draw on specific examples and evidence (e.g., from interviews, document review) from the cases above, as well as surveyed responses from participants about bridging organization contributions (**Table 4**). As illustrated below, however, not every strategy was employed in every case or to the same degree.

Alignment with Social Context

Integrating Actors and Interests

Bridging organizations help to identify and represent multiple social actors and their various and often divergent interests. It is widely acknowledged that the long-term success of a conservation intervention hinges in part on its integration with (local) people, and by association of their needs for livelihood and wellbeing (see Ferse et al., 2010; Glaser et al., 2015). Our cases in Nusa Penida and East Buleleng show how bridging organizations use public meetings, community consultations, and focus group discussions to identify and elicit information about the interests and resource use patterns of affected stakeholder groups. To accommodate this heterogeneity in conservation initiatives, we observed that bridging organizations exercised flexibility in design and implementation.

Indeed, all bridging organizations examined in this paper showed some degree of flexibility in their integration of multiple alternative objectives. In East Buleleng, for example, a process of

TABLE 3 | Summary of results.

Fit category	Bridging strategy	Examples of use by bridging organization(s)[a]
Aligning with social context	Integrating actors and interests	• Identification and flexible integration of diverse users and use objectives (livelihoods, culture, conservation) in conservation initiatives—via multi-use spatial and temporal zoning (CTC and RC-I, advocated by CI-I), social-ecological synergies (LINI)
	Knowledge diversity	• Multiple knowledge systems and perspectives informing conservation initiatives—via integrating local wisdoms and philosophies (CI-I), mixing science and culture in planning and design (CTC and RC-I), and/or utilizing experiential knowledge (LINI)
Use of appropriate governance processes and instruments	Hybridizing and inclusiveness	• Supported creation of pluralist governing structures—via multi-stakeholder, multi-party working groups, task forces, management units (CI-I, CTC)
		• Integration of customary institutions and territorial authorities in governance arrangements—via inclusion of adat, adat councils and/or Pecalang Segara (CI-I, CTC, and RC-I)
		• Opportunities for meaningful participation and input—via public meetings, group discussions, and/or membership on monitoring teams, patrol units, and joint committees (all)
	Capacity building	• Human and institutional capacity increased in resource use planning, management, monitoring and/or enforcement—via technical training, certification, practical experience (CTC, RC-I, and LINI)
		• Support of locally-empowered and/or decentralized leadership—via LMMAs (RC-I) and community-driven programming (LINI)
Linking across scales and levels	Connectivity	• New and strengthened horizontal and vertical linkages between diverse social actors (all)
		• Development of issue-specific sub-networks (CTC) and cross-scale learning networks (CI-I and CTC)
	Scaling	• Conservation initiative appropriately scaled across boundaries to foster coordinated responses—via MPA Network (CI-I)
		• Local initiatives scaled-up and supported from higher-levels—via nested LMMAs in regency MPA (RC-I)

[a] *CI-I, Conservation International Indonesia; CTC, Coral Triangle Center; RC-I, Reef Check Indonesia; and LINI, Indonesian Nature Foundation.*

TABLE 4 | Responses for top contributions of bridging organization to marine conservation and management processes by case[a][b].

Conservation International Indonesia	Coral Triangle Center	Reef Check Indonesia	Indonesian Nature Foundation
■ Facilitating collaboration (82%)	■ Facilitating collaboration (61%)	■ Capacity building and training (67%)	■ Capacity building and training (74%)
■ Knowledge building & learning (47%)	■ Knowledge building and learning (57%)	■ Knowledge building & learning (54%)	■ Facilitating collaboration (68%)
■ Other[c] (47%)	■ Education and awareness (53%)	■ Facilitating collaboration (42%)	■ Knowledge building and learning (58%)
■ Capacity building and training (23%)	■ Conflict resolution (32%)	■ Conflict resolution (33%)	■ Education and awareness (53%)
	■ Other[c] (32%)	■ Education and awareness (33%)	

[a] *Respondents were asked, "how does [X] bridging organization contribute to marine conservation and management processes in the [region/initiative]?"*
[b] *The initial categories included here were further refined and consolidated in line with the main themes in* ***Table 1****.*
[c] *The "other" category included contributions listed such as funding, administrative tasks, technical facilitation, creating new rules, providing checks and balances, and supplying data.*

multi-use zoning was used in order to represent and integrate the different interests of social actors related to biodiversity protection, sustainable fisheries, ornamental fisheries, marine tourism and culture. A community member here explained,

> *I don't want to do just conservation. I want conservation for all—for people, for culture. There needs to be balanced conservation that includes nature, but also people and their needs, their culture, their recreation, and their economic status. There needs to be a balance between nature conservation and social conservation.* (community member, personal communication 2014)

The CTC similarly orchestrated multi-use spatial and temporal zoning in Nusa Penida to resolve overlapping objectives between fishers, seaweed farmers and marine tourism activities. Other strategies, such as the utilitarian approach applied by LINI, explicitly identified synergies between social and ecological objectives. A representative of LINI stated,

> *Absolutely "no-take" areas are problematic. They are not feasible according to the Balinese way of living. That would mean no fisheries, no tourism. [...] In Indonesia, people have the philosophy that "nature is there for us to use." Conservation must consider this.* (LINI staff, personal communication 2014)

These actions are in line with calls from across the CT for greater flexibility in conservation, where solutions seek to balance the

immediate needs of resource users with conservation or long-term sustainability agendas (see Foale et al., 2013; von Heland et al., 2014; Weeks et al., 2014a).

Knowledge Diversity

Bridging organizations help to integrate knowledge systems and perspectives from different social spheres. Scholars advocate drawing from, and combining, multiple types of knowledge to better understand the conservation context and problem (e.g., Majors, 2008; Clifton and Majors, 2012). A representative from RC-I described this process as finding the "*right mix of science and culture*" for conservation initiatives (RC-I staff, personal communication 2013). Another interviewee commented on the inseparability of the two: "*when we talk about Bali, you cannot avoid the culture...once you talk about marine, you talk about terrestrial, you talk about the people, about culture*" (CI-I staff, personal communication 2014). The incorporation of scientific and technical knowledge in our cases was achieved where bridging organizations connected to universities, local research institutes, NGO scientists, and/or managers. Each bridging organization also included its own research-oriented activities to collect scientific data: CI-I undertook marine rapid assessments, CTC carried out biophysical and socioeconomic baseline surveys, and RC-I and LINI collected data on the state of coral reef health and fisheries.

The incorporation of local and traditional knowledge in our cases was achieved where bridging organizations involved the expertise of those with long-standing ties to the area—community members, traditional leaders, resource users, teachers, etc. For example, the experience-based knowledge of ornamental fishers in East Buleleng has been used to guide the installation of some artificial reef structures, and traditional custom (i.e., *Adat*) has been incorporated and reinforced in MPA planning in Nusa Penida through the creation of a sacred zone. Likewise, "local wisdoms" such as "Tri Hita Karana" and "Nyegara Gunung" have been integrated into the Bali MPA Network so as to merge scientific ideas of conservation (e.g., ecological connectivity, social networks) with the Balinese cultural perspective (e.g., "ridge to reef" thinking, harmony between human and nature). A government official added, "*If BMN (Bali MPA Network) is applied with awig-awig (customary law), it will work very strongly because most Balinese think of the ocean and beach as sacred place*" (government rep., personal communication 2014: translated).

Facilitating Appropriate Governance

Hybrids and Inclusiveness

Bridging organizations help actualize hybrid forms of decision-making that combine different sets of public, private and civil society actors. Hybrid approaches reflect recognition that many coastal-marine resources are too complex to be governed by a single social actor or agency (Berkes, 2009). One interviewee commented, "*we cannot do conservation alone. It requires a long process of negotiation and compromise between many groups of stakeholders*" (government rep., personal communication 2014). One way bridging organizations in our cases pursued inclusiveness was to support co-governance arrangements, consisting of collaboration and interplay between diverse representatives from across sectors and scales. In Nusa Penida this took the form of a multi-stakeholder, multi-agency working group (now management unit), and in the Bali MPA Network this was expressed as a 28 member joint Task Force. Hybridizing was also pursued in merging local institutions as part of governance frameworks. In East Buleleng, for example, RC-I helped integrate aspects of customary institutions (i.e., *Adat*) with conservation governance by extending and incorporating the Pecalang Segara as traditional territorial authorities in LMMAs. This was similarly carried out in the Nusa Penida MPA.

A general consensus is that broadening meaningful participation, especially of local communities, is indispensable for the success of marine conservation in the CT and beyond (Christie et al., 2003; Mascia, 2003; Clifton, 2009; Ferse et al., 2010; Glaser et al., 2015). In expressing greater inclusion, a community member in Nusa Penida stated, "*...CTC provides a link between government and [us]. They give us a voice*" (community rep., personal communication 2014). Opportunities for stakeholder inclusion and input facilitated by bridging organizations in our cases ranged from participatory mapping of resource use, public meetings and focus group discussions on zoning, to membership on monitoring teams, patrol units, and joint committees. In practice, such opportunities become venues for discussion and debate, coordination, sharing information, mobilizing resources, and organizing training activities.

Capacity Building

Bridging organizations aid in building requisite knowledge, skills and capacity for conservation practice and governance, especially where sub-national or local governments lack the capacity (or desire) to fill gaps. Methods observed to foster (local) capacity and leadership ranged from formal to informal. Capacity building activities undertaken by RC-I in East Buleleng, for example, have enabled LMMA managers to actively participate and assume increasing responsibility for planning, implementation, ecological monitoring, and enforcement in their coastal-marine areas. The NGO described an aim of its activities to "*...broaden the roles of community members from fishers to tourism operators and reef protectors*" (RC-I staff, personal communication 2014). Enlisting resource users in data collection and analysis educates participants, builds capacity and can foster trust (Mascia, 2003).

Likewise in Nusa Penida, joint patrol and monitoring teams now perform the tasks of enforcement and data collection following facilitation and training by CTC. In describing their interactions, a representative from a local community organization stated,

> *CTC has provided training to us and have built our capacity to make collaborations and strengthen management. [...] We now serve as a facilitator for the socialization and communication of the MPA and work with various stakeholders about conservation issues in the context of the MPA.* (community organization rep., personal communication 2014)

Some bridging organizations also advocated local leaders, and not just involvement, in conservation governance. An NGO member expressed the importance of fostering "*local champions*" to facilitate on-the-group relationships and build stewardship over conservation initiatives (international NGO rep., personal communication 2014). Attempts to decentralize leadership included those where bridging organizations sought to empower locally based organizations (as in the case of LMMAs) and where initiatives were managed and implemented by community members (as in the case of reef restoration). As well, the embedding of key community or traditional leaders in conservation planning and implementation teams, such as working groups, management units or patrol teams, strengthens the overall involvement and conservation leadership of community members.

Alignment of Scales

Connectivity

As entities that connect others, bridging organizations convene a diversity of social actors to create and hold together scale-bridging social networks for conservation. Social networks are important to embrace diversity of perspectives and knowledge representing multiple social actors across seascapes to facilitate adaptive thinking (cf. Folke et al., 2005; Armitage et al., 2009). Through bridging efforts, horizontal linkages have been cultivated across, for example, regency government agencies (as in the case of CI-I) and community groups (as in the case of the CTC). Vertical linkages meanwhile have been fostered between, for example, communities and governments (as in the case RC-I and CTC), and between resource use associations and market actors (as in the case of LINI). Bridging organizations were also the catalyst for the formation of sub-networks of stakeholders focused on particular issues such as dive tourism and mangrove ecotourism in Nusa Penida MPA.

Some bridging organizations in our cases have worked collaboratively in the region for upwards of a decade strengthening connectivity between social actors. This is an important pre-condition for coordination, communication, and learning in conservation across the CT (see Lowry et al., 2009; Cohen et al., 2012; Pietri et al., 2015). For example, the CTC connects Nusa Penida MPA to a wider "learning network" of MPAs, which allows managers and practitioners to share knowledge and experiences between sites in the CT and beyond. Similarly, under the guidance of CI-I, a key function of the Bali MPA Network is to connect MPA managers across the province to enable the exchange of experiences and knowledge:

> *There are many, many NGOs and other organizations that work in Bali, and have not always coordinated. [...] The Bali MPA Network is good to share lessons. It serves as an umbrella for multiple organizations to collaborate and connect...it is about sharing knowledge.* (national NGO rep., personal communication 2014)

> *Coordination with other stakeholders is difficult because each stakeholder has their own interest, and sometimes this leads to conflicts. BMN (Bali MPA Network) will support information exchange between each regency's DKP (Ministry of Marine Affairs and Fisheries), and conflicts caused by misunderstandings or lack of information could be reduced.* (provincial government rep., personal communication 2014)

Scaling

Bridging organizations help foster cooperation to appropriately scale conservation initiatives across geographic and governance boundaries. As urged elsewhere in the CT (Lowry et al., 2009; Green et al., 2011), bottom-up as well as top-down conservation ingenuity is needed. This is shown in the Bali MPA Network, where transboundary conservation is planned to foster coordination across provincial, regency and city units of governance, as well as across sector boundaries (tourism, environment, planning, fisheries). In explaining the challenge, one interviewee stated,

> *Administrative separation by regency has causes differences in managerial decisions and policies between regencies. Bali is a small island, therefore the marine area around Bali is ecologically connected [...]. This means regency management will not work without synchronization with other regencies. This is where BMN (Bali MPA Network) is needed to unite marine management systems in Bali.* (NGO rep., personal communication 2014)

Here, provincial-level prescriptions are a starting point to identify spatial priorities and provide guidelines for the process of MPA design and implementation, which can be scaled-down and adjusted to accommodate local context and opportunities. Alternatively, under the guidance of RC-I, LMMAs in East Buleleng are being scaled-up and reinforced by higher-level governance units through the development of a regency-level MPA. Aligning conservation initiatives with the regency unit of governance was needed to enforce and implement rules that are beyond the reach of community sanctions, and to resolve inconsistencies and conflicts between LMMAs.

DISCUSSION: OBSERVATIONS ON BRIDGING AND STRENGTHENING CONSERVATION FIT

The cases presented in this paper illustrate that bridging organizations can and do promote and sustain aspects of better conservation fit, although with some limitations. In this regard, conservation fit is a means to an end, not an end to itself. By enacting bridging strategies that integrate actors and interests using flexible approaches, actualize hybrid forms of decision-making, build capacity and leadership, and foster cross-scale conservation and scale-bridging social networks, bridging organizations are indeed successfully enhancing aspects of conservation fit. The outputs of these efforts include conservation initiatives that are better aligned with their social contexts, which bring together and empower various public, private and civil society actors, and which better connect people and actions across scales and levels in ways that are locally beneficial.

Our findings show that not all bridging organizations made use of the same bridging strategies or did so to the same degree. In part, this is because bridging organizations and the conservation fit issues they seek to address vary with context.

Most bridging organizations have distinct identities, priorities and strengths or weaknesses that undoubtedly come into play (see Berdej and Armitage, 2016). This implies that different bridging organizations may have different niches with regards to addressing conservation fit issues. Simultaneously, issues of fit can vary by strength, complexity, urgency and/or scale. Recognizing this variation is important to understand how different bridging organizations can be engaged in different ways to address particular conservation *mis*fits.

We observed that bridging organizations share a number of unique features that make them well poised to grapple with conservation fit issues. First, the organizations we studied are able to work across the political or jurisdictional, programmatic and scalar boundaries that tend to serve as organizational barriers to collaboration and information sharing elsewhere. Second, the bridging organizations examined here are positioned at the intersection of diverse actors, and so they are able to draw on broader collections of partners—and their expertise, knowledge and resources—to work together in overcoming barriers and finding common ground. Third, these organizations embody a high degree of organizational flexibility, meaning they tend not to be under the same kind of bureaucratic restrictions or silos as government actors. This allows them to be more nimble in responding to emerging issues, shift programming according to needs, and alter their roles to suit current challenges.

Our cases have also brought to light a number of new and ongoing constraints or barriers that indicate the challenges in achieving conservation fit. Social systems in the CT are invariably dynamic and heterogeneous, comprising multiple sub-groups with differing values, interests and priorities that can change and shift over time (see Fidelman et al., 2012, 2014). Bridging strategies that are successful in one place and time and with one set of stakeholders may not be successful elsewhere. By the same token, a bridging organization is subject to competing demands of various stakeholders, not all of whom have equal ability to voice concerns or exert influence. A major obstacle to fit then is overcoming power asymmetries (see also Clement, 2013). In Bali, for example, tourism is a main source of the province's revenue, creating imbalances with other sector interests such as fisheries. As well, corruption remains an ongoing issue (Fidelman et al., 2014), and curbing it is a priority if long-term conservation successes are to be achieved.

Differing ideologies and understandings of conservation pose a sizable challenge to bridging organizations in the pursuit of better fit. Social groups embody unique knowledge of marine environments, and can have differing ideas of how resources should be conserved, used, or exploited (e.g., von Heland and Clifton, 2015). A business owner in East Buleleng explained this as: "*...a balance between a village life that has been established for centuries, and the rather new and fanciful idea that we need to protect reefs, which has not been understood or grasped in its entirety meaning by the local people*" (business owner, personal communication 2014). The integration of differing ideologies can be difficult in the CT given an overreliance on a western conservation narrative (Berdej et al., 2015), general lack of social science data generation, and limited involvement of domestic (social science) academics (Fidelman et al., 2014; von Heland et al., 2014). Bridging organizations may not possess comparable expertise on, for example, economic development, poverty alleviation, or urbanization (cf. Foale et al., 2013). Moreover, bridging organizations themselves, as mentioned, have their own ideologies, agendas and priorities that can favor particular viewpoints and narratives (see Berdej et al., 2015). There is therefore strong need for additional research on the political and ecological dimensions of bridging organizations in the region.

Lastly, the pursuit of conservation fit can be time-consuming and costly. There are significant costs associated with bridging activities, including funding, time commitments, staffing, and resource expenses. Funding and capacity for conservation is limited in Indonesia, as elsewhere in the CT, and many government bodies do not have staff or budget to engage sufficiently—plans are often made but not followed on the ground (cf. Mills et al., 2010). Decades of disempowerment have also constrained the capacity of many local institutions and communities to organize, innovate and act. This raises questions about the long-term sustainability of conservation fit outcomes in the absence of bridging organizations. For the time being, a reliance on foreign aid has caused tensions, including those related to implementation of conservation activities based on donor timelines (cf. von Heland et al., 2014). One interviewee voiced frustration over donor timeline expectations that do not align with the reality of building relationships and conducting activities on the ground (anonymous personal communication 2014).

CONCLUSIONS: FUTURE DIRECTIONS AND INSIGHTS FOR THE CT

Efforts to improve the fit between conservation initiatives (e.g., marine protected areas, no-take zones) and the dynamic social dimensions of coastal-marine systems are still rare. This research offers empirical insights for conservation practitioners and policy-makers into the social complexity behind coastal-marine conservation in Bali, and in the CT more broadly, and how bridging organizations can improve navigating this complexity. We contribute understanding of the advantages and limitations of bridging organizations as a governance strategy to foster more robust conservation measures that fit underlying dynamic and shifting social contexts. In Indonesia, decentralized governance has presented both the opportunity and challenge to involve multiple social actors and sectors of society, and work on how bridging organization navigate conservation fit issues such as social context, appropriateness of governance and scale holds promise.

Our findings demonstrate key strategies applied by bridging organizations to deliberately address major conservation fit issues faced in the region. These findings have broader relevance to other regions of Indonesia and the CT, who are challenged by similar social and institutional barriers to achieving positive conservation momentum (see Mills et al., 2010; Foale et al., 2013; Fidelman et al., 2014; von Heland et al., 2014; Weeks et al., 2014a). In demonstrating the efficacy of bridging organizations to operationalize conservation fit, we offer the following insights:

(1) Exercising flexibility in conservation planning and practice is important to align efforts with the reality of complex social contexts across the CT. A bridging organization by its nature is situated in a central position where diverse social actors meet and knowledge flows, and so provides space where multiple institutions or practices, perspectives, and alternative objectives might be shared, debated and balanced.
(2) Pluralist structures and inclusive decision-making arrangements involving diverse social actors are an important dimension of efforts to govern coastal-marine resources. A bridging organization can fill requisite capacity gaps to operationalize and institutionalize hybrid governance arrangements through opportunities for inclusion and local leadership, technical advisory and skills training, and/or access to non-local expertise and resources.
(3) Interaction among and across scales and levels is a conservation priority. Through its connections, a bridging organization extends the reach of conservation initiatives by bridging together public, private and civil society actors in social networks for conservation, and by working across geographic and governance or bureaucratic boundaries for coordination.
(4) A bridging organization is not without limitations. Such organizations must contend with obstacles such as changing social contexts, corruption and competing stakeholder demands, as well as ideological differences, power dynamics, influence of donor and funding agendas, and diverse conservation narratives. Some of these may prove especially challenging to overcome in practice. Even still, our findings indicate that bridging organizations have strong capacity to shape conservation strategies in ways that make them more inclusive, adaptive and cross-scale, and which will ultimately lead to higher likelihood of success.

Moving forward, our findings highlight a need for additional research to understand the implications of bridging organizations for the long-term ecological and social success of conservation initiatives. In many of our cases, for example, the conservation initiatives fostered by bridging organizations are not yet institutionalized and further analysis is needed to understand how that process may evolve under different conditions or in their absence. As such, there is a need to undertake a large "n" comparative analysis of bridging organizations in geographically differentiated marine conservation contexts that reflect different social, political and institutional realities. As mentioned, critical political and ecological analysis is needed of how bridging organizations influence social processes such as power, agenda setting and policy narratives that shape conservation (as per Berdej et al., 2015). We do not claim that bridging organizations are guaranteed to enhance conservation fit, but our evidence indicates that they play an important role in leading the conservation process forward, and in fostering multi-actor strategies that meaningfully engage with the social dimensions of marine conservation.

AUTHOR CONTRIBUTIONS

Conception or design of the work (SB, DA); acquisition of data (SB); analysis or interpretation of data for the work (SB, DA); drafting the work or revisiting it critically (SB, DA); final approval of the version to be published (SB, DA).

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Factors Influencing Community Fishers' Leadership Engagement in International Small-Scale Fisheries

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Local leadership is crucial to the functioning of local organizations in small-scale fishing (SSF) communities. By analyzing local leadership experiences of 54 international SSF researchers and practitioners, we aim in this paper to fill knowledge gaps that recent research has identified regarding our understanding of factors that influence the effectiveness of local leadership. Influencing factors are organized using modified versions of the Institutional Analysis and Development (IAD) framework, the Value-Belief-Norm (VBN) theory, and Schwartz's theory of cultural values. We identified factors that help shape leadership engagement and effectiveness at multiple levels, including: precursors to individual action that relate to potential SSF leaders' perceptions of threats and opportunities; institutional constraints at the individual level and community level; and high level governance issues. Precursors to individual action were numerous and multi-faceted, and individual behaviors were shaped by core values and attitudes, culture, experiences, and education. Motivation to participate in leadership can either be altruistic in nature or oriented toward self-enhancement. A lack of motivation for leadership could be attributed to the individualistic nature of many fishers. The availability of capital assets can facilitate or hinder participation in leadership. Individuals who may be willing to take on leadership roles were often hindered by lack of money and time, low educational attainment, or poor social cohesion among community members. The interactions between leaders and followers were crucial for effective leadership, especially a leader's perceived legitimacy and the ability of a community to groom appropriate successors. At the higher level, constant policy change and the resulting uncertainty were linked to decreasing motivation and apathy regarding SSF management at the local level, and disintegrating relationships between government level and local level actors. Our research highlights how local leadership and context are linked, and suggests potential researchable hypotheses that would in the future help further advance empirical and theoretical understanding of leadership influences in SSFs.

Keywords: small-scale fisheries, leadership, institutional analysis and development framework, value-belief-norm theory, community-based fisheries management

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INTRODUCTION

Uncertainty is pervasive in small-scale fisheries (SSFs) due to complex interactions within and between ecological and socio-political systems. SSFs are, as a result, often perceived to have low governability potential (Jentoft and Bavinck, 2014). This perception is exacerbated by a history of perceived failures by centralized, conventional fisheries management agencies (Imperial and Yandle, 2005; Pero and Smith, 2008). Consequently, decentralized or devolved fisheries management approaches (Rudd et al., 2003; Plummer and Fitzgibbon, 2004) have become increasingly popular since the 1980s (Jentoft, 1989; Pinkerton, 1989; Chuenpagdee et al., 2005). Decentralized governance systems transfer decision-making power to local government managers, while devolved governance involves the transfer of substantive decision-making power to local resource users (Rudd et al., 2003), often through community-based or co-management structures (Jentoft, 1989).

If the devolution of SSFs is to be more than a way for governments to simply download their own management costs on communities (Wiber et al., 2010), engagement of community actors becomes central for success as they are tasked with performing key management functions (Rudd et al., 2003; Armitage, 2005). This is especially the case for the local leaders, who are crucial for successful community-based fisheries management (CBFM) (Muehlig-Hofmann, 2007; Bodin and Crona, 2008; Gutierrez et al., 2011; Sutton and Rudd, 2014, 2015; Al Mamun, 2015; Evans et al., 2015). While SSF leadership characteristics and functions have been examined at a relatively coarse scale (Sutton and Rudd, 2014), advances in other fields (e.g., Küpers and Weibler, 2008) suggested that detailed sharper focus on leadership concepts and methods could provide valuable insights regarding the role that leaders play in SSF management. In particular, there is a compelling need to also identify the social conditions that influence SSF leaders and leadership capabilities (Sutton and Rudd, 2014; Al Mamun, 2015), as those help shape ecological and socio-economic outcomes.

Here we seek to strengthen our understanding about which conditions—at the level of individuals, communities, and higher-levels of governance—influence the capacity of local community members to successfully develop into leaders and engage in CBFM, thereby enhancing the delivery of positive ecological and socio-economic outcomes arising from the devolution of SSFs to their local communities. To do this, we conducted semi-structured interviews with 54 international SSF researchers and practitioners, focusing on the characteristics of leaders and the challenges that they face in SSF management. Our results thus provide broad insights into the influences and mechanisms affecting local leadership processes and outcomes in international SSFs.

METHODS

Theoretical Background

Local leadership in SSF is influenced by numerous conditions across socio-political scales, at the level of the leader's own household, their community, and the political context within which their community is embedded. To help identify and organize our analysis, we drew on insights from the Institutional Analysis and Development (IAD) framework (Ostrom, 1990, 2005), Value-Belief-Norm (VBN) theory (Stern et al., 1999; Stern, 2000), and Schwartz's theory of cultural value (Schwartz, 1999, 2012). That combination helps to highlight conditions that influence the propensity of individuals to engage in SSF management leadership and to identify ways in which the broader social cultural and political environments might influence local leaders.

Institutional Analysis Development (IAD) Framework

The IAD framework is a universal policy analysis framework that helps organize and facilitate analyses of how institutions operate and change over time, allowing for greater understanding of the logic, design, and performance of institutional arrangements in a wide variety of settings and scales (Ostrom, 1990, 2005). We use it to organize our analysis and help identify key characteristics of leadership at the individual level and the institutions that catalyze or hinder the development of leaders. When viewed from an IAD perspective, community fisheries become a collection of social actors within an "action arena," the space where individuals interact, exchange ideas and services, and engage in contestation. The framework lays out how behavior is shaped by various sanctions and rewards associated with particular types of rules or social norms (i.e., about what, where, when, and how activities can be undertaken; by whom; and about permitted, required, or prohibited outputs and outcomes).

In a capital asset-oriented IAD (Rudd, 2004, 2010), the state of the world is framed in terms of various capital assets (**Figure 1**), which can be accumulated or depleted. When valued assets and their resource flows are perceived to be threatened (hence linking to VBN theory, below), governments, communities, and leaders themselves have a range of options to alleviate adverse conditions that inhibit them achieving their objectives or adapting to changes in SSF context. Those investments can be in capital assets themselves (e.g., education and training to increase leadership capacity), in changing either the structure of the rules-in-use or their payoffs, and in implementing process-oriented (rather than structural) changes in the governance system (i.e., designing participatory processes that enhance efficiency, equity, legitimacy, participation, accountability, fiscal equivalence, alignment with moral values, adaptability, resilience, robustness or sustainability—see McGinnis, 2011).

Action arenas exist at multiple levels from a single household, to regional, national, or international governance organizations (Ostrom, 2005). The IAD framework can be used to structure the feedbacks between action arenas that are linked across different levels. Our primary focus is on the operational level, where individual SSF actors or organizations in their fishing communities make day-to-day decisions. However, outcomes from higher collective choice and political levels also affect them, creating facilitating or restrictive conditions that affect local leaders' capacity to engage and function in SSF leadership roles.

When extending the IAD framework to multiple levels (**Figure 2**) in our SSF context, the lowest level (and that with the quickest cycle time) is that of the individual leader, who makes

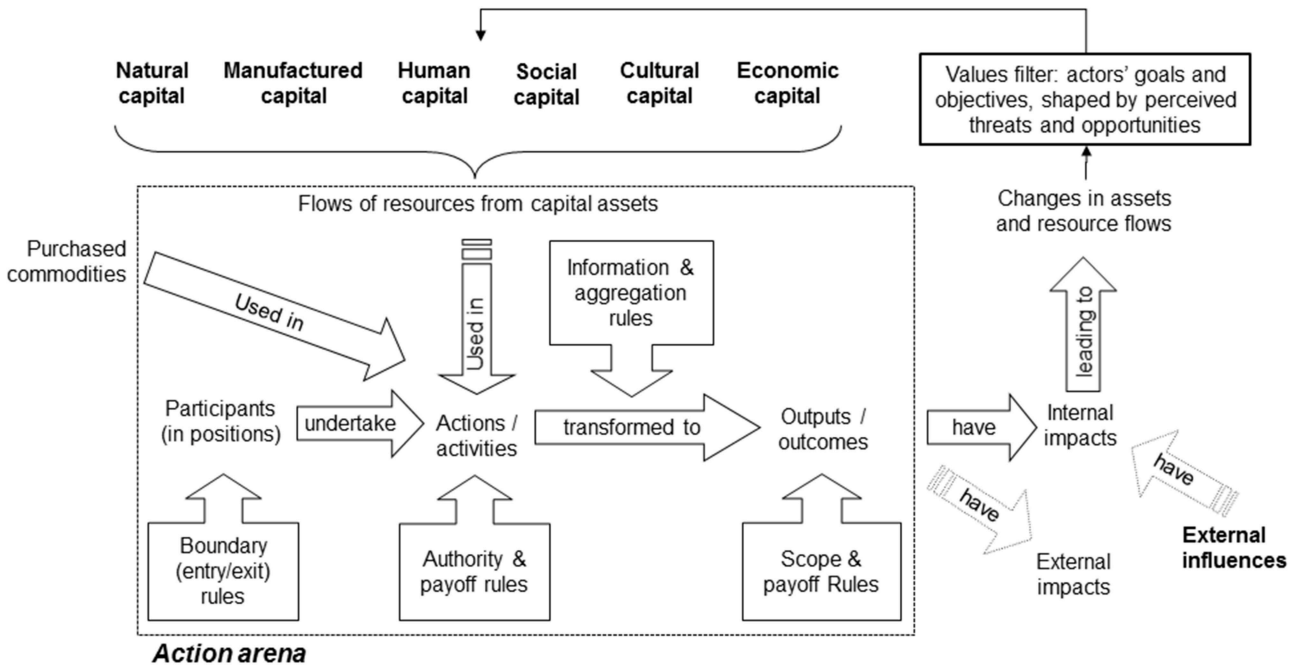

FIGURE 1 | Basic action arena framed in terms of capital assets and resource flows (adapted from Rudd, 2004).

decisions that help him or her reach their personal objectives (e.g., earning a living and having enough money for educating children) or broader objectives regarding the state of capital assets in their community (e.g., infrastructure, social cohesion) or region (e.g., health of fish stocks). Individuals function within their community, and are influenced directly by actions of the community level (e.g., the aggregated outcomes of local fishers on fish stocks; social norms that influence where, when, and how an individual can fish). All actors at the operational level of households and communities are influenced by the actions and outcomes of higher level fisheries management and other organizations tasked with governing or supporting the operational level. For example, the formal rules that govern local fisheries are chosen at the higher level, as are choices about enforcement intensity and the allocation of resources to operational level activities like habitat restoration. At an even higher political level, activities and their outcomes shape general policy directions that reflect the desire of governments or other high-level organizations (e.g., donors). In our analysis, we found respondents who addressed issues at all levels and used the multi-level IAD framework to help organize and make sense of those comments.

Value-Belief Norm (VBN) Theory

The VBN theory (Stern et al., 1999; Stern, 2000) seeks to explain environmentally-significant behaviors. While fisheries leadership may not entirely be an environmental behavior *per se*, we believe that a modified VBN—used as a framework to organize comments about threat perceptions, actor objectives, and propensity to act in certain ways—is useful for framing thinking about SSF fisheries leadership. A key insight from VBN theory is that threat salience is influenced by a number of factors (i.e., cultural context, prior experiences, core values, access to information, and an actor's capabilities—**Figure 3**) that will affect the propensity of that actor to take action and influence the intensity of engagement, subject to institutional constraints. In theory, the more deeply rooted an individual's beliefs are, the more likely an individual is to be aware of the consequences of their behavior (López-Mosquera and Sánchez, 2012). Beyond environmental threat salience research, we believe that the theory can also be applied to perceptions of new opportunities that affect an individual's propensity to engage in behaviors that advance personal goals or become engaged with higher level entities or organizations that have goals reflecting the core values of that individual. For example, an individual fisher would be more likely to engage in a local SSF management if government organizations enforced rules against poaching by community outsiders.

In the context of SSF leadership, individual leaders play a dual role: they act as individuals, making choices about personal actions that fulfill their objectives at the household level; and they also make decisions regarding community-level leadership actions. It is important to distinguish between the two because taking on a leadership role actually means that an individual also formally or informally fills a position at a level higher than the household level. Thus, attention needs to be paid to untangling the actions of individuals and to whether they are acting on behalf of their own household or as an actor with a particular SSF management role to fulfill.

An individual's experience of working in a certain management or leadership context can shape their motivations to participate in future projects. Experiences with successful projects build reputation and credibility that can encourage

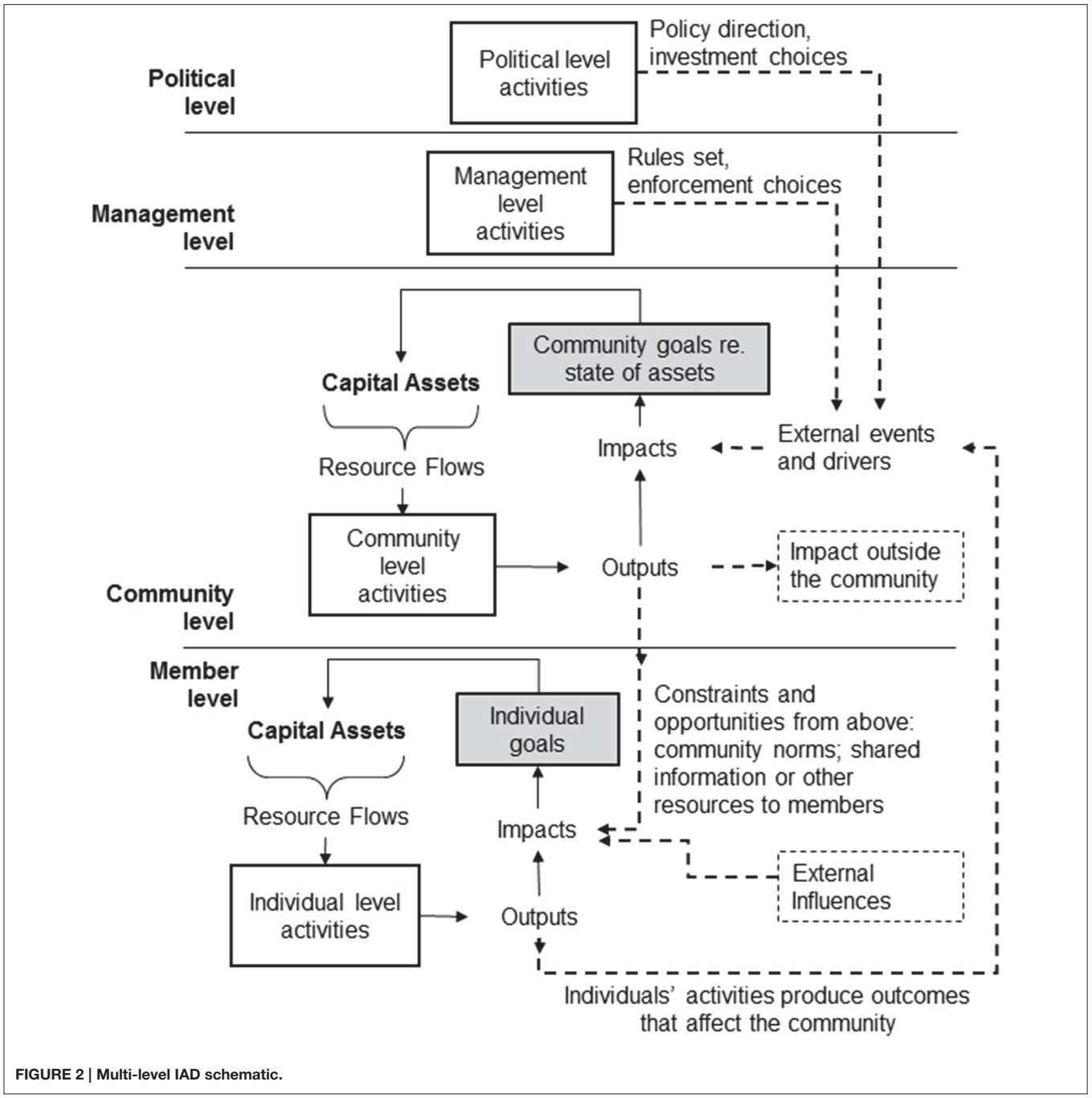

FIGURE 2 | Multi-level IAD schematic.

future participation, while experiences with unsuccessful projects can discourage future participation. Social memory is the mechanism in which information regarding experiences is stored (Adger et al., 2005) and is embedded through community discussions and decision-making (McIntosh, 2000).

Cultural Context

Cultural values such as freedom, prosperity and security represent shared ideas about what is good, right and desirable in a society (Williams, 1970). Cultural values guide people to understand which behaviors are appropriate in various situations (Schwartz, 1999). Cultural values are numerous and can differ substantially between countries. Schwartz (2012) asserted that some values are congruent with each other while others conflict (**Figure 4**).

With four quadrants, Schwartz (2012) defines the four major values types: openness to change; self-transcendence; conservation; and self-enhancement. The closer the values are, the more similar their underlying motivations, while the more distant they are, the more antagonist their underlying motivations (Schwartz, 2012). Therefore, conflicts can arise between individuals and groups that hold different values. The

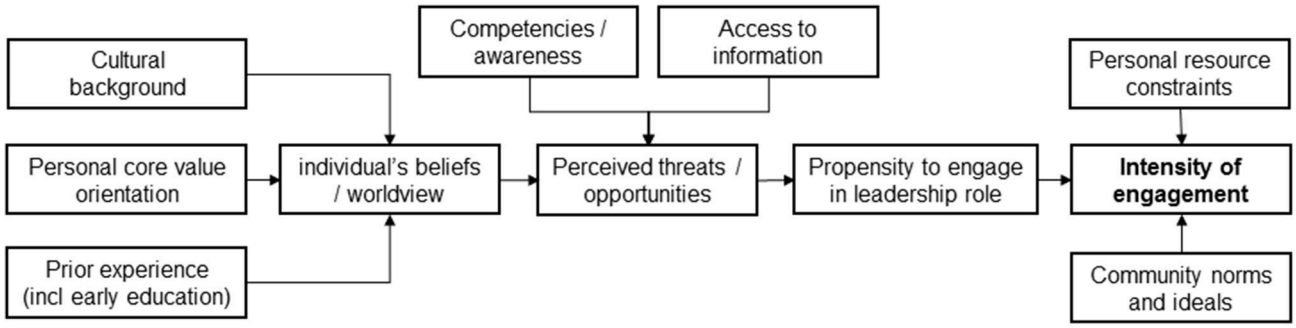

FIGURE 3 | Framing how individuals make choices about leadership engagement.

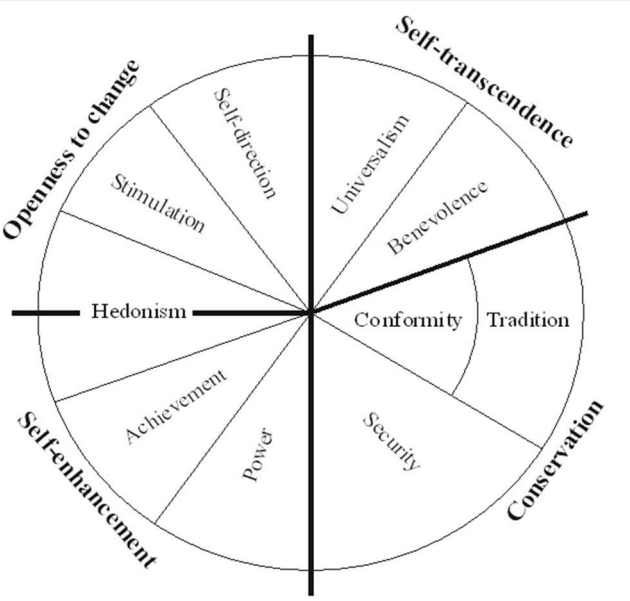

FIGURE 4 | Opposing value types (Schwartz, 2012).

value of openness to change relative to the values of conservation captures the tension between independent thought and readiness to change, and values that encourage order, preservation of the past and resistance to change. Differences of values emphasizing self-enhancement relative to self-transcendence capture potential tensions between the concern for the interests of others (and the environment) and the pursuit of one's own interest.

In synthesis, the IAD framework, and the VBN and cultural value theories facilitate the in-depth analysis of leadership. Individual-level factors we focus on include cultural values, prior experiences, and access to information, all of which influence an individual's propensity to engage in leadership roles. The link between individual-level factors and propensity to engage in leadership is based on the VBN theory (**Figure 3**). The intensity of engagement is constrained by capital assets (e.g., financial and social capital) and community-level activities (**Figures 1**, **2**). Higher level factors at the political level directly and indirectly influence local-level leadership through policy direction and regulation setting.

Empirical Implementation

Interview Questions

To collect contextual information on leadership we used semi-structured interviews that offered participants the chance to explore issues they perceived as important (Longhurst, 2010). Interviews started with a general discussion on the fishery to obtain information about the fish stocks targeted, fishing methods used, perceived health of stocks and the environment, and governance arrangements. We then asked four theoretically-guided questions (listed below) to help direct a conversation. Participants thus had the opportunity to develop arguments and engage in open discussions regarding key issues while minimizing interview time (Weiss, 1995).

How do individuals come to be community leaders? The effectiveness of local leadership is related to the legitimacy or credibility of a leader. Theory assumes that individuals who have a connection to the community or who originate from the community are likely to be successful leaders (Ostrom, 2009). Legitimacy can also be enhanced through formal processes of elections and rotations (Hollander and Julian, 1970). In our interviews we sought to explicate the processes by which leaders most commonly emerges, and the conditions and factors that aided or hindered this emergence from an individual role as householder or small business person to an actor that took on a formal or informal leadership role at the community level.

Why do people get involved with leadership roles? Motivations are an important precursor to the performance of certain behaviors (Giberson et al., 2005). The expression of inherent values is shown through motivations to act. Motivations can determine whether an individual will act in self-interest or for the interest of the wider community (Schwartz and Bilsky, 1987). Deciphering an individual's motivation for becoming involved with SSF leadership roles is therefore crucial.

Are potential leaders prepared for leadership roles? Capacity building is often provided to local communities as part of CBFM projects (Pomeroy and Rivera-Guieb, 2005). Training programs are either directed at the wider community, specific key interest groups, or current leaders. Capacity building increases an

individual's knowledge and skills, which can be then utilized in an action arena (Stern, 2000). Our question aimed to explore a range of tools and approaches used to enhance leaders' ability to function in SSF management.

Do individuals receive external assistance to enhance their leadership capacity and meet their responsibilities as a leader? The introduction of CBFM structures often puts additional pressure on community resources. In many instances local organizations do not have the capacity to facilitate CBFM. For those communities, external assistance in terms of leadership, technical assistance, and the facilitation of access to resources is required (Pomeroy et al., 2001).

Do you think there will be any challenges to leadership going on into the future? In addition to four theoretically guided questions, we included one final question that asked respondents to identify key future challenges regarding leadership in SSFs. The aim was to link leadership emergence to broader environmental, economic, political, and social landscapes.

Sampling Method

We selected cases deliberately to help ensure we covered as broad a range as possible of case study configurations, and to obtain opinions from individuals with diverse expertise. Four contextual variables that were potentially important for SSF success were used to broadly identify 16 general types of case study configurations: development status of the country where the fishery was located; whether fishers regularly participated in CBFM; fishery complexity, defined simply as single-species vs. multi-species fisheries; and management status (i.e., how established the SSF management arrangement was) (**Table 1**). Our aim was to include at least one case study from each of those possible combinations. Sampling was therefore theoretically-informed rather than random or representative. Once as many variable combinations as possible were covered with at least one interviewee, we added interviews opportunistically across case types until we reached our target of at least 50 interviews in total (a reasonable number for future Qualitative Comparative Analysis research—see Sutton and Rudd, 2015).

Potential case studies were identified using academic journals, organization websites, project reports, and the Too Big to Ignore (TBTI) SSF database (toobigtoignore.net/issf/). After case studies were identified, potential interviewees were contacted via email. Our criterion for selecting interviewees was based on their involvement with the SSF. To be involved in this research, the individual had to either be a researcher of, or a practitioner within, a focused SSF. As such, our respondents included academic researchers, government scientists, representatives from NGOs and leaders in community-based organizations. This ensured we covered a range of insights and opinions on SSF leadership from individuals in different regions and with different backgrounds. Of 200 individuals contacted globally, interviews (via Skype or Google Hangouts) were conducted with 54 respondents between January and July 2015.

Kingdon (2003) defined leadership as key individuals who by their skills, experience and personal characteristics are justified in being a central and influential role in social processes. Due to the complexity of leadership, the lack of a common definition for SSF leadership, and the difference in leadership structures between SSF communities, we decided not to have a fixed definition of leadership. Instead we left respondents to define leadership in a manner that was appropriate to their case study; for example, this included a single individual or a group of individuals, external or internal actors, and informal or formal leaders. As we took insights from both academics and practitioners, we had an even mix of respondents who were researchers or advisors to the SSF, and respondents who were themselves leaders.

Interview questions were approved by the Department of Environment research ethics committee at the University of York in November 2014. Confidentiality agreements were signed by all interviewees and transcripts were stored on a private device.

Data Analysis

Interviews were transcribed and coded using NVivo software (www.qsrinternational.com). Theme identification is important to show recurrent unifying concepts or statements within data (Boyatzis, 1998). *A priori* themes were defined drawing on terminology likely to be important for theoretically-informed discussions of SSF leadership performance (i.e., terms relating to potential precursors to individual action; individual and community level action choices and constraints; interactions between various social groups; and higher level socio-political influences). As the interview transcripts were analyzed, themes and sub-themes were modified, refined and often combined to improve clarity. Further, theme structure evolved inductively with emergent themes reflecting representation of unanticipated interview responses (Bradley et al., 2007).

RESULTS AND DISCUSSION

Interview Results

Our 54 interviews covered 52 case studies and 15 of 16 case study configurations (**Table 1**) from 34 countries (**Figure 5**). Conversations lasted between 30 and 120 min, resulting in over 46 h of interview recordings that were subsequently transcribed for textual analysis. In our subsequent reporting of results, we summarize the number of respondents who made reference to particular themes and provide selected interview excerpts. For confidentiality purposes, respondents are numbered R1, R2, etc. This research relied on the opinions and views expressed by our respondents. The potential for biases among our respondents was, we hope, minimized by collecting and reporting on information from a wide range of interviewees across diverse case configurations.

Factors Affecting Individuals' Propensity to Engage in Leadership

Cultural Background

Individuals' perceived threats and propensity for taking action are influenced by shared culture and unique personal experiences. Culture influences an individual's behavior by shaping a repertoire of shared habits, skills, and values (Swidler, 1986). Cultural conditions can be either conducive for collective action or act as a barrier (Pomeroy et al., 2004; di Falco and Bulte, 2011), and either can influence leadership potential. We found

TABLE 1 | Number of case studies of each configuration type.

Configuration	Development status	Fishery participation	Fishery complexity	Management arrangement	Number of cases
1	1	1	1	1	11
2	1	1	1	0	7
3	1	1	0	1	2
4	1	1	0	0	4
5	1	0	1	1	2
6	1	0	1	0	1
7	1	0	0	1	1
8	1	0	0	0	3
9	0	1	1	1	3
10	0	1	1	0	2
11	0	1	0	1	3
12	0	1	0	0	6
13	0	0	1	1	0
14	0	0	1	0	1
15	0	0	0	1	3
16	0	0	0	0	5

Development status: using the Human Development Index (HDI), cases in very high and high HDI nations were ranked 1, and cases in medium and low HDI nations were ranked 0. Fisher participation: if fishers regularly participated in CBFM decision-making the case was ranked 1, and if not, the case was ranked 0. Fishery complexity: if the case SSF was mostly single-species in focus, the case was ranked 1 and if mostly multi-species focus, the case was ranked 0. Management arrangements: if SSF management techniques were fully established, the case study was ranked 1 and if new or unestablished, the case study was ranked 0.

cases studies in this research that exhibited both possibilities, where cultural context was conducive to collective action and vice versa (**Table 2**).

Seven of our cases studies highlighted cultural contexts that facilitated collective action. For small-scale aquaculture in northern Sri Lanka, collective action was traditionally practiced in cooperatives and associations. R1 emphasized that "if people are used to working collaboratively, its's easier." Fisheries and fish resources were an important part of the community's cultural identity in Velondraike, Madagascar. R2 stated that "it's completely intertwined with who they are as people", so that consequently community members actively participated in activities which focused on protecting those resources. Religion also influenced fishing activity and conservation measures. In Bangladesh, fishing activities ceased in line with Hindu and Muslim festivals. R3 noted that fishers have built a special connection to the fisheries, which has helped place a conservation value on fish stocks. The relative homogeneity of communities in the Khong District, Laos—in terms of ethnicity, language and culture—enabled effective information exchange between community members. R4 reported that this enabled individuals to easily evaluate the actions of others.

For other contexts, collective action was hindered by cultural influences. In many SSFs, fishers had individualistic tendencies, which reduced the likelihood of collective action and of following a leader. R8 described the Bajau fishers of Wakatobi, Indonesia, as "rugged in their individualism" and questioned "why on earth would they accept someone being a leader, when they know everything they need to know." Similarly, fishers in Scotland preferred to act independently of regional grouping; that independent orientation, which was a valued trait among fishers in the region, hindered the potential of CBFM (R9).

TABLE 2 | Cultural values facilitate or restrict leadership and collective action in SSF management.

Key findings	Comments/Tally
Fishing is an important part of cultural identity which incentivizes leadership and community participation in SSF management	7
Culture is not conducive to leadership and community participation in SSF management	4

In part, a fisher's individualism is attributed to the characteristics of the resource. Fisheries are a common pool resource, characterized by two defining features, excludability and subtractability. When fish stocks are declining, this can place fishers under pressure to participate in a race to fish (Ostrom, 1990). Independence and individualistic tendencies should not be regarded as undesirable characteristics, as they encourage the propensity to think and behave freely, facilitating the ability to make quick decisions (Poggie, 1980). However, in those cases, what is the likelihood of fishers working collectively, following a leader or becoming a leader themselves? Poggie (1980) recognized that CBFM needs to be compatible with the psycho-cultural characteristics of the fishing community: new management structures should encourage free thought in decision-making, independence, and the creation of community ownership whenever possible.

Core Values

Our respondents highlighted that individuals have different motivations for leadership (**Table 3**). The motivation of a leader influences his or her behavior and can consequently significantly

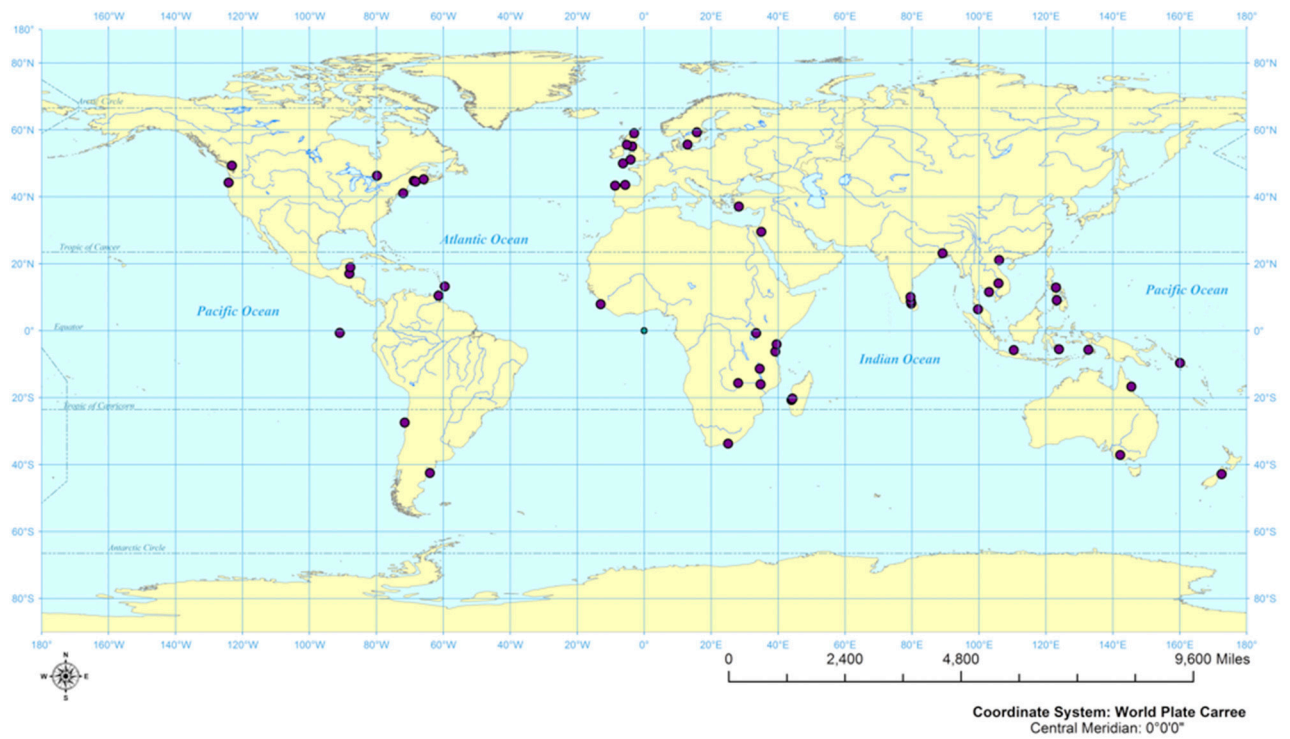

FIGURE 5 | Case study locations.

TABLE 3 | Core values are expressed in motivations for taking on leadership roles.

Key findings	Comments/Tally
Individuals become involved due to altruistic values	9
Individuals become involved due to the opportunities of self enhancement • Livelihoods (13) • Connections (3) • Social recognition (2)	18
Individuals become involved due to environmental values	7

influence the overall effectiveness of the organization (Giberson et al., 2005). We found that altruistic, self-enhancing, and environmental motivations all played motivating roles for individuals to engage as leaders in differing cases.

Nine respondents attributed motivation for leadership to altruistic factors. In western Canada, R12 noted that older fishers believed that "it's time to give a little business back to the industry, the industry has been good to me and I'm going to put my time in." Similarly, older fishers in Bangladesh were found to be motivated to, "support their community and ensure the continued livelihoods for future generations" (R3). In Cambodia, R10 recognized that there will always be a member of the community who is committed to improving the life of community members.

Many leaders were motivated for self-enhancement purposes. Simply getting paid was enough encouragement for poorer individuals in Malawi and Tanzania to take on leadership roles. Securing livelihood opportunities was particularly important in western Canada: "I think a lot of it is that this is their livelihood, this is how they and their families survive" (R12). The connections made with external, influential actors through leadership activities are a second motivating factor. One respondent (R17) stated that "individuals [in Argentina] are always trying to get help or trying to connect themselves to other levels, politically." R13 noted that leadership in Spain "brings all sorts of benefits, because you are the linking organization between all the fishers and the government; I think that's a big motivation." Social recognition was also a motivating factor according to two of our respondents. In Australia, R18 highlighted that fishers "are proud of the recognition they receive…they tend to be held in high regard by their communities and this social license is important to them and their families." In Laos, "leaders are people who were more interested in the prestige of the position, in the sense that they wanted to be known in their communities as important people" (R4).

Environmental values were attributed as motivating factors by seven respondents. A member of a local environmental group in Taunton Bay, Maine had little confidence in the State government; his motivation for participating was to represent sound environmental policy (R23). In the Philippines, R29 highlighted that leaders "do not get paid for the work, it is purely a voluntary service, they believe in the cause of resource conservation and protection." Similarly, R30 commented that the

leader of a marine protected area (MPA) in Spain was a local university professor; "he was on a mission for sustainability; he was really passionate about it."

Our findings offer insight into the motivations of leaders in SSF and highlight different value structures. In line with the work of Schwartz (2012), it is possible to hypothesize that individuals with altruistic or biospheric tendencies are more likely to serve collective interests for the good of conservation, whilst those who express self-enhancement values are more likely to serve individual interests. However, individuals have multiple values which emerge at different times calling for a temporal component to future leadership research.

Prior Life Experience—Early Education

Our respondents identified education as a key factor that influenced fishers' behavior. The introduction or re-establishment of participatory approaches often included elements of education, training or capacity building. Education increases awareness and influences perceptions and beliefs that guide human behavior (Hungerford and Volk, 1990; Stern, 2000). Multiple educational approaches for increasing awareness were practiced in our case studies and targeted both children and adults. As early education is thought to influence threat salience and behavioral choice via its effect on worldviews (as opposed to skills- and awareness-building in adults, which can more directly and immediately affect perceptions regarding threat salience; Stern, 2000), we deal with each separately.

Marine programs were developed for school children in seven countries including Tanzania and the Philippines. Increasing awareness from a young age embedded the importance of marine ecosystem sustainability (**Table 4**). R7 reported that after two decades of the marine program on Apo Island in the Philippines, local children had a strong sense of place and their marine environment was "sacred" to them. Similarly, an MPA organized by the Community of Arran Seabed Trust (COAST) in Scotland, UK, has received strong support from the local community. R19 attributed that level of support to "the continued presence of COAST at community events and awareness raising activities for children in local schools."

Human Capital—Adult Education and Awareness of SSF Threats and Opportunities

Human capital refers to the stock of knowledge that individuals possess in an action arena. The ability for individuals to adopt more profitable and secure livelihood strategies from SSF is in part dependent on education (Dercon and Krishnan, 1996). Adult members of the community benefited from awareness building opportunities that were created through the development of workshops, training programs, and community events (**Table 5**). R3 reported that programs in Bangladesh taught local fishers how to brand their fishery products and participate in micro-credit programs. The development of a co-management program in Spain increased local awareness of the importance of local fisheries resources to the local livelihoods. Consequently, R13 noted that fishermen were volunteering more of their time to participate in surveillance and monitoring. R30 reported that local ecological knowledge, a form of knowledge held by local resource users, was incorporated in Spanish MPA proposals, and that this "fostered a sense of ownership and that's what made it succeed."

Many local fishers, however, have minimal formal education, and this can reduce their ability to participate in CBFM (Hollup, 2000; Vedeld, 2000; Glaser, 2003), a point that was reiterated by our respondents. In Sweden, R6 highlighted that language barriers hindered local fishers in their application for a Marine Stewardship Council (MSC) certification, which recognizes the sustainability of a fishery. Similarly, few community members had the level of education required for higher level positions of an MPA authority in Tanzania; R24 reported that "you have to be able to write on the computer and you have to be able to write in English, so that limits the number of people who can apply to the job." Many individuals simply do not have the capacity or disposition to be leaders. Respondents from the UK, Chile, Canada, and Ecuador highlighted that little or no capacity-building was targeted specifically at leadership. Lack of capacity-building for leadership was attributed to poor funding opportunities or leaders having too little time to attend workshops. Capacity building for leadership was provided for Beach Management Units (BMUs) around Lake Malawi and Lake Victoria in East Africa. However, R31 stated that local fisheries officers did not have the capacity to transfer knowledge on to their successors, and R22 added that training was one-off in nature, not followed by successive training that built skills over time.

Several of our interviewees also reported that increased levels of awareness regarding other livelihood and investment opportunities, combined with the uncertain nature of fishing, could deter individuals from remaining in SSFs. In the Philippines, fishers were "less interested in managing the fishery because they don't depend on it anymore" (R32). In Argentina, "the sons and daughters of fishermen don't want to continue in fishing" (R17). Similarly, R31 emphasized that fishers around Lake Victoria were beginning to invest more in their children's education and that, as they did, their motivation to participate in SSF collective action, leadership and management was diminishing.

TABLE 4 | Prior experience influenced engagement through multiple pathways.

Key findings	Comments/Tally
Early childhood education increased the awareness of local people of all ages	7

TABLE 5 | Human capital at the local level impacts an individual's ability to lead.

Key findings	Comments/Tally
Awareness of other opportunities has reduced motivation to remain in the SSF industry	6
Fishers have poor educational levels that can inhibit participation in SSF leadership	8

Access to Resources

Financial capital

Many small-scale fishers are extremely poor and live well below the poverty line (Béné, 2003). Financial capital at the individual level is therefore often limited. Our respondents noted that fishers' poverty levels impacted on their ability to participate in CBFM in Tanzania, Bangladesh, Malawi, and Madagascar. In Vietnam, R15 stated that "the folks on board are also actively engaged in securing a livelihood, so there isn't a huge amount of time to spend doing project activities. This was reiterated by R37 who recognized that "people may be willing (to participate) but not able…an individual, whose livelihood relies on them being out in the industry—that is a constant problem…it's a catch 22." Timing issues were exacerbated by fishers working hours that are highly influenced by tides, and R23 reported, "no matter how carefully we planned, securing 100% attendance was impossible." Fishermen are increasingly being put under greater pressure due to dangerous working conditions, reduced stocks, and stricter regulations. It is inevitable that time will become even more restricted in the future (Salas et al., 2007). Therefore, the need to provide a secure income reduces the time fishers can devote to both leadership roles and collective action (**Table 6**).

Manufactured capital such as fishing boats and technology are the stock of produced assets that people use over time (Rudd, 2004). The importance of manufactured capital was referred to by two of our respondents. Although this is a low level of coverage, we included it as a distinct category to emphasize the importance of further research on the influence of manufactured capital on leadership. In Bangladesh and Indonesia, a fisher's access to boats was the basis of their leadership. For the Bajau in Wakatobi, formal leadership among community members was an uncommon occurrence. However, R8 confirmed that "temporary leadership can emerge if an individual gets a bit more money, who maybe owns three boats and has a crew…this isn't policy-based leadership, it's fisheries-based leadership but not because of the need to manage the fishery, it's just what you do to run your business."

Social capital

Social capital is an asset built on social networks (Rudd, 2000; Krishna, 2002). It facilitates the transmission of information and reputation, and is a key factor influencing the socio-ecological sustainability of CBFM (Rudd, 2004). While social capital by definition needs multiple actors to function, one can conceptualize that an individual's access to social capital—their niche in the network—strongly affects their capacity to engage as an effective leader. Social capital is also an important resource from an organizational perspective at higher levels of management and political choice processes.

Social capital was an important influencing factor in our case studies (**Table 7**). Trust and confidence between community members decreased the need for strict enforcement in the tilefish fishery in northeast USA (R42). Limited bonding social capital, or the bonds between likeminded people, was, however, also reported at the individual level. Poor social cohesion between fishers prevented collective action in the Galapagos Islands, Ecuador. R43 attributed this to the prevalence of fishers from mainland Ecuador who had stronger connections to their home communities. In Western Australia, bonding social capital was commonly weak among abalone fishers; R44 argued that this was due to "the historically fractious relationships between fishers." R5 recognized that social bonding between community members around the shore of Lake Malawi needed to be strengthened in order for shared objectives to be developed.

A potential mechanism for increasing social capital was also highlighted. Experiences of working collectively are stored in the social memory of communities (Adger et al., 2005). Members of SSF organizations in Spain and Malawi who participated in prior CBFM projects had heightened confidence and trust in their collaborations with other fishers. In these communities, leaders used the experience of working collectively and the social memory of the fishing community to participate more effectively in subsequent projects.

Community-Level Leadership Issues

Leadership Legitimacy

At the community level, individuals need to be considered in relation to the formal role that they play as leaders in fisheries management. Legitimacy is a psychological property of leadership that allows followers to perceive appropriate, proper, and just leadership (Tyler, 2005). Legitimacy is the common way of signaling acknowledgement of a leader (Hollander, 2012). By accepting a leader, followers influence the strength of a leader's influence and consequently the performance of the group. Over half of our respondents identified legitimacy as important and highlighted the numerous pathways individuals can become legitimate leaders (**Table 8**).

Legitimacy can be achieved through formalized mechanisms of nominations, elections, and rotations, processes that define boundary rules and provide clarity regarding the leadership role within which individuals are placed and act. Elections also create a heightened psychological difference between followers and leaders (Hollander, 2012). To become a member of an Inshore Fisheries Group (IFGs) in Scotland, R9 reported that

TABLE 6 | Financial capital influences leadership potential.

Key findings	Comments/Tally
Many individuals have too little money to be involved in leadership activities	8
Many individuals have too little time to be involved in leadership activities	6
Mechanisms that strengthen social capital	4

TABLE 7 | Human capital at the local level impacts an individual's ability to lead.

Key findings	Comments/Tally
Social capital is apparent in the SSF community	6
Social capital is not apparent in the SSF community	4
Mechanisms that strengthen social capital	4

TABLE 8 | Human capital at the local level impacts an individual's ability to lead.

Key findings	Comments/Tally
Leaders can gain legitimacy in numerous different ways • Elections (13 out of 36) • Origins (23 out of 36) • Leadership activities (21 out of 36)	36

an individual had to meet certain criteria outlined by the organization's guidelines. In western Canada, to gain a place on the Board of Directors, prospective members were required to be nominated and elected by current members (R12). Individuals from regional groupings in New Zealand were nominated to become representatives on the New Zealand Rock Lobster Industry Council (NZRLIC) by other community members (R20). Elections increase legitimacy, but in some circumstances elections can also lead to unrealistic expectations of leaders and consequently they can become the subject of criticism (Hollander and Julian, 1970). Elections can, for instance, be corrupt (Hauck and Sowman, 2001) or poorly executed in the face of community members' low literacy rates (Xu and Ribot, 2004).

Our case studies reiterated that the geographic origin of a leader can be important for leadership legitimacy. Local leaders who have a deep understanding of local processes and cultures are essential for collective action (Meaton and Low, 2003; Olsson et al., 2004; Beem, 2007; Bodin and Crona, 2008; Gutierrez et al., 2011). *Calettas* or fishing federations in Chile have strong social bonds, leading R33 to assert that when someone comes from another area, "he will always be an outsider." Leadership positions were maintained within family units in Quinta Roo, Mexico, and Apo Island (despite formal elections for barangay leadership in the Philippines). SSF leaders were also found to be traditional leaders in Malawi, Canada, Vietnam, Laos, the Philippines, and Malaysia, a factor that helped increase their legitimacy among community members.

A leader's legitimacy can also be enhanced through his or her actions. In our case studies, a leaders' legitimacy was strengthened via their reputation, and the trust, accountability, and transparency that they engendered. In Madagascar, R34 noted that "community members have seen the benefit (of their leader), so trust had already been developed." Similarly, in the Philippines, R29 highlighted that "although leaders do not possess leadership skills at first, they evolve to be good leaders because of their first-hand knowledge…they gain the trust of the people in the community." The most important criteria of developing leadership in Jordan fisheries were transparency and openness (R25 and R26).

Leaderful Issues at Community Level

Creating "leaderful" organizations can be important for SSFs. A leaderful organization encourages each member of the community to gain experience of being a leader concurrently and collectively (Raelin, 2003). Due to the difficulties of leadership succession, it is important to expand the focus of leadership. The image of "successful leaders" has to shift from developing individual leaders to developing "leaderful organizations" of multiple leaders (Al Mamun, 2015), thereby increasing the pool of potential leaders. Succession is a social process determined by the interactions between leaders and their constituents, and the capabilities of local communities to produce new leaders (Hart, 1993). Our respondents identified several concerns about leadership succession (**Table 9**) and techniques to potentially facilitate more successful leadership succession planning.

Motivation was found to be a limiting factor in leadership succession. R5 noted that local chiefs in Malawi had minimal motivation for leadership, as CBFM projects were implemented by the government. Reduced motivation among SSF leaders in Argentina was due to fluctuating support from governmental departments and poor success rates of prior CBFM projects; R17 reported that "the fishers started with a lot of motivation and strength, but the same people who are still in the fisheries are tired of continuing…it's really difficult to maintain the motivation." Similarly, R30 stated that due to reduced effectiveness of an MPA in Spain, the local leader is "totally deflated, he doesn't want to be involved anymore."

Leadership succession was impacted by the lack of up-and-coming leaders. In northern Scotland, R50 reported that "we put an advert in the local press and invited applications from anybody who was interested…we didn't get many people who were interested." A limited pool of potential leaders was also experienced in Taunton Bay, Maine; R23 commented that the "area and the resource were just too small…we were a very limited number of people who were interested and that meant we were an inbred group by the end, we didn't get the fresh blood we were hoping for."

An aging population of fishers contributed to concerns regarding leadership succession. Reporting from Spain, R13 noted that "many of the community leaders in the gooseneck barnacle industry are older, which could be problematic considering the dangerous nature of the fishery." R12 added that with the retirement of older fishers, years of cooperative expertise and local knowledge was likely to be lost. Despite concerns of an aging population, barriers to young, nascent leaders were also highlighted in some cases. In Tanzania, India, and Malaysia, older members of the community often discounted the authority of young members. R24 recognized that "you have an older guy and he doesn't want to listen to the younger guy who was supposed to be a leader, it's very difficult—it's definitely a cultural thing."

To overcome concerns of leadership succession, new approaches should be developed to ensure the longevity of leadership. Capacity building was used in several of our case studies as a method to train individuals for leadership. A non-governmental organization (NGO) called Blue Ventures provided newly elected individuals in Bel Sur Mer, Madagascar, training in leadership and organization management skills (R2). R35 reported that in a regional project in the Caribbean, local fishers were given the opportunity to attend capacity building workshops and conferences on SSF. Similarly, R28 who worked for an NGO in Mexico, stated "over the last 3 years, we have worked quite heavily on leadership, working on administration and business training, because it's not something they are used to." Succession planning, the process which stabilizes the occupancy of key positions and consequently helps to ensure the

TABLE 9 | Succession is a beneficial attribute that helps the longevity of successful leadership.

Key findings	Comments/Tally
Concerns of the ability to produce successors for leadership • Motivation (6 out of 24) • Poor capacity building (13 out of 24) • Lack of up-and-coming leaders (8 out of 24) • Barriers to young people (4 out of 24)	24
Techniques to ensure successful succession planning	20

TABLE 10 | Interactions between different SSF organizations/agencies at different levels affect leadership.

Key findings	Comments/Tally
Horizontal and vertical linkages are beneficial for leadership groups	13
Young, educated leaders are crucial in securing and enhancing linking social capital	4

continued effective performance of an organization (Rothwell, 2010), is also explicitly needed.

Vertical Collaborations between Communities and Agencies

Nesting CBFM organizations in numerous institutional layers is crucial (Dietz et al., 2003). Community-based management has been reported to fail when communities lack linkages to higher levels of government (Lejano and Ingram, 2007; Cudney-Bueno and Basurto, 2009). Our cases studies reiterated the benefits of establishing and strengthening ties to different levels of SSF management organizations (**Table 10**). Linking social capital is important to this process and refers to the ability of groups to engage with external agencies to either influence policies or resource allocations (Rudd, 2000; Pretty, 2003).

Several of the fishing organizations in our cases studies demonstrated effective linking roles. Fishing federations in Chile's co-management structure played important boundary spanning roles by communicating community issues to state agencies and vice versa (R36). The New Zealand Rock Lobster Industry Council (NZRLIC) provided a method of linking regional groups with the government in New Zealand. Our respondents also noted methods of enhancing linking social capital. In the Caribbean, R35 recommended the use of neutral platforms to facilitate the interaction of different actors including fishermen and government representatives. Similarly, in India, the Palk Bay Fisheries Management Platform was created to bring together key fishing stakeholders (R46).

Local leaders are crucial in establishing and enhancing linking social capital. A key factor in the ability of communities to interact with higher levels of SSF management is the presence of educated, young individuals (Krishna, 2002). These individuals provide a mediating role by dealing with the complex procedures of a state and understanding complicated governmental language. The importance of an educated, younger generation was reiterated by our respondents. In Chile, some younger generations of fishers have been given the opportunity to study technical aspects of fishing and are thus more prepared and educated. R36 stated that these individuals "have a broader perspective on things."

Elites and Power

Traditional leaders have significant influence over community processes. Traditional leaders include religious or spiritual leaders, caste leaders, and local elites. The potential gains from natural resources such as forestry and fishery products have often enticed local elites to act in self-interest. Consequently, the presence of local elites has been associated with embedded power inequalities and the ineffective use of community resources (Hauck and Sowman, 2001; Kull, 2002; Larson and Ribot, 2004; Njaya, 2007).

Our respondents emphasized that local leadership is not immune from the abuse of elite capture (**Table 11**). R3 noted that formal positions in Bangladeshi co-management were often usurped by rich individuals, who were not members of the fishing community; consequently ethnic fishers (Jalyes) were unable to participate in decision-making. In Indonesia, R45 asserted that CBFM was not the best approach for fisheries management; collaborative or co-management should be implemented to allow for the careful monitoring of community elites by external actors. One respondent also noted that local elites also worked for the interest of the community. R5 commented on a village chief in Malawi who recognized the dangers of elite capture. The chief purposively did not sit on the Beach Village Committee (BVC) but instead orchestrated rotations when committee members became tired or unmotivated to perform leadership responsibilities. R5 referred to this individual as a "benevolent puppet master."

Local elites have a strong influence on CBFM. As our case studies show, the activity of local elites can reduce the legitimacy of local leadership. In addition, the presence of local elites can lead to the dilution of wider community input, corruption, and improper use of community resources (Mahanty et al., 2006). However, elites can also help achieve successful SSF management, for example in Malawi and Mozambique, where traditional leaders have become advisors to SSF committees (Crona and Bodin, 2006).

Interaction between Leadership Groups

Implementing new management structures introduces new institutions, leadership, and potentially new power struggles into SSF communities. As Pinkerton (1989) recognized, key outputs of CBFM to consider are the new relationships that are created between different community organizations. It is especially important to consider how old and new institutions interact, and how power relationships play out (Amy, 1987). The interaction between old and new leadership proved to be an important influencing factor on the effectiveness of local leadership in our case studies (**Table 12**).

Our case studies highlighted experiences where implementing agencies chose to create new leadership authorities within a community. The Galapagos National Park (GNP) was the

TABLE 11 | Elites have a profound influence on CBFM through their leadership.

Key findings	Comments/Tally
Elites have an influential impact on CBFM for both positive and negative outcomes	6

TABLE 12 | Harmonious interactions between "old" and "new" leadership groups and elites.

Key findings	Comments/Tally
The interaction between old and new leaders is crucial to the effectiveness of SSF	6

main administrator of the Galapagos Marine Reserve. In 2008, the Ecuadorian government approved a new constitution that created a new governing institution called the Galapagos Governing Council (GGC). R43 identified deep uncertainty about the function of the GNP and GGC since the new reforms were implemented in 2008. In Malawi, working relationships between the newly implemented and formalized BVCs and traditional village chiefs continued to influence CBFM effectiveness; R22 emphasized that there is "a blending of management systems where you have the chiefs and the villages on one hand and the government on the other; when there's transparency and accountability it's good and when there's not, it's bad." In the creation of the Gulf of Mannar's Bio-Reserve in India, managing authorities chose not to work through existing leaders but created parallel authorities, although R38 questioned "whether this was an entirely sensible decision." R3 reported that project officials in Bangladeshi co-management arrangements decided to hire new local leaders, as many community members were unhappy with the existing leadership.

Limited research has been conducted on how existing leadership and newly implemented leadership can work together. Our case studies indicated that the transition is often complicated and characterized by uncertainty. Uncertainty is particularly evident in the responsibilities of each leadership group. Community members often questioned the legitimacy of their leaders, which reduced the overall effectiveness of leadership. It is important that agencies implementing CBFM consider the impact new leadership can have on exiting leadership and on the relationships leaders have with SSF communities.

Interactions between Local Leaders and External Actors

CBFM often requires external assistance from organizations such as NGOs, government agencies, and research organizations (Pomeroy et al., 2001). Depending on local leadership capabilities, external actors may need to perform leadership roles. Roles may include identifying management options, providing advice and expertise, and helping in community capacity building. Our respondents outlined a variety of experiences with external leadership (**Table 13**).

TABLE 13 | External assistance is important to the effectiveness of SSF leadership.

Key findings	Comments/Tally
External assistance brings benefits to local SSF groups	10
External assistance is not beneficial to local SSF leadership	9
External leaders are paramount to local groups	12

Several respondents highlighted the positive experiences of working with external leaders. An external leader proved invaluable to local SSF in Argentina; R17 reported that "an outsider from Washington had a lot of experience and knew what was happening in other fisheries and how to manage resources…he organized and invited fishermen, students and researchers to visit communities in Chile, to learn of their experiences." Respondents from Vietnam and the Philippines recognized the work of system thinkers who could leverage important resources from international organizations and link them to communities who required extra help.

Despite the importance of external leaders, barriers were also highlighted that restricted their effectiveness. Reflecting on the work of a governmental representative in Scotland, R50 commented that "does he add anything (to our community)? No, he's not as experienced in businesses as some of us are, he is not experienced in fisheries management, he's not nearly as knowledgeable about the fishery as our fishermen, so what does he add?" Concerns about the capacity of external leaders, in terms of resources and knowledge of local systems, were also highlighted by respondents from Malawi, Bangladesh, Madagascar, and the Solomon Islands.

Higher Level Political Context

Institutions and Management

Institutional design—various management techniques, policy instruments, and other required, permitted, or prohibited activities and outputs—is used to influence SSF resource use at the local level (Ostrom, 1990; Rudd, 2004, 2010). Our case studies highlighted how rights-based approaches and direct payments provide economic incentives, which help shape fishers behavior (**Table 14**). If such approaches are designed properly, they provide incentives for fishers to balance resource stewardship, economic efficiency, and social welfare (Castrejón and Charles, 2013).

Rights-based approaches used in our case studies included limited entry, individual transferable quotas (ITQs), individual fishery quota (IFQ) and territorial user rights in fisheries (TURFs). The implementation of rights-based approaches can be contentious due to the exclusion of some community members from the fishery (R12 and R42). R51 recognized that younger members of SSF communities found it difficult to obtain potentially expensive licenses. In northeast USA, a SSF management plan, which included a limited entry program and an IFQ, was initially met with resentment from excluded fishers. However, after concerns were addressed, R42 reported that the management plan now runs smoothly, has secured

rights for local fishers, and has increased cooperation between community members. Similarly, the NZRLIC in New Zealand is made up of nine shares owned by regional groupings and incorporates separate TACs. Through the work of the NZRLIC and the use of TACs, R20 stated that fishers have heightened custodial attitudes resulting in higher levels of environmental stewardship.

Economic incentives can be utilized to motivate fishermen to participate in and comply with CBFM. In a small Jordanian fisheries project, economic opportunities were created for local fishers by project officials who created partnerships with local businesses (R25 and R26). Similarly, in northeast USA, creative marketing ensured local fish was increasingly sold in local restaurants (R42). In Scotland, a major retailer invested in fisheries resources from a remote SSF; R50 noted "if fishermen can see quantifiable advantages of imposed management tools, those tools are more likely to be a hit with them." Payments to cover transport costs and a free lunch were given to participants of co-management projects in East Africa (R31). However, as R5 emphasized, "unfortunately, every time you pay someone for work that is in the collective interest, it reduces their incentive to contribute to anything else in the collective interest without being paid to do so."

Economic incentives are powerful tools used to entice fishers to participate in SSF management. Increased motivation for participation and compliance with regulations was evident in our cases studies for those individuals who have access to rights and/or direct payouts. Those same individuals may be more inclined to follow a leader they perceive will maintain their access to economic incentives or even take on leadership roles themselves to maximize the outputs of their rights. However, as our results allude to, there are limitations to rights-based approaches and direct payouts. Reducing access to fisheries resources has social and economic costs to fishers and their families (Kitts et al., 2007). Poor fishers and younger members of the community are often unable to accces rights, which reduces the likelihood of their participation in CBFM and leadership activities. In addition, the longevity of direct pay-outs influences continued fishers' participation.

Influences of Political Change

An enabling political environment and government support is essential to sustain CBFM (Pomeroy and Berkes, 1997). Changes in government policies can cause knock-on impacts at all levels (Razzaque et al., 2000; Berkes, 2006). Ostrom (1996) found, frequent top-down changes of national, state, and local authority reduced the motivation of highly effective leaders and fishers to regularly participate in CBFM. Our results support the assertion that policy change creates uncertainty of the longevity of CBFM and is linked to changing attitudes among fishers at the local level (**Table 15**).

Uncertainty about the longevity of CBFM organizations was evident in several of our case studies. In Argentina, the government went through several structural iterations for fisheries management and a recent change in the head of the Fisheries Department, which resulted in the decline of effective CBFM. R17 reported that "the State no longer supports local initiatives…the constant change and lack of support makes fisheries management difficult." The government of Tanzania leased an island off the coast of Zanzibar to a private company to run a no-take MPA. R24 suggested that the uncertainty surrounding lease renewal was a major concern for the longevity of the MPA. R52 expressed concerns about the uncertainty of continued funding to the English Inshore Fisheries and Conservation Authorities (IFCAs): "at the moment, we are fine; we are fine up until March 2016 when technically the money runs out. And, on paper, there's no more support funding from the government."

Influences of policy uncertainty on individual behavior were reported by our respondents. In New Zealand, the rights-based approach used in the NZRLIC was designed to engender a custodial attitude among fishers. However, R20 recognized that the government has "created so much uncertainty among the continued use of those rights that custodial attitudes and stewardship are being eroded." Reflecting on experiences of working with fishers in a Inshore Fisheries Group, R9 noted that "there's always a bit of suspicion from the fishermen, of anything to do with the government…if you have been in the fishing industry for 20 or 30 years, you will have seen a lot of changes…the fishermen are very wary."

Activity at the government level is important to consider when researching SSF and leadership. Constant policy change and fluctuating government support creates uncertainty about the longevity of CBFM organizations and the flow of government resources available. Importantly, local leaders may be tied to the interests of particular politicians, which can compromise their ability to truly represent SSF communities (Scholtens, 2015). Our case studies reaffirm that uncertainty is linked to changing attitudes at the local level. Local leaders were found to lose motivation with CBFM in times of constant change due to limited support from government actors, and reduced credibility among community members. Fishers can also become apathetic to management processes, which influences the likelihood of participation.

TABLE 14 | Management techniques influence leadership potential at the local level.

Key findings	Comments/Tally
Rights-based approaches influence behavior at the local level	4
Economic incentives are provided to influence behavior at the local level	3

TABLE 15 | Policy change affects local level leadership capacity/potential.

Key findings	Comments/Tally
Policy change causes uncertainty in the longevity of SSF organizations	8
Constant policy changes are linked to changing attitudes at the local level (positive and negative)	8

CONCLUSIONS

"Everything depends on leaders." (R16).

Local leadership is crucial to CBFM and SSF success. Our research explored the factors that influenced the effectiveness of local leadership. Factors that helped shape leadership engagement and effectiveness were evident at multiple levels: the precursors to individual behavior relating to perceptions of threats and opportunities; institutional constraints on behavior at both the individual and community level; and higher level considerations. Interactions between the levels are intricate and complex, and contribute to uncertainty regarding potential leaders' willingness to engage in leadership roles, their balancing of personal vs. leadership goals, and the ultimate effectiveness of leadership. Thus, many factors either help or hinder leadership effectiveness, depending on the environmental, social, and political context within which SSFs operate.

Precursors to individual action are numerous and multi-faceted. Our research demonstrated that it can be useful to employ theoretically-derived frameworks to help clarify how individual behaviors are shaped by core values, culture, experiences, and education, and how resource limitations or institutions can constrain leadership engagement. Motivation to participate in leadership can be altruistic in nature (for environment or people) or more narrowly oriented toward self-enhancement. Future CBFM research on how and why individuals decide to become leaders could be useful to help guide interventions that might successfully increase engagement in SSF management. In addition, our respondents highlighted that fishers often display individualistic tendencies. Consideration needs to be given to how likely individuals are to participate in leadership roles or collective action. These fundamental individual characteristics of a SSF community have to be factored in when designing CBFM projects.

Individuals and communities have a stock of capitals that they can use in SSF management. The availability of financial, human, and social capital can hinder or facilitate participation in leadership activities and collective action. At the individual level, we found that financial and human capital often restricted activity to such a point that SSF leadership potential was inhibited. Many fishers do not have the time or money available, or education level, needed to contribute effectively to SSF management leadership. The need for additional capacity-building aimed at local communities was frequently noted by our respondents. At the community level, the ability to work collectively and to follow a leader is particularly influenced by social capital. Although strong ties between community members were found in many SSF communities, historically fractious relationships between fishers, and between fishers and external actors can significantly reduce the likelihood of collective action.

Interactions between leaders and followers are crucial to the effectiveness of leadership. Our findings suggest that local leadership is strongly influenced by perceptions of legitimacy among the local fishing community. Legitimacy may be achieved or enhanced through elections, by efforts to build reputation and trust, and via the geographic "credentials" of a leader. We also found, to a lesser degree, that external leaders could also be effective. However, external leaders often have to contend with a lack of trust from communities and limited resources beyond finances, and therefore have a more limited role to play in most SSFs. The ability of a community to produce appropriate leader successors was highlighted as a major concern by our respondents. They recommended developing more "leaderful organizations" to help facilitate long-term and effective leadership succession.

Finally, our focus was primarily on factors that influenced leadership at the local level. Due to the political nature of leadership, it was also apparent that activities of higher-level actors considerably affected how local leaders could actively engage and be successful in their roles. Thus, there always needs to be consideration of the political environment within which SSFs operate. The uncertainty generated by policy change, in particular, can inhibit effective leadership due to fluctuating government support and access to resources. We found that constant policy change could also lead to the disintegration of relationships and trust between government departments and local actors, reduced motivation among fishers to engage in SSF leadership, and apathy toward SSF management initiatives.

The management and governance of SSFs occurs in complex social environments. Local leadership is extremely important to the functioning of SSFs, and especially in contexts where communities and community organizations are tasked with key management roles in devolved CBFM. Our research outlines a variety of factors that influence the effectiveness of local leadership and that can help inform researchable future hypotheses, which will help further advance empirical and theoretical understanding of the role that local leadership plays in successful SSF management. Further research can build on this work to further decipher how different social-ecological contexts influence the effectiveness of leadership engagement.

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AS and MR conceived research, AS conducted and transcribed interviews, AS analyzed data; AS and MR wrote paper.

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Deconstructing the Reality of Community-Based Management of Marine Resources in a Small Island Context in Indonesia

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This study offers a detailed analysis of community-based management (CBM) in a small island in Indonesia. In the study site, area-specific stewardship for a marine territory was informally institutionalized and, in addition to state rules, locally devised rules based on informal agreements have emerged. Using multiple methods for the analysis of the perceptions of the local community, this research examines the actual impact of the different rules on the fishing patterns in that sea territory, and illuminates the rationales of the local population to engage (or not) in the community-based approach to manage the marine resources. The study shows that the CBM initiative has to be seen as part of a convoluted regulatory system that impacts the fishing behavior in the sea territory. A lack of official authority to formally develop and especially to locally enforce rules represents a key challenges for the CBM initiative. This is further complicated by severe coordination problems between the local community and higher level state actors. The study further shows that the motivation of the community members to engage in the enforcement of the informal rules is strongly based on short-term economic considerations. For rules that are perceived to have a strong impact on the individual fishing yields, the fear of potential short-term economic losses constitutes a particular success factor of the local initiative since it motivates the members of the community to enforce local rules, especially when outside fishers break the rules. Yet, if rule-breaking is not perceived to decrease individual fishing yield, or if benefits of the generated yields are shared with the community as a compensation mechanism, the motivation of the community members to engage in rule enforcement ceases.

Keywords: blast fishing, common-pool-resource regimes, fisheries management, Net-Map, perceptions, poison fishing, Spermonde Archipelago, territoriality

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INTRODUCTION

Concerns about the world's oceans and coasts are rapidly growing (Rockström et al., 2009; Burke et al., 2011; Visbeck et al., 2013; Zondervan et al., 2013). One of the most severe threats for marine ecosystems and their associated natural resources emanates from the unregulated and uncontrolled resource use, i.e., an open access situation (The World Bank, 2006). Open access to marine resources is common all over the world since rules, regulations and management are often either lacking or not effectively enforced (Agardy et al., 2005). Such an open access situation is

widely assumed to lead to substantial sustainability deficits (Hardin, 1968; Ostrom, 1990; Agardy et al., 2005; The World Bank, 2006). The purpose of this article is to advance understanding of how to institute more effective community-based marine resource management in a small island setting.

Transforming an open access situation into any type of management regime requires the delineation of territory. While it appears to be more difficult to establish territoriality for marine areas than for terrestrial areas (The World Bank, 2006), research shows that it can be developed, legitimized and institutionalized (Kalikoski, 2007; Glaser et al., 2010). Marine territoriality implies area-specific stewardship coupled with legitimate rights to generate effective means based on formal and/or informal authority that steer human behavior in a specified sea area (Jones, 2014). In this regard, the concept of Common Pool Resource Regimes (CPRR) offers a useful point of departure (Ostrom, 1990; Young, 2006). The related literature holds that, apart from an open access situation, there are three proto-types of CPRR. These include the state CPRR, the private CPRR and the communal CPRR (Bromley and Cernea, 1989; Ostrom, 1990; Pomeroy and Berkes, 1997; Pomeroy and Rivera-Guib, 2006). In a "state CPRR," the state assumes control over the resources or specified territories. Individuals and groups can only use the resources with the consent of the state and must comply with the regulations made by government laws. The state can grant the right to exploit resources to individuals or groups, but control over the resources is exercised by the state (i.e., by government agencies; Bromley and Cernea, 1989). A "private CPRR" refers to the exclusive possession of an area or a set of resources by private entities. Such private entities may not necessarily be individuals, but private ownership can also be transferred to clearly defined groups (corporate private property; Bromley and Cernea, 1989). In a private CPRR, the control over a specified territory, its resources and its products is given to private entities (owner). They hereby gain the right to exercise their rewarded power to exclude others from the use of their terrain or prevent usage of their resources from non-owners. The third category is the "communal CPRR" which has attracted particular attention over the past decades (cf. Dearden et al., 2005; Berkes, 2007b). Such a community-based management (CBM) approach describes a management system of a clearly defined group of people for a set of natural resources or a particular area (Berkes, 2010). Since CBM encompasses many different management situations in which natural resources, whole ecosystems or territories are "owned" and managed by local groups, there is no general definition available. Yet, the quintessence of CBM is that management authority for a defined territory or set of resources is transferred to, or rests with, a clearly defined group at a local level, which shares certain common characteristics (e.g., ethnicity) or commonly resides in a geographical area (Armitage, 2005).

Especially in tropical nations with weak state institutions, CBM has become a popular alternative approach for marine resource management. This is based on the notion that local actors are better suited to devise rules for addressing the roots of marine resource degradation (such as overfishing or the use of destructive fishing gears) than command-and-control approaches and other centrally organized solely government driven approaches (Ruddle, 1999; Ferse et al., 2010, 2014; Cinner et al., 2012). In fact, local communities all over the world have been involved in self-organized approaches to managing natural resources for centuries, and the idea of CBM originated from the acknowledgement of the effectiveness of such indigenous and traditional management systems for natural resources (Wade, 1988; Ostrom, 1990; Hidayat, 2005; Berkes, 2007a). A variety of management regimes for the sustainable use of natural resources has thus emerged based on local decision-making structures and formal or informal rules to secure the long-term socio-economic well-being of local populations (Borrini-Feyerabend et al., 2004, and references therein). The strength of such collaborative local endeavors is that communities can create solutions to local natural resource use problems, which are tailored to the particular local socio-cultural and environmental circumstances (Alcala, 1998; Armitage, 2005; Pomeroy and Rivera-Guib, 2006).

Yet, it is also widely acknowledged today that CBM is not a one-size-fits-all solution to successful marine resource management (Berkes, 2004; Cudney-Bueno and Basurto, 2009; Cinner et al., 2012). Rather, CBM approaches for natural resources harbor a series of hazards and cannot be assumed to be a "panacea" or "blueprint" for successful natural resource management. Various studies have shown that their risk of failure is high (cf. Berkes, 2007b; Christie and White, 2007; Cudney-Bueno and Basurto, 2009; Cinner et al., 2012; Adhuri, 2013). Moreover, it cannot be simply assumed that if government actors endorse the development of CBM initiatives, new and effective rules will automatically emerge for successful CBM of natural resources (Schlager and Ostrom, 1992, 1999). Berkes (2004, p. 623) highlights in this regard that a "community" is a complex, elusive and multidimensional construct under constant change. Even small communities, therefore, cannot be seen as a unitary actor who *per se* acts toward the long-term benefit of the entire community. Rather, every community, whether small or large, is characterized by internal divergences of interests because any community is made up of various individuals and groups, which are embedded in larger systems and affected by influences from the outside (Berkes, 2004). Further empirical research is thus needed to better understand under which circumstances local initiatives can lead to improved sustainable marine resource use in a certain sea territory, and when CBM faces strong difficulties.

Many studies have focused on the design of successful and persistent institutions in a self-organized CBM context that effect more sustainable resource use among the members of a community (cf. Wade, 1988; Ostrom, 1990; Cinner et al., 2012). Much less empirical research is available with regards to implementing CBM in the context of a regional resource use system, and in relation to CBM as part of a nested rule system to regulate resource use in a particular sea territory. In order to contribute to fill this gap, this study empirically investigates a CBM regime for the sea area surrounding Langkai Island, a small island located in the Indonesian Spermonde Archipelago off the coast of Makassar City. The objective of this research is two-fold: First, the study aims to provide a detailed analysis of what rules produced by which CPRR type actually have an

impact on the fishing patterns in the sea territory as perceived by local resource users, and to illuminate potential challenges associated with implementing the rules generated by the different CPRR. The second objective of this article is to examine what motivates the local resource users to engage (or not) in the CBM of the marine resources. This article hereby complements previous more general work on CBM and informal rules in the Spermonde Archipelago by Deswandi (2012), Glaser et al. (2010, 2015) and Idrus (2009).

The remainder of this article is structured as follows. The subsequent section provides an introduction of the study site, which outlines the particular fisheries related problems encountered and illuminates the presently implemented means to address them. Next, the methods applied in this research are described. The article then turns to the results. There, the article first focuses on understanding what rules actually affect the fishing patterns in the sea territory surrounding the study island based on the exploration of the perceptions of local fishers. The following section of the results then examines the rationales of the local fishers for engaging (or not) in the CBM initiative. The results are then discussed and put in a wider context. The article concludes with highlighting the main findings of the study and indicating further research needs to improve CBM initiatives for marine resource management.

STUDY AREA: THE SPERMONDE ARCHIPELAGO, INDONESIA

Indonesia is located within the Coral Triangle, one of the world's marine biodiversity hotspots (Burke et al., 2011). The country has about 81,000 km of coastline comprising about 4000 ha of mangrove forests and the national territory encompasses 5.8 million km^2 of sea area, of which ∼51,000 km^2 contain coral reefs (Syarif, 2009). The marine waters and its natural resources are of fundamental strategic, economic and environmental importance for Indonesia (Cribb and Ford, 2009). Yet, as a result of myriad anthropogenic pressures (Syarif, 2009), Indonesia is expected to experience the strongest decline in fisheries of any nation worldwide (Cheung et al., 2010). This is most severe for the people living in rural coastal areas and small islands, putting the livelihood security of millions of people at jeopardy (Ferrol-Schulte et al., 2013, 2015).

In order to effect more sustainable resource use in Indonesia, a number of laws have been developed in an attempt to regulate the use of the country's fishery resources (cf. Syarif, 2009). These include for instance the ban of destructive fishing gears such as poison and blast fishing, and legislation to support the development of marine protected areas (Ferrol-Schulte et al., 2015). Yet, the different laws pertaining to the regulation of fisheries appear to only have little traction on the ground (Satria and Matsuda, 2004; Radjawali, 2012; Wever et al., 2012). Despite the existence of numerous Indonesian laws in the environmental realm, there have been only very few cases of effective enforcement through courts nationwide (Waddell, 2009). Especially in areas far away from larger towns and cities, the enforcement of government rules including the prohibition of blast and poison fishing by enforcement agencies is highly difficult.

This study focuses on Langkai Island, a small island located at the outer margins of the Spermonde Archipelago, South Sulawesi (see **Figure 1**). The archipelago consists of ∼80–100 small islands inhabited by about 35,000 people (Sab and Katsuya, 2008). The islands greatly differ in terms of socio-economic characteristics (Glaeser and Glaser, 2010). The Spermonde Archipelago is home to one of the largest reef fisheries in Indonesia (Pet-soede and Erdmann, 1998). Due to the physical characteristics of the islands, which hardly permit any land-based livelihood activities (Schwerdtner Máñez et al., 2012), fishery resources are of fundamental importance to provide the households in the archipelago with monetary and subsistence income (Pet-Soede et al., 2001; Glaser et al., 2015; Miñarro et al., 2016).

Yet, similar to other areas in Indonesia and elsewhere in South-East Asia (Burke et al., 2011), the fisheries resources in the Spermonde Archipelago are increasingly depleted (Glaeser and Glaser, 2010; Glaser et al., 2010; Ferse et al., 2012) and the coral reef ecosystems are heavily degraded (Edinger et al., 1998; Plass-Johnson et al., 2015a,b, 2016). This jeopardizes the livelihoods of thousands of people as an ever growing number of fishers in the archipelago competes for increasingly scarce marine resources (Glaser et al., 2010; Deswandi, 2012; Miñarro et al., 2016). Moreover, unsustainable and destructive fishing practices including blast and poison fishing are used all over the archipelago and pose a major threat to the viability of marine resources and marine ecosystems (for more details on destructive fishing and its consequences on the marine ecosystems in the Spermonde Archipelago see esp. Pet-Soede et al., 1999; Chozin, 2008; Wilkinson, 2008; Idrus, 2009; Ferse et al., 2014; Pauwelussen, 2015).

Effective means for more sustainable marine resource use are thus urgently needed to address this development. Unlike elsewhere in Indonesia, traditional customary fishery management systems such as the *sasi laut* in the Maluku Archipelago, for instance described in detail by Novaczek et al. (2001), are not found in the Spermonde Archipelago. Yet, in addition to official government laws, informal means to organize marine resource use have emerged in the Spermonde Archipelago. Today, local agreements between fishers (locally called *kesepakatan)* constitute informal rules, which have developed over time, and contribute to organizing the fishery in several areas in the Spermonde Archipelago (Glaser et al., 2010, 2015), including the sea territory around Langkai Island.

METHODS

The research applies a mixed-methods anthropological research approach to advance understanding of how to institute more effective community-based marine resource management in a small island setting. The study was conducted as part of the third phase of the joint German-Indonesian research program SPICE (Science for the Protection of Indonesian Coastal Marine Systems, 2012–2015) and builds upon the research conducted during the second phase of the SPICE program (2007–2010). Data for this study were collected over a 6 month field research

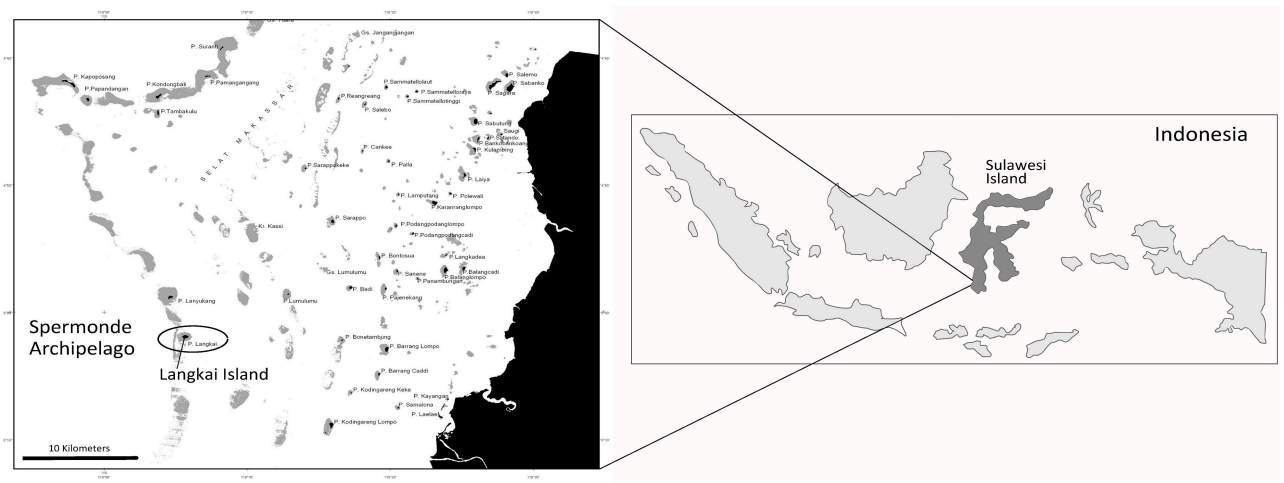

FIGURE 1 | Langkai Island, South Sulawesi, Indonesia.

period in the Spermonde Archipelago area from September 2012 to March 2013. Three visits of about 2 weeks each to Langkai Island were carried out. Further islands, including Lanyukang Island, Barrang Lompo Island, Lumu-Lumu Island, and Barrang Cadi Island, which are located in close vicinity of the study island (up to 2 h by boat), were visited for shorter time periods of about 2–5 days. In addition, a number of interviews with government officials on Sulawesi were conducted for the purpose of this study. Prior informed consent was obtained from all informants in this study. Moreover, the research was conducted in accordance with all ethical standards outlined in the Amended and Updated White Paper on Safeguarding Good Scientific Practice by the German Science Foundation [Deutsche Forschungsgemeinschaft (DFG), 2013]. The following section outlines the different methods used in this research (for more details on the methods see Bernard, 2006).

Key Informant Interviews

Using a semi-structured interview outline with open-ended questions, in-depth interviews were conducted with 69 informants on Langkai Island, on other small adjacent islands whose inhabitants frequently fish in the Langkai Island area, and government officials in Makassar City. The vast majority of respondents in all islands were fishers, but interviews were also conducted with traders and island officials with functions in the local administration structure[1] (for details see **Table 1**). In addition, interviews were carried out with government officials in Makassar City from the Water Police, BAPPEDA (*Badan Perencana Pembangunan Daerah*, responsible for marine spatial planning) and DKP (*Dinas Kelautan dan Perikanaan*, responsible for fisheries and marine conservation). Usually, an informant was not only interviewed once but visited several times over the 6 months research period to inquire about different topics related to this study. Especially on Langkai Island, about eight informants served as central informants and conversations were held almost every day during the time spent on the island. In general, all interviews focused on understanding the development of the Langkai Island economy, changes of the social, economic and ecological circumstances, the different mechanisms in place that aim at organizing the appropriation of fishery resources in the sea territory surrounding Langkai Island, the impacts of these mechanisms on fishing behavior, and the reasons why some mechanisms work better than others. The particular topics covered in each interview were aligned to the expected knowledge of the informant, and sometimes adjusted to the actual knowledge of the interviewee. Except for the interviews with government officials, with whom more formal interviews were conducted, the interviews in the islands were not conducted as formal interviews since the topics covered highly sensitive matters such as the involvement in illegal fishing activities. Rather, after announcing the topic of this research, the intended use of the information, assuring anonymity to the individual respondents and obtaining informed consent from the informants, the interviews were carried out

TABLE 1 | Key informants.

Area	Fisher	Trader	Government official	Total number of informants*
Langkai Island	32	2	4	34
Barrang Lompo Island	10	–	–	10
Lumu-Lumu Island	5	2	2	7
Lanyukang Island	3	1	1	4
Barrang Cadi Island	1	–	1	2
Makassar City	–	–	12	12
			Total	69

**Some of the informants fall in multiple categories.*

[1]Note that almost all of the positions in the administrative structure at the local level are voluntary and unsalaried, and the vast majority of the island officials relied more or less directly on fishery related livelihood activities such as fishing, trading, fishing boat construction etc. for their income.

as informal conversations on the topic of the research to build as much trust as possible. Small groups of fishers, or individual fishers, were randomly approached at their homes or in public places in different areas of the small islands. Sometimes, upon recommendation by other island inhabitants, certain individuals were visited and asked to participate in the interviews because of their key role in CBM, or their anticipated in-depth knowledge of a particular aspect of the research. None of the conversations was recorded to further ensure an informal atmosphere and anonymity of the informant. Instead, particular effort was given to accurately document the content of the conversation in field notes during and after the conversations. All interviews were conducted by the author of this article with the help of a research assistant, who is a native speaker of the different local languages used in the area and has extended experience in working with the island communities on marine resource management in the Spermonde Archipelago and nearby areas. Where applicable, information received in one interview were triangulated in various interviews in the study island, on other islands, and on the Sulawesi "mainland" to verify data and cover a wider range of perspectives.

Participatory Observation

Participatory observation is a research method mainly used in cultural anthropology (Bernard, 2006). For this study, it was used to learn about social processes the interviewees may not be aware of, or are reluctant to talk about, and to further triangulate information obtained otherwise. The scope of participant observation in this study was limited, however, and only included attending relevant official meetings and informal gatherings, as well as observations of fishing behavior in the waters surrounding the island.

Net-Map Interviews

An adapted version of the participatory research method "Net-Map," described in detail by Schiffer and Hauck (2010), was used for this study. The method allows to visualize knowledge about the interplay of complex formal and informal social relations, the influence different actors exert on resource use patterns, and to unveil the social processes in natural resource management (cf. Gorris, 2015; Hauck et al., 2015). Two Net-Maps were developed in group interview sessions with fishers. The social relations that influence the fishing pattern in the Langkai Island waters, as perceived by the participants, were mapped. One group session was conducted with fishers from Langkai Island and the other group interview session was carried out with fishers from another nearby community in Barrang Lompo Island, who were well-known for using illegal fishing methods. On Langkai Island, the Net-Map group was composed of eight participants. On Barrang Lompo Island, the Net-Map session consisted of six participants. It was not intended to ensure a representative sample of the respective island in these interviews, but rather to ensure that the interview participants had long-standing experience of fishing in the sea area around Langkai Island, and possessed in-depth knowledge on how the fishery in the area is organized. Hence, all interview participants in both Net-Map sessions were fishers who frequently fished in the sea territory surrounding Langkai Island and were thus equipped with in-depth knowledge of the organization of the fishery in the area. Moreover, it was sought to include representatives of the wide variety of different fishing gears used in the Langkai Island sea area. Potential candidates meeting these requirements were identified prior to the Net-Map session based on recommendations by key informants, or were key informants themselves as described above. Potential candidates were contacted at their residences, or their fishing boats after fishing trips. Yet, eventual participation in the Net-Map group interview depended on the availability and interest of the fisher.

The Net-Maps were developed in a three-step process. A large sheet of paper was placed in front of the netmapping group. In a first step, the participants were invited to think of all actors that either are affected by, or themselves affect the management of natural resources in the waters surrounding the study island, i.e., who fishes in that area using what gear type, or who has an influence on the marine resource use patterns in the area. The identified actors were noted on cards and glued on the paper. In a second step, the netmapping group described who exercises influence affecting another actor. Influence of one actor toward another actor was indicated by an arrow on the paper. In a third step, the netmapping group participants were asked to judge how much influence they considered the different actors to have on the way marine resources are used in the area. A scale between one and four (four representing the highest possible influence) was used to determine the degree of influence of the respective actor. Discussions on the reasons for the thus constructed map followed. The netmapping approach, as adapted and used in this study, offers the opportunity to advance understanding of the *de facto* marine resource management through the visualization of social relations that affect marine resource use in the Langkai Island sea area. Data was digitalized and visualized using the social network analysis software *Gephi*.

Survey

The study was complemented by the results of a survey (for details see Supplementary Material in the online version of this article) with fishing households to provide socio-economic context data for Langkai Island (see Section Langkai Island: Fueling the Local Economy). The survey was conducted by a team of German and Indonesian researchers in several islands in the Spermonde Archipelago. This article only draws on the results of the survey interviews conducted on Langkai Island. A geographically stratified random sampling was used for selecting the respondents. Thirty-eight survey interviews were conducted representing about 20% of the island's fishing households. The survey participants were the household heads (all male). The households were selected in a lottery system from a list of fishers. Only descriptive statistics was used since the low absolute number of participants in the survey from Langkai Island does not allow for in-depth statistical analysis.

RESULTS

Langkai Island: Fueling the Local Economy

At the end of the 1940s, only 10 people who were all fishers permanently lived on Langkai Island. During that time, the main fishing gear used by these fishers was hand-line and

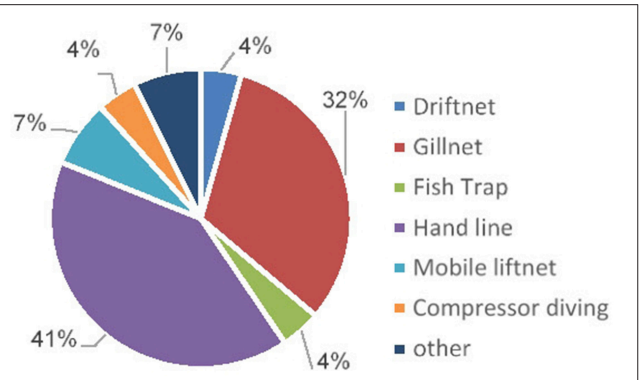

FIGURE 2 | Fishing gears used by Langkai fishers.

the most important targeted species was the Narrow-Barred Spanish Mackerel (*Scomberomorus commerson,* called Tenggiri in local language). Today, the island population has grown to 225 households of which 190 (∼84%) rely on fishing as their primary and mostly only source of income. This reflects the fundamental importance of marine resources to secure the local livelihoods.

The results of the survey show that numerous fishing gears are used by Langkai islanders today (see **Figure 2**). Depending on the season, most fishers used different gear types during different times of the year. Yet, hand line still has remained the most commonly used fishing gear to target a variety of fishery resources (used by 41% of the fishers). The second most commonly used fishing gear is gillnet, used by 32% of Langkai Island's fishers. Further gears used include driftnet, fish trap, mobile lift net, and compressor diving, while some other gears were only used to a minor extent. Despite the introduction of new fishing gears over the past 50 years, which allowed the islanders to target a wider range of fishery resources, the hand-line fishery has remained particularly important for the local economy. The continuous importance of the hand-line fishery is due to the high abundance of economically valuable species in the area that can be caught by hand-line, and especially the occurrence of the Narrow-Barred Spanish Mackerel (which can be sold for ∼50–70,000 IDR[2] per kilo) in the sea area surrounding Langkai Island.

Yet, the lucrative target fish, such as Mackerel, are unevenly distributed over the Spermonde Archipelago. Moreover, the increasingly depleted fish stocks and degrading fish habitats in the Spermonde Archipelago and the neighboring areas have motivated fishermen to search for fish in other areas than only the waters of their home islands. The sea territory surrounding Langkai Island has remained a particularly rich fishing ground where a wide range of valuable marine resources are still available. Hence, the area is not only subject to exploitation by local fishers from Langkai Island, but attracts many fishers from other islands and Sulawesi mainland fostering the competition for the valuable resources in the area.

[2]At the time of this research, 1 Euro was equivalent to about 12,500 IDR (Indonesian Rupiah).

Organizing Marine Resource Use: Rules-in-Use in the Waters Surrounding Langkai Island

Whilst not officially marked by flags or buoys, the "Langkai Island Waters" is a commonly acknowledged and relatively clearly defined marine territory surrounding the island. All interviewees from Langkai Island and from elsewhere, who frequently use the area for fishing, knew and acknowledged this. The interviewees were able to relatively precisely draw the borders of this area on a very large naval navigation map, and to describe the borders mainly based on aspects of the underwater topography and distinct features of the marine ecosystem. Since the area is perceived to belong to the island, the local community considers itself entitled to institute rules for the use of the area's fishery resources. Based on informal agreements, three locally devised rules were instituted for the use of marine resources in the Langkai Island Waters. These include the prohibition of (a) blast fishing, (b) poison fishing, and (c) the use of spear-guns for Mackerel fishing.

The surveillance and enforcement of these local rules were carried out by the local resource users. In addition, an important role in the sustained implementation of these rules and for controlling what gear is used in the waters, so it was argued in the interviews, attributes to the elected island leader (*Ketua Rukun Warga*) to gain improved authority in rule enforcement. Yet, neither the local community in Langkai Island in general nor the island head in particular have a formal authority to develop and enforce such locally devised fisheries management rules for the Langkai Island Waters since the necessary official authority (by law) does not extent out to the sea territory, but only accrues to organizational matters on the community's land. As for the prohibition of blast and poison fishing, i.e., for the rules also found in national law, the enforcement of these rules for the Langkai Island Waters thus relies on the cooperation with the Water Police based in Makassar City. This is a difficult situation, so it was argued in the interviews, as the islanders do not hold official authority to detain rule-breakers until the police arrives. With regards to the spear-gun rule, there is no legal basis at all and the Water Police is not entitled to engage in enforcing this rule. Hence, the remaining option for the islanders to enforce all three rules at the local level is to apply alternative informal means for enforcement. Common practice is that, if somebody is spotted in the Langkai waters who uses or is suspected to use gears, which are prohibited by the local rules for the marine territory, fishers form a group, ideally with the island leader among them, and inform the respective fisher about the rules that apply to the Langkai Island Waters. Usually, according to the islanders, this is sufficient to scare the fishers away. If not, Langkai islanders may also throw stones at the rule-breakers. This common enforcement practice was also widely confirmed by fishers from other islands, who fish in the Langkai Island area, and whose inhabitants are particularly famous for fishing with bombs, poison and spear-guns. In fact, it was stated in the interviews in other islands that the interviewees heard that the fishers of Langkai Island would even confiscate the fishing gears, or set fishing boats on fire, which both would cause severe

economic loss for the fishers. While it was widely confirmed in the Langkai Island community and elsewhere that stones are used to scare rule-breakers away, the more drastic measures may also be a legend spread in the area.

The Role of the Local Community in Marine Resource Management

This section illuminates the perceived impact of the rules produced by the state CPRR and the CBM[3] on the fishing practice in the Langkai Island Waters based on the two Net-Map group interview sessions. **Figure 3A** shows the results of the group session with Barrang Lompo Island fishers, and **Figure 3B** shows the results of the session with Langkai Island fishers.

Both groups identified fishers using different gear types in the Langkai Island Waters (for details see **Figure 3**). The fishers of Langkai Island created a more detailed picture of the fishing gears used in the area, which is certainly due to their more in-depth knowledge of the marine resources use patterns close to their island. With regards to who has an influence on marine resource use patterns in the area, both groups identified the Water Police (which is based in Makassar City) and the local community in Langkai Island. The notion of the Langkai islanders in both group sessions represents their influence on marine resource use patterns in the Langkai Island Waters. Government departments, and particularly the Department of Fishery and Marine Conservation (DKP), were only mentioned to have an impact by the Barrang Lompo Island group. The interview participants from Langkai Island did not see their direct influence on the resource use patterns in the Langkai Island Waters. This may be explained by the fact that Barrang Lompo Island is relatively close to Makassar City, where the government departments reside. Due to this proximity, and maybe also due to the fact that the Barrang Lompo Island residents are well-known throughout the Spermonde Archipelago for using destructive fishing, government programs such as awareness raising campaigns frequently target fishers from Barrang Lompo Island, whilst such activities occur very rarely on Langkai Island.

Both groups argued in the interviews that the Water Police has a strong influence on poison and blast fishers (influence is marked by arrows in **Figure 3**), who attempt to fish in the area. The Langkai Island community was also found to affect these two types of fishing operations as a result of the informal agreements for this specific portion of marine territory. Moreover, the Langkai Islanders also influence the use of spear-gun fishers as, based on the local rules, they are not allowed to fish for Mackerel in that area. Hence, in the view of the both Net-Map groups, both government actors and the island community contribute to regulate marine resource use in the Langkai Island Waters.

Participants of both sessions agreed that the Water Police has the maximum possible influence (indicated by the size of the dots in **Figure 3**) on the resources use patterns in the Langkai Island Waters due to their official power of apprehending fishers using illegal gears. Despite the fact that illegal fishers will most probably not be prosecuted in court, participants in both groups argued that, if caught by the Water Police, illegal fishers will still spend some days or even weeks in jail during which they cannot generate income for their family, and that they also have to spend a significant amount of money for their release. This means a substantial financial loss for these fishers. However, it was argued in both sessions that, while the Water Police generally exerts strong influence on the resource use patterns, patrolling only occurs rarely in the general Langkai Island area, as it is far from the police station in Makassar City, and patrolling the area

[3]Note that the Fish Aggregation Devices (see below) are located outside the Langkai Island Waters and are thus not included in these interviews.

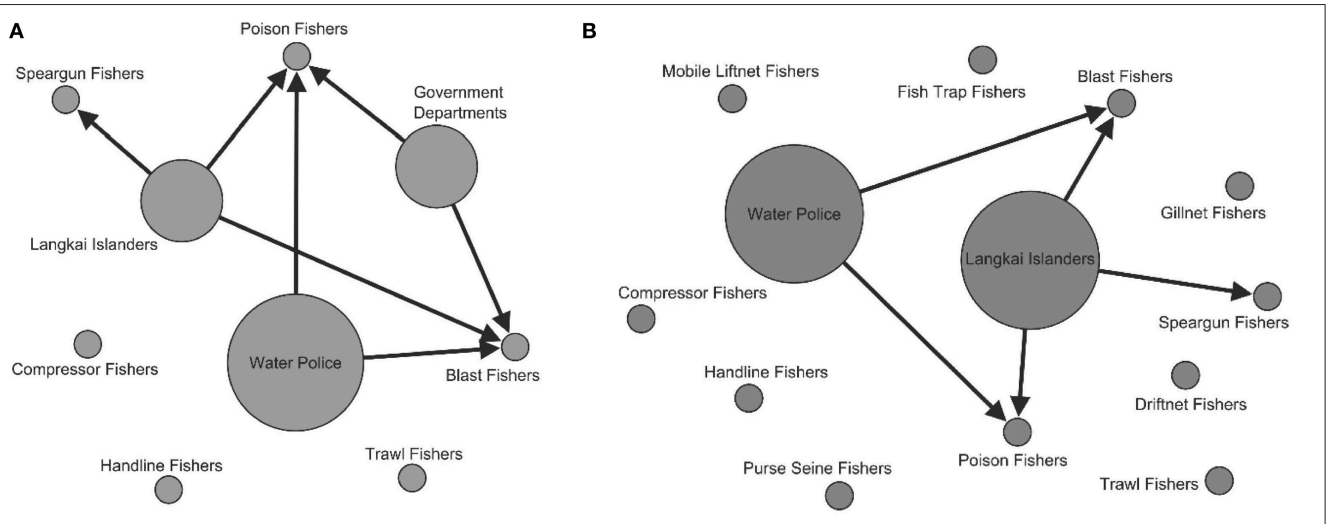

FIGURE 3 | Managing marine resources in the Langkai Island Waters. The figure shows the perceived impact of the state CPRR and the CBM on marine resource use in the Langkai Island Waters based on the Net-Map group interviews with fishers from Barrang Lompo Island **(A)**, and with fishers from Langkai Island **(B)**. The arrows indicate that an actor exercises influence toward another actor in the Langkai Island Waters. The size of the dots is scaled to the perceived influence of the actor on resource use in the area on a scale between 1 and 4 (the larger the dots, the higher is the perceived influence).

requires high financial input in terms of gasoline. In addition, the large Water Police boats are visible from a long distance and, if they are in the area, fishers will not carry out any illegal fishing operations. Therefore, while the general influence of the Water Police in terms of deterring blast and poison fishing when in the area is considered high, their actual impact on avoiding illegal fishing operation in the Langkai Island Waters is limited due to their rare presence in the area. By the participants of the Barrang Lompo Island group, the other government actors were perceived to be less influential compared to the Water Police. It was argued that the influence of the other government actors stems from the awareness raising campaigns about the danger of blast and poison fishing, which led some of the respective fishers to reconsider their fishing practice.

The perception on the influence of the local community on Langkai Island on the resources use patterns in the area slightly varies between the Net-Map sessions conducted in the two islands. The Barrang Lompo Island interview group saw less influence of the Langkai Island community compared to the Water Police. In contrast, the Langkai Island interview group also perceived the island community to have maximal influence. Participants in the Langkai Island group argued that they can develop rules for the area, which are complied with by the fishers from Langkai Island itself, and also by the majority of outsiders. Yet, the participants also highlighted that their means of actual enforcement is limited as they do not possess legal enforcement authority. The Langkai Island group reported that the cooperation with the police *"is not always easy"* as the police may be in other parts of the Spermonde Archipelago, or elsewhere, and may not come to Langkai Island, even upon request by the islanders. Therefore, Langkai Islanders usually rather tend to only scare rule-breakers away from the area instead of detaining them and cooperate with the police. The participants in the Barrang Lompo Island group argued along similar lines but especially highlighted that the islanders do not possess official authority to enforce rules in the Langkai Island Waters and, therefore, awarded the local community in Langkai Island with less than the maximum amount of "influence points."

Community-Based Management of Marine Resources: Why Do Local Fishers Engage in Rule Enforcement?

The support of local initiatives and the active engagement of a high share of the community in the enforcement of the related rules is a necessary precondition for a functioning rule system. This section illuminates the rationales behind the motivation of local fishers on Langkai Island to engage in the enforcement of the locally devised rules. **Table 2** at the end of this section summarizes the fishers' rationales for engaging in the enforcement of the local rules.

Blast Fishing

Blast fishing is widely used in the Spermonde Archipelago. While there was also a more frequent use by fishers from Langkai Island up to the 1990s, today, only one fisher sometimes uses small bombs. The fishing practice by this fisher is despised by the other community members, but it was argued in the interviews that the other fishers cannot do much about it, except for trying to keep the fisher from operating the bombs in the Langkai Island Waters. Whilst a number of people on Langkai Island reported that they are also very strict on enforcing the blast fishing prohibition, in fact, other fishers reported that they tend to remain *"inactive"* in the enforcement of this rule and rather tolerate the use of blast fishing in the Langkai Island Waters for four main types of reasons.

(1) *Issues in enforcement:* In addition to the previously described issues related to the coordination with the police, another problem with the enforcement of this rule was highlighted in the interviews. If fishers use illegal fishing gears or act suspiciously, and Langkai islanders want to search their boats for illegal fishing gears, a common problem relates to the fact that the fishers who use explosives for fishing frequently have boats with stronger engines than the Langkai Island fishers with their rather simple and small boats. The blast fishers thus usually can escape before the Langkai islanders get the chance to come aboard. While the overall goal to prevent fishers from using blast fishing in the Langkai Island Waters is hereby achieved, this adds to the problem of cooperation with the Water Police since the islanders can rarely detain blast fishers. According to the interviewees, the overall problematic enforcement situation decreases the motivation of trying to catch blast fishers since it is often perceived as *"not to be worth the effort."*

(2) *Reciprocity:* Reciprocal hospitality represents an important aspect in the wider Spermonde Archipelago. In case fishers come from distant areas during their fishing trips to the prosperous fishing grounds of Langkai Island, or go fishing in the open water beyond the shelf of the Spermonde Archipelago platform, fishers stay overnight in the Langkai Island area. The local term *Sawakung* refers to layovers in foreign islands or on their boats adjacent to the island during fishing trips. They are of mutual benefit for the guest and the host. While outside fishers are provided with shelter, goods and services in the host island, these layovers hereby generate additional revenues for the Langkai Island community. Moreover, these stays facilitate knowledge exchange between the islanders and outsiders. Despite the rich fishing grounds in the Langkai Island area, some of the fishers from Langkai Island sometimes themselves perform long-distance fishing trips to other fishing grounds, and have to do layovers in the nearby islands. The interviewees in Langkai Island expressed concerns that, if they engage in trying to detain or scaring rule-breaking fishers such as blast fishers away, they would deny the outside fishers access to the fishing area. This would create problems for the Langkai fishers in case they themselves needed to visit the home island of these outside fishers for a layover. Langkai fishers thus feared that their engagement in rule enforcement would seriously affect their fishing operation in a negative way if they were not able anymore to visit the fishing grounds close the respective islands where the Langkai fishers themselves relied on the goods and services offered by the host community. Another

more general worry with regards to reciprocity was that the fishers using illegal fishing gears are believed to have very good relations with *"important people"* in Makassar City, which is why blast and poison fishers most probably will not be prosecuted for illegal fishing. Moreover, interviewees feared that they themselves would *"get problems"* if handing over illegal fishers to the police since it might be taken as an offense by *"the important people in Makassar"* to apprehend fishers who are under their protectorate.

(3) *Lack of perceived strong negative impact on own fishery yield:* Almost all hand-line fishers, who target Mackerel, perceived that blast fishing operations would not have severe negative consequences for their own fishing. The Mackerel is no target fish for blast fishing. Interviewees highlighted that Mackerel only occurs in small groups of few individuals while blast fishers only target schools of fish to increase the profitability of the blast fishing operation. Moreover, it was stated that the Mackerel moves too fast to be caught by a bomb operation. The blast fishers thus can only catch Mackerel accidentally, which was referred to as *"a lucky accident for them,"* but not on purpose. It further seems to be commonly perceived that the Mackerel spawns on the seafloor, whilst the bomb is not operated close to the seafloor due to the danger of particles that may be expelled from the water by the explosion. Blast fishing is thus believed to also not affect the Mackerels' spawning grounds. For that reason, the fishers argued that blast fishing has limited effects on the abundance of their target fish, and its spawning grounds. As a result, the blast fishing is seen not to have severe negative consequences on their yields. Similarly, the gillnet fishers also saw no direct negative impact of blast fishing on their yields, for the same reasons[4].

(4) *Benefit-sharing:* A strong argument produced in the interviews was that there is a general understanding in the Spermonde Archipelago that, if the blast fishers operate a bomb, everyone who is nearby can assist the blast fishers in collecting the *"harvested fish,"* of which a helper would get a share of one out of three parts of the fish collected by him (see also description by Chozin, 2008; Deswandi, 2012). This provides a strong economic incentive for some islanders to assist the blast fishers instead of enforcing the local rule. In addition, the benefit-sharing was perceived to be a type of compensation mechanism for the environmental damage caused to the marine ecosystems in Langkai Island Waters.

Poison Fishing

The situation with poison fishing is different and at the time of this study there were no active poison fishers on Langkai Island. According to the informants, the prohibition of poison fishing was enforced much stricter locally than the prohibition of blast fishing. While the (1) *issues in enforcement*, and (2) *reciprocity,* as described in the previous section, remain the same in the given rationales for engaging in the enforcement of the poison fishing rule, in contrast, the (3) *perceived strong negative impact on own fishery yield,* and the (4) *benefit-sharing* differed for the case of poison fishing.

(3) *Perceived strong negative impact on own fishery yield:* It was argued in all interviews that poison fishing is believed to cause much stronger negative environmental impacts than blast fishing. Poison fishers specifically target coral reef fish. Anecdotal evidence suggests, so it was argued in the interviews, that the poison, if distributed by the local currents, may *"turn a vast marine area in a dead zone."* This includes the destruction of large coral reef areas, and of the majority of marine life that happens to be in the area during the time of fishing operation. Based on the perception of the interviewees, poison fishing causes a much stronger impact on the environment and on their own fishing yield[5].

(4) *Lack of benefit-sharing:* Unlike the blast fishers, who provide an economic incentive in exchange for the environmental damage caused, poison fishers do not share their catch with other fishers. Hence, poison fishing offers no economic incentives for the local community to tolerate it.

Spear-Gun Fishing for Mackerels

The third local rule-in-use relates to the prohibition of spear-gun fishing for Mackerel, one of the marine resource most valuable to the Langkai Island fishing community. This rule appeared to be at least as strictly enforced locally as the prohibition of poison fishing. The reasons behind (1) *issues in enforcement*, and (2) *reciprocity*, as already outlined before, also remain to some extent for this rule, but cooperation with state actors was not possible at all. Differences compared to the blast fishing rule again accrue to the (3) *perceived strong negative impact on own fishery yield,* and the (4) *benefit-sharing*.

(3) *Perceived strong negative impact on own fishery yield:* The Mackerel fishery is vital for the local economy on Langkai Island. Hand-line and spear-gun are the two fishing gears most adequate to target Mackerel. According to the informants, the agreement to prohibit the use of spear-guns for Mackerel fishing has two central reasons. First, as previously noted, the price for Mackerel caught by hand-line ranged between 50 and 70,000 IDR[6] per kilo at the time of this research. The kilo price for Mackerel caught by spear-gun was with 40–45,000 IDR much lower. The lower price results from the fact that the fish caught by spear-gun displays strong visible marks (i.e., the entry and exit injuries of the spear). To achieve the highest possible price for the amount of fish in the area, spear-guns are not used by the Langkai Island community, but only by outsiders. The spear-gun, however, is more effective than using hand-lines, and more fish can be caught in less time. If fishers from other areas use spear-guns, they have an advantage over the Langkai Island fishers and can catch a larger share of the total

[4]It could not be revealed in further communication on the matter with marine biologists whether this perception holds true, or whether this is a misperception.

[5]It could not be revealed in further communication on the matter with marine biologists whether this strong impact is true, or whether this is a misperception.

[6]At the time of this research, 1 Euro was equivalent to about 12,500 IDR (Indonesian currency).

fish in the area, but the overall yield will only be sold at a lower overall price. This would decrease the overall revenue that could be generated from the fish in the area. The second reason for the agreement is that the local Mackerel fishers perceived that, if Mackerel is caught by a spear-gun, the remaining fish will be scared away due to the fast movement of the spear and the blood spilled into the water. It was argued that, if only hand-lines are used to catch Mackerel, the *"fellow fish"* will not notice that *"somebody"* is missing and stay in the area while the use of spear-guns *"scares them"* away immediately. While fishers would prefer an overall legal prohibition of the use of spear-guns for Mackerel fishing in the entire archipelago, it was argued that the Langkai Island community can only influence what happens in the Langkai Island Waters. Both objectives of the rule thus relate to achieving the highest economic return from the overall abundance of the fish in the area.

(4) *Lack of benefit-sharing:* The use of spear-guns for fishing Mackerel by outside fishers offers no economic incentives for the local community to tolerate it.

Fish Aggregation Devices (FAD)

In addition to the rules pertaining to the Langkai Island Waters, a further local informal agreement is found in the area. A Fish Aggregation Device (FAD, locally called *rumpon*) is a tool to attract fish and keep them nearby. It is an effective tool to concentrate fish in a certain area, which then can be easily harvested. Langkai Island fishers installed FAD westwards off the island, already outside of the area that is perceived to be the Langkai Island Waters. The general understanding among the fishers, not only in Langkai Island but also in other areas of the Spermonde Archipelago (cf. Chozin, 2008), is that who owns the FAD, and maintains it, also privately owns the fish that it aggregates, and that fishing around the FAD is prohibited, or requires the permission of the owner. The informal agreements regarding the FADs thus can be considered a private CPRR in which individuals own a set of marine resources in a defined marine area. For harvesting the fish around the FAD, some owners on Langkai Island collaborate with purse-seine fishers from other areas. The general agreement for the FAD is that if there is enough fish in the area, the purse-seine fishers will inform the owner that they now start to harvest. When harvesting a FAD, the catch will be shared and the total amount of harvested fish divided into four parts, of which one part goes to the FAD owner, whilst the other three parts go to the boat that harvests the fish[7]. If the FAD owner himself harvests the FAD, of course, he keeps the fish to himself. Since the rules associated with the FAD are no CBM rules, but the rules relate to a private CPRR, different issues arise compared to the CBM rules. The clearly economical nature underlying the motivation of the owner to engage in enforcement is obvious, and all owners reported that they try to enforce the rules as strictly as possible.

(1) *Issues in enforcement:* A central issue for enforcement relates to the fact that the rules for the FAD are based on a private CPRR instead of a CBM. This means that the owner is the main person responsible for monitoring the rule, not the whole community. While the motivation of the owner to engage in enforcement is obviously high, monitoring a FAD (or several FAD) that is not in direct vicinity of the island is highly difficult for a single person (in some instances they are assisted by other family members). In addition, similar to the spear-gun rule, the lack of legal recognition of this private CPRR complicates the enforcement. In case the rules are broken by "illegal" fishing around the FAD, the owner will claim a large compensation fee from the rule-breaker, which already happened in the past, as reported in several interviews. In both interviews with islanders and district government officials, it was stated that the arrangement is also agreed upon with district government officials, who may voluntarily support the owners of FAD in settling their claim, but without legal recognition of the arrangement. Particularly the lack of legal recognition of the individual ownership of the FAD owners thus presents a drawback for the effective settlement of potential compensation claims by the FAD owner for rule-breaking.

(2) *Reciprocity:* Whilst the incentive is high to "steal" fish from FAD owners, especially reciprocity-related social and economic sanctions prevent this from happening. The vast majority of the Langkai Island community members stated that they would not steal from the FAD as the fish belongs to the owner, and, if they were caught, they would

[7]Note that there seem to be different agreements related to the FAD in the wider Spermonde Archipelago area. Chozin (2008) describes the FAD as a tool that is harvested by blast fishers using bombs. According to his detailed ethnographic description of another area in the Spermonde Archipelago, the sharing ratio is 2:3 in which the owner of the FAD gets two portions of the fish and the harvester gets three. As for the Langkai Island FAD, the FAD are harvested by Purse-Seine fishers, which also might explain the different share-ratio between the harvester and the FAD owner.

TABLE 2 | Summary of the Fishers' rationales for engaging in the enforcement of the local rules.

Locally devised rules pertaining to gear type	Gear used by islanders	Issues in enforcement	Reciprocity issues negatively affecting engagement in enforcement	Perceived impact on own yield	Benefit-sharing	Involvement in rule enforcement
Blast fishing	(Almost) No	Yes	Yes	Low	Yes	Low
Poison fishing	No	Yes	Yes	High	No	High
Spear gun fishing	No	Yes	Yes	High	No	High
Fish Aggregation Device (FAD)	Yes	Yes	No	High	No	High

"feel ashamed" and had to pay a high compensation fee. Outside fishers also reported that they feared hostility during *Sawakung* if they broke the rule, which would complicate their visits to the fishing grounds close Langkai Island. This shows that for the rules related to the FAD, the issues surrounding reciprocity support the compliance with the FAD rules due to the fear of social and economic sanction.

(3) *Perceived strong negative impact on own fishery yield:* As a matter of course, breaking the rules related to the FAD by non-owners was perceived to seriously harm the owners' income.

(4) *Benefit-sharing:* When "stealing" from the FAD, there is no benefit-sharing of the rule breaker that could relax the engagement of the FAD owner in enforcement.

DISCUSSION

Effective means to address the unregulated and uncontrolled use of marine ecosystems and their associated natural resources are urgently needed (The World Bank, 2006; Young et al., 2007). While local approaches appear to be a promising means to achieve more successful natural resource management (Ruddle, 1999; Armitage, 2005; Ferse et al., 2010, 2014; Cinner et al., 2012), CBM harbors a series of hazards (Berkes, 2004; Cudney-Bueno and Basurto, 2009; Cinner et al., 2012). A better understanding of these hazards is needed to contribute to institute more successful CBM.

In line with other observations from Indonesia and elsewhere, this study supports previous research that challenges the portrayal of CBM as isolated endeavors in which communities are buffered from the "outside" world (Agrawal and Gibson, 1999; Berkes, 2004, 2007b; Cudney-Bueno and Basurto, 2009; Seixas and Berkes, 2010; Adhuri, 2013; Pauwelussen, 2016). The results of this study show that particular problems emerge from "trans-local" variables, which hamper the effectiveness of the self-organized local endeavors. Moreover, the study illuminates that divergences in the economic rationales of the community members are an important factor which affect their motivations to engage (or not) in local approaches to managing marine resources.

The Challenge of (Self-) Organizing Local Approaches to Managing Marine Resources in Context of an Entangled CPRR System

The marine resource use patterns in the sea area around Langkai Island are impacted by a convoluted rule system generated by different types of CPRR. While the Indonesian state CPRR rules to ban highly destructive fishing are indeed found to have a perceived impact on the marine resource use in the waters surrounding Langkai Island, this study confirms wider observations that the enforcement of environmental law is fraught with difficulties (cf. Idrus, 2009; Glaser et al., 2010; Wever et al., 2012). Especially corruption, the long distance from the Water Police base to the case study area, and insufficient funds for adequate patrolling are central factors resulting in enforcement shortcomings of the rules produced by the state CPRR. This represents an eminent threat to the marine ecosystems and the abundance of fishery resources (Patlis et al., 2001; Dirhamsyah, 2006; Jones et al., 2011). Partly in response to the shortcomings of the state CPRR, local rules-in-use have emerged in the case study area despite the lack of legal authority to do so. Area-specific stewardship for a marine territory surrounding Langkai Island (CBM) and individual ownership (private CPRR) was informally institutionalized and locally devised rules based on informal agreements were instituted for a specified portion of the sea area surrounding Langkai Island. However, while the islanders' authority to devise rules for the Langkai Island Waters may be to some extent informally acknowledged by outside fishers, the self-organized local initiative lacks the official authority to formally develop and especially to locally enforce rules. As a result, close coordination between the local community and state actors is needed which represents a strong challenge, especially in context of a remote small island community.

In consequence, the findings of this research further support the classical argument made for instance by Ostrom (1990, 2005) that, in order to contribute to increase effectiveness of self-organized local endeavors, and to reduce the challenge of coordination with higher level state actors for instituting and enforcing rules, a clear allocation of rights to the local level to devise rules, and the endowment of the community with appropriate legal means to enforce the rules, is essential. Moreover, Seixas and Berkes (2010), who explored success factors in multiple case studies on community-based enterprises in natural resource management, found in this regard that networks and partnerships which extend beyond the boundaries of a community are an important means to improve coordination in a nested rule system. Given the findings of this research together with the results of other studies from Indonesia and elsewhere (cf. Adhuri and Visser, 2006; Cudney-Bueno and Basurto, 2009; Gasalla, 2011), both aspects appear to be highly salient to effect more successful self-organized local natural resource management.

CBM in a Regional Resource Use System

The active engagement of the local population in the implementation of local regulations is a necessary precondition for a successful CBM initiative. In this respect, the analysis of local resource users' perceptions, which are socially constructed and informed by both personal experience and the information available (Clayton and Myers, 2009), are crucial to understand what motivates (or not) individuals to engage in CBM of marine resources (McClanahan et al., 2005; Walker-Springett et al., 2016). This study reveals how the divergences in the perceptions of the members in a community affect their motivation to engage in the CBM endeavor. Moreover, the findings particularly illustrate the challenges of dealing with factors that lie outside the influence sphere of a community.

The vast majority of Langkai Island fishers cooperate and comply with "their" rules as produced by the CBM and the private CPRR. The fishers of the Langkai Island community neither use poison fishing, nor blast fishing, nor spear-guns in the Langkai Island Waters. Moreover, poaching at the FAD is

perceived to be highly risky as it is difficult to conceal it in such a small island community. Thus, in fact, the rationales underlying the motivation of the islander to engage in rule enforcement, as reported in this study, mainly relate to rule-breaking of outsiders and, therefore, have to be understood in the context of defending the local resources against undesirable fishing behavior by non-community members. While research has shown that social sanctions can effectively induce intra-community cooperation for collective action and compliance among community members (Ostrom, 1990, 1999, 2005), this study shows that this does not necessarily apply for non-community members. Rather, inter-community reciprocity concerns may arise when engaging in enforcing the local rules against outsiders, which can hamper the effective enforcement of the local rules. As a result, the reliance on social sanctions may be a pitfall in effecting rule compliance when the aim is to defend local resources against outsiders (see also, for instance, Cudney-Bueno and Basurto, 2009).

The findings show that there are differences in the strictness of the enforcement of the local rules. These differences mainly stem from economic rationales of the community members. In fact, the motivation for the engagement in the enforcement of the local rules by the Langkai islanders are strongly based on short-term economic considerations, i.e., on a "give-and-take" basis in the local context. If the fishing activities of rule-breakers are not perceived to strongly harm the fishing yield of individuals, and/or if benefits of the generated yields are shared with the Langkai Island community as a compensation mechanism for the environmental harm caused, the motivation of the affected community members to engage in rule enforcement seems to cease. As a result, the prohibition of the fishing activities, which are perceived to cause a stronger impact on the short-term economic return of local fishers without compensation mechanisms are much stronger enforced. Ostrom (1990) raised concerns that the compliance of community members with self-organized rules that regulate the use of natural resources may be undermined, if resource users value the expected future opportunity of resource availability and possible future gains less than the value they can generate now or in the near future. While this may hold true for intra-community compliance to self-organized rules, the findings of this study indicate that the perceived danger of short-term economic losses of the local community members may be a particular success factor of a CBM initiative, if the aim of a CBM initiative involves to defend local resources against undesired use forms by outsiders.

Despite the presence of diverse rules-in-use for organizing the marine resource use in the case study area, conservation thinking, i.e., the aim to preserve an intact local marine environment in the long run, played almost no role in the rationales given in all interviews. Rather, it appears that the locally devised rules in that area intend to ensure that the local community gets an adequate share of the diminishing local marine resources, which are exploited by a growing number of fishers from elsewhere. This also leads to concerns that the environmental conservation effects of the locally devised rules in the area may be limited and should be considered incidental.

CONCLUDING REMARKS

Especially in tropical nations with weak state institutions such as Indonesia, CBM has been widely advocated for its potential to achieve more effective natural resource management. However, detailed case study analyses of the challenges for implementing CBM in a particular sea territory remain very rare, but are particularly needed to understand the potential pitfalls for local approaches to marine resource management. This article provided a detailed analysis of a case study in Indonesia to contribute to fill this gap and help to institute more effective community-based marine resource management.

The results of this study particularly emphasize the context dependence of the success of a CBM initiative for marine resources because a certain CBM initiative, even in what seems to be a small community in a remote island setting, is characterized by internal divergences, and by "trans-local" variables which create complex interdependencies. Especially divergences in the economic rationales of the community members are important factors which affect their motivation to engage (or not) in both the CBM and the private CPRR. While especially short-term economic considerations appear to be a particular success factor in this study, such rationales underlying the motivation of community members to engage in CBM raise concerns about the sustainability orientation of the local measures.

While the scope of this research with its narrow focus on a small sea territory appears limited, the study brings a suite of aspects to attention that are often overlooked, but are highly salient to understand the factors underlying successful CBM. Moreover, the situation in this island mirrors the situation of communities in other areas in Indonesia, and also in other countries with weak state institutions. Further research is especially needed on how to address the pitfalls of CBM that are induced by factors that lie beyond the reach of local communities, and on mechanisms for improved coordination between the different types of CPRR. This is particularly urgent for remote places such as a small island, where large portions of the population heavily depend on increasingly degraded resource systems to secure their livelihoods. Moreover, perception studies represent important means to assist marine planners, policy makers and natural resource managers to better understand the reality of CBM initiatives.

AUTHOR CONTRIBUTIONS

The author is responsible for data collection, analyses and writing of the manuscript.

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SUPPLEMENTARY MATERIAL

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Analysis of Perceptions and Knowledge in Managing Coastal Resources: A Case Study in Fiji

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Sustainable management of coastal resources depends on human knowledge and perceptions of natural resources and coastal environments. However, empirical evidence has been limited in order to understand linkages between knowledge, perceptions and collective actions to achieve sustainable resource management. This case study analyzed perceptions and knowledge among diverse stakeholders: villagers, government officials, scientists and staff of a non-governmental organization who are collaboratively working in a Fijian coastal community to manage the local coastal resources. Analyses were made using the integrated local environmental knowledge (ILEK) concept and frameworks of discourse analysis to clarify interlinkages between perceptions, knowledge and collective actions for a variety of examples. Research was conducted in Kumi village on the island of Viti Levu in Fiji, and the investigated projects included the management of a locally managed marine area, seaweed aquaculture, sea cucumber restoration and ginger plantations. These initiatives have shown that diverse knowledge on coastal resources and environments influence perceptions among people in a complex way, and transformation of perceptions produced new sets of knowledge through the generation of hypotheses regarding the management of coastal resources. Collective actions were promoted by the transformation of perceptions, and social learning processes were mobilized by these collective actions. Traditional institutions, cultures and leadership roles deeply embedded in the local communities had strong influences on shared perceptions among community members to provide foundations for collective actions. Dynamic transformations of perceptions promoted by integrated knowledge among community members were critical enablers of collective actions to achieve sustainable resource management.

Keywords: coastal resource management, perceptions, integrated knowledge, stakeholders, collective actions

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INTRODUCTION

Coastal communities across the Pacific Islands continue to face challenges in managing their marine and terrestrial resources effectively. Demand for seafood is growing (Delgado et al., 2003) and fisheries products are one of the highest traded food commodities worldwide (Asche et al., 2014). Pacific island developing countries experience slow economic growth and development, and almost 100% of the populations live within 100 km from the coast (Martinez et al., 2007). The fisheries resources are highly valued and provide 50–90% of animal protein in the Pacific islands

(Pacific Community, 2012). The life of people in these coastal areas depends on fisheries, tourism, agriculture, mining and small businesses, and they are vulnerable to various environmental problems in both terrestrial and marine areas (Kronen et al., 2009; Bidesi et al., 2011). Although Fijians are well renowned in adapting to their island environment (Veitayaki, 1995; Veitayaki et al., 2015), there have been continuously high levels of coastal fisheries exploitation in the past decade (Hand et al., 2005; Teh et al., 2009).

As the threats of resource depletion, overfishing, consumerism, population growth and climate change have become profound, there is a growing need for research regarding the knowledge and perceptions of communities to promote collective actions that can ensure a sustainable use of natural resources. In Fiji, people have been managing their coastal resources through the introduction of new crops, implementation of locally managed and protected marine areas, and small-scale projects to restore depleted coastal resources (e.g., mangroves). These adaptive responses among people have been promoted through collective actions supported by their knowledge and perceptions on the surrounding coastal environment and resources. Also, traditional social systems and decision-making processes in Fijian communities are likely to play significant roles in these responses. In previous studies, perceptions have been recognized as a promoting factor of the process of changes in fisheries management (e.g., Cinner and Pollnac, 2004; Brewer, 2013; Bennett and Dearden, 2014; Barley-Kincaid and Rose, 2014). However, less attention was given to the transformation mechanisms of perceptions and the underlining knowledge systems that influence collective actions by local people with regard to the complex management of their multiple coastal resources and environments. In this paper, perceptions are defined as the cognitive framework of people to see the external world, to extract meanings and create collective actions with regard to the coastal resources they utilize in their daily lives. We assume that perceptions are dynamically transformed by the emergence of knowledge that is also dynamically produced and translated through livelihood and practices among people living in an ever-changing world. Locally-based scientists, who are embedded in communities, play an important role to integrate and systematize diverse knowledge. This could be either a residential type of living in the community as a member and stakeholder, or a visiting type, having the research bases in remote areas to "use" local communities as a field research site (Sato, 2014). We also recognize that there are various types of "bilateral knowledge translators," including residential and visiting researchers, government agencies, non-governmental or non-profit organizations (NGOs, NPOs) circulating and integrating transdisciplinary knowledge derived both from external scientists and from local communities (thus "bilateral") to create meanings of various knowledge components for local communities (Sato, 2014).

In this paper, we analyze transformation mechanisms of knowledge and perceptions to promote collective actions and social learning among diverse stakeholders: villagers, government officials, scientists and NGO members, who are collaboratively working in a Fijian coastal community to manage the local coastal resources. The renewable resources discussed in this paper include coastal marine resources (seaweeds, *Anadara* clams and sea cucumbers) and a land resource (ginger). We analyzed the cases of collective actions among villagers to manage or restore these resources, and discuss (1) how knowledge production and translation contribute to the dynamic transformation of perceptions among stakeholders, (2) how collective actions can be promoted based on shared knowledge and perceptions, and (3) how social learning in collective actions influence perceptions and knowledge systems. We discuss the importance of knowledge translations to promote these processes, with special attention given to the function of knowledge and perceptions rooted in traditional institutions, rules and practices. Results of these analyses contribute to elucidate interlinkages between knowledge, perception and collective action to achieve effective community-based management of coastal resources in complex social-ecological systems.

METHODOLOGICAL APPROACH

Study Area

The Republic of Fiji has 332 islands with a population of 909, 389 (CIA, 2015), and a total area of 18, 333 km^2 (Lane, 2008). There are more than 800 villages and settlements in Fiji, and these communities are dependent on both terrestrial and marine resources for survival and sustainable development (e.g., Kitolelei et al., 2011). Kumi village is located 17° South and 178° East on the eastern side of Viti Levu, the main island of Fiji (**Figure 1**). It has a population of 273 people with 84 households and is one of the seven villages in Verata District. The total area of the district is 235, 95 km^2 of which are coastal and marine and 140 km^2 terrestrial. The terrestrial ecosystems of Kumi village include secondary forests and grasslands, as well as farmlands and plantations. The marine ecosystems include coral reefs, seagrass beds, intertidal flats and mangrove forests. The diverse marine ecosystems are home to a variety of marine resources, which the villagers of Kumi harvest for subsistence and commercial uses.

The marine resources that are sold in local markets include *Anadara* clams that are collected by women, and various finfishes. In Kumi and its district, the *Anadara* clams that can be found in shallow mudflats and seagrass beds, are a traditional totem that people respect and honor (Vunisea, 1996). Members of coastal communities in Fiji have traditional clan totems, including various marine species, that they revere and respect. The *Anadara* clams are totems and at the same time an important income source for Kumi villagers, and therefore enable community members to respect coastal management decisions that are relevant to protect their totems. Root crops such as cassava, taro and other vegetables are additional sources of income. Kumi villagers sell their marine and agricultural products in three main markets (Korovou, Nausori, and Suva), and at times products are also sold within the village itself. The average income of households in 2014 was $79.2 FJD (∼38 US$) per week as a result of the sale of fisheries catch.

Kumi village has a community canteen and a truck that are managed by the community to provide services for its members. There are several other committees that are responsible for

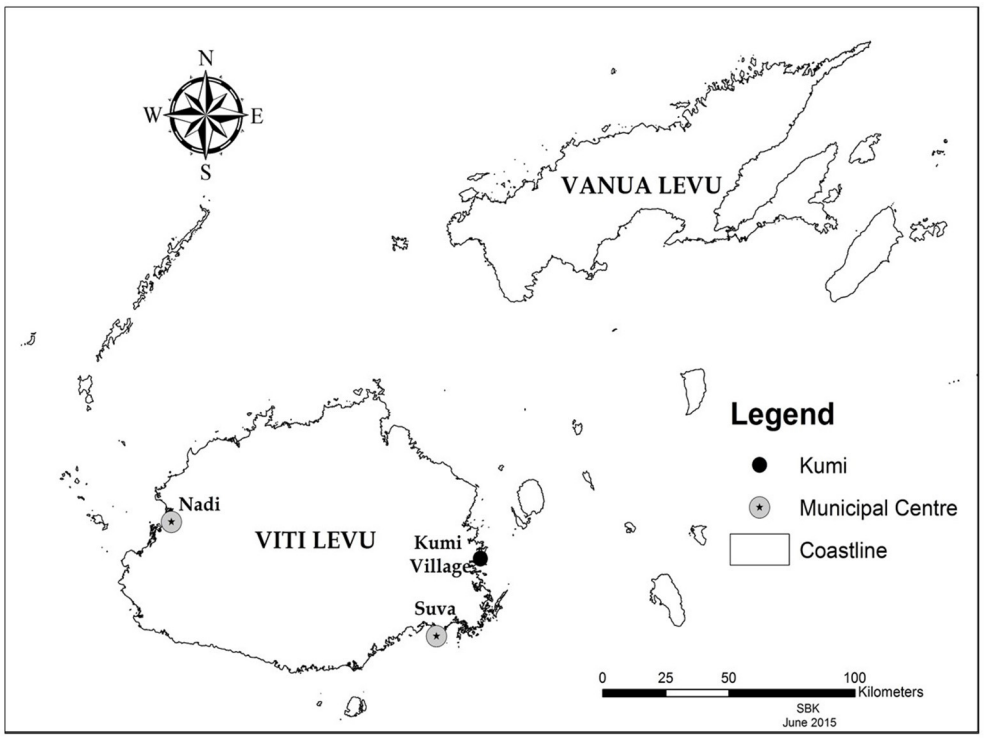

FIGURE 1 | Location of the case study site, Kumi village, on the eastern coast of Viti Levu Island.

various community-related decision-making, and development projects of the village, including committees for: women's group, water supply, education, a shop cooperative, seaweed, sea cucumber, and ginger. Fijian coastal villages such as Kumi are characterized as closely-knit communities with strong traditional decision-making systems. For example, the traditional fishing boundaries designated to villages (the *qoliqoli* boundaries) are shared and followed amongst the clan members (Kitolelei et al., 2014). The tradition of "*solesolevaki*" is one such rule, implying the importance of working together as a group to achieve a given task for the community. The *tabu* tradition, in which fishing areas are closed for a certain period of time, is a tool that is still commonly practiced throughout Fijian communities (Johannes, 2002). Following such traditional rules and customs is constructive behavior in the communities, and breaking them can result in traditional punishment and social shaming. And while they are increasingly questioned and partly eroding (Vunisea, 2002), these strong and still widely-existing traditional institutions and rules remain one of the outstanding characteristics of Fijian community life.

Field Research Methods

This research focuses on perceptions of diverse stakeholders from within and outside Kumi village (see **Table 1**), who are collaborating in the coastal resource management of the village. Particular emphasis was placed on dynamically transforming perceptions among the villagers, who are the major actors and caretakers of these resources. The research used a transdisciplinary approach, including participatory observations, and individual as well as group interviews, which were conducted on three visits to the village and to different stakeholders' offices between October 2013 and June 2014. Twenty three stakeholders from a wide array of groups including government officials, university scientists, an officer of a conservation NGO, and Kumi villagers, were selected (**Table 1**). The rationale behind the selection was that they were actively involved in collective actions to manage Kumi's coastal resources, and built trust with the authors to collaborate throughout the research process. We could identify only a limited number of women who were actively taking responsibilities in decision-making of these collective actions, resulting in male dominance among interviewees from Kumi village. The exceptions were two elderly women who were respected among stakeholders and playing leading roles in these actions. Care was also taken to secure diversity among interviewees to avoid research bias (e.g., when several interviewees would belong to one clan) and to be able to triangulate and analyze the complex processes and interlinkages of knowledge production, transformation of perceptions, and individual as well as collective actions. Individual and group interviews were structured into two sets: the first one targeting Kumi villagers regarding ongoing collective actions, and the second one targeting external stakeholders regarding the roles and functions of "knowledge translators." All interviews and participatory observations were conducted by the first author, a graduate student of Kagoshima University at the time of this study. The university did not have a formal evaluation

TABLE 1 | Number of villagers and other external stakeholders involved in this study.

Types of stakeholders		Number of organization	Number of interviewees	Men	Women
KUMI VILLAGERS (TOTAL)		**N/A**	**15**	**13**	**2**
Categories	Community leader		2	2	
	Youth leader		1	1	
	Elders		2	2	
	Leader of collective action		4	4	
	Active participants of collective action		3	2	1
	Women group leader		1		1
	Fishermen		1	1	
	Farmers		1	1	
EXTERNAL STAKEHOLDERS (TOTAL)		**4**	**8**	**6**	**2**
Categories	Government	2	2	2	
	The University of the South Pacific	1	5	3	2
	NGO	1	1	1	

committee for the ethical considerations related to social science field studies, which is why we strictly followed the Code of Ethics of the International Sociological Association (Section 2 Data Gathering, see International Sociological Association, 2011), including security, anonymity and privacy of the stakeholders involved in our study, and prior informed consent.

Discourse analyses were conducted using a simplified form of qualitative sociological discourse analyses summarized by Ruiz (2009). The memos of interviews and group discussions as well as informally obtained narratives of these stakeholders in participatory observations were analyzed to extract their knowledge systems, perceptions and collective actions. In our preliminary field survey, we identified four ongoing collective actions in the village: a seaweed culture project, sea cucumber restoration, a ginger project, and the management of locally managed marine area (LLMA). Textual analyses were conducted with the accumulated discourses to extract sentences related to or containing words related to these collective actions. Contextual analyses were performed with these discourses to extract knowledge and perceptions behind these collective actions. In the analysis, knowledge was identified from discourses containing a set of information with regard to characteristics, status and modes of utilization of relevant coastal resources, and it was distinguished from those identifies as containing perceptions that represented the functional meanings of the available knowledge. The knowledge and perceptions thus extracted were then classified and mapped on the conceptual framework described below to visualize interlinkages between knowledge, perceptions and collective actions. All processes were interrelated so that, for example, the interpretations provided by categorization and mapping influenced the textual and contextual analyses. The processes were repeated until we reached an unambiguous interpretation as described in the results.

Analytical Framing of Knowledge, Perceptions, and Collective Actions

Over the years, various authors have documented diverse types of knowledge produced and shared in the Pacific Islands (Johannes, 1981; Thaman, 2002; Berkes, 2008; Campbell, 2009). The concept of integrated local environmental knowledge (ILEK) is introduced in this study as the key analytical element connecting knowledge, perception and collective action. The ILEK concept differs from previously introduced categories of local and empirical knowledge, such as traditional ecological knowledge (TEK; Berkes, 2008) or local ecological knowledge (LEK; Olsson and Folke, 2001), in its emphasis on dynamic and integrative views on knowledge (Sato, 2014). ILEK is generated by the interactions between diverse knowledge production processes in local communities, including scientific research, and integrates diverse types of knowledge produced and utilized by stakeholders (**Figure 2**). In this way, ILEK presents a range of solution-oriented knowledge systems in a transdisciplinary way, as it incorporates every relevant domain of science and technology as well as the empirical local knowledge and experiences required for the management of such complex social-ecological systems. ILEK is also characterized by its dynamic nature, constantly re-produced and transformed through interactions of the various involved stakeholders as knowledge producers. These stakeholders and "bilateral knowledge translators" play an important role in integrating and systematizing the diverse knowledge components that are used as bases for decision-making and collective actions. Such a dynamic and integrative view on knowledge with recognition of the diversities of knowledge producers and translators is essential in understanding its linkages with perceptions and collective actions in complex social-ecological systems.

The analyses on interlinkages between knowledge, perceptions and collective actions were made based on our own observations and referring to previously accumulated information on

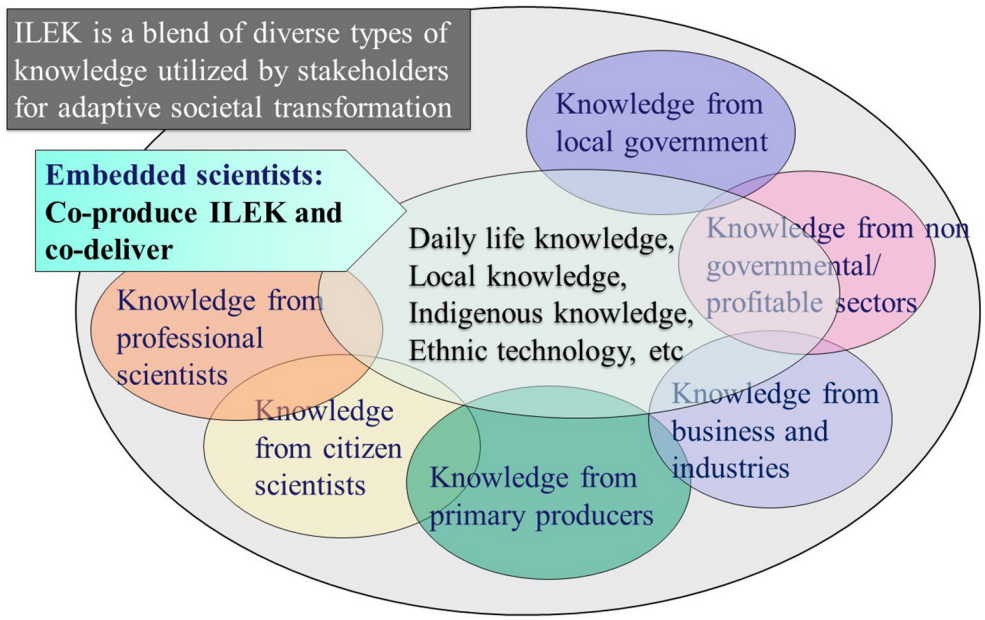

FIGURE 2 | Conceptual diagram of integrated local environmental knowledge (modified from Sato, 2014).

diverse knowledge systems in Fijian communities (Sauni, 1999; Veitayaki, 2000; Lane, 2008; Govan, 2009; Teh et al., 2009) through the lens of ILEK. **Figure 3** shows the conceptual framework of analysis for this study regarding knowledge (components of ILEK), perceptions, and individual as well as collective actions modified from Gregory (1997). There are many types of knowledge being continuously produced that become part of the available ILEK for stakeholders, which dynamically influences people's perceptions. Transformation of perceptions in turn influences ILEK by stimulating hypothesis-generation and integration of new components of knowledge. Changes in a particular part of the perception systems influence behavioral patterns of each individual to create actions, which then sum up to collective actions to manage coastal resources and environments, especially when particular types of perceptions are shared among stakeholders. Individual and collective actions produce feedbacks to perceptions and knowledge by providing participants with opportunities of social learning. In other words, the perception arena in this framework is an agent connecting input (knowledge) and its outcome (actions). This analysis provided a set of snapshots of interlinkages between knowledge, perceptions and collective actions in the continuous processes of community-based coastal resource management, which extended beyond our study period. We aimed to extract important factors of collective actions by accumulating and analyzing these snapshots obtained in the limited study period.

This conceptual framework assumes that collective actions can serve as a platform for social learning processes of all participating stakeholders, including residential and visiting researchers, to transform their knowledge systems (ILEK) and perceptions, thus resulting in adaptive improvements of the quality and impacts of actions. Transformed knowledge in this process may be disseminated to other villages in Fiji and potentially even beyond to be used for adaptive management of coastal resources in other regions. In this system, the transformation of perceptions by diverse stakeholders is assumed as a fundamental enabler of knowledge-based societal transformation toward sustainable futures of the coastal communities.

RESULTS

Diversities of Knowledge among Stakeholders

The knowledge production processes and characteristics of produced knowledge varied among stakeholders with different interests and prioritized values. **Table 2** represents diversities of prioritized values and framings of knowledge productions among major stakeholder groups working in Kumi village, extracted from the individual and group interviews. The gaps between the villagers and external stakeholder groups seem to be substantial, with little commonality and overlap expected for the knowledge produced from such framings and value systems. All these different knowledge components contribute to ILEK and are shared among villagers with different degrees of emphasis, which may result in individually isolated practices. Therefore, knowledge translation to extract and share new meanings of diverse knowledge sets is essential to create shared perceptions supporting collective actions.

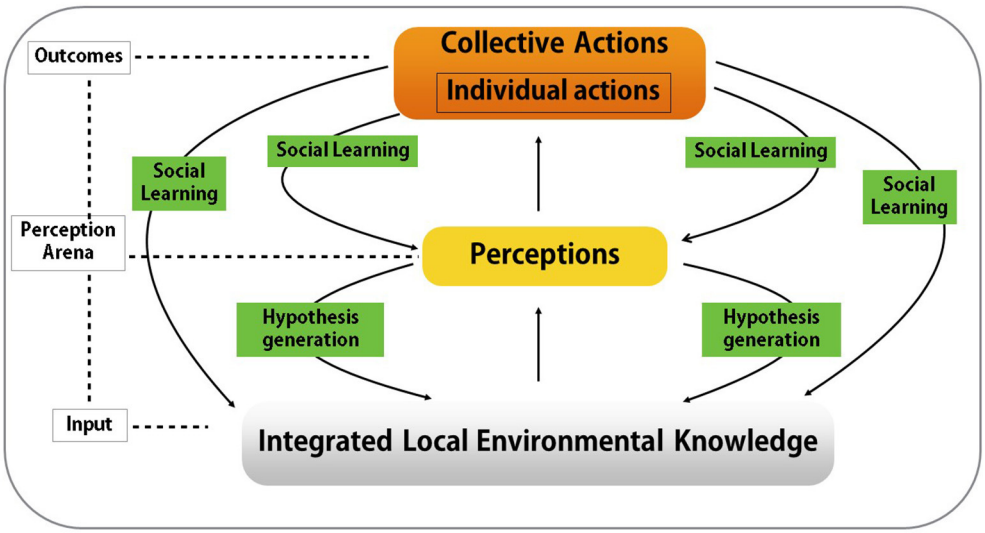

FIGURE 3 | Analytical framework of interlinkages between integrated local environmental knowledge, perceptions, and individual as well as collective actions.

TABLE 2 | Prioritized values and framing of knowledge productions among diverse stakeholder groups working in Kumi village.

	Kumi villagers	Government officials	NGO	The University of the South Pacific scientists
Prioritized values	Improve livelihood and well-being	Policy development and implementation	Contribute to conservation and community development	Research and education
Framing of knowledge production	Utilize locally managed marine areas and other external projects for community development	Sustainable management of coastal resources	Conservation and sustainable management of coastal resources	Environmental sustainability
	Management and restoration of fisheries resources	Promoting environmental conservation	Promoting human health and wellbeing	Conservation of nature and ecosystem services
	Maintaining local culture and traditions	Ensuring food security	Improving own profile	Influencing national and international policies

In Fiji in general and also in Kumi village, sharing of knowledge among villagers is promoted through collaboration in activities such as fishing, farming, art and crafts, small-scale businesses and community functions. Fourteen among 15 interviewees in Kumi village stated that knowledge components created from community activities were shared in village meetings (5 interviewees) and through general customs and traditions of sharing knowledge (5), while others generally stated that it was shared (4). Younger generations were also mentioned to have an opportunity to share knowledge (1). A common practice in Fiji is producing and circulating knowledge during social functions where community members congregate during *kava* drinking sessions. During these events, local knowledge and experiences on coastal resources and their management are shared among members through informal conversation, and the members gain access to new knowledge sets when available. These social functions are basically open for the external stakeholders and therefore provide opportunities of interactions between different knowledge systems. Another common knowledge sharing process observed in this study was based on the communal way of life. Most houses are built at close proximity in the village and people are living in a closely-knit community resulting in information being easily spread from one household to the other. The term "coconut wireless" is given to this spreading of knowledge without any formal form of information-sharing. Various knowledge and skills derived from external stakeholders, including scientists, seemed to spread into the village through such processes, with translation of their meanings to fit to the villagers' context. On the other hand, opportunities for external stakeholders to learn and digest villagers' knowledge sets and perceptions seemed to be relatively limited except for the channels of kava ceremonies, resulting in mismatches between external interventions and villagers' perspectives and motivations. In this study, we found various types of knowledge translators contributing to mitigate these challenges, which will be described below.

Interlinkages between Integrated Local Environmental Knowledge, Perceptions, and Collective Actions

Figure 4 represents a snapshot of interlinkages between particular knowledge sets in ILEK, components of related perception systems, and relevant specific collective actions taken by the villagers during the study period. Through the discourse analyses, we identified seven categories of major knowledge sets, which were related to sea cucumber restoration, seaweed aquaculture, agriculture practices, and traditional resource management systems. These knowledge sets were classified into the basic knowledge often provided by external stakeholders such as government agencies and scientists (black), transformed knowledge sets translated from the basic knowledge by interactions among different stakeholders (blue), and traditional and empirical knowledge underlining almost all decision-making practices (green). Fourteen, seven and 11 villagers respectively referred to these three types of knowledge. Nine villagers mentioned that knowledge created and visualized shareable value in the community (indicating transformation of perceptions), and 13 stated that the knowledge motivated people to manage resources (mobilizing collective actions).

These knowledge sets seemed to influence villagers' perceptions on the effectiveness of new and traditional resource management systems and techniques, the economic as well as other benefits related to resource management and their livelihoods, and on the potentials of knowledge-based consensus-building practices in the village. This transformation of perceptions in turn produced a series of collective actions. For example, influx of knowledge and changes of perceptions related to the effectiveness of new techniques of sea cucumber restoration and its potential economic benefits resulted in collective actions to restore sea cucumber resources in 2012. Knowledge related to seaweed aquaculture influenced perceptions on effective techniques and marketability, resulting in the implementation of a seaweed project in 2013. Various knowledge sets on farming techniques visualized the plausibility of producing new profitable products, and influenced the local perceptions on marketability of agricultural products, bringing about the implementation of a ginger project in 2013.

On the other hand, we could not identify direct influences of particular knowledge sets on perceptions regarding implementation of the locally managed marine area (LMMA) in this study except for the indirect effects of knowledge and perceptions on traditional resource management systems and local leadership, which might be the prerequisites for the implementation of LMMA. This observation seemed to be reflected by the relatively longer time period after the initial launch of the LMMA in this village in 2007. The collective actions to manage the LMMA have been performed continuously to reach the stage maturity and stability of the management practices in this study period. Perceptions on the benefit of having a LMMA and its effective management systems might be less pronounced because they have already been shared and well-established among villagers.

Social Learning and Hypothesis Generating Processes

The original ideas and basic knowledge and skills for sea cucumber restoration and seaweed aquaculture were brought into Kumi village by Ministry of Fisheries and ginger farming by Ministry of Agriculture, while the LMMA system was disseminated by The University of the South Pacific scientists based on successful cases in other villages. However, these knowledge components and associated perceptions have been dynamically translated to allow new meanings through social learning in the processes of designing and conducting collective actions (**Figure 4**). Collective actions on sea cucumber restoration and seaweed aquaculture quickly transformed perceptions among participating community members on the effectiveness of materials and techniques of culture and restoration provided by the government agencies. People seemed to generate new perceptions on the value of more convenient, affordable and sustainable local materials for these practices, started testing these local materials based on the newly generated hypothesis, and brought about transformation of the knowledge system through social learning. Sea cucumber restoration also went through social learning processes regarding effective breeding of the species in small fenced enclosures in shallow waters. Villagers learned through their practices that sea cucumbers tended to congregate around the enclosure fence when sea cucumbers density in the enclosure was high. The knowledge derived from this observation transformed their perception on effective restoration techniques, generated a new hypothesis on density effects of sea cucumbers in the enclosure, and transformed their practices to induce possible spillover effects by breeding in the enclosure. On land, implementation of ginger planting supported by the government transformed their land use pattern for farming through learning by practice to utilize slopes on hills for ginger production, which had not been used for other crops so far. This collective action transformed their perceptions on improving livelihood and wellbeing by growing additional marketable products and produced new knowledge sets related to agriculture practices.

The first LMMA in Kumi village was established to manage *Anadara* clams for the period from 2007 to 2009, and the success of this practice transformed perceptions of villagers with regard to potential impacts of LMMA upon their livelihood, well-being and sustainability of resources. Based on collaborations with The University of the South Pacific scientists, villagers also seemed to transform their perceptions on the values and impacts of their own management practices. This transformation of perceptions probably produced a new set of hypotheses regarding appropriate locations for LMMA setting and effects of shifting LMMA sites. The villagers had successively established and managed LMMAs from 2009 to 2011 and 2011 to 2016, but they had changed the LMMA site every time in between. This decision of selection and relocation of LMMA sites by villagers may be brought about by the transformed knowledge sets regarding appropriate environmental conditions of *Anadara* clam production, and impacts of shifting the LMMA location to improve environmental conditions. In all these

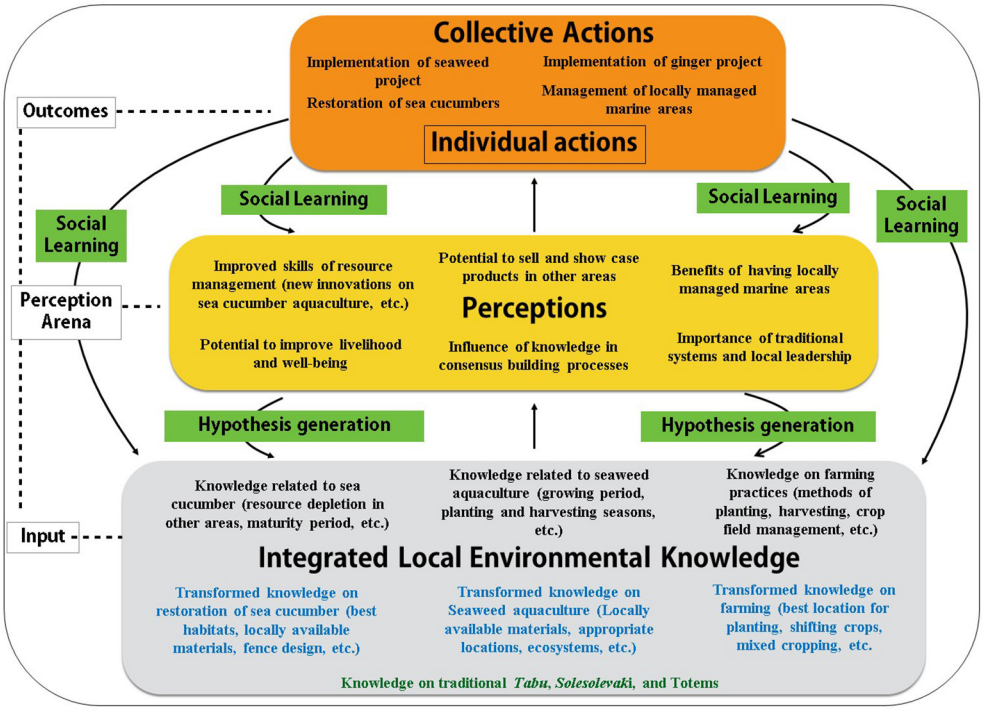

FIGURE 4 | Components of integrated local environmental knowledge and perceptions of people leading to relevant collective actions (see text for details).

examples, collective actions provided a platform of social learning among participants to transform their perceptions and generate new hypotheses with regard to the resources and their own management practices, producing new knowledge sets within their ILEK.

Bilateral Knowledge Translators in the Community

The dynamic transformations of ILEK and perceptions among villagers have been shared with other external stakeholders (i.e., knowledge producers) in various ways. Officials of the Ministry of Fisheries were frequently observed to visit Kumi to monitor the outcomes of the sea cucumber and seaweed projects. They collected data on the growth and quality of the products and observed locally-shaped restoration and aquaculture techniques, which were already disseminated to other villages. At the same time, they contributed new knowledge on technical developments in other villages to be shared with Kumi villagers. In the case of the LMMA, The University of the South Pacific scientists (including the lead author) played similar roles to promote knowledge circulation among villages that take collective action to establish and manage LMMAs. One community member of Kumi working in a company outside the village had also disseminated the success stories of LMMA in Kumi to other villages. All of these knowledge producers in and outside of the village can be regarded as "knowledge translators" (Crosby, 1997). In this study, they mobilized bilateral knowledge circulation by visualizing new meanings of locally developed knowledge and skills, to be shared with government, scientists and other communities in the area.

Among these knowledge translators, all external stakeholders interviewed in this study recognized that the *turaga ni koro* played a significant role for Kumi as a link between the community and external translators (see Biturogoiwasa, 2001). The *turaga ni koro* is the headman of a Fijian village, chosen by the villagers and endorsed by the provincial government. He advises the traditional chief and other decision makers within the village regarding interventions from the external world. At the same time, we found that the *turaga ni koro* in Kumi advised external stakeholders including government agencies, NGO and university scientists with regard to conditions and needs of the village in general, especially with regard to resource managements (**Figure 5**). The village chief, elders, sub-clan chiefs, and religious leaders occasionally played a role of knowledge translators by traveling out of the community and attending meetings or visiting other communities within the province or region. By observing and learning from the marine resource management practices in other areas, they also shared their knowledge and influenced perceptions of the members of their own community. In addition, external translators from government, NGOs and The University of the South Pacific also directly visited the village to convey scientific knowledge. In all these processes, the *turaga ni koro* played a significant role as the gatekeeper of the community by controlling and promoting interactions between different knowledge systems and perceptions of diverse stakeholders, both within and outside of

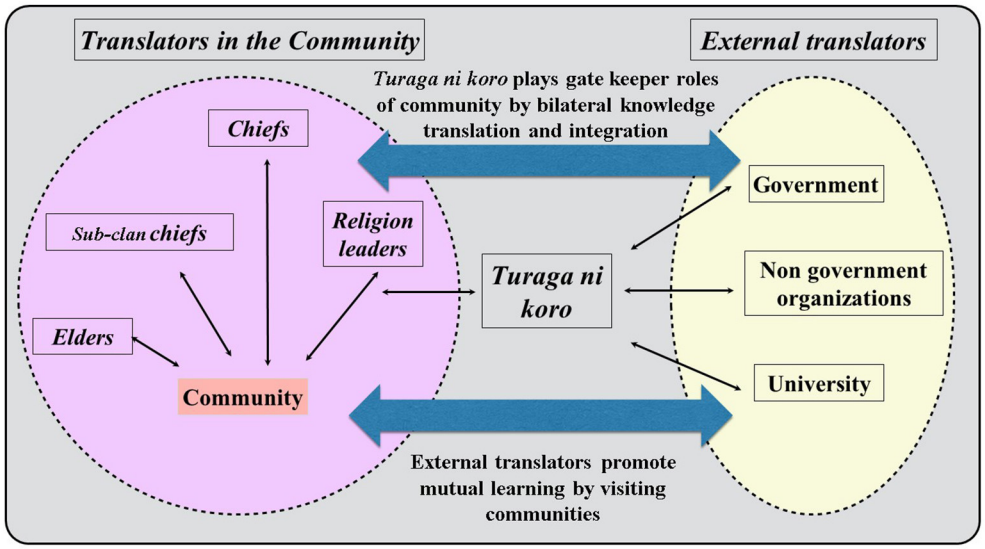

FIGURE 5 | Network of knowledge translators and the roles of *turaga ni koro* in Kumi Village (see text for details).

the village. He organized *kava* ceremonies in his house with the external stakeholders when they visited the village to promote knowledge exchange with the leader and decision-makers of the community. He guided these people around the village for interaction with other community members. Through these gatekeeping activities, the *turaga ni koro* seemed to translate the knowledge from both sides through the filters of his own perceptions, and blend external and local knowledge and skills to transform ILEK.

Perceptions Rooted in Traditional Institutions

In Kumi village, we found *tabus* in fishing practices, the sharing concept *solesolevaki*, clan totems, and traditional leadership as the fundamental institutions and decision-making systems of the community and its ILEK (**Figure 4**). Perceptions regarding the importance of these traditional aspects promoted collective actions based on consensus and collaboration among community members.

A previous record found that the *tabu* tradition had been practiced in areas of Kumi fishing boundaries (Tawake et al., 2001). In this study, we found that knowledge on the *tabu* tradition was shared among Kumi villagers, and perceptions on its importance for the community served as the bases for collective actions of fisheries resource management (including the LMMA and sea cucumber restoration). The tradition of "*solesolevaki*" was shared and regularly practiced among Kumi villagers, including collective actions identified in this study. This practice seemed to provide behavioral foundations to integrate individual actions among different gender and age groups, to share responsibilities and collaborate in various labor-intensive community tasks. All interviewees in Kumi recognized that these collective actions were the result of community customs in the village. It was also likely that the cohesion among villagers to perform *solesolevaki* provided a platform for mutual support systems among group members, and mitigated potential conflicts of interest among participants of collective actions. The totem and related traditional knowledge on ecology and harvesting of the *Anadara* clams influenced the perceptions among Kumi villagers on the importance of managing the habitats of this important resource. This perception deeply rooted to their traditional culture provided a foundation to promote collective actions regarding the LMMA as well as the seaweed aquaculture on the mudflats, both of which were expected to contribute to improving the clam habitats.

All traditional institutions and rules mentioned above were supported by the traditional village chief, elders, sub-clan chiefs and religion leaders and other important actors involved in decision-making on community level (**Figure 4**). The clan systems, centered around leadership of the chiefs with various traditional institutions and rules (such as *tabus, solesolevaki,* and totems), have been the oldest and most long-enduring institutions in Fiji, formed much before other institutions were brought into the communities by the colonial and current governments. We witnessed that these ancient institutions were still functioning well in Kumi village to date, to promote sharing of responsibility and collaboration among community members.

DISCUSSION

In this study, we found that dynamic production and circulation of ILEK contributed to transformations of perceptions regarding the status and values of coastal resources, the importance of locally developed techniques for resource restoration and management, the impacts of such new techniques on improving livelihood and well-being, and the significance of traditional institutions in achieving effective implementation of resource

management projects. However, we also found that each component of knowledge in the ILEK such as knowledge on sea cucumber restorations or seaweed aquaculture did not directly correspond to particular sets of perceptions. Rather, the linkages between knowledge and perceptions seemed to be complicated in a way that each knowledge component influenced diverse sets of perceptions through different pathways of knowledge translations and meaning making. The resulting transformation of perceptions generated new hypotheses related to knowledge components which were often different from the original components. Our findings strongly suggest the importance of a complex systems approach to understand the interlinkages of knowledge and perceptions facilitated by knowledge translation and feedbacks through social learning and hypotheses generation.

The transformation of perceptions had significant impacts on promoting various collective actions in this case study, supporting our initial theory of their fundamental function as an enabler of collective actions. However, ILEK and its constituent knowledge sets do not always produce collective actions toward sustainable directions. Collective actions are often influenced by the prioritized values among stakeholders and prospects of tangible outcomes of the actions. Previous case studies in communities of developing countries even showed mismatches between knowledge of stakeholders and actions taken that led local communities away from conservation practices (Bennett and Dearden, 2014). However, we found in this study that various knowledge sets introduced by external translators and digested by villagers via their own "knowledge translators" had transformed their perceptions to incorporate important aspects including more sustainable management techniques, and potentials to improve local livelihoods and well-being. The *turaga ni koro,* knowledge translator and gatekeeper of the village, seemed to play an essential role in this process. The *turaga ni koro* in Kumi village was likely to function as a residential researcher (i.e., knowledge producer) in the community as he integrated various types of knowledge to visualize resource values, effectiveness of techniques, and visions of management outcomes. Detailed comparative analyses of various types of knowledge producers and translators are needed to elucidate their core functions to transform perceptions to produce collective actions toward more effective coastal management measures.

Collective actions among diverse stakeholders are essential for the success of community-based management of coastal resources, especially common property recourses including forestry and fisheries (Cox et al., 2010; Ratner et al., 2013). Collective actions are promoted by perceptions among involved stakeholders and underlying knowledge systems, while participating in collective actions again influences perceptions and knowledge systems of the participants through social learning processes (Shackleton et al., 2009). This interactive process is assumed to promote dynamic and adaptive transformations of local institutions by the relevant stakeholders to cope with complexities associated with coastal marine resource management. Collective actions observed in this study provided ample opportunities of social learning for both villagers and external stakeholders, including government officials and scientists, even though there were significant differences in prioritized values and the framing of knowledge. Collective actions apparently strengthened the perceptions of diverse stakeholders on the values of community practices and improved the local approaches to sustainable resource management. Continuous interaction between The University of the South Pacific scientists and villagers in the case of locally managed marine area was an essential factor to mobilize social learning processes of all parties involved. Monitoring activities by the Ministry of Fisheries and Agriculture officials were effective to promote social learning between these officials and members of the different communities they collaborated with. Understanding the functions of formal and informal mechanisms of knowledge translation, such as continuous networking and interaction of involved stakeholder groups, seems to be indispensable to support social learning.

This study clearly showed the persisting importance of traditional institutions, rules and decision-making systems for producing collective actions that contribute to the sustainable management of coastal resources in Kumi village. The *tabu* traditions, *solesolevaki* practices, and the clan totems played indispensable functions to create respect for community decisions, unified actions toward common goals, and platforms for introducing sustainable management practices. These institutions were implemented and utilized in a consistent way under the strong leadership by the traditional chief of the village. Such strong traditional institutions and leadership foundation may be regarded as having limited potential to apply to societies in other parts of the world. However, if we take a closer look at the mechanisms that support these institutions, we can identify the fundamental parts played by shared respect of local rules and community decisions (*tabu*), recognition of importance of working together for common goals (*solesolevaki*), and understanding of linkages between cultural values and sustainable use of natural resources (totems). Societal mechanisms to maintain trusted leaderships were another fundamental factor to provide platforms for various collective actions in the community. All of these factors may in fact have a universal value, as important components of perceptions among community members toward their own community environments (natural, social, and cultural) and their own collaborative practices. The processes toward the creation of ILEK to enable the transformation of local perceptions incorporating these universal values, are essential to manage coastal common property resources, and are of interest to resource management researchers and practitioners in Fiji and beyond.

This case study was conducted in a small coastal village with a relatively small sample size and gender imbalance as outlined above. The study period was limited to provide snapshots of a long and continuous process of resource management and community development practices in the village. Even though the research design had such drawbacks, it could reveal essential enablers of transformation of perceptions to promote various collective actions. In-depth interviews clearly focusing on specific collective actions combined with the qualitative analyses to extract knowledge and perceptions related to these

ongoing actions seemed to be an appropriate approach to bring about core findings of this study that suggested broader applicability in research of coastal resource management. A more comprehensive research design to obtain more detailed discourses from a larger and balanced sample are expected to verify the effectiveness and limitations of the qualitative discourse analyses. Furthermore, an in-depth analysis of the inequality/gender imbalance in decision-making would be required to provide a better understanding of the power of transforming perceptions and their relationship to collective actions.

CONCLUSION

In conclusion, a dynamic production and circulation of ILEK in Kumi village contributed to the transformation of perceptions, promoting a series of collective actions for the sustainable management of the local coastal resources (marine and terrestrial). These collective actions provided ample opportunities of social learning for both villagers and external stakeholders, transforming their ILEK to generate new hypotheses and in turn influence their perceptions. Traditional institutions, rules and decision-making systems played essential roles in producing collective actions contributing to the sustainable management of various coastal resources, and these collective actions transformed and strengthened local perceptions on the universal values of traditional systems for their community. These observations were in good accordance with Ostrom's eight principles for managing common pool resources (Ostrom, 1990). The collective actions had a well-defined boundary and reflected both local needs and social-ecological conditions. The rules and procedures of the actions were discussed and agreed among local stakeholders, and external stakeholders respected these decisions and drew lessons from them. The traditional rules and decision-making systems in place in Kumi village seemed to work well for preventing rule violation and solving conflicts. Probably the important remaining challenge is the sharing of responsibilities for sustainable coastal resource management with actors from a broader context, connected to both coastal resources and local livelihoods, such as seaweed and sea cucumber middlemen and traders, exporters of agricultural products, as well as policy makers and development agencies at national and international levels. To tackle this challenge, knowledge translators such as the ones identified in this study may play a significant role to promote collaborative interactions between the coastal communities and potential external stakeholders through knowledge integration and transformation of perceptions.

AUTHOR CONTRIBUTIONS

JK conducted all field research, wrote initial manuscript of the paper, and contributed to finalizing revised manuscript. TS provided theoretical background, analytical framework and conducted analyses of the data, and participated in field research. TS and JK jointly made blush up of the manuscript.

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Oceans of Discourses: Utilizing Q Methodology for Analyzing Perceptions on Marine Biodiversity Conservation in the Kogelberg Biosphere Reserve, South Africa

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This paper attempts to empirically investigate perceptions regarding marine biodiversity conservation among different stakeholders of the Kogelberg Biosphere Reserve, South Africa. The study's data was collected by following Q methodology in combination with semi-structured interviews and participant observation. Q methodology combines elements from quantitative and qualitative research traditions, providing researchers with a systematic and rigorous means to study human subjectivities. Primary data were gathered from stakeholders who either live, work, or have performed research in the Kogelberg Biosphere Reserve. A combination of interpretative discourse analysis and Q factor analysis was employed to identify perceptions. The results reveal that there are two operating discourses with clear stakeholder divisions. The science discourse is characterized by its scientific management-based ecological approach. On the other hand, the livelihoods discourse is primarily concerned about the social implications brought about by Kogelberg as a biosphere reserve. The paper goes on to argue that the meaning people attach to the concept of "marine biodiversity conservation" is relational as it is based on their lived experience. It further highlights the importance of performing context-specific social research of protected areas, as it is difficult for conservation projects to meet both ecological and social needs without understanding the viewpoints of engaged stakeholders and local communities.

Keywords: marine biodiversity conservation, Kogelberg biosphere reserve, environmental discourses, environmental subjectivities, Q methodology, perceptions, nature conservation

INTRODUCTION

Loss of biodiversity is one of the most prominent aspects of the environmental crisis the world is facing. It is estimated that the earth is home to somewhere between 5 and 15 million species, of which only 1.8 million are known to science. While species dying out is a natural process, the current extinction rates are assumed to be 100 to 1000 times greater than the "normal" rate, which

is largely due to human activities such as habitat destruction and fragmentation, overharvesting or pollution (Stoll-Kleemann and Bertzky, 2004: p. 1; Kearns, 2010: p. 7). Loss of biodiversity and rapid depletion of natural resources is present in all known ecosystems. While the ocean has been regarded as a source of infinite resources for a long time, it is estimated that 70% of the earth's commercially targeted fish species have been overfished to the point where their stocks are in grave danger of being depleted. On a global scale, some of the most threatened marine species include whales, dolphins, salmon, sea turtles, sharks, manatees and dugongs[1].

Biodiversity loss is therefore expressed as one of the main contemporary environmental concerns along with climate change and desertification (United Nations, 2002: p. 3). In response to reduce the loss of biodiversity worldwide, UNESCO has created 651 biosphere reserves (BR) in 120 countries worldwide as part of the Man and the Biosphere program (MAB). Biosphere reserves are experimental places, which see interdisciplinary approaches being tested to understand and manage changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. These reserves can be more closely described as areas comprising terrestrial, marine and coastal ecosystems, promoting biodiversity conservation of species as well as sustainable development of local human populations[2]. Such a reserve is an open area without any fences to "keep people out" and "nature in." Furthermore, BRs are governed in such a way that local communities, farmers, conservation agencies and local governments are committed to protect the landscape and its biodiversity together[3]. Participation of local communities in the management of biospheres is seen as crucial to make the project succeed, while at the same time aiming to include traditional ecological knowledge into ecosystem management. However, many attempts of conserving biodiversity have failed, and the BR concept as put forward by UNESCO is no exception (Stoll-Kleemann and Bertzky, 2004; Hyman, 2006). Many of the BRs neither have the resources nor the capacity to meet the global mandate put forward by UNESCO, a problem that is particularly evident in developing countries. Another important problem in a biosocio-economic system is that these systems are dynamic and complex, and consist of many interactions between humans and institutions. As a consequence, conflicts emerge on multiple levels. Stoll-Kleemann and Bertzky (2004: p. 2) note that biodiversity conflicts are often a result of the different preferences, values and objectives of different actors.

Environmental arguments, such as protection and conservation of biodiversity might appear to be factual and scientific, but they are also meaningful, ethical and suggestive (Næss, 1974: p. xxiii), representing a certain discursive perception of an issue. However, the ways in which individuals think about and understand environmental problems such as biodiversity conservation, is a vital issue in the study of environmental politics that often remains unexplored in the literature. Yet, this issue should be regarded as one of central importance because "until we know the 'discourses' people use about the environment, it will be very hard to judge what, and whether, environmental policies will be socially acceptable, and therefore capable of being implemented" (Barry and Proops, 1999: p. 338). Reality is socially constructed; therefore the analysis of meaning becomes central. In this way, it is not an environmental phenomenon in itself that is important, but the way in which society makes sense of this phenomenon. The meaning attributed to a concept such as "biodiversity conservation" affects the outcomes, institutions and laws, and further becomes the context, or discourse, in which environmental issues are talked about.

These meanings do not appear out of nothing, but are the result of a particular set of operational routines and accepted norms and rules that give coherence to social life (Hajer and Versteeg, 2005: pp. 176–177). Understanding the local context and the local way of thinking about environmental issues is therefore crucial for creating development projects and plans that aim at protecting biodiversity. Furthermore, the study of environmental perceptions in particular is very important in creating an understanding of the social complexities embedded in the environmental crisis.

This research has set out to contribute to the debate of biodiversity conservation and how differing discourses influence stakeholder perceptions and management of BRs. In order to investigate perceptions of marine biodiversity conservation, the study utilized a case study approach to understand how different stakeholders of a BR perceive biodiversity conservation of marine areas. The area of focus was the Kogelberg Biosphere Reserve located in South Africa. The study furthermore aimed to illustrate the utility of Q methodology for conducting perception-based research. The following sections will provide the background and context to the case study under investigation, before then turning to the actual process of applying Q methodology.

CONSERVATION THROUGH THE ESTABLISHMENT OF BIOSPHERE RESERVES

The Kogelberg Biosphere Reserve (KBR; **Figure 1**) was proclaimed as South Africa's first BR in 1998 (Turpie et al., 2009: p. 1). Some of the objectives highlighted in the establishment of BRs include the preservation and sustainable utilization of natural resources, as well as economic development that aims to be socially and environmentally just. It also includes education, monitoring and research as core and ongoing priorities (Tucker, 2013: p. 2). These areas are typically divided into core areas (where the highest level of protection is afforded and little or no consumptive uses occur), buffer zones (surround the core, and limited development and activities occur) and transitional zones where a range of activities and developments (i.e., including farming, residential or resort projects) take place[4]. Furthermore,

[1]Marinebio website, http://marinebio.org/oceans/threatened-endangered-species/ Accessed 10.08.2015.

[2]UNESCO website, http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/ Accessed 07.08.2015.

[3]Kogelberg Biosphere Reserve website, http://www.kogelbergbiosphererereserve.co.za/ Accessed 10.08.2015.

[4]Kogelberg Biosphere Reserve Company website, http://www.kbrc.org.za/ Accessed 05.04.2016.

FIGURE 1 | Map of location, towns and zones of Kogelberg Biosphere Reserve, South Africa[5].

BRs are managed by a range of organizations, including government departments, national parks authorities, provincial conservation bodies, local government departments, regional and municipal councils, non-governmental organizations (NGOs), community organizations, also with participation of researchers and universities.

The KBR is located in an area known as the Cape Floral Kingdom, comprising approximately 100,000 hectares at land and at sea[6]. This area has approximately 5800 endemic plant species, which is more for its area than anywhere else in the world[7]. The KBR, also known as the "heart of the floral kingdom," contains rich wildlife with a variety of different bird, amphibian and mammal species, and boasts with South Africa's largest penguin colony. About 30% of the KBR consists of marine areas, which are particularly biodiversity rich. This is where the cold Atlantic currents meet the Indian Ocean's warm waters, creating a home for a variety of marine species. The reserve starts in the Atlantic Ocean, 7.5 km from land, and stretches two nautical miles out to sea[8]. Being located in the Overberg municipality, the area is surrounded by small villages that include Rooi- Els, Pringle Bay, Betty's Bay and Kleinmond (Turpie et al., 2009: p. 3). In terms of development and economic activity, the trade and services sectors make up almost half of the economic production, with tourism playing a vital role (Turpie et al., 2009: p. 9). Being in close proximity to the coast has meant that the inhabitants

[5]Map courtesy of Johns and Johns (2001). Edited by Stephen Young.

[6]KBRC Kogelberg Biosphere Reserve Company website, http://www.kbrc.org.za/index.php?dirname=docs_09about/history Accessed 20.06.2016.

[7]Kogelberg Biosphere Reserve Company website, http://www.kbrc.org.za/index.php?dirname=docs_03nature/flora Accessed 24.08.2016.

[8]Kogelberg Biosphere Reserve Company website, http://www.kbrc.org.za/ Accessed 05.04.2016.

of the surrounding villages have developed a dependency and relationship with the sea. Primary use of the coast and its resources include the harvesting of abalone (Haliotis midae), west coast rock lobster (Jasus lalandii), line fish and kelp. In the recent past, the harvesting of abalone has seen a moratorium being placed on the resource by the National department of forestry and fisheries as incidences of poaching and overharvesting are driving the species toward extinction. The tradition and history of fishing in one particular village, Kleinmond, has been well established and dates back many generations. However, the continued illegal harvesting and pressures for greater access to the coastal marine resources by local resource users (amongst others) of the KBR and elsewhere along the country's coast have been a subject of concern for the National department of forestry and fisheries (Turpie et al., 2009: pp. iv–vi; Sunde, 2014: p. 23). As a result strict controls have been implemented by resource managers, and various efforts directed to streamline conservation efforts and economic and livelihood considerations within the KBR.

Management responsibility for the KBR is shared by a group of local and regional stakeholders. Its key management body is the Kogelberg Biosphere Reserve Company (KBRC), which works in collaboration with stakeholders from government, academia, business and NGOs[9]. In this management structure there are different subgroups or stakeholder working groups. The Kogelberg Marine Working Group (KMWG) is one such gathering of involved stakeholders. It was established in 2009, with the aim to contribute to the management of a no-take Marine Protected Area (MPA) in Betty's Bay (see **Figure 1**), which was established to facilitate the recovery of fish stocks and prevent marine species from being overharvested. The KMWG deals with marine and coastal environmental and social challenges (such as curbing poaching to protect the interest of the fishers) (Anchor Environmental, 2009: p. 4; (Hagan, 2016): pp. 15–18). The rationale for establishing a BR in the Kogelberg area was to ensure better biodiversity conservation through stakeholder involvement. It was envisaged that it would also address issues related to development pressures and poverty alleviation (Hyman, 2006: p. 23). However, the KBR has not achieved all of its desired successes, which has resulted in limited conservation and social developmental outcomes and stakeholders who struggle to cooperate (Hyman, 2006: p. 1; (Müller, 2010): p. 152; (Hagan, 2016): p. 56). While previous studies have pointed out that stakeholders in the KBR are facing management and cooperation difficulties as a result of divergent interests and perceptions (Hyman, 2006: p. 84–88; Müller, 2010: p. 152), this study has focused on stakeholders' perceptions of marine biodiversity conservation in more detail. The original study[10] looked at five key stakeholder groups of the KMWG: CapeNature, scientists, small-scale fishers, World Wide Fund for Nature (WWF) and Seawatch (Hagan, 2016: pp. 18–19). This article will not discuss the latter two, as only two individuals from each of these Non-Governmental Organizations (NGOs) were working directly on marine conservation in the KBR. CapeNature is a governmental institution that chairs the KMWG. They have the statutory responsibility for biodiversity conservation in the Western Cape as governed by the Western Cape Nature Conservation Board Act 15 of 1998[11]. Other stakeholders include both natural and social scientists, providing inputs in terms of management recommendations, monitoring and evaluation, as well as participation in stakeholder engagement. The fishers' group refers to men and women from the fishing villages of the KBR, whose livelihoods depend on small-scale fishing.

MATERIALS AND METHODS

In order to gain an understanding of the different ways marine biodiversity conservation in the KBR is perceived, data gathering was carried out using Q methodology in combination with semi-structured interviews and participant observation. The data from this process was analyzed using Q factor analysis and interpretative discourse analysis. A "discourse" is in this context understood as *"a shared way of apprehending the world. Embedded in language, it enables those who subscribe to it to interpret bits of information and put them together into coherent stories or accounts. Discourses construct meanings and relationships, helping define common sense and legitimate knowledge. Each discourse rests on assumptions, judgments, and contentions that provide the basic terms for analysis, debates, agreements, and disagreements* (Dryzek, 2013: pp. 9–10).

Q Methodology

In the 1930s, the psychologist Stephenson (1953) developed Q methodology as a means to systematically study human subjectivity. The methodology combines the strengths of both quantitative and qualitative research traditions, and is suitable to investigate questions about personal experience and matters regarding taste, values and beliefs (Baker, 2006: p. 2343). Q method is primarily used in psychology, but it has also been embraced by scientists as a means to investigate human subjectivity on a variety of issues, particularly in politics and health research (Eden et al., 2005: p. 414). In later years, Q method has also rapidly expanded to environmental studies (Dasgupta and Vira, 2005: p. 2; Eden et al., 2005: p. 414; Webler et al., 2009: p. 8). Previous publications in social environmental research have scrutinized a wide range of topics, including environmental policy (Addams and Proops, 2000), global environmental change (Niemeyer et al., 2005), environmental management (Bischof, 2010), successful biodiversity conservation (West et al., 2016), and animal rights (Kalof, 2000). The method has also been utilized in work on environmental policy and environmental discourses in order to gain a more thorough understanding of stakeholder perceptions (Dasgupta and Vira, 2005; Guimaraães, 2010; Pike et al., 2014).

All Q studies are reconstructive and characterized by two key features. Firstly, the collection of data is done in form of Q sorts (Watts and Stenner, 2012: p. 178). This is typically

[9]Kogelberg Biosphere Reserve Company website, http://www.kbrc.org.za/index.php?dirname=docs_04projects/partners Accessed 12.05.2016.

[10]This paper draws on research undertaken as part of the first author's master's dissertation.

[11]CapeNature website, http://www.capenature.co.za/about-us/ Accessed 12.05.2016.

(but not always) done by presenting people with a sample of statements about a topic, which is referred to as the Q-set. The selected respondents, called the P-set, are instructed to rank-order the statements from their personal point of view on a score sheet. Following this process, which is called the Q sort, people give their subjective meaning to the statements and thus reveal their subjective viewpoint (Van Exel and de Graaf, 2005: p. 1). Secondly, these Q sorts are factor-analyzed for establishing different patterns (Watts and Stenner, 2012: p. 178). Unlike standard survey analysis, Q methodology is not aimed at establishing patterns across individual characteristics such as age, gender and class. Instead it looks at patterns within and across individuals by focusing on their discursive understanding of a particular issue. It works on the assumption that there are a limited number of ordered patternings within a particular discursive realm, attempting to reveal those patterns in a structured and interpretable way (Barry and Proops, 1999: p. 339). The method is primarily explorative, for qualitative recognition of the mere existence of subjective views instead of measurement of pre-defined attitudes or perceptions. One of the main strengths of the method is that it provides statistically significant results from a reasonably low sample size (Brown, 1993: p. 94). Furthermore, it converts in-depth subjective information into quantifiable data in a way that traditional methods are not capable of Pike et al. (2014: p. 667).

Administering the Q Sort

Influenced by the steps created by Brown (1993) and later elaborated by Van Exel and de Graaf (2005), this Q study was conducted by following six steps; (1) defining the concourse; (2) developing the Q sample; (3) selecting the P-set; (4) Q sorting; (5) semi-structured interviews; and (6) analysis and interpretation.

Employing Q methodology, the first and most important step is to identify all the possible statements the actors within the relevant domain could make about the subject matter (Van Exel and de Graaf, 2005 : p. 4), in this case marine biodiversity conservation. The concourse, or "the flow of communicability surrounding any topic" (Brown, 1993: p. 94) was collected through key informant interviews with two representatives from each stakeholder group, as well as interviews and informal conversations with other members of the identified stakeholders, living or working in the KBR. A snowball sampling method was employed after attending a KMWG meeting in order to meet and contact relevant respondents. A purposive sampling approach was also employed with people who had relevant views on the matter without being directly related to the KBR context. These included fishers from other parts of the coast (outside the KBR) as well as conservation biologists and politicians working with nature reserves in the Western Cape. This was done to triangulate the various ideas surrounding biodiversity conservation in general and of marine areas in particular. These interviews and conversations (about 40 in total) resulted in hundreds of statements, which were transcribed, coded and divided into categories. These categories emerged inductively from the coding process, focusing on the most re-occurring issues. For instance, issues related to the MPA came up frequently and were therefore included, while gender was only brought up once and thus excluded. The Q sample was selected by choosing a few statements from each category (Webler et al., 2009: p. 10). Particular emphasis was placed on interviews with people living and working in the KBR, minutes from meetings of the KMWG and scientific literature from the area. This resulted in 45 statements being collated. In this way, the selection procedure was based on field observation and interview data, in contrast to being based on pre-existing theory and categorizations. In addition to the Q sorting task, a key focus of the study was to emphasize the qualitative interview in combination with each Q sort. The Q sorts and interviews were set up to be no longer than 1 h, therefore the amount of statements had to be reduced accordingly. The selection procedure used experts (social scientists who had worked in the KBR during the last 2 years but were no longer actively involved) as a means of piloting the suitability of the Q sample. This resulted in a final Q set consisting of 23 statements (see **Table 1** below).

The next step was to develop the P-set, which is a "structured sample of respondents who are theoretically relevant to the problem under consideration. (...) The aim is to have four or five persons defining each anticipated viewpoint, which are often two to four, and rarely more than six" (Van Exel and de Graaf, 2005: p. 6). From the three stakeholder groups, eleven key informants were selected; four scientists (two social, two natural scientists), four fishers and the three CapeNature managers responsible for the KBR. As there is a limited amount of dedicated people who are engaged in the KMWG or the daily operations of the coastal areas of the KBR, the authors prioritized key informants with high levels of influence and engagement. The original study, which also involved Seawatch and WWF, contained 15 respondents for Q sorting. One of the benefits of Q methodology is that only few participants are needed to give statistical significant results. According to Barry and Proops (1999), as few as 12 participants can generate statistically meaningful results, because each participant's Q sort provides a vast amount of information (Barry and Proops, 1999: p. 334).

The Q set was given to the respondent in form of a deck of randomly numbered cards. Each card contained one statement from the final Q sample. The respondent was first instructed to sort the deck into three piles; "agree," "neutral/undecided," and "disagree," depending on his/her personal point of view. Thereafter, the respondent was instructed to sort out the statements on a score sheet with a pyramidal, or "quasi-normal," sorting distribution, ranging from "strongly disagree" (−4) to "strongly agree" (4). The sorting distribution was pre-arranged; the whole Q set had to be allocated a ranking relative to one another within this distribution (see **Figure 2**). Each Q sorting was combined with an interview. During the sorting procedure, the respondent could choose whether to talk the researcher through each statement, or to sort first and do a follow-up interview afterwards. After each sorting, the respondent was asked to elaborate on his/her point of view, explain the most salient statements, and discuss whether there was any themes the respondent felt missing in the deck.

The Q sorts were subject to Q factor analysis, which is the most quantitative part of Q. The factor analysis was carried out

TABLE 1 | Statements, with scores on the two extracted discourses, sorted from consensus to strongest deviation.

No.	Statement	Factor 1 Scientific	Factor 2 Livelihood
11	The marine working group for the management of the KBR is just talk, talk, talk. They don't get anything done.	0	1
17	If we are to stop plundering nature for its resources, we need to change our ways of living. For this to happen, human nature has to change. That's impossible.	−2	−1
21	The marine reserve policies are not from South Africa. It is an agenda from America and Europe to plunder our resources—resources belonging to us.	−2	−3
10	To work with the sea's resources you need to be a conservationist. It needs to come from the heart, you need to care about what you are doing.	1	1
23	I wish I could prevent poaching along the coast, but I can't.	−1	0
2	Living with the sea is my way of existing.	2	3
7	If we don't do something about the ocean, the ocean will die.	2	1
13	I am in favor of protection, but it must include the fishers.	4	2
6	Environmental issues such as ocean pollution or protection of wildlife are outside of my control. I cannot do anything about it.	−3	−2
8	Rules among the fishers are enough to ensure the continued existence of marine species.	−3	−2
1	There is no point trying to conserve nature. The only thing that matters to people is prosperity and economic wealth.	−2	−4
22	I need to be allowed to do what I need to do to make a living, although it means that some plant or animal species might go extinct.	−4	−3
4	The KBR should not be a management issue. It should be left alone to the people living there.	−1	0
9	Most of the people working on the marine areas of the Kogelberg Reserve don't care about conservation.	0	−2
12	Animals are worth just as much and have the same right to live as humans.	0	2
16	When you live in nature you tune into a certain aspect where you feel more comfortable and become part of it. But you also realize how vulnerable it is, and how much protection it needs. It desperately needs to be looked after.	2	0
3	We need to have non-catch areas where no one is allowed to fish, and open areas where only local fishers are allowed to fish. The commercial industry must be left out of the equation.	0	2
14	Our government officials are corrupt.	1	−1
15	The conservation ideal is that nature is left as close to its natural state as possible.	1	0
5	If the abalone goes extinct, the ecosystem becomes unbalanced.	3	0
20	The way that humans exist and live today, their techniques for production and acquisition of resources, are no longer at pace with the natural state. We have outstripped the ability for natural ecosystems to recover from, and provide for, our requirements.	3	−1
18	The fishers are the protectors of the fishing areas and the sea, but by imposing MPAs without our permission, the responsibility is taken away from us.	0	4
19	If there is a problem of decreasing fish stocks one must start with introducing restrictions on the big fish boats, not on the small scale fishers who fish for their livelihood.	−1	3

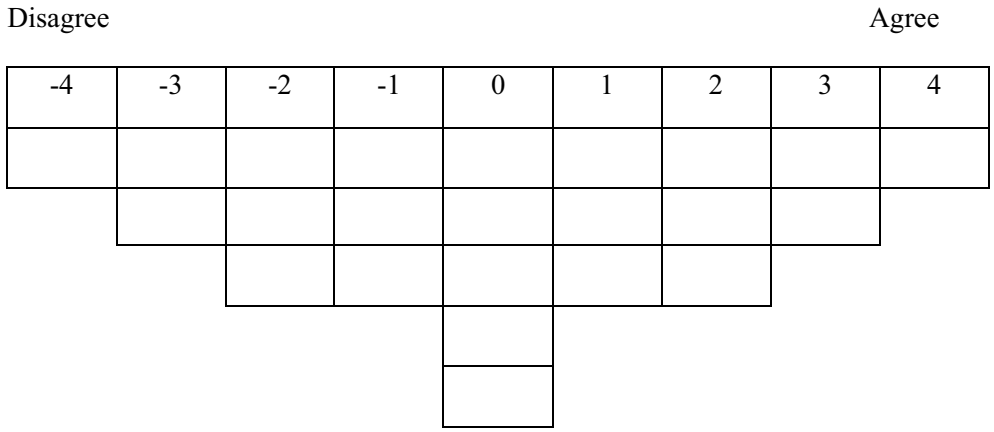

FIGURE 2 | Pre-arranged frequency distribution.

with the help of PQMETHOD-2.35[12], particularly designed for Q methodology. The package correlates every respondent's Q sort with every other Q sort. The resulting correlation matrix was then used for a centroid factor analysis (to define centers of gravity in the matrix and express these in specific terms; (Brown, 1993): p. 113). Varimax rotation was then used to rotate the remaining factors into a "simple structure" in order to extract factors that are significant according to the protocols of Q (Barry and Proops, 1999: p. 341). The package extracts all significant factors and conveys them as the "best estimate" of the sorts that represent them (Barry and Proops, 1999), capturing the common essence of the sorts. Based on their correlation to certain factors, the package provides a way of recognizing fundamentally different viewpoints and grouping respondents around these. The factors resulting from this analysis are not necessarily represented by any specific individual, but rather represent an "ideal type," which is a virtual respondent that is fully representing one of the distinguished viewpoints (Bischof, 2010: p. 605). Usually, each respondent has aspects of more than one "ideal" sort in their personal sort. Q sorts that come closest to this ideal are listed. The significance of a factor is determined statistically by its Eigenvalue (i.e., the sum of squares of the factor loadings). Eigenvalues higher than 1 are considered significant (Van Exel and de Graaf, 2005: p. 18). Another statistical criterion is the composite reliability[13] of a factor, which depends on how many respondents define it. The more respondents define a factor, the higher the reliability (Dasgupta and Vira, 2005: p. 14). A factor should be defined by at least five respondents. This will result in a factor reliability of 95%, which is sufficient to obtain a clear factor reading (du Plessis, 2005: p. 168). Correlation between an individual Q sort and shared factor was considered significant if a factor loading exceeded ±0.36 (West et al., 2016: p. 186).

The "ideal" Q sorts resulting from this procedure were interpreted along with the interview data to gain a better understanding of the outcomes of the factor analysis. As most respondents expressed their view on each single statement in the Q deck and answered interview questions related to these themes, the interview data carried extensive amounts of information that could be directly attached to each quote. This data assisted in interpreting the meaning of each statement and understanding the rationale behind why statements were sorted in a particular order (Gallagher and Porock, 2010: p. 298). In addition to the factor analysis, interview data and observations from the field were subject to interpretative discourse analysis to triangulate the results. Interpretative discourse analysis is committed to gaining an in-depth understanding of the actors' frame of reference, and possesses a view of language as being constructive rather than merely representational. It emphasizes the social construction of meaning and the central role of language as a symbolic medium in constructing social reality (Heracleous, 2006: pp. 11–12). Prior to the Q factor analysis, all the interviews and accompanied field observations were coded and analyzed separately, focusing on elements such as language, content, meaning, knowledge system and worldview. Later the interviews were compared with each other and analyzed. Therefore, interview data and field observations were subjected to interpretative discourse analysis on its own, and assisted the Q factor analysis by including respondents' interpretations of statements when analyzing the factors.

RESULTS

The factor analysis revealed that there are two operating discourses in the KBR, and that these discourses have a clear stakeholder division. All respondents in the P-set loaded on a factor. The three CapeNature representatives loaded on factor 1, and the four fishers on factor 2. The natural and social scientists were split. The two natural scientists load on factor 1, while

[12]Schmolck, P. (2015) *The PQ Method Page,* online: http://schmolck.userweb.mwn.de/qmethod/ Accessed 01.02.2016.

[13]In PQMethod the formula Rxx = 0,80p / [1 + (p − 1), 080] is built into the program. 0,80 is the presumed average reliability of the Q sorts comprising the factor, while p is the number of those Q sorts. Rxx is the test-retest reliability coefficient. When p = 5 Q sorts the factor reliability is Rxx = 0,80(5) / [1 + (5 − 1),80] = 0,9524 (from du Plessis, 2005:169).

the two social scientists load on factor 2. The discourse held by CapeNature and the natural scientists will in the following be referred to as the "scientific discourse," while the fishers and the social scientists adhere to the "livelihood discourse." The Eigen value of the scientific discourse is 5.3067, while it is 2.1598 for the livelihood discourse. The composite reliability is 97.3 and 96%, respectively.

The two "ideal type" Q sorts for the scientific and the livelihood discourse are shown below in **Table 1**. In the table they are presented from statements of "strongest consensus" to statements of "strongest deviation." Statements of high consensus refer to statements that have been sorted similarly on the "ideal type" Q sorts of both discourses. It shows what aspects do not distinguish significantly between the two discourses. Consensus does not automatically mean that the statement has scores in the middle (near 0), it can also be non-neutral. **Table 1** shows that, according to the factor analysis, statements #2, #4, #6, #7, #8, #10, #11, #17, #21, and #23 do not distinguish considerably between the different discourses but show common grounds between the two.

The statements of strongest deviation show what issues differ most between the two discourses. **Table 1** shows that the most important statements of distinction are statements #1, #3, #5, #9, #12, #13, #18, #19, and #20. These statements are statistically significant and therefore central when describing the discourses; they show the distinguishing issues and their relational importance. The interview data carried vital information explaining the respondents' thoughts on the issues highlighted in the statements, as well as the reasons why they sorted the way they did.

Furthermore, the results of the interpretative discourse analysis have been triangulated with the Q factor analysis to validate the factor interpretation. The following section will present the scientific discourse and the livelihood discourse in closer detail, interpreting both data from the Q factor analysis and the interpretative discourse analysis.

The Scientific Discourse

What is distinctive about this account is its normative management-based ecological approach. This discourse displays a strong concern about the destructive impact human behavior has on the environment. It emphasizes the necessity of creating management plans and projects to reach conservation objectives, and that these projects need to involve the fishers to succeed optimally.

Three statements are particularly important for this discourse, namely #13, #20, and #5. These three statements happen to be the statements of strongest agreement for this discourse, while also being among the most distinguishing ones to the livelihood discourse. The statements of strongest disagreement are #6, #8, and #22, however none of these statements are of great significance in defining this discourse in a comparative perspective to the other one, as all three are statements of consensus.

There is support for the idea that all citizens should take responsibility for environmental problems, and that the South African government has a statutory duty to protect marine biodiversity. According to this view, the Kogelberg belongs to the South African state and therefore all South Africans, not only the locals who live in the reserve. As commented by a natural scientist: "*Just because they happen to live there next to that piece of coast, I don't see that that necessarily means ownership or users rights. Theoretically, all of the resources belong to the state. That's what it says in the constitution. (...) People living outside the KBR have concerns and a right to know that that is being managed properly for the benefit of all South Africans, not just the people who happen to live in it."* Marine conservation in this context involves regulating people's utilization of the sea's resources. As pointed out by another natural scientist: "*I do think that it's never fully recognized that, if you look at our law, all the sea and it's resources are held in trust for all South Africans. Not just the people who happen to live by the sea."* These statements therefore concur with dominant discourses which stress that MPA's are particularly important in this regard in order to keep marine areas healthy, which is necessary for protecting marine species.

While a desire to strive toward "pristine" conservation ideals is present in the scientific discourse, regulation of human activities and more specifically the presence of people are cited as an important environmental and social challenge in achieving this state. In the interviews, this was demonstrated by the following response: "*A MPA, which is less than 10% of an entire coastline, needs to be pristine. Not to do away with people's right to catch fish. But to have an area where we know what it used to be like. That is also an ideal place to monitor change. Climate change and change that doesn't come through human pressures. So it's got a very critical need."* (CapeNature Official). This discourse expresses support for the viewpoint that local communities' use of marine resources is an important factor in species being threatened. In the interviews, both scientists and CapeNature representatives directly referred to the tragedy of the commons scenario when discussing the issue of fishers as protectors (statement #13). Following this view, the primary objective of the fishers is to optimize their daily economic return. According to one CapeNature official, "*obviously fishermen are concerned about their resource, but the problem is the tragedy of the commons scenario. If you don't catch the fish, the next person is going to catch the fish."* Having to act according to one's own self-interest instead of "the common good" is closely connected to the socio-economic reality of fishers' dependency on marine species to provide means of securing the necessities of life. According to this approach, conservation is also a matter of education, as locals harvesting marine resources may not always have sufficient knowledge of the biological repercussions. Central here is the assumption that protecting marine species will result in gains for the fishers in the long term. While holding positions for conservation with limited human interference to protect stocks, there is also recognition of the idea that it is important to include local fishers and other environmental users in conservation efforts, and that this is regarded a prerequisite for management projects to succeed. To this a scientist explained: "*We must include fishers, otherwise we are doomed to fail. The more desperate and poor the fishers are, the more difficult it is. It's quite easy in America or Australia where you've got an educated fishing population. It's not a walk in the park, but it's a hell of a lot*

easier than when you've got a desperately hungry fishing population that has had the disservice of an apartheid education."

The Livelihood Discourse

What is distinct of this view is a strong concern about the social implications brought about by the Kogelberg as a BR, particularly injustice toward the fishers and the fishing communities. The key concern is that although nature needs to be sustained, conservation of marine areas cannot deprive people of their livelihoods. Importantly, this discourse also expresses a strong opposition to the Kogelberg MPA. During an interview this was passionately expressed by a fisher who thought that *"The MPA is absolutely worthless. As far as the fishermen are concerned, it was stolen from them."*

The most influential statements of agreement in defining this discourse are #18 and #19, as well as #3 and #12. The most important statements of disagreement are #1 and #9. In the interviews, the fishers describe their respective villages and the ocean as something that is part of them, and something that belongs to them. With family bounds dating back generations, they believe that living from fishing is their inherited right and part of their identity. Conserving nature is talked about as a way of life where one coexists with other species, in contrast to creating and enforcing policies. The current arrangement with the MPA and fishing rights processes is considered as unfair and unnecessary. These sentiments, which were continuously expressed during interviews with the fishers, were related to their opinions on commercial fishing boats that catch vast amounts of fish. A fisher from Kleinmond explains: "*I think the big boats are taking all our fish out of the water. Then when we go to sea there is nothing left for us. It's a major problem for us because they come very near to the shore."* Another aspect linked to this is a feeling of inequality. Being among the poorest in the KBR, the fishers feel restricted by fishing rights and the fact that they are prohibited from fishing in the MPA as they have previously done. A fisher explained his position by adding: "*People should be taken into consideration. I think it can't just be imposed without the public impact. They just took an area and declared it a protected area. No one could say anything at all. It was the fisher's favorite fishing spots. And now they are sentenced out of it. It's illegal to fish there, and that are the best places to fish. Then you get a clash of interests. The fishermen feel they are not acknowledged when it becomes illegal. The responsibility is certainly taken away from us."* What also became apparent was that some fishers hold resentments toward white people of the area whom they believe are not penalized for "breaking the rules," e.g., when they are planting alien trees in their gardens or dislocating sand from the beaches. This can be understood as an expression of injustice on behalf of the poor fishing population, as they believe conservation restrictions are imposed on them alone.

The livelihood discourse indicates that the fishers think and understand marine conservation differently than the other stakeholders. However, the social scientists have sorted their Q sorts similarly to the fishers and therefore loaded higher on factor 2, or the livelihood discourse. The interview data shows that although the fishers and the social scientists load on the same factor, there is an important difference between these two groups. While the fishers refer to their own personal experience and livelihood challenges, the social scientists who work in these communities emphasize that although they do not relate to the situation in the same way, they do understand and generally support the viewpoint of the fishers. To this a social scientists responded to statement #2 (living with the sea is my way of existing) by adding: *"That's not relevant to me but I can see that it's relevant to a lot of people who live in the Kogelberg. So I would strongly agree with somebody who said that, of course. My job is linked to it, but I wouldn't say it's my way of existing personally."*

One of the biggest concerns for the fishers, and also recognized as important aspect by the social scientists, is that the current functioning of the KBR is depriving people of their livelihood. Here, a social scientist added: *"The KBR is a particular concept. It's a foreign concept to most people out there. It was not very well brainstormed, not very well discussed, not very well implemented. So I can understand that most people don't really like what they see there because most of the projects run by the KBR have been very conservationist. There's very little livelihood development, or socio-economic benefits to the community living there."* Therefore, the focus on social issues needs to be understood in the context of several social challenges, which include abalone poaching, violence, crime and drug abuse. Uncertain fishing rights and stricter conservation controls being exercised not only expose fishers and their livelihoods to vulnerabilities, but also exacerbate existing community challenges.

Importance of Stakeholders' Lived Experience

While the factor analysis demonstrates that there are two distinct discourses operating among the KBR stakeholders, certain viewpoints are shared between the two. "Consensus" is found among more "neutral" or less important statements, such as #10, #11, #23, but also among non-neutral statements such as #2 and #21. What is important to note is that although there is (dis-)agreement between the discourses, this (dis-)agreement is found on two different parts of the discourses. Although both groups disagree strongly with a statement, this disagreement is based on a different way of thinking about the subject matter. For instance, both the scientific and the livelihood discourse respondents strongly disagreed with statement #22 ("I need to be allowed to do what I need to do to make a living, although it means that some plant or animal species might go extinct."). Although there is consensus among the stakeholders that they disagree with this statement, the interview data show that three of the fishers had problems sorting this statement before it eventually ended up on strongly disagree. While one fisher said he would rather die hungry, the other fishers explained this as a difficult dilemma that is hard to answer.

> *"I would rather die poor than to exploit that for my benefit (point at the sea). I would feel bad when I die if I plundered to get a nice car. That's not what I'm about. Maybe that's why I'm so poor (laughs)."*
>
> Fisher, Kleinmond

> *"When you got to eat, you got to eat. Either you go extinct or it goes extinct. It's a difficult one."*
>
> Fisher, Pringle Bay

The respondents falling under the scientific discourse recognized that there is a difference between not wanting to cause something to go extinct in theory and actually being in that situation. There was general agreement that letting a species go extinct is very selfish and morally wrong, however, because the respondents in this group have never been in that position they emphasized that it was hard to relate to it. Here a natural scientist added: *"Me putting it in the 'I disagree with' is obviously indicative of my upbringing and social conditions in life and the fact that I haven't been put in the position where it's me or something else."* This phenomenon was also found in other consensus quotes, such as statement #2 ("Living with the sea is my way of existing."), a non-neutral statement both discourses agree with. The sea provides a livelihood for all the respondents, although somewhat indirectly for some interviewed stakeholders. Nevertheless, respondents generally expressed a strong relationship with the sea, predominantly on different grounds. While recreational and job-related activities were crucial to both systems of belief, the supporters from the scientific discourse talked about ecosystem services, while the fishers brought up their direct dependency on consuming and selling marine species to sustain their livelihoods.

What these examples indicate is the importance of how lived experience influences stakeholders' thoughts and ideas. People in the KBR experience and understand nature in different ways depending on how they live their lives. The concept of "biodiversity conservation" has different meanings to different stakeholders, and this meaning emerges in relation to practice. This research therefore supports the claim that our definition of "nature" is constructed by us giving it a certain meaning, as well as by discursive processes. Thus, what we understand as "natural" is also social and cultural (Escobar, 1999: p. 2).

DISCUSSION

The MPA As a Source of Dispute

All the stakeholders who participated in this study emphasized the importance of conserving both natural resources and livelihoods, as the two are closely linked. In this regard, the primary concern of the scientific discourse was the natural environment, while the social issues related to the BR were of greatest importance to the respondents falling under the livelihood discourse. In contrast to the CapeNature representatives and the natural scientists who considered it a necessary conservation means, fishers perceived the imposition of a protected area as taking away their responsibility to act as custodians of "their" marine resources. This finding is not surprising, as other studies that included documenting and analyzing perceptions of biodiversity conservation in South Africa have found similar attitudes recorded from community members living adjacent or near protected areas (Sunde and Isaacs, 2008; Watts and Faasen, 2009; Williams, 2013). Research undertaken by Faasen (2006) and Watts and Faasen (2009) in the Tsitsikamma, South Africa, for instance investigated whether synergies existed between biodiversity conservation and sustainable rural development, and documented local community members' perceptions of the no-take policy of the MPA in the area. This work highlighted that local communities harbor discontent and opposing views toward the conservation mandate of the management authorities and that there was a need to foster better involvement and participation of community members in decision-making processes. Similarly, Williams' (2013) study in the same area highlighted that the local communities historically had access to various fishing sites until the proclamation of the national park and subsequently the establishment of a "no-take" MPA. It was found that community members and fishers alike did not regard the current management and status quo as legitimate, and continuously referred to historical and traditional fishing practices as evidence of their rights to access the current MPA and its fisheries resources (Williams, 2013: p. 13). While opposing views of what exactly constitutes conservation and how this may result in discontent especially from neighboring communities toward MPAs, Sunde and Isaacs (2008: pp. xiii, 19–22) noted that a key area of concern relates to the fact that communities perceive themselves as bearing the costs of marine conservation with limited benefits in return. What exacerbates the conflict is that in some cases current practices of protected areas were not perceived as a legitimate conservation approach among communities, especially where locals were not involved in the conceptualization or implementation of these areas. These examples show that conflict and disputes between stakeholder groups are already found on the discursive level, as stakeholders possess dissimilar systems of belief. These trends are disturbing, as creating and sustaining MPAs is a key conservation strategy for the South African government, which has expressed its commitment to meet international and related national obligations toward protecting its biodiversity. One of these is to ensure that local communities participate in conservation efforts, which could come up against several challenges if these efforts threaten to undermine local livelihoods (Sunde and Isaacs, 2008: p. xiv).

Championing Conservation Cooperation

Conflicts and disputes over natural resources are present across the world and therefore not unique to the South African context. What is significant in the South African experience is that the conservation approach was influenced by historical and political trends of the time. This meant that the country's conservation approaches were largely influenced by discriminative events and practices, and resulted in differing discourses in relation to environmental protection. These differences saw a conservation paradigm that was based on being exclusionary, riddled with conflict, and alienating the majority of the country's people to the objectives of conservation areas (Carruthers, 1989: p. 215). However, with the advent of democracy in the early 1990's, there was a need to address the deep inequalities and misconceptions that were woven into everyday discourses and the legal fabric of environmental legislation and management. Perceptions about the environment and the protectionist approaches demanded urgent attention in the government's post-apartheid environmental planning (Wynberg, 2002: p. 234), and emphasis was placed on the need for meaningful engagement between stakeholders involved in conservation planning and management. South Africa has made significant progress in

developing policies to address environmental priorities and social development. Yet the debilitating legacies of apartheid, coupled with contemporary politics, environmental concerns and pressures to ensure and promote sustainable use and access to natural resources, still present various challenges for achieving conservation goals. One such challenge is ensuring effective implementation and enforcement of policy and legislation, as well as monitoring policy outcomes[14]. This is related to the continued top-down decision-making processes in natural resource management, marginalization of local communities, and the dominant scientific narrative in conservation management, which have been well documented in earlier studies in the regional context (Sunde and Isaacs, 2008: p. 5; Müller, 2010: p. 153; Sowman, 2011: p. 299; Williams, 2013: p. 13; Sowman et al., 2014: p. 31).

Many biodiversity-rich areas are subject to conservation strategies of some form and should include people as part of its biodiversity. In a developing country context, these people are typically among the economically poor who depend on natural resources to contribute to their livelihoods. While various conservation paradigms, such as the dominant discourse of sustainable development, recognize inclusive and participatory approaches, their implementation often fails. However, the ways in which people relate to nature, biodiversity, or species extinction varies greatly. Being rooted in different discourses, the ways in which environmental concepts are perceived depend on people's relational lived experience. Locals might not agree to the fundamental principles of conservation and, while being recognized as stakeholders, it has been difficult to integrate their system of belief into existing conservation approaches. Here, the importance of understanding these environmental discourses becomes apparent and highlights the need for more context-specific research of BRs and protected areas, including the social environment that is part of these systems.

A key issue that results in cooperation difficulties is related to discursive ideas of how biodiversity should be protected (Hyman, 2006: pp. 84–88). This was stressed by fishers who claimed that their interests and perceptions on marine biodiversity conservation, as well as their traditional way of life, were marginalized and not considered in conservation objectives. It is important to stress however that even if these conditions were met, this would not necessarily mean better cooperation between the stakeholders managing a protected area. What is key though is to acknowledge that communities and local stakeholders are part of the area that needs protection, and that their "buy-in" and inputs are necessary in order to collectively work toward meeting conservation objectives. Coupled to this ideal is that conservation practices should be viewed as socially just and should work toward "understanding how people perceive an issue [which] is essential to the whole process of 'problem identification,' both normatively and politically" (Barry and Proops, 1999:338).

The KBR is a case in which different discursive ideas of how biodiversity should be protected result in cooperation difficulties among stakeholders and limited outcomes (Hyman, 2006: pp. 84–88). On these grounds, the authors would like to stress the importance and encourage more context-specific socio-economic research regarding the establishment, implementation and maintenance of protected areas. Conservation efforts and projects will continue to fail if the belief systems, inputs and ways of life of local communities (and other relevant stakeholders) are not taken into account. In this regard, conservation should be a part of people's discourses, part of their livelihoods and not seen as a burden, exercise or an approach that instills fear or compromising on one's livelihood. While including people and incorporating their knowledge and way of life does not automatically mean that conservation will succeed, it is an important priority that cannot be overlooked and should be included when initiating and implementing conservation objectives.

Evaluation of Q Methodology

This study has demonstrated that Q methodology can provide a valuable tool for researching environmental subjectivities. Drawing on the strengths of both qualitative and quantitative research traditions, it offers a promising method for studying perception-based research and makes an important contribution to science as it is able to identify and analyze multiple discourses. The application of Q methodology in all its stages is an efficient, yet demanding task. Nevertheless, it provides a reliable and logical framework for studying perceptions with validated results. The statistical nature of the Q factor analysis provides outcomes and data interpretations that are less prone to researcher bias. By combining interpretative discourse analysis with Q in this study, it revealed that this combination worked well in verifying results and providing deeper meaning and insights to the data. The study undertaken here thus concurs with the findings of Wolsink (2004), who emphasized that Q is particularly suitable for research that combines it with other research methods (Wolsink, 2004: p. 2676), such as participant observation.

Limitations

One methodological limitation is related to the sample size; in this regard, a small P-sample size carries some limitations. Here, it implies a finite number of factors to reach the Eigenvalue level of 1.0. This is because the Eigenvalue $\leq$ 1.0 indicates that the unrotated factor explains less than the variance of one respondent, so with a small number of respondents this might happen sooner. Thus, it may be that a larger sample size, and particularly when recruited from other stakeholder groups, would have resulted in more discourses. Another methodological shortcoming is the double meaning as well as reasoning of some statements, which required careful qualitative analysis of the interview data and thereby put extra emphasis on the interpretative discourse analysis.

This study has studied a very heterogeneous group of people with major socio-economic diversities. This represented a challenge particularly when selecting statements, as the stakeholder groups tended to use language quite differently. One can therefore not reject the possibility that sensitivity to formulations has had an impact on the Q sorting procedure.

[14]South African National Biodiversity Institute website: http://www.sanbi.org/biodiversity-science/science-policyaction/biodiversity-policy Accessed 22.06.2016.

Particularly consensus statements following the Q factor analysis might be a result of the statements being poorly formulated. The possibility therefore exists that some of the consensus statements could have been sorted differently if it was formulated in another way. It should also be noted that although there were clear stakeholder groupings in this study, other members of these groups might not share the same ideas, as these groups were not homogenous. The fishers as example might perceive marine conservation differently than the overall local community. Although all the fishers in this study shared similar ideas, a Q study that only focused on the fishers might have shown a wider spectrum of perceptions within the fishing community.

Perceptions of marine biodiversity conservation are part of a larger environmental discourse, which is further related to people's wider ontological worldview and systems of knowledge. Additionally, it is not static and will change and develop over time. Therefore, this research can only provide a limited description of the prevailing discourses, at best highlighting the most prominent similarities and differences. The authors therefore note that the research is not directly transferable or intended to prescribe conservation management. The aim is rather to demonstrate that the use of Q methodology is relevant and can provide reliable analysis for scrutinizing perception-based research. Q methodology allows researchers to understand the perceptions and interests of people in their own terms and categories rather than making assumptions. Therefore, based on this study's outcomes, the authors would strongly encourage further application of Q methodology in other studies in order to increase the amount of research that aims to conceptualize and analyze context-specific environmental challenges.

CONCLUSION

Conserving biodiversity is an important endeavor and one of the greatest contemporary environmental challenges. The KBR is an exceptionally biodiversity-rich area, which should be conserved. In doing this, the need for stakeholder engagement and cooperation has been identified and established in the form of the KBRC and various working groups (Anchor Environmental, 2009: p. 4). Previous studies have shown that stakeholders in the KBR are facing management and cooperation difficulties by pointing at divergent interests and perceptions (Hyman, 2006: pp. 84–88; Müller, 2010: p. 152). This study has contributed to research on how different perceptions and understandings of conservation influence the conservation objectives and activities of a BR. In doing so, this study set out to investigate how marine biodiversity conservation is perceived in the KBR by examining different discursive realms, and how stakeholders adhere to these discourses. It targeted stakeholders of the KMWG, who is tasked with promoting and ensuring coastal conservation and development. This study has found varying ideas of what constitutes biodiversity conservation and how it should be implemented. It further highlighted some of the difficulties and challenges for cooperation in this particular case. The case study has presented two different ways of perceiving marine biodiversity conservation among stakeholders of the KBR, which is grounded in different discourses. While these two differing discourses have highlighted specific positions, there was a common concern shared for the current environmental situation in the reserve. This was revealed in the importance and shared belief that protecting nature is of significant importance and to everyone's benefit. Another important finding was that there was a shared belief by stakeholders who all agreed that local communities and their livelihoods should be a key consideration in all conservation approaches.

While researching perceptions is not an easy task, this study employed Q methodology to demonstrate how perception based research can be validated. This study provided insights into the discourses present at a particular time in the area. Taken the complexity of the issue and the shortcomings of doing this exploratory study, in many ways, this research begs a companion piece to describe the different discourses in closer detail. In conclusion, the authors would like to emphasize the importance of increasing the number of research projects that study environmental discourses, as it is crucial to understand the social context and implications for conservation initiatives. While there is a need to conserve biodiversity globally, it is important to bring people into the debate and how they think, talk about and see themselves in or as part of the natural environment. Understanding the ways in which people think about conservation in particular is key when considering that it is not only a scientific problem but also a societal problem.

AUTHOR CONTRIBUTIONS

KH conducted research as part of her masters course under the supervision of SW. For this publication KH and SW worked in co-operation to produce the manuscript submitted here.

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Putting *Lifeworlds* at Sea: Studying Meaning-Making in Marine Research

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An individual's "lifeworld" guides perceptions, the attachment of meaning and in sum, the interpretation of reality in everyday life. Yet the lifeworld (Ger. *Lebenswelt*) has been an undertheorized concept within interdisciplinary marine research. Through a two-stage analysis, we critically engage with the philosophical foundations, heuristic value and the methodological versatility that the interpretivist concept of the lifeworld stands to offer, drawing from contemporary marine scholarship. With two illustrative case studies exploring the lived realities of vastly different waterworlds in rural Uzbekistan and Sri Lanka, we further engage with the strengths and limitations of integrating a lifeworlds analysis into interdisciplinary work on localized perceptions. As a second step, we analyze the efficacy of adopting a phenomenological-lifeworlds approach in order to inductively explore diverse realities of coastal and sea-based peoples, while acknowledging the terrestrially-bound and anthropocentric genesis of the lifeworld as a concept. Therefore, in order to enliven hybrid thematic currents, conceptual debates and methodologies on "marine lifeworlds" on its own terms, we propose two thematic vantage points for interdisciplinary intervention by: (a) critically engaging with cognitive-material meanings and lived interpretations of "saltwater" realities; (b) tracing multiple modes of sociality and being with/in-the-world that go beyond human entanglements. In sum, we argue that while the lifeworlds concept affords spaces through which to study the complexities and ambivalences rife in surface-level perceptions, it promises the means with which to sidestep over-simplistic inferences to the vague and embattled notion of "culture," while widening horizons for reflective and experimental-experiential lines of inquiry.

Keywords: lifeworlds, meaning making, applied phenomenology, marine epistemologies, seascapes

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INTRODUCTION

> "Only the magic and the dream are true—all the rest's a lie."
> –Rhys (1999)

Jean Rhys' novel, set in nineteenth century plantation Jamaica, offers a postcolonial feminist re-telling of the tragic tale of "Bertha" Mason, Edward Rochester's mad wife, who remains locked away in an unforgiving turret of Charlotte Bronte's *Jane Eyre*. In the latter Victorian novel she is dragged out, fighting tooth and claw, more harpy-like than animal, more mythological than misplaced.

Yet in Rhys's (1999) *Wide Sargasso Sea*, Bertha—or Antoinette Mason—a fiercely intelligent and imaginative young Creole woman is presented in a very different lifeworld that is her own, on an island far removed from the cultivated frostiness of English country life among the landed gentry.

It is this lifeworld that the stranger—Rochester—whom she weds, comes to fear and ultimately loathe, with its tropical "mountains and hills, rivers and the rains... its sunsets of whatever color... its beauty and its magic... its indifference and cruelty." The growing revulsion that he harbors toward his new wife lies inimically coupled to this antithetical world that he covertly delights in othering—replete with disease and rumor, obeah ritual and languid decadence. To Rochester, Granbois seems unreal and hallucinatory, while England appears surreal and dream-like to many of the young Anglophone women of the West Indies, yearning for "return" to an island they had never set foot upon. It is this slippage between embodied presence and absence, of wakefulness and the dream-like, in which the two lifeworlds in the *Wide Sargasso Sea* are so intimately interwoven.

Yet, what is in a *lifeworld* and why should it matter in community-based research? Within ongoing debates on inter and transdisciplinary approaches in addressing "real life" problems, the inclusion of local lifeworlds in order to guide researcher reflexivity, in determining research processes and the interpretation of findings have repeatedly been stressed (Pohl and Hadorn, 2007). While the notion of "lifeworlds" (Ger. *Lebenswelt*) is often used metaphorically in order to place emphasis on the salience of local perceptions and worldviews, its conceptual and empirical uses and limitations remain under-researched across the coastal and marine social sciences.

Since its formative stages of conceptual development the "lifeworld" has remained a relatively nebulous and opaque concept when perceived from outside the disciplinary frames of interpretive sociology and psychology. Furthermore, it is often perceived as being methodologically elusive and complex for practical application in empirical field-based contexts. While much ethnographic analyses bearing the term lifeworlds exist, they arguably pay scant lip-service in concretely conceptualizing what precisely is meant by the term. Furthermore, the concept offers little recourse to social scientists that remain wary (and weary) of wielding the hollow notion of "culture" as an explanatory force, given its dangerous ambiguity and inclination toward essentialist theorizing.

Rather than attempting to tame and pin down a linear, all-encompassing definition of lifeworlds, this paper serves as an open invitation to socio-environmental scholars and policy analysts who are increasingly turning toward perceptions-based, interpretative and social constructivist thinking in order to invigorate community-based research.

The second section provides a kaleidoscopic glimpse into the various threads of lifeworld theorizing, drawing attention to the often slippery axes between the following dualisms—(a) the individual and the collective, (b) the experiential and the ideational, (c) of appearance (exteriorized) and essence (interiorized) and (d) the subjective (first person) and the objective (third person). The third part of the paper proceeds to reflect on the flexible application of the lifeworld concept through the use of two empirical studies of fluid waterworlds (see Anderson and Peters, 2014), one implicating freshwater and the other saltwater.

Following on from an empirically grounded discussion, the fourth section offers critical insights into whether the study of "marine lifeworlds" holds much conceptual purchase and empirical relevance at all, given the vast corpus of maritime and coastal-related social science research that has embraced an interpretive perspective, though not necessarily a phenomenological one. While briefly attending to some of the reasons for the apparent absence of marine lifeworlds-inspired research as opposed to more coastal-related foci, we provide critical points of departure and thematic interventions through which the study of marine epistemologies and ontologies (i.e., ways of knowing and being) may enliven existing interpretivist research endeavors.

UNBRAIDING THE *LIFEWORLD*: THE ANATOMY OF A CONCEPT

The understanding and study of social reality has been a core preoccupation across diverse sub-disciplines including social philosophy, existential anthropology, interpretivist sociology, and cognitive psychology. Since the early 1900s, the notion of the "lifeworld" has often appeared in the social sciences and the humanities, as an integrative concept with which to describe the particularities of an individual's lived experience in everyday life. However, before engaging with this comparatively hydra-headed term, the very philosophical and epistemological foundations of the lifeworld approach warrants further exploration.

Contemporary approaches to lifeworlds thinking, emerged as the progeny of two vastly influential theoretical traditions in the late nineteenth and early twentieth century, particularly across the Austro-German and French philosophical milieu. At its broadest, *phenomenology*—as a philosophical tradition and movement—can be traced back to the Austrian School founded by Franz Brentano that built upon classical Hegelian notions of the experience of being in the world. Broadly framed, early phenomenological philosophers like Husserl (1970), Heidegger (1977), Mannheim (1929), Merleau-Ponty (1981), and Lyotard (1991) were concerned themselves with the structures of experience in everyday understanding, and in the interplay of common sense and how particular forms of "knowing" and "being" arise from experience (Roth, 2004; Bengtsson, 2013). These currents vastly influenced the work of humanist thinkers and writers like Jean-Paul Sartre, Albert Camus, and Simone de Beauvoir, as they engaged with broader interrogations of being and not-being, social alienation, otherness, and nihilism.

Phenomenology is primarily concerned with the experience of "being there" (Ger. *Dasein*)—in all our humanness—that far transcend the surface meanings of ordinary perception and experience. Modes of existence were understood as being patterned by and grounded in very situated spatio-temporal,

socio-relational and symbolic spheres of everyday life. In the contemporary context, phenomenological approaches still remain influential within fields such as area studies, urban and medical anthropology, peace and conflict studies, natural resource governance, educational psychology, social work, nursing practice, management research, and disability studies, incorporating diverse methods spanning the qualitative-interpretive, quantitative and the poetic-reflective (see Nieuwenhuys, 1994; Ehrich, 2005; Jackson, 2005, 2012; Johansson et al., 2008; Oberkircher and Hornidge, 2011; Finlay, 2013; Siriwardane, 2015). Phenomenology can be therefore seen as a distinct epistemological philosophy—a style of thinking. Scholar-practitioners, particularly within the field of critical pedagogical research, often drew attention to its ontological, existential currents, treating it as a "way of being" or as a philosophy of life in itself (Hultgren, 1995, p. 379). This position bears far-reaching implications on how research practice and writing could be ethically and reflectively re-learned, an aspect that we will be exploring in greater depth.

The second strand of lifeworlds thinking originated from the hermeneutic tradition, latterly branching into the sub-field of *phenomenological hermeneutics*. Hermeneutics can be broadly defined as the theory of interpretation (Dahlberg et al., 2008, p. 66), implicating scholars such as Gadamer (1975) and Ricoeur (1974), who were particularly engaged in exploring the gaps inherent between perception, language, embodied expression and action, together with the wider processes of storying human experience. Later work like that of Johansson and Emilson (2010) and Bengtsson (2013) grew out of the Gothenburg tradition with a focus interaction-based meaning-making, for example in the context of educational research on preschool children and their non-linguistic (yet highly expressive) routines of inter-subjective play-based worlds.

While it is evident that there is no singular way of defining and doing phenomenological lifeworlds research, it must be borne in mind that phenomenology, and consequentially early theorizations of the lifeworld, did not explicitly engage with matters of empirical research. Indeed, early phenomenological thinking stood as a distinctly philosophical (and ethical) project. For thinkers like Edmund Husserl (1970), who first introduced the term "lifeworld" in a treatise written between the wartime years of 1916 and 1917, the notion arguably stood out as a dynamic counter-concept to the privileged role of scientific rationality and the crisis of the modern technological world. Phenomenology reflected the disenchantment of contemporary thinkers with the ideals of natural science and technology as "models for philosophical engagement" (Madsen, 2002, p. 10). The lifeworld then stood, not as a radical juxtaposition or dialectical Other, but as a world of commonly shared experience, encompassing worlds of belief (*doxa*), of preconceived notions of prejudice and illusion for example. In this light, the world of scientific rationality and knowledge production was but one lifeworld among others.

While we have thus far explored the ontological and epistemological foundations of the lifeworld approach, how then can this multi-stranded approach be accessed with some degree of conceptual clarity? Husserl never quite as cogently *defined* what was meant as a lifeworld. Moreover, his work left to be asked why "worlding" metaphors mattered when exploring perceptions, attitudes and meaning-making processes. In other words, would not a singular focus on self-expressed perceptions, not seem as sufficient as empirical facts?

These questions take us back to the German philosopher Heidegger (1977), who was arguably the first to integrate phenomenology with classical hermeneutics, borrowed from neo-Kantian, Kierkergaadian, and Weberian theoretical currents (Bengtsson, 2013). From a Heideggerian vantage point, perceptions were mere surface articulations. They were often conscious and could be rationalized logically, yet their salience, preconditioning and the more subtle tacit forms of knowing, thinking and feeling that still remained relatively less apparent. Perceptions then, at its simplest, were akin the proverbial tip of the iceberg. Often, the distance between perceptions and actions, believing and doing, could not simply be explained by chipping away at subjective attitudes or collectively recognized norms and mores.

The lifeworld to Heidegger was about "being-in-the-world" (Ger. *in der Welt sein*). What this concretely translates to is the conceptualization of phenomena and experience that are lived and inter-subjectively experienced, yet could still remain tacit. It differed from Husserl's critique on the "natural attitude" (Ger. *natürliche Einstellung*) of phenomena as materially known and felt (Dahlberg et al., 2008, p. 33). Therefore, multiple lifeworlds—as differently conceived and lived—could exist in a single material realm, for example a coastal stretch inhabited by seaweed farmers, dive operators, aquaculturalists, hoteliers and naval entities.

However, Heidegger's conceptualization of the lifeworld concept sat within this wider philosophical project, and was a long distance away from being empirically translatable for research practice. For the French philosopher Merleau-Ponty (1981), the lifeworld approach adopted a more differentiated hue, which he conceptualized as "being-*to*-the-world" (Fr. *entre au monde*), in which the human body (and its embodied practices of everyday life) comprised the primary site of knowing, feeling and being. In his view, the "Eye" and the "Mind" (implying the Cartesian mind-body dualism) were not disconnected but mutually reinforcing, in which the world came to be interpreted and known through how it was materially, relationally and symbolically *felt*. In this light, it remains telling why interpretive scholarship within the fields of medical and educational psychology and disability studies for example, tend to be influenced by Merleau-Ponty's foundational work on embodiment. Moreover, there exists a recent and steadily growing body of marine/maritime scholarship that attends to the affective and multisensory meanings and subjectivities produced by dwelling with the sea—whether in terms of "finding one's sea legs" as an embodied experience of enskilment related to fishing and sea navigation (Pálsson, 2000), or through (masculinist) sensibilities of getting high on a "stoke" when surfing a wave (Evers, 2004).

Ultimately however, it was the Austrian sociologist, Schütz (1932, 1960) who consciously attempted to extricate lifeworlds thinking as a purely theory-based endeavor, into a practical concept for empirical analysis. Schütz, like Merleau-Ponty, was influenced by early Husserlian currents, but his primary focus rested on locating patterned structures through which lifeworlds could be understood. For him, the very act of conceptualizing (and contextualizing) lifeworlds—both literally and metaphorically—as "worlds" (i.e., domains or realms of experience, knowing, doing and feeling), was paramount to the exercise of grounding the concept. As he posited, "in using the term 'world'...we mean only that different people are consociates, contemporaries, predecessors or successors to one another and that they accordingly experience one another and act upon one another in the different ways in question" (Schütz, 1960, p. 143).

For Schütz, the lifeworld was bound through temporal and spatial dimensions comprising four interlocking socio-material worlds. The individual's immediate environment, the social world of contemporaries (*Mitwelt)*, interlocks with the precedent world of predecessors (*Vorwelt*) and successors (*Folgewelt*). While the immediate environment (*Umwelt*) appears to be shaped by direct, close relationships to family members and friends, the surrounding world (*Mitwelt)* is characterized by the interaction with those actors and social structures potentially subject to the individual's personal experience. This experience stands in relation to the individual through *typification*—the process of conceptually identifying, differentiating, naming, sorting, and assigning symbolic meaning to perceived material and relational phenomena, that begins in infancy. As the *Vorwelt* is shaped by relationships to ancestors and interpretations of the past, the *Folgewelt* is shaped by relations and actions directed to/at the future (Schütz, 1932, p. 160). Together, these four worlds of the individual constitute the reality of everyday life, or the Schützian interpretation of the "lifeworld."

It was for the American-Austrian-German sociologists Berger and Luckmann (1967), that the differentiation between objective and subjective lifeworlds appeared paramount in adding more nuance to the interpretive study of reality. The subjective lifeworld, formed via typifications, constitutes the researchers' own lifeworld including those that are encountered during the research process. On the other hand, the objective lifeworld however appears as the naturalized milieu, setting spatial and temporal boundaries that are concretely lived, and may not be apparent within collective consciousness. These boundaries however are not simply limiting; they are generative in the sense that the spatial-temporal scope of an individual's lifeworld directly depends on the zone of operation" (*Wirkzone*) characterized by the geographic, social, as well as the mental mobility of a person. Therefore, diverse practices of small-scale as well as industrial fishing are not merely treated as a livelihood, but as a way of being-with-the-world and as "a way of life" (Weeratunge, 2009).

Yet, at this point it is must be noted that a Schützian reading of lifeworlds can be critiqued for its focus on the individual as a primary subject of analysis. Thus, collective lifeworlds, were somewhat simplistically interpreted as the additive stratification of individual experience, making for the interpretation of "shared reality" as merely the sum of its constituent parts. Indeed, the work of Berger and Luckmann (1967) proved influential in sociological institutionalist theory building, given its heuristic methodology in studying normative change, and the interplay of collective roles, norms, discourses and practices (see March and Olsen, 2005). Yet arguably, the analytical tools offered in tracing trajectories of institutional change remain relatively less defined.

Meanwhile, two other influential German lifeworld theorists that warrant brief discussion: the Frankfurt School critical theorist Habermas (1955, 1984), and the phenomenological hermeneutic philosopher Gadamer (1975). In combining Chicago School pragmatism and early currents of structural-functionalist thinking, Habermas' view of the lifeworld stood in stark contradiction to what he defined as the "systems world" constituting the exteriorized rationalization of everyday action, as evident in modern bureaucracy for example. It was then the focus on the interaction between the two realms—in which the systems-world often "colonized" an individual's lifeworld, through tacit influences such as media practices that steer collective thinking and action. One of the more compelling tropes through which this tension is illustrated can be found within the substantial raft of fisheries-related governance literatures and environmental management practices that explores interactive encounters between bureaucratic, scientific and locally-situated knowledges, particularly within diverse co-management structures and other communicative contexts, whether more participatory or top-down (see Wilson and Jacobsen, 2013). The work of Gadamer (1975) on the other hand, took Husserl's conceptualizations further by integrating the notion of *Vorurteile* (preconceptions). His work contributed to reflexive praxis-oriented research that set the foundations for a practiced attitude of exposing and confronting pre-judgements, particularly through intersubjective encounters. Thus, a Gadamerian reading potentially offers conceptual insights into questions of individual agency and resistance, regulatory and informal norm-based compliance, constituting interwoven thematic currents that are gaining increased traction within interdisciplinary fisheries research.

In order to chart their diverse epistemological currents, **Figure 1** depicts how the concept of the lifeworld evolved.

Having explored the salience of understanding researcher lifeworlds, how does one set about reflecting upon, documenting and storying the lifeworlds of *others?* As the following section illustrates illustrates, since the concept entered the realm of social science discourse, much has been done in the way of creatively translating and operationalizing lifeworld approaches into research processes, while simultaneously guiding researcher ethics and reflexivity. Moreover, it critically examines the conceptual and empirical advantages and limitations of applying a lifeworlds approach to contemporary research on two different types of lived "waterworlds"—one in an arid, landlocked freshwater site in Central Asia, and the other constituting a saltwater milieu in a South Asian coastal setting.

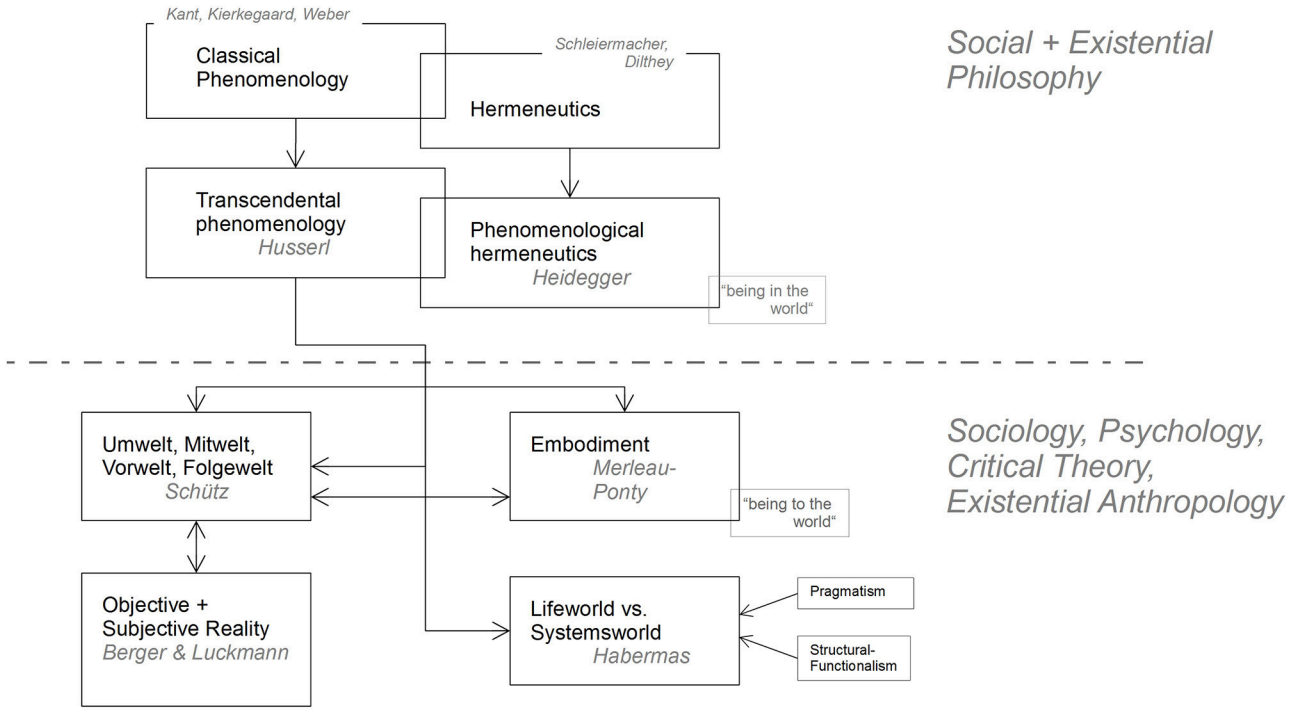

FIGURE 1 | The Building blocks of the Lifeworlds concept. The chart aims at establishing clarity, yet does not make the claim of being exhaustive or non-expansive. Nor does it claim to holistically represent the diverse ontological and epistemological currents that influenced the foundational theorists presented.

OPERATIONALIZING LIFEWORLDS IN EMPIRICAL RESEARCH

The paradox of attending to and understanding the substance of individual lifeworlds, particularly if it is interpreted as constituting the implicitly lived or presupposed realm of everyday life, has been a central topic of debate within anthropological and sociological research. First how can the tacit and unexpressed (or inexpressible), emerge to the surface of consciousness? Second, how can a researcher—particularly one who is relatively distanced from the lifeworld of those she partners—explore at times unexpressed meanings? Thus, the attempt at bridging this epistemic distance, between the interiorized (implicit) and the exterior (the manifest), tends to emerge as a leap of faith.

Furthermore, what questions of power and authorial voice materialize when claims are made about conclusively studying and writing about individual and collective lifeworlds? On one hand, lifeword theorizations have almost exclusively been individual-centered. On the other, the ability to write about lifeworlds, may run the risk of potentially strengthening truth-claims through textual preeminence. This double-bind, between the persuasive currency of being able to extract knowledge on lifeworlds, and the (em)powered researcher to grasp the otherwise implicit and tacitly known may potentially result in a dangerous cocktail of epistemic privilege and representational objectivity. Researcher positionality and reflexivity have therefore remained a central concern, particularly within the scope of field-based qualitative research. Ethnographers in particular have been doubly conscious of the early colonial origins of their enterprise, and continue to contribute to lively debates on the ability of fully grasping meanings and implications by one's socio-political positioning during fieldwork (see Lynch, 2000).

In contemporary phenomenological lifeworld research, this is often achieved through a three-step iterative process in which experience is bracketed, otherwise known as "bridling." The first stage entails a systematic effort to suspend judgment, by stepping outside preconceived notions of how things are expected to seem and to work. The second stage requires the conscious effort of dwelling with and within the phenomena in question. Put differently, a researcher's attention may be re-focused to her content of what is experienced, and what makes experience possible in the first place. The process of cultivating generative openness to the first and second stage interpretations of meaning comes to bear, allowing one to consciously compare alternative templates and mental maps of how the same phenomena has been interpreted in the past. Taken together, these steps prevent a field-based researcher from acting upon pre-existing assumptions and interpreting lived realities too hastily. Moreover, it lays bare the fact that as researchers, "we can be self-reflective without being self-aware" Dahlberg et al. (2008, p. 165). This quotation takes into account the significance of experience that influences further actions, and the consequences that come about by reflecting *with*, rather than on others.

Johansson et al. (2008, p. 2) see this as a concrete form of bridling, which does not make the pretense of abandoning all pre-assumptions, but instead embraces the possibility of "slowing down the process of understanding in order to see the phenomena in a new way," often integrating multisensory subjectivities and relationalities. For example Peters (2010) in problematizing scholarly representations of the sea as a mere metaphorical image of life on shore, draws attention to the very linear act of objectifying the sea through dynamics of voyaging, trade, empire-building and territorialization. Therefore, in (re)centering fluidities beyond spatially bounded terms, Anderson and Peters (2014, p. 5) calls for the imperative need to enliven scholarly engagements with diverse marine epistemologies that see (water)worlds as being in "flux, changeable, processual and in a constant state of becoming."

As varied as the conceptual interpretations of watery lifewords has been, so have been the methodologies with which to research them. Oberkircher and Hornidge (2011) operationalized the phenomenological concept in the form of "water lifeworlds" through a contemporary Schützian interpretation by paying closer attention to how objective and subjective realities were coupled in Khorezm, Uzbekistan. Their methodological substance therefore entailed social facts and processes they themselves observed (e.g., everyday actions and decision-making trajectories) combined with the discursive-symbolic world of narrative reflections, mental maps and new or emergent concepts. Once again, the epistemological frame was driven by the particular problem-based research puzzle in question. They examined why perceivable forms of water saving were hardly present in an arid terrain such as Khorezm, and across a socio-cultural milieu that seemingly articulated counter-rationalities on the sacredness of water and its centrality in establishing social status.

By attempting to understand nuances inherent in the in-betweenness of these divergent rationalities, the temporal and spatial boundedness of the "objectively" perceived lifeworld was first explored. This entailed how farmers constructed their picture of time and space alongside diverse water users and managers. Furthermore, these lifeworlds comprised meanings about vegetation seasons, flows of freshwater, and how times of scarcity and abundance were cognitively labeled. As a second framing, typologies, values, and institutions (as rules, norms, and rationalities) were explored. In particular, they focused on how individuals compared, categorized and classified their diverse Khorezmian waterworlds. The authors did this by identifying several layers of typologies: (a) types of water (for example locally embedded meanings around hard water, muddy water, and freshwater, literally translated as being delicious); (b) types and roles of people (for example diverse groups of "upper people" in the social hierarchy), "water persons" linked to the ancient institution of *mirabs* in Central Asia, *fermers* or large farm operators etc. and (c) types of land.

These boundaried pictures and typologies were compared with intersecting values and institutions—as discursively articulated, for example, through diverse state-led management principles, commonsensical logics and socio-religious rationalities on water provision and use. What the study drew attention to was why the rationality of water saving stood out as a "missing concept" in these diverse water lifeworlds, despite the ubiquitous Uzbek expression—*suv hayot*—or water is life (p. 406). By squarely drawing out and comparing rationales that prevent water saving as opposed to those that valorized the need to do so, the authors drew attention to the seemingly "messy" oscillation of lifeworld dynamics as they unfolded amid the complexities of everyday life. As we proceed to illustrate, this contemporary Schützian use of lifeworlds phenomenology, as a means to study problem-centered empirical questions, offers a number of conceptual and methodological advantages, as well as potential limitations and pitfalls.

On the other hand, Siriwardane's (2015) island ethnography on fisher lifeworlds in postwar Sri Lanka, with a distinct focus on the interactions between geographically and ethno-religiously diverse groups of migrants, settlers, and locals offers a different starting point. In asking why particular fisher collectives were othered as veritable "outsiders" or strangers, the study drew inspiration from existential anthropological readings on lifeworlds (see Jackson, 2005, 2012; Das, 2006). In this context, the "everyday" was taken as a realm that was not simply normed, routinized and rendered ordinary, but also as a site of active production, particularly in the way that power asymmetries come to be produced and contested. Moreover, in forewarning against the tendency of treating the concept the lifeworld as a "blanket term to encompass and 'explain away' every (ambiguous) facet of lived life" (Siriwardane, 2015, p. 96), the lifeworld concept was reshaped to suit everyday translocal and livelihood-based experiences and sensibilities.

At first glance, local hostilities directed at bilingual fisher migrants who shared long biographical histories of seasonal mobility seemed intuitive. They often encamped near local settlements that practiced similar forms of craft-based fishing. Their apparent bilingualism also actively worked in the disfavor of other migrant groups, given the fact that many continued to mask outward expressions of hybrid ethno-linguistic belonging, particularly when interacting with locally embedded military institutions. Yet, upon further exploration, it could be argued that the very rationalities around belonging, place-based identities, (historic) social presence, and "home" did not always cohere. The normative underpinnings through which communal insiders and outsiders were differently framed lay in a host of interpretations entailing crisscrossing: (a) pioneer narratives (i.e., "Who fished here first," "Who cleared this land?"), (b) discourses on ancestral belonging and homeland (e.g., the primacy of having lived in the east coast, despite having been serially displaced over wartime), (c) biographical livelihood identities bound through "blood" and inter-generational enskilment, and (d) navigational imaginaries and historic legitimacies of mobility, through west-east coast sojourning. The institutionalized backdrop against which postwar militarized insider-outsider frames were being established was hardly ever articulated when exploring inter-group amity or hostility. For example, the *vorwelt* (pre-world) of bilingual fisher migration trajectories during wartime established encampments that were perceived by local residents as sites of exemption and rule breaking. This further exacerbated localized antagonistic perceptions, even between diverse migrant groups.

In comparing different lifeworld conceptualizations between both Oberkircher and Hornidge (2011) and Siriwardane (2015), it can be ascertained that such phenomenological approaches enable researchers, often not trained in field-based qualitative ethnographic work, to explore local terms through meanings (as lived) that go far beyond their semantic definitions and terminology. For example, if the pervasively uttered phase *suv hayot* was taken literally, as a blanket cultural expression defining Uzbek life—the paradoxes around practices that otherwise imply that water is unproductively allocated and used across the Uzbek hydraulic bureaucracy, would have remained relatively underexplored. In a similar vein, homogenizing all migrant fishers as strangers and outsiders would have led to the problematic glossing over multiple modes of sociality and ways of relating-to/with-the world (vernacularly theorized as *sambandam*) along liminal coastlines. Thus, the close attention paid to what seemed at face value as contradicting realities, enabled both studies to elude the trap of over-simplified and essentialist readings of localized "culture."

Furthermore, turning to the lifeworld as an empirically applied methodology enables researchers to interrogate their own lifeworlds and potentially, check biased western-centered rationales and framings of aspects such as time, space, notions of reciprocity, and systems of socio-economic exchange. While this opens up collaborative spaces for co-production and interpretation of data between researchers and those they partner, and for self-reflecting on epistemic power and privilege, the lifeworlds approach also enables us to acknowledge and capture nuance and ambivalence. The distance between "representation and practice" (Busby, 2000, p. 34), and what is discursively articulated and what is ultimately enacted, often appears as a central trope in localized fisheries research for example, taking contexts in which institutional norms are both sanctified as well as broken under specific circumstances (Siriwardane, 2015, p. 147). The lifeworlds approach therefore calls for a cultivated sense of epistemological un-knowing, embodied in the German phenomenological notion of *Gelassenheit* (of letting be or to dwell, Dahlberg et al., 2008, p. 81 and 100).

The concept may also act as an epistemological starting point that can be used across diverse socio-cultural and regional contexts. While the concept may provide a heuristic vantage point through which a non-Eurocentric de-centered study could be envisaged, its claim toward epistemological universality may also act to its disadvantage. For example, phenomenology remains a deeply humanistic endeavor. Therefore, the lifeworld as a concept is inevitably an Anthropos-centric one, which encompasses more than just human interactions and engagements. While social meanings around inter-species relations (for example values toward non-human sentience for example), may visibly appear within lifeworlds writing, the means through which socio-nature can be seen as a subject possessing agency (and not passively objectivized as foreground that is acted upon) still remains fertile ground for further theoretical work (see Kohn, 2013; Viveiros de Castro, 2016).

Meanwhile, a commonly articulated limitation of the lifeworlds approach can be found in its methodological individualism. The stratification of individual experience is seen as constituting collective or communal lifeworlds, a reading that has often been critiqued for its simplicity and inability to account for normative transformations. The old quandary of seeing and describing the world through the eyes of others remains a paradoxical task. Typologies and typifications therefore serve to essentialize and legitimate particular interpretations of reality, often in ways that may be complicit to existing power inequalities and forms of social injustice, for example politically legitimated ethno-racial, gendered and class-based classifications.

Both Oberkircher and Hornidge (2011) and Siriwardane (2015) point toward the limitations inherent in typologizing "categories" of people as if social identities were container-like constructs, even if these labels were to an extent self-assigned. At the same time, their work allude to the difficulty in formulating alternative framings, which may well be far removed from daily discourse and practice. Therefore, by no means does this critical discussion stand to offer pat solutions to long-standing and debated questions on the preeminence of focusing on individuals as a unit of analysis, or on the other hand, on groups and collective framings. Moreover, the age-old philosophical agency-structure debate that our discussion forecloses further problematizes the dialectical relationship between individual capacities and freedom of choice, against the inherent constraints set by institutional rules and wider societal norms.

As the following section proceeds to illustrate, the use of phenomenological lifeworlds has remained a marginal current, particularly across interdisciplinary coastal- and marine-related social science scholarship. However, as we proceed to argue, "marine lifeworlds"-inspired research (although not explicitly having drawn on phenomenological currents) have historically constituted a vast corpus of work, particularly in the fields of maritime and marine anthropology, together with coastal and cultural geography. While fisheries-related accounts of diverse "peoples of the sea" have often depicted an anthropos-centric bias, we further explore what inclusionary forms of more-than-human lifeworld research could be further pursued in ways that more expansively engage with the newly emergent sub-fields of multi- and interspecies ethnography. It is a conversation that draws interdisiciplinary marine researchers, particularly from the natural sciences, into a lateral dialogue with the social sciences and the environmental humanities on the practice of hybrid phenomenologies of the sea in order to push for more non-representional, de-centered and non-western centric explorations of oceanic relationalities and connections that prefigure a broader politics of life.

COASTAL OR MARINE LIFEWORLDS? DE-TERRESTRIALIZING AND UN-HUMANIZING A CONCEPT

The very notion of lifeworlds remains to be taken as an open-ended concept that is malleable enough to be creatively reworked and applied across multiple socio-environmental contexts. Yet phenomenologically-inspired lifeworlds research has traditionally privileged the study of terrestrially-bound themes. It can be argued that the problem lies with the humanistic

social sciences that have been less forthcoming in putting lifeworlds out at sea.

When the role of the sea in imperial and colonial expansion came to be understood beginning in the fifteenth century, the ocean was still overwhelmingly and paradoxically perceived in Enlightenment scholarship as "a quintessential wilderness" (Mack, 2011, p. 17), an atemporal place and as cultural *tabula rasa*. As Emile Cocco writes (Cocco, 2013, p. 6), "the sociological ignorance of the sea is quite striking against the major role played by the maritime environment in literature, religion or philosophical thought" despite critical interventions made by philosophers such as G.W.F. Hegel who "celebrated the sea for its uttermost importance in the development of state, economy and European identity."

Over at least the last three decades, coastal and historic geography, maritime anthropology, sociology and cartography have made significant conceptual and epistemological inroads to grounding and understanding the diversity of marine spaces and "peoples of the sea," distinguished by everyday processes of sense-making and daily practices of cohabiting fluid waterworlds (see Acheson, 1981; Astuti, 1995; Steinberg, 2001; Cordell, 2007; van Ginkel, 2007; Peters, 2010). Seas and coastlines were therefore more than mere resource bases and sites of socio-economic extraction, value and exchange. Seascapes have been perceived as spaces of enskillment and ancestral belonging, as dreamscapes of danger and presence, and as sites of desire and dwelling, while practices such as voyaging and coasting have historically been interpreted in relational terms, that connected expansive networks of social groups and distant spaces (see Firth, 1946; McWilliam, 2003; D'Arcy, 2006, 2013; McCormack, 2007; Hau'ofa, 2008; Cohen, 2010; Lehman, 2013).

Mack (2011) argues that the majority of community-based research has been undertaken on coastal spaces, overwhelmingly focused on land-dwelling (and often gendered) social groups such as fisherfolk, traders, seamen, dockworkers, coastguards and surfers, for example (see Nieuwenhuys, 1994; Laderman, 2014). Yet a smaller corpus of research engages with liminal spaces, mariners and ship-based societies, from cruise liners to piracy networks and floating armories (see Rediker, 2004; Langewiesche, 2005; Gharibyan-Kefalloniti and Sims, 2012). Meanwhile the study of marine scientific research expeditions and commercial seabed mining ventures mark an exciting new turn in the study of floating societies and of underwater verticalities (see Helmreich, 2009; Steinberg and Peters, 2015).

Recent strands of interpretative marine research, particularly across the fields of cultural geography, anthropology and sociology have predominantly been concerned with two key, interlocking questions. The first concerns interrogations of how traditionally earth-bound, "land-locked" disciplines such as human geography and sociology, together with their very "grounded" methodologies (evidenced in terms such as *field*work) could be put out to sea. As an increasing number of cultural geographers argue, the mere thematic expansion on marine topics and the study of the sea as a "different" space barely answers this rallying call; indeed, conscious efforts to start thinking "from the water" is required in order to "chart new representations, understandings and experiences of the sea, plotting water worlds that are more than a "perfect and absolute blank" (Anderson and Peters, 2014, p. 4). Yet in actuality, the disciplinary boundaries through which these conceptual and epistemological modes of understanding (and practice) unfold remain relatively less permeable, especially when marine-centered and land-based social and natural scientists continue to talk *away* from one another.

In part, these disciplinary gaps foreground the pressing need to "de-terrestrialize the Academy" (Hornidge, 2015). It draws attention to the urgency to foster deeper and more explorative efforts of putting into dialogue (as opposed to uncritically comparing) the diverse worlds of hinterland, coastal and marine-based societies, and their social-natural assemblages. Moreover, it seeks to question the very conceptual and methodological assumptions that have arguably favored terrestrially derived interpretations of reality. For example, as Mack (2011, p. 23) argues, much theory-work and empirical refocusing is needed in order to bring the study of seascapes to the same level of conceptual and methodological sophistication as the study of landscape geography or anthropology.

The second overarching conundrum rests on how expanding the many ways in which de-centered non-human-centric vantage points in studying seas, oceans and their manifold connectivities could be better explored. It comes as little surprise that the overwhelmingly humanistic hue of lifeworld theorizing in the past—best illustrated through what Kirksey and Helmreich (2010, p. 546) refer to as the paradox of human exceptionalism—that placed the (thinking-being) Anthropos at the center of its empirical inquiry. Inevitably the lifeworld then constituted a humanized gaze of the world, as evidenced in the case of anthropomorphized writings for example. Arguably the mere presence of the so-called "non-human" both lively and inanimate, in an epistemological sense, unwittingly came to be patterned around the figure of the human, and its broader material and symbolic implications for socio-political and economic life—invariably recast as food stock, tradable commodities, and land/seascape backdrops among others.

How then have more recent endeavors into delineating marine epistemologies taken shape? Moreover, what can be said of their inherent limitations, while reimagining more inclusive and hybrid templates implicating non-linear phenomenologies of the sea? Two distinct and inter-related thematic strands within inductive social science research stand to be taken as critical points of departure through which a lifeworlds approach could be potentially enlivened. The first entails a significant body of largely coastal ethnographic and historic research undertaken through the interpretive lens of "saltwater" realms, meanings and interactions (see Sharp, 2002; McNiven, 2004; Schneider, 2012). The second constitutes the lively and dynamically growing field of critical ocean geography that attempts to rupture, stimulate and experiment with novel ways of thinking and writing *through/with* (as opposed to on) "wet ontologies" (Steinberg and Peters, 2015), while weaving in both interspecies being and becomings, together with the material flows, processes and social lives of inanimate objects and previously understudied forms of lived dimensionality such as volume and marine verticality (see

Anderson, 2012; Sammler and House-Peters, 2013; Muttenzer, 2015).

We first turn to phenomenologically-inspired work on saltwater realities and processes of sense-making. In the history of science, saltwater has been both a powerful substance as well as a metaphor to think with/through. As Helmreich (2011, p. 133) reminds us, the very blueness of seawater became a "matter of cultural construal, rather than of sheer empiricity" when invoking the famous proclamation made by the German anthropologist Franz Boaz.

In the contemporary context, marine realities referenced through saltwater networks and figurations—including people, places, the "non-human" (i.e., fish, waves, technologies) and their forms of interaction and movement, are seen through collectives such as the Australian indigenous Saltwater People Network (NAILSMA), and the Canadian grassroots fisher organization the Saltwater Network. Moreover, in scholarly writing, the inference to "saltwater people" (Sharp, 2002; McNiven, 2004) came to be synonymous with indigenity and aboriginal forms of socio-spatial mobility, knowing, and interacting across localized seas that were at the same time spiritscapes, imbued with maritime rituals and complex historiographies of their own.

Of late, varied sub-fields under the rubric of "salty geographies" have been gaining greater appeal among interpretative scholars particularly across Anglo-American and postcolonial contexts. In attending to translocal voices calling for the "historicization of the ocean"—not only does it aim to reflexively de-terrestrialise academic lenses through which multistanded histories and sociologies have been conventionally interpreted, but it also attempts to trouble the stability of geopolitical identities and the very temporalities under which they have been (re)made and naturalized. Once more, social-natural assemblages and meshworks have stood as dominant conceptual and epistemological frames with which to enliven hitherto understudied connectivities, agencies and socionatural-political dynamics not only between conventional outcasts, un/familiar figures and material spaces (e.g., buccaneers and wreckers, port harbors and littoral utopias), but also of questions around non-human presence, interaction and their transformations, a line of inquiry we will later revisit.

However, two important methodological limitations present themselves when figuratively and empirically conceptualizing the material-symbolic substance of saltwater worlds. The first shortcoming entails the problematic conflation of "saltwater" realms with notions of indigeneity. While significant advances within this body of literature have predominantly focused on postcolonial and decolonial aboriginal histories and interpretive framings, the specificity of this term arguably runs the risk of uncritically accepting a sense of "authentically" dwelling with the sea. Its conceptual framing potentially forecloses "non-traditional" sensibilities and practices that entail entire coastal (and marine) lifeworlds in their own right. Second, while seascapes themselves can be theoretically imagined as "a cosmologically totalizing" realm rather like terrestrial desertscapes (Siriwardane, 2015, p. 158), there emerges the tendency of essentializing or "othering" the sea as a world that is entirely detached from land-based sensibilities. As postcolonial geographers such as Connery (2006) posit, the ontological distanciation between land and sea is strongly suggestive of a Eurocentric imaginary. Furthermore, complex land-sea interactions inevitably determine how life is experienced and lived, for as Ingold (2000, p. 167) asserts, everyday perception formations are never passive processes, and are structured against frames of socio-environmental meaning-making. However, the ways in which land-sea distinctions are typified, typologized and taken for granted as objective reality (in a Schützian sense) may remain intensely differentiated. Thus, what is considered to be typically "of the sea" or "of the land" may be separately interpreted and lived, however it is important to bear in mind that since Bronislaw Malinowski's *Argonauts* (Malinowski, 1922) among others, anthropological writing reveal that the absolute spatio-cognitive separation between watery realms and the terra firma are barely universal (see Anderson and Peters, 2014, p. 8).

Another emergent field within interdisciplinary marine research is what could be broadly framed as "interspecies worldings," if we were to more meaningfully reuse the term borrowed from the environmental humanities (see DeLoughrey, 2015). While engaging more productively with broader questions around human hubris, anthropocentricity, and of racialized universality particularly evident within highly politicized debates on the Anthropocene, through which it troubles notions of "both indigeneity as well as interspecies ontologies in an era of sea level rise that is catalyzing new oceanic imaginaries" (p. 352).

Having emerged at the crossroads of three interdisciplinary currents constituting environmental studies, animal studies, and Science and Technology Studies, multispecies ethnography (as a predecessor to interspecies theorizing) sought to bring a host of less visible and understudied organisms, from fungi to mollusks and oceanic microbes into anthropological conversations by virtue of acknowledging that they possessed "legibly biographical and politics lives of their own" Kirksey and Helmreich (2010, p. 545).

Epistemologically, this conceptualization departed from conventional ways of thinking about the non-human as object, and rather as bodies and substances habiting and co-constituting shared human social worlds. In plainer Schützian terms, such worlds are reversely *peopled* by more-than-human forms of life and inanimate objects positioned across subjectivities, spatialities and temporalities of worlds that are pre/past, contemporary and future (also see Viveiros de Castro, 2016, pp. 156–157). However, the means with which to draw out this relational ontology without unduly falling into the trap of anthropomorphism has always remained a challenge. The "more-than-human" was conceptually privileged over more deficit-centered "non-human" subjectivities. Second, it strove to explore diverse, multi-stranded and power-laden networks, assemblages and meshworks implicating more-than-human entanglements everyday life, which enlist not only animals, plants, and microorganisms, but also objects, technologies, knowledge forms, minerals, air, water, and energy flows for example. For example, Probyn (2013) in tracing people following fish, stories a complex figuration of how pelagic herrings, anchovies, sardines, local corporates, and Japanese universities co-produce internationally tradable tuna that she termed as a "more-than-human fish,"

replete with its own individualized historic records that would put a contemporary biometric identity card to shame.

While a more comprehensive description of the generative trajectory through which multi/interspecies epistemologies developed goes beyond the scope of this paper, it is worth noting that the earliest scholars (including Donna Haraway, Paul Rabinow, Eduardo Kohn, and Anna Tsing among others) who have written on these relationalities have argued that human nature and living by default encompasses pluri-worlds (see Kirksey and Helmreich, 2010, pp. 549–548). Indeed, as decolonial scholars often posit, post-Enlightenment rationalities and hierarchies privileging mastery over Nature and concomitant narratives of stewardship have in turn historically muted these existential states (see Belcourt, 2015). While the conceptual fault lines between multi- and inter-species ethnography remain blurred, arguably the latter focuses on communicative worlds comprising multiplications of associations shaped through networks, events, circulations and other forms of encounter. Lively vocabularies, particularly in the overlapping disciplines of cultural geography and anthropology follow these interspecies (life)worldings, comprising for example Ingold and Pálsson's (2013) understandings of "biosocial becomings" and Latimer's (2013) notion of "being alongside" as opposed to "being with."

Lifeworld-inspired sensibilities also offer nuanced understandings of powerful yet invisible materialities (and their performativities), like in the case of Robertson's (2014) study on island groundwater networks and flows in Kiribati and their multiple enactments. For others like Peters and Steinberg (2015), multi-sensory, corporeal and affective engagements with the sea (for example, salt on skin, the performativity of a recreational beach) calls to attention values of not just "thinking *from* the sea, but how we can think *with* the sea" and what this means in widening explorative horizons for understanding multiple modes of marine sense-making. As a start then, it would seem prudent to acknowledge that what these fluid ontologies spell are arguably less visible and cognitively less graspable dimensions such as volume, liminality/mobilities, the unruliness of depth, and of vertical territorializations for example (see Steinberg and Peters, 2015). Yet these multisensory and embodied forms of knowing can be further enriched critically by hybridizing older lifeworld readings for example Merleau-Ponty's being-with-the-world. To take this concept further would mean to use it in prefiguring traditional meanings of spatial and temporal depth. It would also warrant critical reflections on the *limits* to knowing and feeling, contemplated through what Mazis (2010, p. 123) eloquently puts as "the further displacement of the human into the world's play of becoming."

These conceptual and epistemological currents have further crisscrossed with the recent turn toward non-representational ethnography, particularly within the disciplines of human geography, anthropology and sociology (see Thrift, 2008). Not only does it emphasize the tracing of more-than-human relations, but pays attention to the very events, practices, socio- and pre-cognitive structures of feelings, mobilities, including the extra-textual and "non-discursive dimensions of spatially and temporally complex lifeworlds" that have otherwise stood concealed by conventional ethnographic styles that have "been in the habit of uncovering meanings and values that apparently await our discovery" (Vannini, 2014, pp. 1–2). In this context, embodied actions and movements themselves speak and enact, rather like the surfed waves that people allude to as watery "places" that conjoin together (Anderson, 2012).

At first glance, it may appear that conventional phenomenological-lifeworlds research has little to lend an open-ended and experimental epistemology, particularly one that has little to embellish in terms of drawing forth externalized meanings in order to render any objective explanation. Yet upon closer inspection, the very *experientialist* spirit that is warranted of immersive lifeworlds research (see Jackson, 2012) beckons what a non-representational ethnographic journey would entail, not in the least self-reflexivity. The experimental becomes the experiential and vice versa, making for a compelling case for critical conversations and border crossings between relational concepts cleaved within contemporary cultural geographies and anthropologies on the one hand, with neo-classical theorizings and operationalizations of the multi-stranded concept of the phenomenological-lifeworld.

CONCLUSION

We argue for a more conscious engagement with the concept and diverse epistemological foundations of lifeworlds (Ger. *Lebenswelten*) in interdisciplinary coastal and marine research. Our discussion serves as an open invitation for interdisciplinary scholars to more critically reflect the advantages together with the shortcomings of diverse lifeworlds conceptualizations. At the same time, we reiterate the double bind that contemporary phenomenological praxis finds itself in. On the one hand, the philosophical complexity and the diverse epistemological foundations of lifeworlds theorizing make its entry into present-day interdisciplinary research relatively more challenging. On the other hand, the apparent paucity of perceptions-based research on marine-centric/specific knowledges and the experience of everyday life makes for an urgent case for the integration of lifeworlds approaches. Eventually, it is the attempt to free the lifeworlds concept from a singularly land-based lens that makes further research into marine-based phenomenology far more appealing and pressing at the same time. How then, could the endeavor for embarking on lifeworlds research across multiple coastal and marine realms, possibly begin?

Epistemologically, this multi-stranded concept opens up reflective spaces through which we, as interdisciplinary researchers, could unpack experiences and meanings around our own positionality. Methodological processes such as bridling offer practical techniques through which to consciously suspend judgment and explore biases and assumptions that are implicit to our own lifeworlds. Through two illustrative case studies on diverse waterworlds, we have shown how surface level perceptions-based research may still run the risk of perpetuating subjective assumptions often taken as constituting "objective" reality.

Conceptually, we reveal how the integration of a specific lifeworlds approach within interdisciplinary work warrants active reflection, depending on the research puzzle or question that it seeks to understand. Empirical community-based fieldwork is hardly a process that entails passive encounters between "subjects," sets of data, and their forms of knowledge generation. While it offers little recourse to meta-level analysis, it provides the means to detangle fine-grained nuances across multiple and locally-situated realities that are often regarded as being "messy," encompassing values, norms, worldviews and actions that may often sit in contradiction to each other. While the concept affords the space through which to study the complexities, ambiguities and ambivalences inherent across both land- and sea-based societies, it further promises the means through which to sidestep over-simplistic and essentialist inferences to the vague and embattled notion of "culture."

Methodologically, while the concept favors the study of an individual's interpretation as the primary unit of analysis, it provides varied empirical layers through which implicit meanings could be drawn to the surface. Abstractions of course are never entirely static nor complete, in similar ways that knowledge(s) and forms of knowing are constantly in flux. Having problematized the endeavor of: (a) "reading the world" through categories of knowing (e.g., beliefs, mental maps), (b) of being and becoming (e.g., identities, material movements, flows); (c) of multiple socialities (e.g., more-than-human assemblages), and; (d) through experience (e.g., events, routinized social practices), the methodological foundations of the lifeworld enable us to work with concretely situated frames that people use to guide as well as to challenge perceptions and behavior.

The lifeworld approach presents an empirical frame and an integrative research agenda through which diverse modes of dwelling with, and working the sea could be investigated, transcending a vast body of work related to coastal communities and spaces. Several thematic vantage points stand to be taken as points of departure in enlivening deeper forays into "marine lifeworlds." Rather than merely deliberating on surface-level perceptions, the lifeworld enables us to think beyond them. Novel and hybrid approaches to understanding marine epistemologies/forms of knowing would therefore require an ongoing engagement with how varied conceptual strands, methodological devices and thematic foci could be reworked in creative ways in order to consciously unhinge the concept from its terrestrially-bound roots, which at the same time naturalize the nature-cultural binary.

Thus, thinking through place-based and materially interpreted realms such as saltwater-worlds and their manifold socialites and interactive entanglements which in turn solicit new ways of thinking, feeling and writing with/alongside oceans and seascapes (i.e., wet/fluid ontologies and interspecies worldings) are but an open-ended starting point. Attempts at integrating and tracing dynamic flows of lifeworld matter, relationships and symbolic meanings and events—from fish and oceanic currents to in/visible material flows and events that are constitutive of everyday life—opens up fertile ground and exciting imaginative possibilities with which to launch an inductively-shaped concept out to sea.

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All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication. RS: Conception or design of the work; Manuscript drafting and critical revision of the article. AH: Critical input on the article.

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Fishers' Perceptions of the Recurrence of Dynamite-Fishing Practices on the Coast of Tanzania

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Dynamite or blast fishing remains the most pervasive destructive fishing method in the coastal waters of Tanzania. It constitutes a major threat to small-scale fisheries through degradation of reefs and other critical habitats for fish. The Tanzanian Government has implemented several measures including a high rate of patrols and surveillance campaigns in the sea to try to deter the use of dynamite in fishing. However, most of these measures have failed to reduce its occurrence over the past years. Little is known on why existing management measures are failing to generate effective solutions to address dynamite and other forms of destructive fishing activities. This study was undertaken to examine perceptions of fishers on the persistent recurrence of dynamite-fishing activities within the present fisheries' management regulations. A random sample of 180 individual fishers was interviewed in two coastal districts using a household survey questionnaire. Key informants, semi-structured interviews and participant observations were used to collect additional data. Almost two thirds of survey respondents felt that an apparent recurrence of dynamite fishing is attributed to the inconsistencies of the fisheries management approaches deployed to thwart the use of dynamite. However, other factors such as absence of appropriate organization of the many involved actors, kinship ties, and migrant fishers played crucial role on the persistence of dynamite fishing. There was a common perception among all survey participants that lack of trust and transparency toward and within anti-dynamite initiatives negatively impacted the involvement of fishers in their efforts to reduce the use of dynamite. An improved situation where decision-making processes are coordinated among fishers, non-governmental, and governmental stakeholders is important to support ongoing management measures, in order to increase legitimacy, and long-term success of efforts to get rid of destructive fishing practices among small-scale fishers in Tanzania.

Keywords: dynamite fishing, fishers' perceptions, destructive gears, interviews, coastal tanzania

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INTRODUCTION

Humans have been the primary drivers of the changes in the coastal marine environment (Lotze et al., 2006; Crain et al., 2008; Sale et al., 2008; Waycott et al., 2009) and are expected further to exacerbate pressures on coastal ecosystems (Boldt et al., 2014; Jiao et al., 2015; Lucas and Smith, 2016). The increased human pressure on marine ecosystems has caused many environmental

problems, particularly the loss of important ecosystem services (Halpern et al., 2012). Several studies (Costello et al., 2010, 2012; Coll et al., 2016) show that fishing presents one of the greatest human pressures on marine ecosystems, and one of its main threats is through destructive fishing techniques (Dayton et al., 1995; Watling and Norse, 1998; Wilkinson, 2004; Mak et al., 2005; Fox and Caldwell, 2006; Benn et al., 2010; Fenner, 2014; Petrossian, 2015).

The use of destructive fishing techniques, including explosives and poisons, has been part of many small-scale fisheries for decades (Mak et al., 2005; Palma, 2010; Authman et al., 2013; Petrossian, 2015). The literature (Saila et al., 1993; Mazlan, 2005; Fox and Caldwell, 2006; Glaser et al., 2015) shows that explosive or blast fishing has been and still is occurring in many countries around the world. For example, explosives have been used in Hong Kong waters for at least a century, leading to the introduction of legislation to ban explosives in 1903 (Cornish and McKellar, 1998). A study on the status of destructive fishing activities in the Pacific Islands showed that by the early 1980s, nearly half of the cases on reef degradation were related to damage from explosives and poisons (Veitayaki et al., 1995). In the Western Indian Ocean (WIO) region, these methods, particularly dynamite or blast fishing, are still common, especially on the coast of Tanzania (Samoilys and Kayange, 2008; Wells, 2009; Braulik et al., 2015b; Slade and Kalangahe, 2015). For example, dynamite fishing has been experienced in Tanzania since the 1960s and although it was declared illegal in the 1970s it has continued largely unabated since that time (Guard and Masaiganah, 1997; Wells, 2009; Braulik et al., 2015b). Wagner (2004) asserted that in the 1980s and 1990s, the frequency of dynamite-fishing events along the coast of mainland Tanzania reached a peak. Some extreme cases of dynamite events were also recorded. For example, over 441 blasts were recorded from October to November 1996 in Mtwara, while in Songo Songo Archipelago, 30 blasts were heard every 3 h (Francis et al., 2002). Likewise, 100 blasts were recorded during one 6-h period at Mpori Reef in the same year (Francis et al., 2002).

While destructive fishing methods are not a new phenomenon, they have posed seemingly intractable challenges to scholars and policy makers seeking to phase them out (Wells, 2009; Nurdin and Grydehøj, 2014; Heber Dunning, 2015; Petrossian, 2015; Slade and Kalangahe, 2015). The devastating impacts of destructive fishing techniques on marine ecosystems and human populations have received considerable attention in scientific studies (Jennings and Lock, 1996; McManus et al., 1997; Riegl and Luke, 1999), and the effects of dynamite fishing have also been investigated in detail (Saila et al., 1993; Guard and Masaiganah, 1997; Pet-Soede and Erdmann, 1998). Dynamite explosions are known to leave coral reefs in rubble and kill more fish than are harvested (Guard and Masaiganah, 1997; Mak et al., 2005; Fox and Caldwell, 2006). They are also potentially dangerous to the people who use them (Guard and Masaiganah, 1997). However, a lack of capacity to enforce fishing legislation, especially in the Pacific, Southeast Asia, and sub-Saharan Africa, coupled with the quest for high catch rates from dwindling fish stocks have resulted in an extreme increase of these methods in areas dominated largely by small-scale fishers (Kuperan and Sutinen, 1998; Sumaila et al., 2006).

Different coastal states have already designed strategies and developed measures to curb increasing threats to marine fisheries from destructive fishing practices (Agnew et al., 2009; Munyi, 2009; Wells, 2009; FAO and UNEP, 2010). However, destructive fishing remains the stark reality of fishing activities in some regions, particularly in the above-mentioned regions (Mangi and Roberts, 2006; Braulik et al., 2015b; Giraldes et al., 2015; Sheppard, 2016). For example, the initiative by the Beach Management Units supported by the World Wide Fund for Nature (WWF), monitoring blast frequency at Songo Songo, located in the Lindi region in Tanzania, for 15 months up to late October 2014, recorded 8765 blasts, an average of 21 per day (Liganga, 2015). A large-scale vessel-based survey conducted over 2692 km of Tanzania's coast in 31 days recorded 318 blasts, where the highest intensity area for blasting was in the vicinity of Dar es Salaam City (Braulik et al., 2015b). However, Tanzania had previously reported an effective control of dynamite fishing in the late 1990s (Darwall and Guard, 2000). This happened when a massive crackdown on dynamite fishing was achieved under the joint operation (dubbed operation "*pono*") between the Tanzanian Navy and Marine Police with support from the local community members who had been sensitized about and mobilized to take actions against dynamite fishing. Nonetheless, numerous WIO nations have virtually no dynamite fishing (Braulik et al., 2015a,b).

Despite many advanced efforts to phase down dynamite fishing, including the success registered during the Tanzania's 1990s anti-dynamite campaign, these practices persist along much of the Tanzanian coast, including Tanga, Pangani, Bagamoyo, Temeke, Mtwara, Rufiji, and Kilwa (SeaSense, 2010; Anderson, 2011; Slade and Kalangahe, 2014). Critics argue that Tanzanian government authorities are overlooking the fact that fishers have an important role and should be at the center of actions targeting a halt of dynamite fishing. Arguably, the active role and potential capability of fishers to stop dynamite fishing remains largely unutilized and their actions have not been scaled up by fishing authorities at local governments to meet targets to halt destructive fishing. More recently, there has been some backlash against anti-dynamite campaigns (Slade, 2011; Slade and Kalangahe, 2015), where even the strongest support to fight destructive fishing activities, offered by fishing communities as symbol of their cultural value to fisheries resources, have not prevented the use of dynamite. This has eventually resulted in a fisheries management stalemate, making the use of dynamite virtually impossible to alleviate (Braulik et al., 2015b). Government reports indicate that the most acute illegal fishing issue in Tanzania is dynamite fishing (United Republic of Tanzania (URT), 2016). A recent government report tabled in the parliament during the 2016/17 budget session shows that 35 detonators, 17 explosives, and 252 kg of urea—used for home-made blasts—were confiscated during the 2015 reporting period. Anecdotal evidence suggests that dynamite incidences in Tanzania are now probably more prevalent than they have ever been. Halting dynamite will require more comprehensive information, based on the perceptions and roles of fishers in

these widespread dynamite-fishing activities, and support from government and non-governmental stakeholders for the fishing community to enhance their alternative livelihood strategies.

This paper therefore attempts to investigate the perceptions of fishers on the recurrence of dynamite-fishing activities within the present fisheries legislation and regulations that call for fishers to collaborate in fishery management. Management of fisheries in mainland Tanzania is guided by the Fisheries Act of 2003 and is supported by the Fisheries Regulations of 2009 (Fisheries Division, 2014). The research was guided by the following questions: why do fishers still resort to dynamite? Are there any internal mechanisms coastal communities might employ to discourage the resumption of dynamite fishing? Furthermore, this study aimed to unravel what social interactions (e.g., cooperation among fishers, reciprocity, and trust), if any, can be used to persuade communities whose livelihood takes place in an environment of dynamite activities, to shoulder efforts with government and other fisheries stakeholders such as community-based fisheries organizations and local Non-Governmental Organisations (NGOs) to halt these activities. A successful strategy to understand perceptions of fishers on dynamite-fishing is critical for processes dedicated to reduce it substantially. Fishers perceptions should then be fed into projects and initiatives that seek to reduce destructive fishing practices (Foster and Vincent, 2010; Heyman and Granados-Dieseldorff, 2012). Understanding perceptions of fishers is crucial for local efforts to reduce, and optimally, prevent degradation of fisheries resources, and thus promote conservation efforts (Bacalso et al., 2013; Katikiro, 2014a).

MATERIALS AND METHODS

Study Sites

Two coastal districts in Tanzania (Mtwara and Temeke) were chosen as case study sites for this research (**Figure 1**). Temeke district (municipality) was at the time of this research one of the three administrative districts within the Dar es Salaam region. Dar es Salaam is Tanzania's largest city and the most important one for both commercial and governmental activities. However, in 2015, two other districts were established within the Dar es Salaam region. One of this is Kigamboni, which covers part of the area previously under the jurisdiction of Temeke district. Temeke has the largest coastal stretch compared to Kinondoni and Ilala—two other districts that previously made up the Dar es Salaam region (National Bureau of Statistics (NBS), 2014). The 2012 population and housing census shows that Temeke district has 1,368,881 inhabitants, accounting for about 31% of Dar es Salaam's population United Republic of Tanzania (URT) (2013). Temeke's socio-economic profile indicates that there are 1450 registered fishers and about 2000 that are not registered (Temeke Municipal Council, 2010)

Mtwara district is located on the southernmost region of Tanzania. Based on the population census of 2012, Mtwara district had a population of 336,302 people. The fishery in the district is quite extensive with over 4500 fishers (Everett et al., 2014). Its remoteness and proximate location to the northern side of Mozambique enable easy access to dynamite perpetrators and reduce effective control of destructive fishing activities attributed to the absence of effective border control of fishing activities.

The majority of households in these two districts depend on fishing, crop farming, and small-scale business for their livelihoods (Market Axis, 2014; NBS RC's Office Dar es Salaam, 2014; Katikiro et al., 2015).

The study districts were chosen for representing the ones possibly more directly affected by dynamite incidences in both rural and urban areas, which reflects retardation in actions to thwart destructive fishing activities. However, a recent study by Braulik et al. (2015b) using a combination of manual and semi-autonomous detection, which recorded a total of 318 blasts between March and early April 2015, revealed that 70% of the blasts came from Temeke district. Mtwara contains a substantial high number of recurrences of dynamiting events where in some areas more than two blasts per hour were heard (day and night).

Both study districts have at least community-driven initiatives that patrol against illegal fishing and at that operate a database for collecting information on dynamite incidences. For example, SeaSense—a NGO that targets the conservation of flagship species such as sea turtles and marine mammals with support from local communities—recorded 1120 dynamite blasts in 2008 in Temeke district and some other parts of Dar es Salaam (SeaSense, 2012). Mtwara benefited from the NGO SHIRIKISHO from the late 1990s to the early 2000s where it led massive anti-dynamite campaigns (Katikiro, 2014b).

The site selection was also based on: the predominance of migrant fishers who are often associated with destructive fishing methods, the significant large number of fish traders, which enables ready marketing for fishery products, and having a significant number of villages whose people have strong economic and cultural relations with marine fisheries. It was also assumed based on previous work on fisheries management in the area (Katikiro, pers. observation) that individuals taking part in this study would be aware of effects of dynamite fishing on fish stocks, the environment and human health. District fisheries officials assisted in the selection of study sites. Three villages were selected randomly in every district, making six villages altogether. The characteristics of each area to fit in the study was verified by a research team upon arrival in the district. This was made by crosschecking if the village had at least two of the criteria mentioned above. The population and sample sizes for the individual fishers surveyed are provided in **Table 1**.

Data Collection

Two months were spent in each district to collect data using a mixed-method approach with triangulation and the use of secondary sources including gray literature, reports, published materials and institutional documents on local fisheries and conservation activities. An overview of the methods is provided in **Table 2**.

Semi-structured interviews were held with a purposive, snowballed sample of 24 community members of the six study villages. Participants for semi-structured interviews were selected because they were active in or associated with the fishery, were information-rich on challenges facing fisheries in their villages and would provide different viewpoints. This could either be

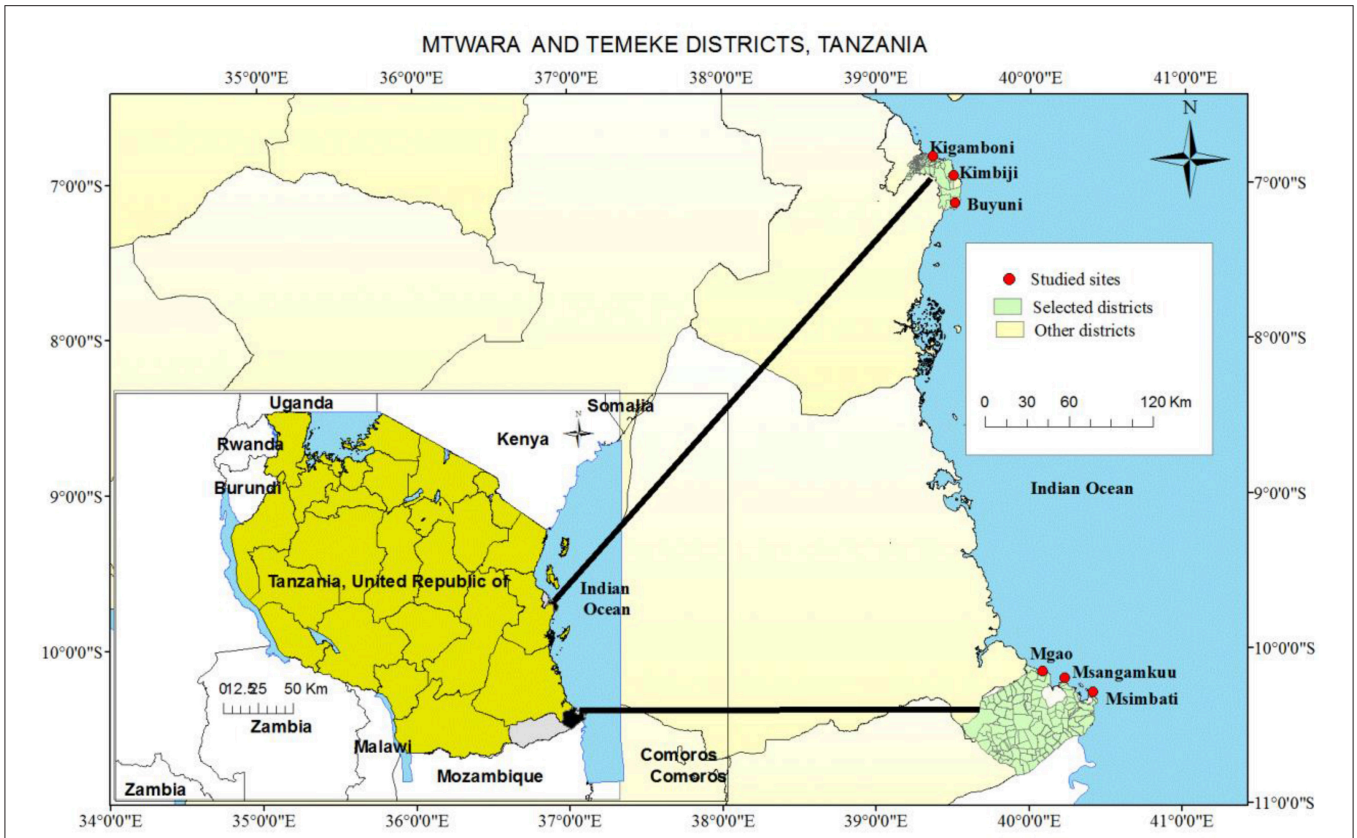

FIGURE 1 | Sampling villages in Temeke and Mtwara districts, Tanzania.

TABLE 1 | Villages and sample of individual fishers interviewed during household surveys.

District	Villages	Population	Sample
Temeke	Buyuni	6000	40
	Kimbiji	1903	22
	Kigamboni	3245	32
Mtwara rural	Msangamkuu	3180	31
	Mgao	1336	23
	Msimbati	2864	32

Source: Ward Executive Offices (2015).

TABLE 2 | Data collection methods used in this study.

Method	Respondents	Sample size
Semi-structured interviews	Fishers	24
Questionnaire interviews	Heads of fishing households	180
Key informant interviews	Fisheries officials, fish traders, NGO personnel, academic researchers	21
Participant observation		

directly as a fisher (illegal or legal), fish processor, fish trader, or indirectly as member of a fishing household, key stakeholders such as NGOs focusing on fisheries issues, or those working as food vendors, net repairers and other fisheries-related jobs. A summary of the topics explored during these semi-structured interviews is shown in **Table 3**.

Semi-structured interviews aimed at the perspective of local institutions such as village and traditional leaders, kinship relations and fishers' organizations on how the problem and effects of dynamite fishing are framed in their understanding of improving fisheries management. The interviews took up to 50 min each and were all held in Swahili. Questions were open and phrased to avoid the responses being prompted by the interviewer. The interviewer took notes for each semi-structured interview. No recording was done because of the sensitive nature of the topic and to guard the privacy of interviewees.

A questionnaire survey among local fishing households was then conducted through face-to-face interviews with a random sample of 180 individual fishers. Only one individual fisher, in most cases the head of household, was interviewed (see **Table 1**). Surveys are frequently used to examine perceptions and attitudes (Blair et al., 2013). For this study, the survey was designed to provide quantitative information on dynamite-fishing activities and fishers' perceptions of its reoccurrence. The structured survey questionnaires (Annex 1) comprised questions on specific details of the surveyed households, such

TABLE 3 | Summary of the main topic questions addressed in semi-structured interviews.

1. Trends about destructive fishing practices over the last 10 years
2. The sources where most dynamite perpetrators in the village obtain explosives
3. Implementation of fisheries regulations in villages to stop the use of dynamite
4. Initiatives to stop dynamite fishing
5. Satisfaction with fisheries management
6. Existence of informal enforcement of laws against dynamite fishing practices established and run by community members
7. Social interactions such as cooperation or kinship activities that support or fight dynamite fishing
8. Role of village institutions such as village environment management committees and village government in actions to combat dynamite
9. Fishers' reasons behind the use of dynamite
10. What would make fishers stop using dynamite

as experience with destructive fishing methods; fishing patterns (e.g., seasons, operational details, species abundance, compliance to regulations, etc.); environmental and health risks of using dynamite; sources of dynamite; proportion of fishers who use dynamite; initiatives and NGOs in place to "combat" dynamite use; fishing license and knowledge on change in fishing activities. The survey also covered themes related to characteristics of dynamite fishers, attitudes of fishers toward dynamite, perceived negative impacts of dynamite fishing on their livelihoods and direct environment, and the level of consultation and involvement of local fishers in decision-making processes on dynamite and fishing in general. Survey questions were asked in Swahili. The questions were kept short and mainly closed with fixed alternative answers (mainly yes and no). Scale questions were also asked to allow respondents to agree or disagree with particular statements. In most cases, a five-point Likert scale was used for scale questions.

In addition, 21 key informants were selected to provide a broad representation of environmental organizations, fish traders, government officials engaged in fisheries management and law enforcement, and local business leaders, particularly from the tourism and hotel sectors. Key informants were interviewed using open-ended questions. The interviews focused on their perceptions on the health of fisheries resources, the occurrence of dynamite blasts, the existing regulations and enforcement measures, recent reforms in the fisheries sector, village committees to monitor and control destructive fishing, and the future condition and direction of the fishery if dynamite use remains active. Key informants were chosen utilizing both opportunistic and snow-balling techniques. Interviews ranged from 30 to 70 min. Each interview was subsequently transcribed and analyzed for key words and statements.

Because dynamite fishing is illegal and perpetrators will not want to be known to outsiders, precautions were taken to ensure that interviewees would not be influenced by wariness of and discomfort about being interviewed. This was done through protecting their identity and conducting interviews in a conversational and rather informal manner.

Throughout the fieldwork, participant observation was undertaken in all six villages to make additional observations that capture the complexity of destructive fishing activities and validate the interviews and survey data during the analysis. Detailed field notes and photos were taken (where the situation allowed) to record observations and were used for triangulating interview data.

Positionalities of the Researchers

The first author was formerly employed by the Marine Parks and Reserves Unit (MPRU). The second author is still employed by the MPRU. The MPRU is a government institution established under the Marine Parks and Reserves Act 29 of 1994, and its roles among others is to oversee the management of marine protected areas in mainland Tanzania. Part of the study areas were within the marine protected area jurisdiction (Mnazi Bay-Ruvuma Estuary Marine Park located in the southernmost coast of Tanzania) while the other one was not. Based on the authors' professional duties, they may already have been known in the study areas. This relationship enabled networking and knowledge exchange, but clearly also created a by-product, i.e., to be considered as a "government marine conservation official." In the beginning of the research for this study, the authors were not sure if this connection would favor them or not. The authors tried to ensure that participants did not feel as mere research subjects. Obviously, some of the local community members still perceived the authors as "government officials" and not academic researchers, hence their radical criticisms about dynamite fishing, management strategies and the government's role in these. To address the issue of positionality explicitly, the authors were open about the limits of their research in effecting changes in the lives of individuals who agreed to be interviewed. They were also open in answering any questions people had about their research and clearly stated that they were trying to understand the persisting dynamite fishing activities from the participants' perspective.

Given the fact that respondents for this study were drawn from local community members, government and NGOs, the relationships of power encountered were significantly different. In the interview context, it often became clear that the authors were expected to be the power holders because they were the ones asking the questions. However, the authors attempted to traverse the landscape of power relations during interviews by attempting to create momentary spaces where their positionalities and those of respondents complemented each other. The time spent in each study site also helped to build trust as the interviews were not conducted in the form of one-off encounters which often make people more suspicious. Undoubtedly, some respondents remained suspicious to this research work, but the authors tried to strike the balance by building mutual trust and rapport where they continued to present themselves as impartial, seeking information related to fisheries and livelihoods for academic purposes.

Data Analysis

Data from the household surveys were analyzed using descriptive statistics. After data were entered and confirmed in a spreadsheet,

information was processed with the Statistical Package for the Social Sciences (SPSS 20). Qualitative information and extensive field notes were coded inductively, and themes and categories were identified accordingly (Grbich, 2007). Further analyses were then performed using content analysis (Patton, 2002). The data generated with all interview methods and secondary sources were then categorized and used in a complementary way for the presentation of the results.

RESULTS

Socio-Economic and Demographic Profile of Household Survey Respondents

Table 4 presents the basic socio-demographic characteristics of the questionnaire survey sample. Most households surveyed had at least one person from their household employed full-time in fishing and were thus receiving over 50% of their income from fisheries. Most households surveyed showed negative perceptions regarding the government support for their fisheries-dependent livelihoods by reiterating that government support for fishing activities was not enough. Furthermore, most household interviewees stated that local fishing interests such as continued fishing in areas that are set aside as no-take areas, or their preference for certain gear types, were not being addressed by the current fisheries' management regimes, resulting in conflicts between fishers and government agencies responsible for fisheries.

TABLE 4 | Socio-demographic characteristics of the survey sample (n = 180)*

Variable	Frequency of occurrence (%)
GENDER	
Men	142 (78.9)
Women	38 (21.1)
AGE	
18–30	64 (35.6)
31–50	73 (40.6)
>50	43 (23.9)
LENGTH OF RESIDENCE	
<1 year	8 (4.4)
1–5 years	48 (26.7)
6–10 years	80 (44.4)
>10 years	44 (24.4)
FISHING STATUS	
Full time	143 (79.4)
Part time	37 (20.6)
LENGTH OF TIME INVOLVED IN FISHING	
<10 years	95 (52.8)
11–20 years	32 (17.8)
21–30 years	32 (17.8)
>30 years	21 (11.7)

The focus was to interview the household head; in their absence any other person aged above 18 was interviewed.

Perceptions on Government-Led Enforcement Campaigns

Questionnaire survey responses indicated that fishers and local people who are not engaging in fishing alike are knowledgeable about the importance of patrols in the sea to stop dynamite activities. Enforcement campaigns were identified by 68% of survey respondents as a contributory agent to ensure protection of fisheries resources. The majority of survey respondents (72%) indicated that although enforcement campaigns, which happen sporadic depending on availability of funds and human resources, provided useful practical means to deter dynamite activities, they do not offer incentives for a de-dynamite pathway. Some of the incentives referred to included modern fishing gears such as large nets, cooling devices for storing fish and engine powered boats. More than half of the survey respondents (55%) believed that preparations and eventually implementation of patrols at some instances led to dynamite suspects preparing strategies to avoid being arrested. Participant observation during fieldwork and further inquiry with key informants confirmed that often not every dynamite perpetrator encountered by patrols was arrested. Many survey respondents (47%) indicated that the government agenda to stop dynamite fishing is unclear and that little attention is paid to this problem at any given time as compared with other aspects related to the misuse and degradation of natural resources (such as illegal logging and poaching of wild animals).

Almost 27% of survey respondents argued that dynamite practices were rarely resolved with law enforcement campaigns because of absence of targeted actions and ill-equipped patrolling protocols, in combination with a lack of dedicated efforts to eradicate the networks of dynamite suppliers. Instead, most dynamite perpetrators arrested by law-enforcing agents would usually end up in a situation where the suspects would retaliate by insulting or trying to harm informers. Further, it was mentioned by these respondents that the suspects may relocate into areas where enforcement is not yet existing. The majority of survey respondents (84%) cited lack of seriousness by responsible government agencies, incompatible models of resource management, bribery and unwillingness to enforce law, as factors for continued dynamite-fishing activities in their areas. When asked why the implemented enforcement measures were incapable of resolving the dynamite problem despite a high rate of patrols and surveillance campaigns, 82% of key informants argued that some of these strategies were flawed and corrupted because of different perspectives and weights given to the problem by people carrying out those campaigns. This in turn leads to leakages of information eventually reaching the potential offenders. Eventually, the potential culprits temporarily refrain from dynamite fishing or relocate to other fishing grounds during the campaigns. This was also confirmed by participant observation where the authors observed potential dynamite fishers postponing their fishing schedules after being tipped off on the forthcoming patrol missions.

Over 70% of key informants remarked that enforcement campaigns also fail to succeed because of political interests, dictating what should be done. At times when election polling

is nearing, they were asked to disengage their campaigning duties and respond to immediate pressures of politicians. But once they reduce their enforcement efforts, it becomes almost impossible to either operate campaigns or stop the spread of dynamite fishing. In the end, as explained by nearly 50% of key informants, halting dynamite through enforcement seems to be ineffective because the socio-political environment cannot credibly support such efforts. Despite these failures, a good proportion of survey respondents (48%) believed that enforcement activities usually end at least with some type of explicit reduction of dynamite supply and other illegal fishing activities.

Community Awareness and Initiatives to Curb Dynamite Fishing

Over 70% of survey respondents who began fishing longer than the past 20 years stated that dynamite was already used when they began their fishing career. The vast majority of survey respondents (90%), and almost all participants in the semi-structured interviews, agreed having noticed a series of locally driven sensitisation and awareness-raising activities spearheaded by village leaders that aimed to reduce dynamite fishing over the last 10–20 years. However, only 18% of survey respondents reported having received support, information and training to stop dynamite (and other destructive) fishing activities. Almost all key informants agreed that all fishing activities should be non-destructive. When asked why they thought dynamite is reoccurring when every fisher was aware of its effects, these key informants said that it was only another malpractice in the society (like cattle robbery), which requires a case-by-case solution and should not be generalized to all fishers. Further probing of community awareness on the dynamite problem led to the responses summarized in **Table 5**.

Information gathered from government and NGO reports, triangulated with data generated from participant observations, showed that significant efforts have been undertaken to inform communities about the effects of dynamite not only in the study sites but along the coastal districts of Tanzania. These included sponsored radio programmes to raise awareness among the local communities on the ecological and human health impacts of dynamite fishing, participatory videos (Slade, 2011) and dissemination of awareness materials. Awareness and capacity-building programmes, however, were cited by almost 45% of survey respondents to be confined to areas where the pioneer NGOs on anti-dynamite campaigns were based, and were thought to underrepresent opinions of fishers. These activities were reported to be more in Temeke than Mtwara because Temeke enjoyed relatively high coverage by the SeaSense organization. This organization however, as commented by key informants, has been somewhat dormant in recent years following lack of funding and aging of some of its founding members.

The study revealed that local people are willing to report events of dynamite fishing, but credible and trustworthy government officials where they could report to are not organized to ensure a timely flow of information and subsequent actions. Several respondents (32%) of the semi-structured interviews observed that it was extremely difficult for local fishers to locate these agents. Furthermore, it emerged during household survey interviews that people who had voluntarily taken the task to monitor dynamite perpetrators and report them to the responsible authorities sometimes faced serious threats by the dynamite fishers. In some instances, dynamite detonators were placed at house compounds to intimidate the volunteers, especially in villages of Mtwara district, and there were reports of injuries after acid was splashed on their faces. Interview results indicated that while many fishers were aware of the effects of dynamite use, they find it difficult to report plans or people engaged in it because they feel they were not protected against these. Indeed, perpetrators could be close relatives, and in certain circumstances perpetrators could be linked to influential people in their communities who cannot easily be punished or fined through the current legal mechanisms and institutions.

TABLE 5 | Responses (n = 180) to the yes/no questions on awareness of the dynamite fishing problem during the household survey.

	Yes (%)	No (%)
1. Have you ever used dynamite or engaged in a fishing crew that used dynamite?	23.89	76.11
2. Do you believe the use of dynamite has spread in your village in recent years?	56.67	43.33
3. Are you aware of any legal restrictions to the use of dynamite for fishing in your village?	62.22	37.78
4. Are you aware of any local customs or local rules which relate to the use of dynamite fishing?	15.56	84.44
5. Do you know if there has been any major change in prevalence of dynamite fishing over time in your village?	57.78	42.22
6. Do you know what proportion of fishers is using dynamite in your village?	60.56	39.44
7. Do you collaborate or take part in efforts to fight dynamite fishing?	21.67	78.33
8. Is dynamite being used in addition to existing fishing gears?	64.74	35.26

*Several survey statements were asked to probe the respondents' view of dynamite fishing activities. All respondents were required to answer each statement as: 1, strongly agree; 2, somewhat agree; 3, undecided/unsure; 4, somewhat disagree; 5, strongly disagree. The answers across the five categories are provided in **Table 6**.*

New Entrants into the Fishery and Actions against Dynamite Fishing

While some projects by the government and NGOs were mentioned to have existed in the study sites—Temeke having more active organizations than Mtwara—over 55% of key informants and 70% of participants in the semi-structured interviews indicated that these projects often overlooked the component of empowering fishers for actions against destructive fishing. Almost all survey respondents (95%) considered that new groups joining fishing activities were not adequately introduced to options of less-destructive fishing. They suggested that these groups of individuals, which usually lack exposure to fishing or have little knowledge and experience in fishing, should receive adequate information about different gears, and the issuing of

TABLE 6 | Distribution of responses ($n = 180$) across the range of the five answer categories in a Likert scale.

Statement	Category of answers (%) across a five points Likert scale				
	Strongly agree	Somewhat agree	Undecided	Somewhat disagree	Strongly disagree
Dynamite is carried out year round	23.89	49.44	12.22	8.33	6.11
Dynamite fishing activities in recent years have generally increased	31.11	43.89	12.78	7.78	4.44
Initiatives and actions to stop the use of dynamite have failed to yield expected outcomes	10.56	39.44	29.44	13.33	7.22
Actions currently implemented by the government would reduce ongoing dynamite fishing practices	5.00	11.67	41.67	24.44	17.22
Most dynamite perpetrators obtain dynamite from construction and mining sites	5.56	32.22	40.56	16.11	5.56
Dynamite is used instead of other fishing gears	3.33	16.11	42.78	29.44	8.33
Media coverage to raise awareness of the community on aspects related to dynamite fishing is scant	12.78	41.67	28.89	12.22	4.44
Village councils have developed by-laws and engage in monitoring and control to reduce the incidences of dynamite fishing activities	2.22	11.67	36.11	33.89	16.11

fishing licenses should also be done in a more meaningful and transparent way than is currently done. To date, anyone can gain access to fishing through the existing licensing system by paying around US $10 annually. Respondents claimed that better inclusion of new entrants into fisheries management activities is crucial to accentuate stewardship toward the use of less harmful fishing gear. Most household survey respondents (80%) stated that because of lack of skills and adequate knowledge on fishing, new entrants are often persuaded easily to adopt destructive techniques in fishing as a way to meet their immediate income needs (**Figure 2**).

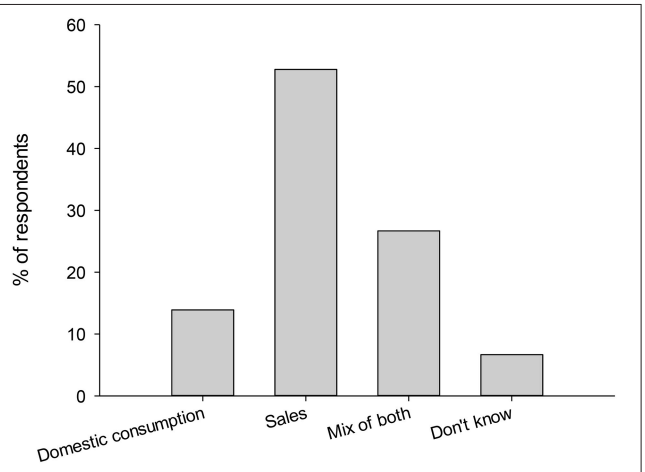

FIGURE 2 | Perceived uses of fish caught using dynamite.

Government Approaches to Reduce Dynamite Fishing

Statements of nearly 40% of key informants indicated that local government authorities in the study districts did not have clear and consistent plans to protect fish stocks from dynamite activities. Most of these informants believed that poor progress in combating dynamite is partly attributed to lack of commitment by the relevant authorities where fisheries is given less priority compared to other sectors. However, nearly 70% of survey respondents clearly stated that they would value positively measures that allow fishers to share their knowledge and their greater involvement in decision making to curb dynamite

Many key informants (48%) mentioned that the dynamite problem is often approached in a fragmented manner, with the population and the environment suffering in favor of economic and political considerations. Information from household surveys also showed that local authorities have often stigmatized fishers in general as criminals. The views of almost 60% of key informants made it clear that as long as fishers feel criminalized and left behind in management and development plans, any efforts to persuade them to support a reduction of dynamite fishing are likely to encounter significant opposition and little commitment from community members. Fifty six percent of survey respondents said that this is sometimes caused by unreliable information on whether certain individual fishers or fishing villages are producing or stockpiling materials used for dynamite fishing. To their knowledge, some of the information is baseless and diverting the truth from actual dynamite activities. According to the key informants, false and misleading information therefore often leads to reduced commitments to act against dynamite.

Improving Actions against Dynamite Fishing

Almost all participants from all interview methods used in this study, including informal conversations in the study sites, agreed that many fishers were willing to participate or invest in actions and initiatives that would result in the reduction of dynamite activities. They gave various recommendations for improving actions already undertaken, and designing of new activities to support anti-dynamite initiatives (**Table 7**).

While the majority of survey respondents (85%) supported the idea of deploying the Tanzanian Navy to address the dynamite problem; it was, however, noted that this cannot be the final solution but just a quick remedy to the dynamite-fishing

TABLE 7 | Suggestions given by the household survey respondents (n = 180) to improve actions against dynamite fishing.

Recommendation	Responses (%)
Improve communication between fishers and fisheries officials	15 (8.3)
More representation of fishers in control measures of fishing activities	35 (19.4)
Local leaders be involved at every stage of monitoring and control of fisheries resources	61 (33.9)
More public meetings and awareness raising programmes on effects of dynamite fishing	46 (25.6)
More support to fishers using various fishing gears from local government authority	23 (12.8)

dilemma. According to the key informants, military actions as seen during the operation *pono* in 1998–1999, could positively address the dynamite-fishing crisis. However, lack of a clear long-term policy on how to integrate the military in anti-dynamite operations did reduce its mission. Arguably, as opined by some key informants, the inefficiency of deploying the military was demonstrated by continued dynamite activities when the operations were concluded, or by complaints about incidents of human-rights violations, as was the case in other natural resource cases like the operation *Tokomeza Ujangili* of 2013. *Tokomeza Ujangili* was a planned nationwide operation to combat poaching (Legal and Human Rights Centre (LHRC), 2015). It was ostensibly aimed at poachers but was terminated following widespread charges of human-rights abuses against local community members.

It was observed during the fieldwork for this study that without efficient government support, the village environment management committees in the study sites have not been successful in stopping the use of dynamite and other destructive fishing activities. Over 50% of the key informants argued that despite being chosen among local community members, these committees seem to have no impact on fishers' decision to continue fishing with dynamite and violate the fishing regulations. There were also complaints among local communities that these committees have been part of the problem by allegedly being involved in assisting members of their families or clans and in-migrant fishers to circumvent enforcement of fisheries regulations. At the same time, while both fishers and members of village environment management committees agree that dynamite fishing has a profound impact, including the likelihood to harm the fishers, their perceptions on the destructive effects on the environment remain vague.

Almost 60% of key informants said that planning for a national goal for reducing dynamite activities, i.e., hoping to cut the use of dynamite to a certain degree within a particular timeframe, would increase the effectiveness of anti-dynamite campaigns. They also mentioned that a significant loophole including absence of provisions in the current fisheries legislation that could impose heavy and deterrent penalties to suspects should be addressed, which allows suspected offenders to legally purchase explosives. Overall, 22% of semi-structured interview respondents emphasized that there should be a background check on actual intention, occupation and criminal records before one is legally able to purchase explosives and detonation materials, which are commonly known to be destined for the mining sector. Furthermore, around 54% of the key informants and 20% of survey respondents mentioned that there have been various initiatives such as educational programmes and fishing grants for purchases of fishing equipment in place to combat dynamite use over the past decade, and new initiatives (both community-based and government-driven) could benefit from their lessons. The establishment of institutional arrangements needed to co-ordinate fishing activities and interactions between fishers and fisheries officials, and mainstream legal fishing activities, were also mentioned during the key informant interviews, especially by those who had knowledge of the recent government initiative for the formulation of a Multi-Agency Task Team (MATT). The MATT initiative was launched in 2015 by the Tanzanian Government to help find a lasting and effective solution to the widespread incidents of environmental crimes, including dynamite fishing. It was further said that such intervention efforts need to be focused to undermine and outsmart any efforts by dynamite fishers. For some key informants, the high level of interest demonstrated by a number of NGOs especially WWF in Tanzania should be integrated into government initiatives and actions.

DISCUSSION

The integration of fishers' perceptions may enhance their acceptance of and positive reactions toward curbing destructive fishing activities. The most noted barrier for fishers and local communities at large was the perceived low level of attention paid to their values, beliefs and livelihood challenges by policy-makers and government authorities responsible for fisheries. The lack of trust and transparency toward and within anti-dynamite initiatives also seems to be a major factor to thwart destructive fishing. Participants therefore perceived that their daily needs were widely ignored, which contributed to reduced commitment to address the dynamite problem. Although there are cases from elsewhere in the world where fishers were reported to be active in anti-dynamite programmes (Murshed-e-Jahan et al., 2009; Heber Dunning, 2015), the findings of this study show that Tanzania still has a long way to go in this respect. The household survey respondents stated that if government agencies would accord opportunities, such as fishers having key leading roles in anti-dynamite activities and sufficient participation of local people during the design and implementation of anti-dynamite programmes, their own capacity and confidence to act against the offenders would increase significantly. Basing plans and actions on opinions of all fishers irrespective of their methods of fishing would mean that the majority of fishers would no longer feel carved out in core issues of their livelihood (Hauzer et al., 2013). Doing so could lead to more participatory formulations of anti-dynamite strategies, with well targeted actions such as reducing supply of dynamite for addressing destructive fishing activities. This however may not be a panacea to destructive activities when

there is not much transparency and trust in decision-making processes.

While the challenges facing small-scale fisheries in Tanzania cannot be overemphasized, anecdotal evidence suggests that some fishers use illegal and destructive fishing methods to secure control over resources. Despite the fact that initiatives by NGOs and government departments (to phase out dynamite use) have already provided some notable results (Slade and Kalangahe, 2015; United Republic of Tanzania (URT), 2016), there is little evidence to date that this has positively influenced attitudes and perceptions toward reducing dynamite practices by either minimizing frequency or occurrence of blasts. The majority of the household survey respondents opposed these initiatives, explaining that they were not consistent with the reality of core problems of their livelihoods and seemed to divide the community instead of prompting solutions in any perceptible way. This is a context-based concern and reduces the long-term options to act against dynamite and other destructive fishing techniques. The greatest opportunity to address the local needs is to give greater recognition to and actively seek to improve fishing-based livelihoods. This may involve development of sustainable schemes that provide multiple benefits to local fishers. Typical of these include conservation programmes in Bangladesh offering hilsa fishers economic incentives (Islam et al., 2016) and compensations to fishers impacted by marine renewable energy projects in the UK and Ireland (Reilly et al., 2016).

The recurrences of dynamite blasts in many coastal areas suggest that measures already undertaken to combat destructive fishing activities in coastal waters of Tanzania have proven less successful (Sjöstedt and Sundström, 2015). While such programmes are often implemented jointly by various stakeholders, they still seem to lack detailed plans on how to integrate local community members and consider their livelihood needs. Additional steps need to be taken to deepen the co-operation between various stakeholders in combating this notorious way of catching fish. For example, Tanzania has since early 2015 started to develop a national task force and strategy that would guide activities, especially prohibition campaigns, against dynamite fishing. Although compliance and surveillance strategies are exclusively a government-led activity and not specifically aimed at putting fishers on eye-level to government officials, implementing anti-dynamite activities with fishers taken on board could help fishers feel the legitimacy of the processes and support it. While there would appear hierarchical differences because of power asymmetries between fishers and government authorities, a substantial number of key informants in this study noted that this would break down barriers that had previously prevented appropriate communication between groups with different interests. This would be in line, for example, with the case in Papua New Guinea (Rochers and Ame, 2005), where lack of credible and trustworthy communication channels between managers and fishers was the most often mentioned potential barrier to the reduction of illegal fishing activities. The uncertainty about effective communication pathways provides a reason for some individuals or groups of fishers to minimize their support for initiatives toward anti-dynamite cooperation and will have to be further investigated by future research.

The strong perceptions of lacking consultation and participatory involvement in decision-making on dynamite fishing are not only relevant to Tanzanian fishers. A growing literature reported complaints by fishers (and those working in fisheries) about their lack of participation in management processes (Mikalsen and Jentoft, 2001, 2003; Symes and Phillipson, 2009; Trimble and Berkes, 2013; Holm et al., 2015). But the reasons behind this perceived or real lack of participation are always critical and challenging aspects. In the current study, it remained unclear how participation of fishers could in fact influence decision-making for sustainable fisheries, including the design of community-managed fishing areas. Participation is anticipated to include the ultimate users of resources as active participants in decision making and certainly allow their needs to be accommodated. Pita et al. (2010) elaborated that fishers in Scotland feel that the nature of their participation does not allow them to have a strong voice and stake on matters contested. Their study also suggested that presence of many representatives of fisheries management institutions lead to low and passive participation of fishers in the implementation of management actions. As a result, fishers were found to have a small role, which is consistent with what de Vivero et al. (2008) defined as the participation paradox. Fishers found themselves losing prominence and importance, fading into the spectrum of interests that compete with their own (Pomeroy et al., 2001; Wilson et al., 2003; Yandle, 2003; Gray and Hatchard, 2008). When the processes were open to a broader group of stakeholders, exchange of information and the management process could gradually become more open and transparent (Mikalsen and Jentoft, 2003, 2008; Trimble and Berkes, 2013). When many groups are involved, fishers may feel less stigmatized and the chances to consider their concerns may increase.

Official approaches to tackle dynamite fishing should avoid direct accusations of fishers as "the sole perpetrators." Blaming, judging and eventually criminalizing fishers about reoccurring destructive fishing activities not only violates their basic rights and contributes to ignoring their voice, but also comes with severe social dynamic consequences. Norton (2015) found that for South Africa, the highly restrictive laws do not decrease incidents of degradation of natural resources without addressing the reasons that have created poor conditions for fishing communities in the first place. Instead, they lead to higher rates of illegal fishing activities (Norton, 2015). This may result in further consequences, including the relocation of destructive practices to other areas. For example, many survey respondents during this study said that some fishers who were unable to access the fish stocks because of poor fishing gears have been arrested for trying to purchase materials used for preparing dynamite bombs. Criminalizing fishers without first addressing their livelihood concerns is likely to have a disproportionate impact on more vulnerable groups of fishers, like those without efficient fishing gear, appropriate skills and capital.

This study also highlighted the existence of low priority and coverage of the dynamite crisis in the Tanzanian media. Until recently, the manner of how NGOs and community-based initiatives prioritized the anti-dynamite agenda remained

vague. There are few cases of conservation volunteers, both local and foreign, who could act as champions to instill people transiting to legal and less destructive fishing practices. A lack of political will and strong socio-cultural patterns such as kinship and family relations in coastal areas seem to have influenced a high tolerance of destructive fishing activities and promoted low national attention. When the capacity of local institutions and actors on anti-dynamite campaigns could be improved by working closely with fishers, in an open and transparent way (Pet-Soede and Erdmann, 1998; Kokorsch et al., 2015), measures and strategies deployed to reduce dynamite fishing could be viewed as more legitimate. So far, most of these measures and strategies were viewed by fishers as illegitimate, and even village governments may seem to give a go ahead for dynamite fishing in their areas as opposition to what they perceive to threaten their access to resources.

While some regions around the world have similar problems with compliance to fishing regulations like Tanzania, they are strictly enforced in other countries of the WIO region such as in Mozambique and Kenya. Despite the positive support some fishers in Tanzania have shown toward the implementation of fishing regulations, already designed measures to reduce the use of dynamite are not easy to implement and enforce on a long-term basis. Sometimes, corruption issues become vivid, especially when untrustworthy officials side with offenders and get away with destructive practices. The current fisheries legislation does not explicitly address dynamite issues, resulting in a lack of penalties attached to destructive actions. While a review of the current fisheries legislation is still underway, the process will also need to take in measures that would limit the supply of dynamite materials. Ideally, anti-dynamite campaigns, especially patrols and surveillance, should serve as a tool to identify areas of improvement to make sure that every fishing household has the opportunity to benefit from fish stocks and to identify persistent barriers for enhancement of livelihoods. But too often, as was the case in this study, they do not, and fishers have been dissatisfied with the current approach to curb not only dynamite but also other destructive fishing techniques.

Given the extent to which the coastal marine environment is facing degradation from dynamite practices, especially in peri-urban fishing areas, the findings of this study show a need to address a critical set of fisheries' management issues. Despite the lack of data for site-specific management decisions to halt dynamite use, this article has pointed out some general interactions between fishers and fisheries officials that need to be improved through partnership between different fishers and the government. Those interactions combine with the good governance which takes in crucial issues for both parties to determine relevant information that could help curb dynamite use. Future studies should explore how transition to legal fishing techniques could deter dynamite-fishing activities at the local level and how they could be favored by individual fishers whose livelihoods so far depended directly or indirectly on dynamite fishing.

CONCLUSION

While Tanzania boasts of various initiatives already in place to combat dynamite fishing, the lack of a nationally unified fisheries management approach and of institutional arrangements needed to co-ordinate and mainstream legal fishing activities, contribute to the low success of these initiatives. Fishers interviewed generally felt ignored by fishing authorities, criminalized as employing destructive fishing methods, while they were given little chance to express their opinions, views and involvement in the use of dynamite. Fishers need to participate in meaningful ways for actions against dynamite use to be effective. Despite the fact that different fishers in the study sites were not completely certain of the potential of top-down measures such as patrols and surveillance campaigns, an overall negative attitude toward these initiatives prevails. This is one of the many barriers toward the success of limiting dynamite use over time. Consideration of fishers' perceptions and their heterogeneous behavior are prerequisites for the development of strategies to legitimize actions against dynamite use and other destructive fishing techniques, and will increase responsibilities and accountability of fishers at individual levels. If destructive and non-destructive fishers a like participate in the management process, there could be potential to change their destructive fishing behavior rather than feeling ignored by policy makers. There is not much scope for local fishers to play a crucial role in the success of management measures in situations where different stakeholders often manifest clearly divergent values and interests, as in the case of dynamite, where the "greedy" are likely to benefit the most.

AUTHOR CONTRIBUTION

RK conceived and designed the study. RK and JM conducted interviews for data collection. JM contributed secondary data. RK analyzed the data and wrote the paper.

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SUPPLEMENTARY MATERIAL

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The Role of Perceptions for Community-Based Marine Resource Management

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Every community-based marine resource management (CBMRM) inherently takes place in a highly complex social–ecological environment, and stakeholder perceptions related to various aspects of the natural and social environment guide behavior in every stage of the management process. This paper provides an introduction to the psychology of perception with regard to marine resource management. In particular, it offers a typology of CBMRM relevant perceptions along with an analysis of psychological, societal, and physical factors that modulate them. Based on this analysis, we propose the introduction of specially trained local Perception Experts (PE's), whose role will be to recognize and reflect individual perceptions of involved stakeholders, and to communicate them at community meetings where decisions are made. This empirically testable addition to current CBMRM schemes could help to increase participation, develop management measures that fit the capacities of the involved stakeholders more accurately, and hence, contribute to a faster rehabilitation of marine resources.

Keywords: perception, community-based resource management, psychology, participation, attitudes, norms, values

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INTRODUCTION

In times of increasing socio–ecological pressures, sustainable resource management is more important than ever. Conservation and resource use behaviors are motivated by a variety of factors and understanding the psychological underpinnings may offer valuable insights for resource management approaches. Key here is stakeholder perceptions, which affect the management process from earliest conception to the actual implementation and monitoring. The centrality of the issue is increasingly acknowledged and recently there have been calls for perceptions to be considered as a part of natural resource management strategies (Jefferson et al., 2015; Bennett, 2016).

Community-based marine resource management (CBMRM), where communities manage the marine resources upon which they depend for daily life, constitutes a common management scheme that makes apparent the essential role stakeholder perceptions play in such efforts. Coastal and island communities around the world have typically used and managed their crucial marine resources autonomously based on experience handed down from generation to generation (Zann and Vuki, 1998; McMillen et al., 2014). In today's context, these endeavors are often instigated or supported by outside partners [e.g., governmental agencies, non-governmental organizations (NGO's), academic research teams], who offer supplemental ecological analyses

along with advice on contemporary management methods (Mühlig-Hofmann et al., 2006; Glaser et al., 2015). Whatever the exact circumstances, every CBMRM procedure inherently takes place in a highly complex social–ecological environment (Glaeser and Glaser, 2010, 2011). As such, it is influenced by external factors (e.g., environmental changes, market access, and demands) as well as internal community-specific conditions (e.g., inherited ownership structures, hierarchies, religious influences, or societal obligations). An individual's perception of either of these significantly shapes the dynamic of the entire project, including decisions on management measures and their execution.

Community-based resource management frequently encounters problems due to stakeholder misunderstandings, lack of commitment, non-compliance, or conflicts (Bloomfield et al., 2012; Glaser et al., 2015). In our opinion, a commonly underestimated cause for this predicament is the differential perception of environmental changes, coping strategies, and social processes on part of individual stakeholders. For example, community members may evaluate ecological conditions quite differently, therefore reaching dissimilar, possibly even incompatible conclusions regarding management demands. Once in place, the specific responses to such given challenges might be considered efficacious by some, yet completely unsuccessful by others. Throughout this process, the perceptions that stakeholders have of each other can lead to further dissonance among them. We believe that insights from environmental psychology can prove essential for addressing these obstacles (see also Jefferson et al., 2015; Walker-Springett et al., 2016).

The main objective of this paper, therefore, is to offer practitioners involved in CBMRM an introduction to the psychology of perception as it relates to resource management within local coastal communities. Here, we will assume a slightly unorthodox approach, where perception is defined and assessed through a carefully hewn phenomenological lens. Accordingly, the emphasis will lie on the structure of perception as the necessary condition of the possibility of experiencing the world in a meaningful way. Going a step further than merely acknowledging the importance of perceptions, we propose the introduction of specially trained Perception Experts (PE's) as a possible, empirically testable addition to community-based resource management approaches.

ENVIRONMENTAL PSYCHOLOGY BACKGROUNDS ON PERCEPTIONS AND CBMRM-RELATED BEHAVIOR

Environmental psychology "examines the influence of the environment on human experiences, behavior and well-being, as well as the influence of individuals on the environment, that is, factors influencing environmental behavior, and ways to encourage pro-environmental behavior" (Steg et al., 2013b, p. 2). In doing so, environmental psychology has generated and adopted a series of theories explaining behavior and the factors that shape it. Of these, some are particularly valuable for the CBMRM context, such as Ajzen's theory of planned behavior (1991), the norm activation model (Schwartz, 1977), the protection motivation theory (Rogers and Prentice-Dunn, 1997), and the transactional model of stress and coping (Lazarus and Folkman, 1984). More recent models include the integrative socio-cognitive model of private proactive adaptation to climate change (MPPACC), which focuses on adaptation to weather extremes (Grothmann and Patt, 2005), and Bamberg's stage model of self-regulated behavior change (2013). Space limitation and purpose of this article preclude us from examining every theory in detail, but suffice it to say aspects of each underlie the present discussion.

In the following, we will describe what psychologists mean by perception, outline the role it plays in CBMRM, identify different stakeholders whose perceptions affect CBMRM, highlight what is being perceived, and summarize the main factors shaping CBMRM-relevant perceptions.

Perception Defined

Psychologists commonly envision perception as that process by which individuals organize sensory information and interpret it as "having been produced by properties of objects or events in the external, three-dimensional world" (Gerrig and Zimbardo, 2008). This definition is as oversimplified as it may be useful. It reduces perception to merely the act of sensing physical stimuli and to creating mental representations of environmental information. One could ask though, whether the activities in receptor cells and neurons in the brain, both clearly indispensable physiological *aspects of* perception, are by themselves sufficient to qualify *as* perception. Moreover, it is not clear whether the representational scenario, according to which we encounter objects as mental intermediaries, is truly the most adequate conception of how we perceive the world. Phenomenologists have long argued that perception is unmediated and confronts us not with mental images of objects, but with the objects themselves (Gallagher and Zahavi, 2012)[1]. Hence, defining perception as the operation of organizing sensory information into mental images seems overly reductionistic.

A more comprehensive account of perception is used in studies assessing people's responses to unpredictable and potentially adverse challenges. *Risk perception* has been defined as an individual's "subjective judgment about the risk associated with some activity, event, or technology" (Böhm and Tanner, 2013, p. 24). This obviously involves not only the sensation of objects, but also higher cognitive processes such as reasoning. The perceiving individual logically discerns its future actions over and against the seeming facts with which it finds itself confronted. It does so with regard to held knowledge, previous experiences, and values. While clearly more refined,

[1]The problem with representational theories is simply that it is unclear how the phenomenal subject would know that an intramental image represents a given extramental object. If indeed it is the resemblance to the extramental object that provides an intramental image with its representational quality, as representational theories would have it, a subject must have direct access to the extramental object to realize said quality. (For a detailed discussion see Gallagher and Zahavi, 2012).

this definition overemphasizes reflective cognition and largely ignores the affective aspects of evaluating one's circumstances.

In the present study, we use perception as the subjective way people experience, think about and understand someone or something. This involves conscious and unconscious processes of meaning making in a complex social and natural world, as well as affective states and reactions. The objects of perception can be quite concrete or abstract, animate or non-animate entities, simple or complex, all depending on where the attention of the perceiving subject is focused. To put it into phenomenological terms, perception has an intentional structure and as such, is always about or of something (Gallagher and Zahavi, 2012). It is not merely the reception of information, but a process that involves the interpretation of phenomena within a given context. Rather than the external world impressing itself upon a passive subject, the subject's attention focuses perception onto a "perceptive field," thereby allowing the rest of the world to recede into the unconscious background. What directs the subject's attention is not only its physical surroundings, but also its interests and needs. In other words, whether a subject perceives objects while engaged in fishing is partially determined by the physical qualities of the objects sensed, yet largely also by his attention resulting from his desire to catch fish. One can say, then, that perception, further influenced by psychological and physiological factors, constitutes the background of experience and thus, guides a phenomenal subject's conscious acts (Merleau-Ponty, 1962).

At first sight, this working definition may resemble the psychological concept of *attitudes*, but upon closer analysis it reveals an additional dimension that renders it more comprehensive. Attitudes are defined as the evaluation of an attitude object (Eagly and Chaiken, 1993; Haddock and Maio, 2012), whereas our use of perception refers to a more integral process involving the experience and interpretation of encountered reality. In this sense, it comes close to the common use of the term perception as "the way people think about or understand someone or something" (Merriam-Webster Online Dictionary, 2016).

The Dynamics between Individual Perception and Group Behavior

As mentioned above, CBMRM is always a social enterprise, insofar as it is a concerted, collaborative community effort involving specific actions toward a shared goal. In this sense, it is a form of group behavior. The group, here, is characterized not only by its common objective, but also by the interdependence of its members and their interactions (social structure), as well as a common social identity (Jonas et al., 2014). How individual stakeholders act depends to a great extent on the influence of the group, just as the group's overall actions are shaped by the individual behaviors of its members. In other words, CBMRM is invariably the result of a dynamic relationship between individual and group behaviors.

This complex interrelation is commonly absent from portrayals of CBMRM, which remain on the meso-level of the group and depict the process as a rather straightforward progression of distinct steps from problem identification to implementation of management procedures (**Figure 1**). Accordingly, when the decline of marine resources is identified as a problem that cannot be addressed by the community alone, official partners are approached for assistance. Subsequently, strategies for marine resource management are developed and implemented. Depending on compliance and the evaluation of the process and results, the problem will be reassessed. Of course, this captures the process in theory, though at the expense of a more adequate analysis that takes into account the interaction of group and individual.

In fact, the picture becomes even more intricate when one takes into consideration stakeholder perceptions that significantly shape individual behavior and, thus, CBMRM as group behavior. Simply put, whether and how community members act in terms of managing local marine resources depends on whether they perceive circumstances as requiring such actions. For instance, individual stakeholders might become aware of changes in environmental features or may simply develop an unreflected sense of change that raises concern. They may attribute reasons for why the observed changes exist and in turn infer the need for some kind of action to adjust

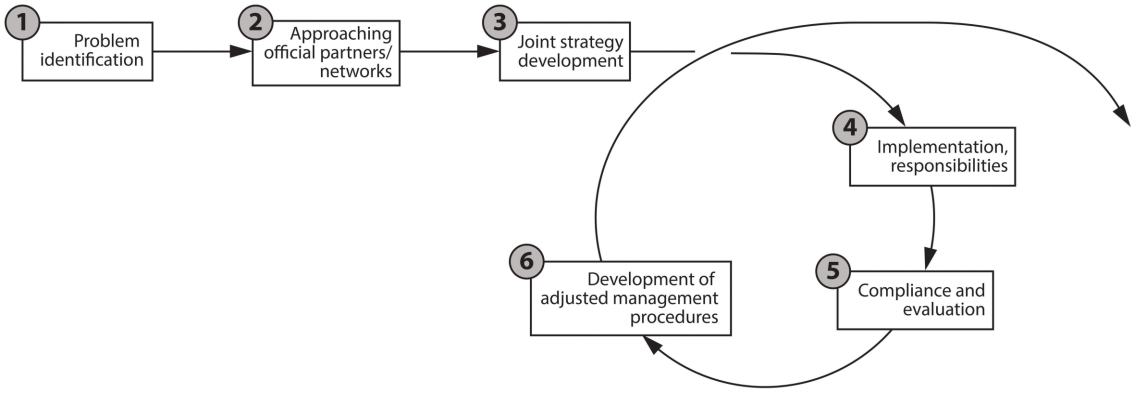

FIGURE 1 | Example of a CBMRM process as seen by a marine ecologist.

the situation. Once coping strategies have been devised and implemented, individual stakeholders appraise them with regards to efficacy and associated costs. The behavioral outcomes and experiences provide feedback, which can result in a reappraisal of the situation, and of coping strategies. Thus, throughout the CBMRM process individual behavior presupposes perceptions, which in turn affect CBMRM as a group activity.

Perceptions Influencing CBMRM Efforts

Perceptions in the context of the CBMRM process are manifold. But before going into detail here, it is important to remember that much of environmental perception functions unconsciously. For instance, changing temperatures and precipitation rates, or dwindling fish stocks can be experienced as a new reality without immediate or continuous conscious reflection upon reasons and consequences. This poses two significant issues for CBMRM efforts. First, stakeholders may not be able to clearly voice their concerns during the planning phase. As a result, important aspects of the status quo of the resources to be managed may go unnoticed and the resulting management plans may not be entirely adequate for the given situation. Second, and closely related to the first problem, stakeholders may not agree with specific management proposals, but cannot articulate their reasons. Thus, CBMRM efforts may actually encounter serious challenges before they have really begun.

Figure 2 gives a brief overview of three major areas—environmental changes, coping strategies, and social processes—whose contents overlap and are not independent of one another. For example, the perception of responsibilities for environmental changes and responsibilities for interventions are connected. The objective here is to offer a brief overview that helps identify the variety of possible perceptions relevant for CBMRM. Previous studies on perception in CBMRM have usually paid attention to specific segments of perceptions and provided very useful insights. Nevertheless, a more systematized approach, as we offer it here, might open up new perspectives for researchers, marine resource managers, and communities.

Perceptions Related to Environmental Change

At a very fundamental level, individual stakeholders may perceive physical changes in their environment, and based on it, assess the situation with regard to immediate or future intervention. Perceptions of impaired marine ecosystem health can include declining fish numbers and sizes, increases in algae density, the absence of known species and presence of novel species in familiar fishing grounds, altered coral colors along with increasingly fragile or broken calcareous structures, or changes in what is washed up on beaches. For the most part, these are readily sensed differences, but there are also other, more intricately perceived anomalies, such as declining catch over longer periods of time along with the associated impacts on income and food security, as well as the lack of specific species for traditional functions (Veitayaki et al., 2015). The perception of such changes can be interpreted not only as an unfortunate environmental deterioration but also as a risk to accustomed and valued lifestyles and personal well-being.

Simultaneously to perceiving environmental changes, stakeholders may attempt explaining the situation as to gauge potential courses of action. Where responsibility is placed can make a significant difference regarding future behavior change and participation in any kind of CBMRM effort. For instance, if human behavior is perceived as a reason for the change, stakeholders will allocate culpability either to themselves or others and negotiate possible responses accordingly. However, if, for example, environmental deterioration is seen as divine punishment for human transgressions, stakeholders could

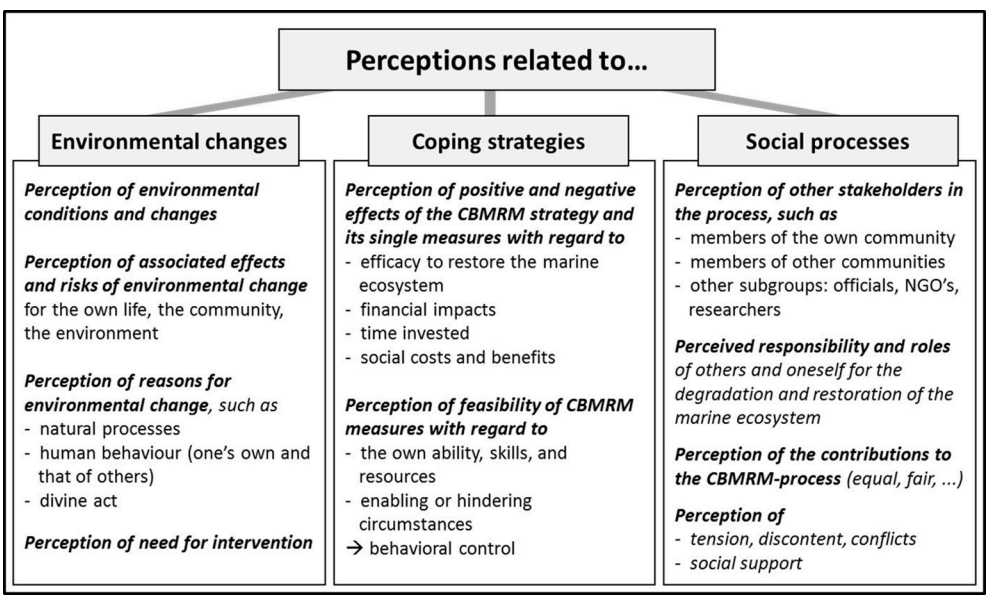

FIGURE 2 | Perceptions playing a role in the CBMRM process.

consider morally offensive behaviors entirely unrelated to the treatment of natural resources and conclude remedies with no further ecological impact (Mortreux and Barnett, 2009; Kuruppu and Liverman, 2011). Whether the changes are perceived as due to human actions or due to a larger process, stakeholders are faced with the question of whether they are actually able to address the changes, and how. Their response to this shapes future decisions with respect to CBMRM.

Thus far, there has been limited research focus on the perception of marine biodiversity change. Inquiries related to changes in marine biodiversity have largely been restricted to ecological and occasionally anthropological rather than more comprehensive studies encompassing psychological assessment (Mills et al., 2013; Young et al., 2016; Webster et al., 2017; Katikiro, 2014). One reason for this is clearly that here the detection of change is complex, involving a plethora of organisms, long timescales and various factors of change. Despite these undeniable difficulties, we nonetheless suggest intensifying a holistic strategy and encourage cooperation of marine biologists, ecologists, environmental psychologists, social scientists, governmental and non-governmental organizations, and communities. The benefits gained from including such a transdisciplinary approach for monitoring and evaluating environmental perceptions in CBMRM processes potentially far outweigh the methodological challenges associated with their implementation.

Perceptions Related to Coping Strategies

How stakeholders perceive coping strategies that have been devised and implemented in response to perceived environmental change is yet another area of inquiry for environmental psychologists (Grothmann and Patt, 2005). What makes this category interesting is that it reveals the importance of perceptions at every stage of the management effort. Already during the planning phase, stakeholders have a particular impression of a potential CBMRM strategy and will support the intended measures only insofar as they perceive them as adequate. As the strategy is implemented, they may experience the procedure quite differently, and it is at this point that some will withdraw their participation. When management measures have been in place for a while, stakeholders will most likely assess their success differently, once more potentially giving rise to conflict or disenchantment. In short, throughout the whole CBMRM process, stakeholder perceptions of the actual measures can decide the ultimate success of the entire enterprise.

The perceptions related to CBMRM strategies can be divided into two broad categories: first, the perceived positive and negative effects of a measure and second, perceptions related to feasibility, including potential behavioral barriers and facilitators to engage in specific activities.

Positive and negative effects of a measure do not only include its efficacy with regard to the restoration of the marine ecosystem, but also to the associated costs and benefits for individual stakeholders. These can be of a monetary nature, yet also related to the individual's invested time, energy, and social recognition or disapproval by others. No-take areas, for example, can be perceived as very effective to restore the marine ecosystem, but also as costly and consequently, undesirable. For instance, additional expenses for fuel to travel further to alternative fishing grounds and extra time spent on fishing trips may make it hard for some stakeholders living adjacent to the protected area to comply with such a measure.

In addition to their perceived effects, single CBMRM measures will be judged by the involved individuals with regard to feasibility. Here, the perception of behavior facilitators and barriers is specifically relevant for stakeholder motivation. The extent to which people perceive themselves as able to exert an intended behavior depends on the perception of their individual skills, abilities and resources (Bandura, 1977). These assessments affect how actively stakeholders will engage in the community management effort. In addition, the sense of how circumstances allow stakeholders to bring to bear their abilities to partake in one or each decided measure plays a crucial role. Both aspects, the perception of individual abilities and enabling or hindering circumstances can be summarized as perceived behavioral control which is known as one important factor for motivating behavior (Ajzen, 2001, 2002). In Pacific small island contexts for example, where traditionally women fish in near-shore areas, establishing protected zones close to the beach would make it impossible for women to fish at all for lack of skills, abilities, and resources to go elsewhere (Mühlig-Hofmann, 2007). Finally, not only the perception of their own abilities, but also the perception of potential alternatives to make a living, will affect their motivation to engage in conservation measures that might impair their own subsistence.

Taken together, these perceptions related to management strategies and measures can be key to resolving issues of stakeholder discontent with CBMRM and resulting lack of commitment. It is therefore absolutely crucial to reflect on them carefully throughout the entire process and particularly to anticipate them when precise management plans for a community are being conceived.

Perceptions Related to Social Processes

As outlined above, CBMRM is a group behavior involving various stakeholders and subgroups, which include, among others, the participating local communities of resource users, advising scientists, regulators, and government officials, as well as supporting NGO's. Social dynamics unfold both, within and between subgroups; individuals perceive and consequently interact with one another in their own group and also with individuals of other subgroups. These continuous perceptions of and experiences with one another constantly shape future expectations and behaviors.

With respect to social perceptions, the perhaps most important subgroup of stakeholders are the resource users themselves, who in essence depend on the well-being of the local marine environment. As residents of the same village or region, these individuals likely engage with each other frequently and because of it stand in rather complex relationships with one another. Whether such a group can organize a facilitated effort to manage resources is dependent to a large extent on whether individual resource users perceive the activities of other group members as equitable, responsible, and just. Moral perceptions,

as difficult as they are to diagnose, are absolutely key to the social dynamics of communities (Syme et al., 2000). They are therefore, also crucial for CBMRM.

Concerns about justice come to bear already in the earliest stages of a CBMRM process, where negotiations of necessary management measures are strongly affected by who individual community members consider responsible for the state of the marine ecosystem (Montada and Kals, 2000; Fielding and Head, 2012; Kalamas et al., 2014). If others are seen as responsible for the observed environmental deterioration, stakeholders might not see any reason to act. Alternatively, group members could demand a greater contribution to the management efforts from those they deem accountable for the state of things. In any case, with the question of liability unresolved dissension within the community is almost inevitable. Hence, it is important, that the causes of marine environmental change are discussed transparently and a course of action is devised jointly along with a clear and accepted distribution of responsibilities.

Once management measures have been established, stakeholder attention will shift somewhat from responsibility to equity, where individual contributions to the group effort are perceived in comparison with a stakeholder's own efforts (Van Lange, 1999). For instance, when others seemingly spend less labor, time, or money on altogether costly procedures, stakeholders might find their own involvement unduly taxing. Likewise, some community members may be perceived as disproportionately benefiting from the measures (e.g., if they live farther away from an established no-take area than the perceiving stakeholder or possess the means to travel further to fish when no-take areas were set up in their usual fishing spots). Perhaps the most damaging to stakeholder ambition would be if others are perceived as cheating. Fraudulent behavior undermines trust and therefore, the entire CBMRM effort, which as a group behavior is dependent on reliable stakeholder participation (Yandle et al., 2011; Van Lange et al., 2013). In turn, general participation according to the agreed-upon course of action can further a sense of community and ultimately increase motivation of individual stakeholders. Whatever the particular perceptions related to fairness, for the CBMRM process it is advisable to maintain a high degree of transparency at all times. In the best case, a social norm of fair co-operation would emerge. Although the perceptions of responsibilities and individual contributions are subjective and may not always be objectively verifiable, they will guide the CBMRM process and the motivation to engage in it.

Aside from the actual resource users, other subgroups, such as government officials, NGO's, or research teams, play an integral part in a functional CBMRM process, and how they are seen by participating community members is crucial for overall success. When outsiders are perceived as competent, credible, perhaps even likeable, but most certainly culturally sensitive and consequently, as an acceptable authority, community members are far more likely to welcome advice and collaborate in a lengthy management approach (Fiske and Dupree, 2014). Of course, here past experiences with either of the participating outside subgroups decide current relationships: Some communities might have had extraordinarily positive experiences, whereas others could have gone through disappointments and may therefore be not as open and optimistic when it comes to new plans for co-operation.

Although these factors are inherent to any human relationship and interaction, it might be helpful to be aware of their potential influence on CBMRM endeavors. Consequently, perceptions related to social processes are relevant in all stages of the CBMRM as it is by definition a group conduct extending over a longer period of time.

Factors Modulating Individual Perceptions

Perceptions are affected by a variety of individually and socially relevant psychological factors, of which **Figure 3** offers a systematic overview. As we mentioned initially, perceptions are focused onto a perceptive field by physical, societal, or psychological circumstances, and their interactions. By way of illustration, how a community member perceives the state of the natural resources on which she relies is significantly affected by the environmental conditions she encounters, her relationships with others within the community, and her personal needs, interests, or psycho-physiological status. Thus, perceptions are not simply the result of a sensory input generating neural representations, but rather the product of a complex interaction between the perceiving individual and its

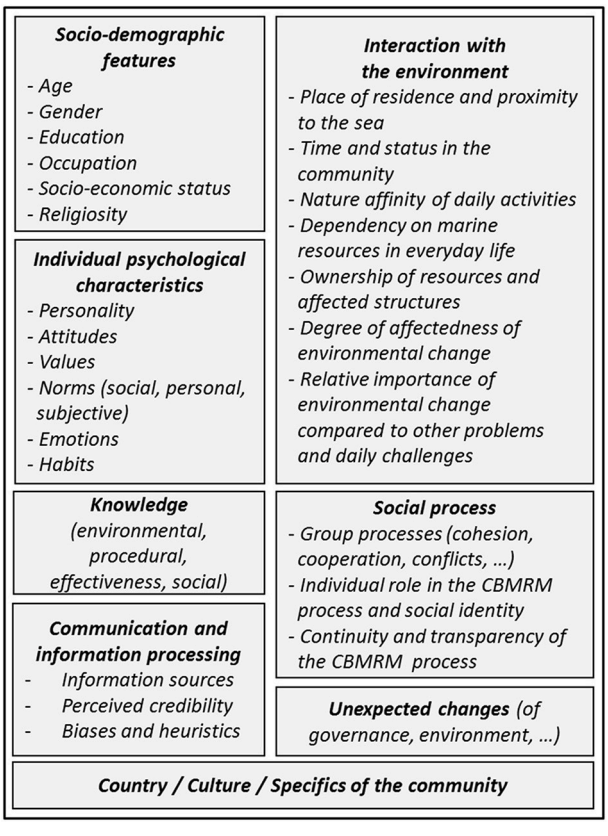

FIGURE 3 | Factors affecting perceptions and interpretations in the CBMRM context.

surroundings. In view of such intricate reciprocity it does not surprise that even modulating influences of the most unlike kind can alter perceptions at each level (environmental change, coping strategies, or social processes). Analyzing single factors isolated from the rest is therefore prone to oversimplification. Nonetheless, in the following section we provide a brief overview with short introductions to the most relevant classes of perception modulating factors.

(1) *Socio-demographic characteristics.* Differences in perceptions can be related to socio-demographic characteristics like age, gender, education, or socio-economic status. Religiosity, place of residence, property situations, as well as status and time spent in the community can also help to understand how people perceive their environment and potential management strategies (e.g., McClanahan et al., 2005; Anton and Lawrence, 2014; Jefferson et al., 2014; Rasool and Ogunbode, 2015; van der Linden, 2015). Furthermore, the interaction with the environment shapes perceptions that are relevant in CBMRM-contexts (Pita et al., 2013; Wyles et al., 2014; Beardmore, 2015).

(2) *Knowledge.* For understanding people's perceptions it is further useful to be aware of the knowledge that they hold. Knowledge can include *declarative knowledge* about environmental systems and associated mental models, *procedural (action-related) knowledge* about what to do and how to do it, *effectiveness knowledge* about which actions can have beneficial outcomes, and *social knowledge* referring to motives, intentions, and expectations of others (Bostrom et al., 1994; Kaiser and Fuhrer, 2003). Often, informational strategies aim at imparting only environmental knowledge to raise awareness and try to motivate behavioral change. Yet, normative information about the behavior of others can be even more motivating than pure factual information about the environment (Cialdini, 2003; Goldstein et al., 2008).

(3) *Communication.* As CBMRM is a social process, face-to-face as well as mediated communications are essential in shaping perceptions and mutual understanding. Naturally, the potential for misunderstandings here is exceedingly high, especially when non-community members suggest the implementation of unfamiliar strategies, like the adoption of novel management schemes (Pomeroy and Carlos, 1997). An often-underestimated communication problem is a subtle form of what one might summarize as culturally contingent misconception. That stakeholders speak the same language does not guarantee they use terms and concepts in the same culturally appropriate fashion. Also, proficiency in a given language may differ between stakeholders within a CBMRM project (Nunn, 2009). Thus, although project advisors from outside the community (e.g., NGO's from a different country) and local resource users technically speak the same language, they may still fail to understand each other. Aside from such language barriers, what can further impede mutual understanding between involved stakeholders is whether the dialogue partners perceive each other as trustworthy and credible. Even more, successful communication may ride on whether stakeholders perceive their conversation partners as similar to themselves (Siegrist et al., 2000). How things are communicated and by whom, plays an important role in any group behavior.

(4) *Cognitive biases and heuristics.* How information is perceived and interpreted is influenced by cognitive biases and heuristics, which are rules of thumb and an economic way of using cognitive resources (Tversky and Kahnemann, 1974; Böhm and Tanner, 2013). Being aware of effects like the positive optimism bias, the affect heuristic, or the availability and anchor heuristic cannot only help to better understand perceptions, but also to improve communication and decision-making processes (Weinstein, 1980; Gregory et al., 1993; Finucane et al., 2000; Böhm and Pfister, 2005; Gattig and Hendrickx, 2007).

(5) *Personality.* Clearly, community members vary in their personalities, which can lead to varying perceptions and, consequently, dissimilar behaviors. For example, personality-related tendencies of thinking such as self-efficacy and control beliefs contribute to reveal why individuals engage in or refrain from certain actions (Bandura, 1977; Judge et al., 2002; Kormanik and Rocco, 2009). How individuals engage in a group effort depends furthermore on personal abilities like social competence and creativity, as well as on personality related interests, needs, and motives.

(6) *Norms.* Particularly in social contexts, perceptions and behaviors are inherently shaped by social norms, i.e., "rules and standards that are understood by members of a group, and that guide and/or constrain human behavior without the force of laws" (Cialdini and Trost, 1998, p. 152). What is more, individuals also adapt their behavior to what they believe others would consider acceptable (subjective norm). Furthermore, rules and standards referring to one's own behavior (personal norm) are crucial (Keizer and Schultz, 2013).

(7) *Values.* In addition to norms, the values that individuals and social groups hold determine the interaction with one another and the environment. In psychology, values are defined as desirable trans-situational goals that vary in importance and serve as guiding principles in the life of a person or a social group (Schwartz, 1992, 2006, 2012). Values include beliefs about desirability or undesirability, are relatively stable, ordered in a system of priorities, and serve as guiding principles for the evaluation of people, events, and behaviors (de Groot and Thøgersen, 2013). Values have been shown to affect attitudes and behaviors, and the value-belief-norm-theory of environmentalism describes such processes (Seligman and Katz, 1996; Stern et al., 1999; Stern, 2000; Thøgersen and Ölander, 2002). Identifying underlying values in communities can be helpful to explain and understand CBMRM-relevant perceptions and behaviors.

(8) *Attitudes.* As already mentioned above, the concept of perception or public perception is often used in a similar

way as the concept of attitudes. In psychology, attitudes are defined as the evaluation of an attitude object—which can be a person, place, thing, event, or action—and include firstly a cognitive component referring to thoughts and beliefs about the attitude object, secondly an affective component which refers to emotions related to the attitude object, and thirdly a behavioral component relating to previous, current and anticipated behaviors related to the attitude object (Eagly and Chaiken, 1993; Ajzen and Fishbein, 2005; Haddock and Maio, 2012). Attitudes can vary in valence and intensity. They do not only affect the processing and interpretation of information but also bias attention. Although individuals might have positive attitudes toward environmental protection and sustainable resource use in general, their specific attitudes related to concrete CBMRM measures can vary greatly. Therefore, to elicit people's attitudes toward a certain measure, it is prudent not to rely on general statements, but to be as specific as possible with regard to the attitude object in question and about involved actions, contexts, and times. In that way, attitudes contribute to the explanation and prediction of behavior (Ajzen and Fishbein, 1977).

(9) *Emotions and affective reactions.* Affective states, that is, a person's positive or negative feelings about specific objects, ideas, images, or other stimuli, are often underestimated variables when it comes to managing natural resources, even though they are powerful motivators of behavior (Keller et al., 2012). A case in point would be the assessment of risks, where emotions are used as mental shortcuts to reach conclusions especially when the required decision is complex or mental resources are limited (Finucane et al., 2000; Slovic et al., 2007; van der Linden, 2014). Therefore, it would be advantageous to be aware of emotions involved in CBMRM so perceptions can be better understood and motivation can be maintained.

(10) *Habits.* In daily resource use individuals tend to repeat behaviors more or less habitually. Habits are "cognitive structures that automatically determine future behavior by linking specific situational cues to (chains of) behavioral patterns" (Klöckner and Verplanken, 2013, p. 198; Aarts and Dijksterhuis, 2000). As some fishing practices that contribute to the degradation of the marine ecosystem are likely to have been in place for quite some time and already have become habits, alternative practices might be difficult to imagine and relearning requires some conscious change. It is hence important to identify and reflect on existing habits and acknowledge their power in guiding daily perception and behavior. Based on that, it might be easier to break up habitual structures, which contribute to resource-overuse and plan more sustainable alternative behaviors.

(11) *Social interactions.* When it comes to social interactions affecting individual stakeholder perception, phenomena such as competition and acknowledgement are of fundamental importance. For example, efforts of single group members are known to increase in situations of perceived social competition and decrease if a person perceives its contribution as hardly visible or unimportant (Latané et al., 1979; Kerr and Bruun, 1983; Williams and Karau, 1991; Stroebe et al., 1996; Kerr et al., 2007). Critical for the problem at hand is also the fact that stakeholders possess a social identity that "describes those aspects of a person's self-concept based upon their group memberships together with their emotional, evaluative and other psychological correlates" (Turner and Oakes, 1986, p. 240). As a member of a particular group, a stakeholder might seek to maximize the benefits of her own group over that of other stakeholder groups. Hence, some stakeholders will try to advance the interests of their own village, whereas others may act to achieve a common goal cooperatively with all subgroups and stakeholders (Tajfel and Turner, 1986; Turner et al., 1987; James and Greenberg, 1989; Lickel et al., 2000; Johnson et al., 2006). Being cognizant of social groups and addressing potentially existing prejudices or conflicts, which might hamper effective cooperation for CBMRM, would therefore be valuable (Nelson, 2009).

(12) *Cultural context.* Zooming out from an individual to a societal perspective, it is clear that all the aforementioned factors need to be seen embedded in the cultural context. Cultural dimensions affect perceptions, group processes, and social practices (Hofstede, 2001; Triandis, 2001; House et al., 2004; Schwartz, 2006; Trompenaars and Hampden-Turner, 2012). Accordingly, if stakeholders from outside are involved in the CBMRM process, or if approaches developed elsewhere shall be applied, potential contradictions to the cultural context should be anticipated. Generally, it is important to bear in mind that the psychology on which the present discussion is based has its origin in Western thought. Applying its concepts and analyses elsewhere, as for example the Pacific Islands or African coastal regions, must be done cautiously and with the necessary consideration of cultural idiosyncrasies.

Ramifications of the Psychological Insights on Perceptions

This study set out to provide CBMRM practitioners with an introduction to the psychology of perception so that frequent problems of stakeholder misunderstandings, lack of commitment, non-compliance, or conflicts could be avoided. At this point, three conclusions of what has been said can be drawn:

First, perceptions play a central role at every point of a CBMRM endeavor. As we have pointed out above, CBMRM is often oversimplified as the sequentially unfolding resource management process around the shared objectives of a homogenous community (**Figure 1**). However, this view neglects to a large part the heterogeneity of involved stakeholders as well as differences in their individual perceptions (Campbell and Vainio-Mattila, 2003). When stakeholder perceptions are taken into consideration, a far more complex picture begins to emerge (**Figure 4**). Perceptions affect every aspect of CBMRM, which is why an organized reflection on them throughout the process is necessary.

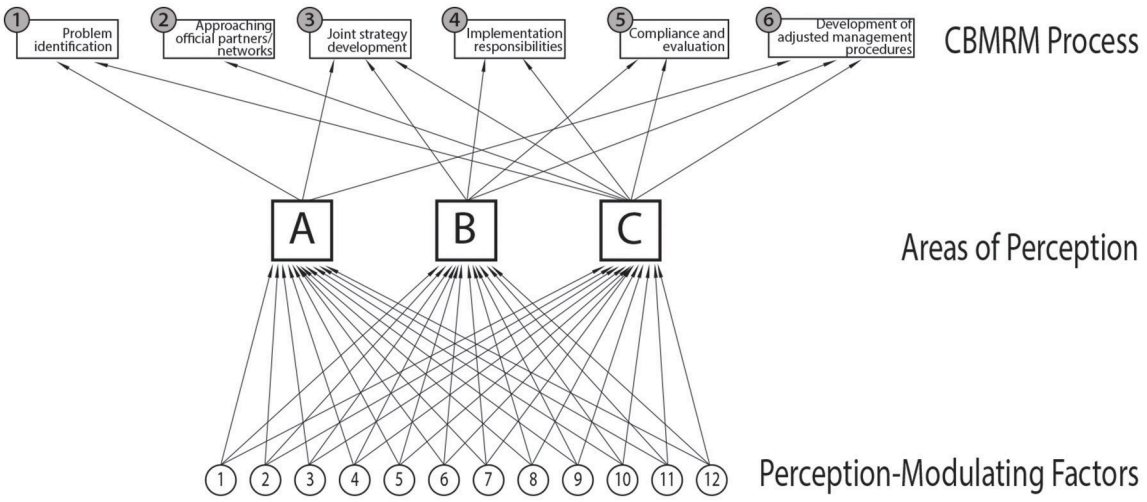

FIGURE 4 | CBMRM stages affected by perceptions.

Second, perceptions relevant to CBMRM can be grouped into three major areas with regards to (A) environmental changes, (B) chosen coping strategies, and (C) the involved social processes. These different types of perceptions act at various points of any CBMRM effort (**Figure 4**). Thus, perceptions of environmental changes are pivotal during the early stages of problem identification and the development of a joint strategy, but also during the evaluation of the implemented management schemes and subsequent adjustments to the strategy. Perceptions with respect to chosen coping strategies are of relevance during the development, implementation, and subsequent evaluation of the actual measures. Finally, social perceptions directly affect CBMRM efforts at every step of the way. With this in mind, practitioners can anticipate potential problems and their causes long before they occur. Moreover, they can respond more adequately to misunderstandings between stakeholders that may arise during the CBMRM process and which, if left unattended could hamper the management process.

Third, perceptions in all three areas are shaped by a variety of psychological factors (1–12 in **Figure 4**). How stakeholders experience their situation and respond to it largely depends on their socio-demographic background, knowledge, attitudes, norms, or other kinds of psychological modulators. The ability of practitioners to identify any one of these factors can mark the difference between success and failure for a CBMRM effort. Taking them into consideration allows the development of more adaptive strategies tailored to the specific needs of a community in need of resource management. Equally important, it would help facilitate productive communication between stakeholders during the CMBRM process, especially once misunderstandings or conflict have ensued.

Although the role of perceptions is increasingly acknowledged in the CBMRM literature (Pita et al., 2011; Jefferson et al., 2015), only little attention has been paid to psychological theories connecting perceptions to behavior (Bennett, 2016). As a result, perceptions that are crucial but not obvious are usually considered neither in CBMRM theory nor in CBMRM projects. Several studies focus on perceptions related to coping strategies, asking primarily about stakeholder perceptions of implemented fishing restrictions and their efficacy (e.g., McClanahan et al., 2005; Bloomfield et al., 2012; Cinner et al., 2014; Katikiro et al., 2015). Others address mainly environmental perceptions with regards to changes in catch size, fishery stock, condition of current fishing grounds, and the number and type of affected groups or species (Jefferson et al., 2014; Katikiro, 2014). A small minority of inquiries either combines the two, while even fewer include social perceptions (Gelcich et al., 2005; Abecasis et al., 2013; Deiye, 2015). Even though some of these studies control for socio-demographics and occasionally psychological factors such as personal values, virtually none of them have embedded their inquiry into psychological theory. For example, perceptions are almost never defined nor are different types of perceptions comprehensively distinguished. Moreover, how psychological factors shape perceptions and ultimately, behavior is a problem left unresolved. With the present summary of perceptions from the perspective of environmental psychology we hope to offer researchers and practitioners a theoretical foundation for more constructive management methods.

Going beyond theoretical foundations, one question that might arise for practitioners is how to include the diverse range of perceptions in actual long-term CBMRM projects. Over the past decades, one strategy seeking to work with stakeholder perceptions is a participatory approach, where a special emphasis is placed upon developing natural resource management strategies jointly with every relevant stakeholder (DeCaro and Stokes, 2008; Ferse et al., 2010; Lin and Chang, 2011; Akbulut, 2012; Rabe and Saunders, 2013). Yet, against better intentions these approaches more often than not fail to consider the full breadth of relevant perceptions. As a result, they miss the inclusion of underprivileged members of society in decision-making processes over longer timescales and in effect, perpetuate existing power structures and inequalities

(Akbulut, 2012; Rabe and Saunders, 2013). Although the idea of participatory, community-based management has valuable potential, the gap between expectations and reality is often undeniable. One reason for this might be that participatory projects are frequently facilitated by outside experts, who tend to face not only project-related constraints with regard to time and resources, but also lack local expertise, social embeddedness, and authority (Campbell and Vainio-Mattila, 2003; Akbulut, 2012). Furthermore, most resource management endeavors rely on the expertise of ecological experts rather than that of social and behavioral scientists (Campbell and Vainio-Mattila, 2003). It therefore is no exaggeration to say that approaches to community-based resource management considering stakeholder perceptions in their full complexity are still largely missing.

In the following, we propose one potential solution to the challenge of working with perceptions in CBMRM that considers not only their diversity, but also addresses the need for continuity to work with stakeholder perceptions throughout the whole CBMRM process.

PERCEPTION EXPERTS—A PRACTICAL PROPOSAL

As clearly shown, perceptions of involved stakeholders affect every phase of the CBMRM process. Acknowledging the importance of perceptions for CBMRM contexts raises the question how psychological understandings of perceptions might enable community-based managers to detect possible inefficiencies and their causes early on to respond more flexibly, and how such a process could be anchored and unfold in a community-based context. As an empirically testable approach we propose that appointed individuals from the communities receive a tailored training program on psychological backgrounds.

Core Tasks of Perception Experts and their Role in the Community

When a CBMRM process is initiated and a management strategy is developed, usually certain tasks are defined and designated among the community members. These tasks (e.g., of fish-warden) focus mostly on environmental monitoring and watching over compliance with the decided rules and measures (Mühlig-Hofmann, 2007; Pomeroy et al., 2015). Already at that phase of the process, being aware of perceptions of involved stakeholders can offer insights in how management measures are assessed or where difficulties for compliance might arise. Therefore, from its earliest stages on, the CBMRM process would benefit from having trained individuals who work with perceptions of involved stakeholders to reach management approaches which fit stakeholders' needs and capabilities.

The core task of such "perception experts" (PE's), would be mainly a reflective and communicative one. First, they are to reflect prevailing CBMRM-relevant perceptions together with involved community members and other stakeholders. Second, they should help to detect misunderstandings or biases which could then be clarified in communication within the community. Finally, by facilitating a transparent and respectful communication, the PE's will ensure that concerns, expectations, and needs of all CBMRM-stakeholders are taken seriously and will be articulated during regular CBMRM meetings.

As modes of participation and decision-making can vary greatly across regional and cultural contexts, defining the specific role of the PE's would demand developing it together with local stakeholders, such as fishing communities and local institutions like universities or NGO's. Specifying the PE-role and agreeing on it within the community should vest some degree of authority and legitimization to the appointed individuals (Leaua and Aniţei, 2012). This should include, for example, being entitled to invite subgroup meetings, do interviews, and accompany stakeholders at their fishing- and CBMRM-relevant activities. Furthermore, the PE's role should allow them to speak and reflect on perceptions in regular CBMRM-related community meetings.

As CBMRM is a long-term social–ecological process, perceptions and specific needs of involved people are likely to change over time (Roovers and van Buuren, 2016). PE's should therefore be in regular exchange with the stakeholders about perceptions of the status of the marine resources and management measures. Hence, the CBMRM strategies could be adapted dynamically depending on perceptions, ongoing environmental changes, and needs. Also, potentially needed support for individual stakeholders could be identified and provided more purposefully to help to reduce objective as well as psychological behavioral barriers.

Perception experts would not only encourage community members to reflect their own perceptions and behaviors, but foster a participatory process in which stakeholders could shape the CBMRM process more actively. Decision makers, marine managers, as well as community members would engage in active feedback loops (Staats et al., 2000; Abrahamse et al., 2007). On the one hand, they would receive information on each other's perceptions of the environment, coping strategies and the process dynamics, and, on the other, get behavioral feedback on what CBMRM-measures proved useful for what reasons, or why single measures might suffer from a lack of acceptance. Since behavioral feedback is an essential factor for motivating behavior, experiencing that realistically negotiated goals can be achieved is likely to support people's motivation for remaining dedicated and committed over a longer timeframe (McCalley and Midden, 2002).

In the case that additional necessity for conflict-mediation arises, which would need clarifying support going beyond the PE's competence, traditional and trusted conflict mediators could come into play (Alsop et al., 2006). Depending on the cultural context, these mediators could be, for instance, church members, village leaders, or others who usually engage in the role of traditional conflict mediators with the respective authority.

Nomination of Perception Experts

How PE's are selected will prove a complex issue, first and foremost because of the cultural and social diversity of communities engaging in CBMRM. As we have pointed out, the

role of the PE's is primarily to listen to stakeholders, reflect upon their statements with regard to perceptions, and communicate their insights to the entire community during significant periods of the management process. Obviously, PE's must not only be respected and trustworthy authority figures within their community, they also need to possess some innate skills enabling them to engage stakeholders in open conversations and to create the safe spaces in which these exchanges can take place. Who qualifies as an authoritative voice within the community and how they are endowed with such a responsibility would clearly depend on the cultural background of the community in question.

We cannot offer one general solution to the problem of PE choice, but a few general concerns regarding selection criteria can be outlined. First, as mentioned above, PE's need to be authority figures that are trusted and well-respected within the community. These may be individuals who already hold positions of authority and trust (e.g., religious figures, community elders, etc.) or persons who can fill such a position for the very first time. Either way, PE's will have to be self-confident, while at the same time humble enough not to overestimate their abilities. In other words, PE's need to be self-reflexive and aware of their own potential biases and prejudices. Second, PE's have to be competent communicators, which implies on the one hand an aptitude for listening and on the other hand, the ability to distill relevant information. Third, PE's need to be able networkers, who have proven their capacity for bringing together various community members from diverse backgrounds to address issues of communal import. Fourth, PE's will have to be empathic, as well as endowed with a certain non-verbal sensitivity. This may very well be the most important trait for a PE, simply because it underlies all previously mentioned abilities. Fifth, PE's will have to be creative, finding novel, and heretofore untested approaches to resolve issues such as potential conflicts or misunderstandings arising from stakeholder perceptions. In summary, one could say that PE's should be selected on their social standing within the community, their social competence, and their communicative skills.

In addition, it would be important to recruit at least two PE's (or more, depending on the size of the community) to prevent loss of expertise should one PE be absent. Finding two individuals (or more) answering all of the demands listed above could be quite a challenge in itself, which is why it might be necessary to select two complementary individuals, who each possess some of the skills and together cover most or all of them. Of course, it would be necessary for both of them to be able to work together, which once more could be a function of the cultural context. For example, in strongly patriarchal societies with far-reaching gender separation, it may be both necessary as well as difficult to have a male and a female PE work together. Whatever the particular social structure of the community in question, it would be mandatory that the PE's will take into consideration perceptions of the greatest number of community members possible.

Potential Training Contents

PE's can be understood as "system experts" (Mieg, 2001, 2006) who have experience within the local human-environmental system and receive a science-based training to gain "interactional expertise" (Collins and Evans, 2007). Similar to training programs for fish-warden which have shown to benefit CBMRM efforts (Mühlig-Hofmann, 2007; Pomeroy et al., 2015), a specific training course could be developed for the PE's. Key partners for the development of such a training program could be psychology departments of local universities working in close cooperation with marine science departments, local governments, NGO's, and communities.

Insights from areas of environmental, social, motivational, and communication psychology in combination with expertise from marine science and conservation studies could serve as the basis for creating training contents. To enhance a mutual learning process, the training should be interactive, based on a mix of contentual input by the trainers, interaction between the trainees, and practical exercises.

Figure 5 illustrates a suggestion for potential contents of a three-step program consisting of first, a training session providing theoretical backgrounds and practical tools; second, a practice run using the learned skills; and third, a second training session where experiences from the practice run are reflected, and ideas and concepts laid out in the first training session are expanded.

The first training session would focus on relevant perceptions in the CBMRM context and factors affecting them, as well as on mapping stakeholders that are involved in the whole process. Subsequently, ways how to elicit information about prevailing perceptions should be learnt and practiced. This could comprise interview techniques, group facilitation methods, and the use of qualitative and quantitative interview tools. Furthermore, ways of analyzing and integrating results to summarize and present them in community meetings should be introduced. Beyond that, prospective PE's should gain process-competence and get encouraged to reflect their own perceptions, assumptions, and role in the community.

Between the first and the second session of the training course, the prospective PE's should get the opportunity to practice the approaches and tools they have acquired during the first training session at home in their communities. Exercises could encompass, for instance, getting an overview of the involved stakeholders in the local CBMRM-process, practicing observation skills, and doing test-interviews to compile a portfolio of factors that motivate or hinder relevant behaviors. Besides the value of practicing, the trainees could introduce and explain the role of the PE to the community and get first feedback and ideas to work with. Such exercises would also be important for the PE's to see if they feel comfortable with their new role and are willing to continue.

For the second training session, all trainees should contribute updates from their communities that can be used to further analyze the role of stakeholder perceptions and ways to include them in CBRMR-related decision-making. Based on their observations and test-interviews, the training participants should use this session to compare the CBMRM-relevant perceptions and their main modulating factors that they could detect in their communities. Here, similarities and differences

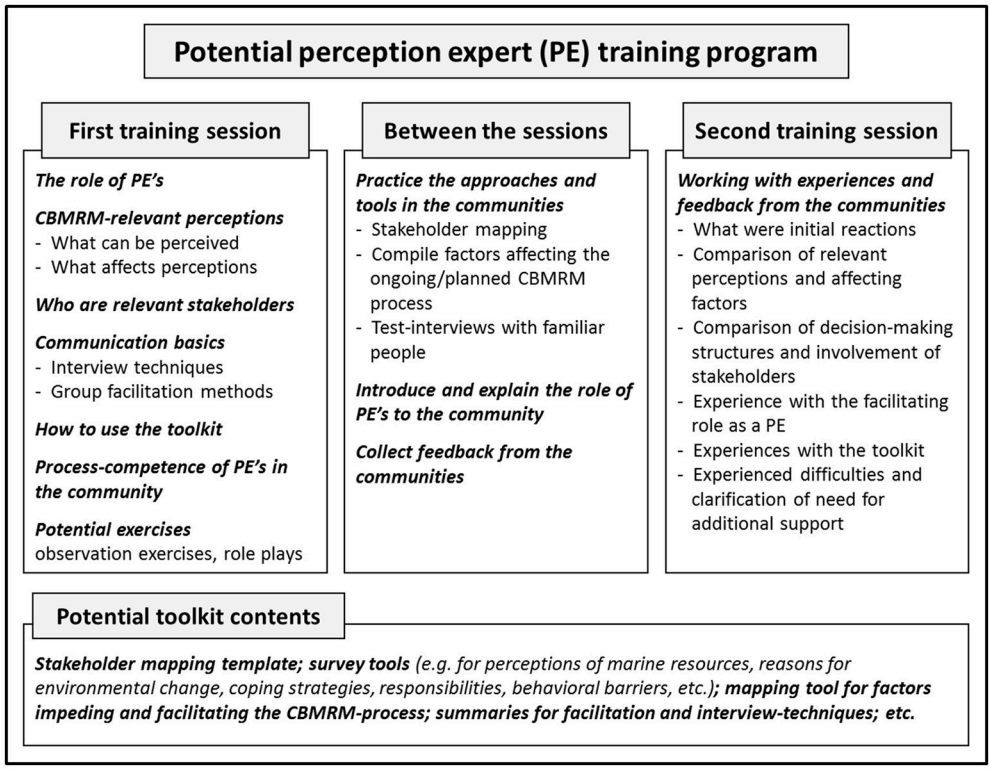

FIGURE 5 | Potential contents for the perception expert training program and toolkit.

between single communities could be highlighted, and important factors that might have been overlooked so far could be added. In a next step, the analysis of local decision-making structures could serve as the foundation for the development of strategies to work with perceptions in the specific CBMRM-processes.

The second training session would also fulfill the purpose that the trainees could describe their experiences with the toolkit, potential difficulties they encountered, and where they see the need for additional support for their work in the communities. This support could include, for example, an association of local experts who could assist the PE's. One group of experts could be the PE-trainers at the university or NGO who could take a supervising role not only during the time of the training-course but also for later consultation. Supervision is an approach that has proved very useful in other fields of psychology (Davys and Beddoe, 2010). Furthermore, a network of local PE's could be established to work together, exchange, and support each other. Thereby, it would also be possible to co-create further strategies for the PEs.

Last but not least, the competences of the PE's will not only be shaped by the initial training, but are likely to develop further over time and adapt to the needs and the composition of a community. If the PE-concept would prove valuable and should get established, experienced PE's could also train successors to ensure continuity. Thereby, the expertise could stay within the community.

Potential Toolkit Contents

To facilitate the work of the local PEs, a compilation of easy to use tools could be developed in addition to the training contents. These tools could comprise checklists and short summaries of facilitation and interview techniques (e.g., McFadzien et al., 2005, for a Pacific small island context example). There could be tools for quick-surveys with suggestions for open or closed questions regarding perceptions of marine resources, perceived reasons for environmental change, and perceptions of coping strategies. The tools could further focus on perceptions of responsibilities for environmental change and coping-responsibilities, as well as perceptions of the own role, abilities and perceived behavioral control. Additionally, the toolkit could include suggestions for community-specific stakeholder mapping, mapping of factors impeding and facilitating CBMRM-relevant behavior, and suggestions for summarizing the results in community-meetings. During the training course, the single tools could be introduced, tried out, and practiced between the first and the second training session. As part of a continuous co-creation-process, all tools could also be developed further and enhanced over time to incorporate the input from the communities.

Putting the PE-Approach to the Test

We are well aware of the fact that the proposed introduction of PE's to CBMRM raises a number of questions that are difficult to assess beforehand. As the introduction into the psychology of perceptions has made clear, perception and its modulators can

be culturally determined, so that one has to wonder whether the training of PE's would have to be so culture-specific as to make it practically infeasible. How exactly can environmental psychologists and others preparing training material for PE's anticipate the particular cultural idiosyncrasies of individual coastal communities? Should PE's be community-members or external professionals? Would the comprehensive and time intensive task of a PE be manageable for a longer time on a voluntary level, and what kind of compensation would be necessary or advisable? And perhaps most importantly, would conflicts arising within communities during the CBMRM process exceed the competence of PE's and potentially put them into a vulnerable position within the community? Some of these questions can only be resolved when the proposal is put to the test.

In order to gauge the efficacy of PE's in CBMRM it would be important to conduct pilot studies in a small number of communities, preferably from varying cultural backgrounds. To that end, it is imperative to carefully design both, the PE programs as well as the method by which they will be evaluated. Here, defining criteria for assessment is key. As we see it, possible indicators of success could be increased participation of various stakeholders in the negotiation process, a better understanding of ongoing environmental changes and management necessities, greater agreement among community members on adequacy of the chosen management measures, greater adherence to decided rules, as well as an overall reduction of conflict. Ultimately, however, the main criterion by which to establish the potential PE's may have for CBMRM would be a better and faster rehabilitation of marine resources.

In all, the PE approach is just one proposal and other ways to work with perceptions are conceivable. Our overall hypothesis is that the explicit inclusion of perceptions would benefit CBMRM-processes. We therefore invite practitioners and scientists to develop and test ways to systematically incorporate environmental psychology expertise on perceptions and behavior to CBMRM endeavors.

CONCLUSION

Environmental psychology, as the science examining the relationship between human experience, behavior, and environment, provides theoretical and methodological expertise for understanding the role perceptions play for environmental behavior (Steg et al., 2013a). Therefore, the main objective of this paper has been to offer practitioners involved in CBMRM an introduction to the psychology of perception with regards to resource management within local marine communities. As has become apparent, perceptions are important and at work in every stage of the CBMRM process. They guide not only individual behavior, but also group conduct and, in the end, determine the welfare of the ecosystem in question. Stakeholder perceptions are nonetheless often disregarded in management planning, and usually receive attention only when obstacles are encountered. Given the importance perceptions have for resource management, it seems only prudent to make them a central part of the CBMRM process (Jefferson et al., 2015; Bennett, 2016).

As one way to include perceptions in CBMRM endeavors we proposed the introduction of specially trained perception experts (PE's) recruited from the communities as a possible, empirically testable addition to community-based resource management approaches. PE's are to reflect CBMRM-relevant perceptions and related behaviors together with stakeholders, detect misunderstandings, and assure that stakeholders' concerns are being heard and taken seriously in CBMRM processes. Based on the systematic compilation of CBMRM-relevant perceptions, we suggested the development and empirical testing of a training course and a toolkit for local PE's through a cooperation of local universities, NGO's and communities.

The described inclusion of perceptions in existing decision-making processes would build on traditional knowledge, beliefs, and norms, and acknowledge their importance. Decision-making procedures that have emerged over time within communities or cultures would be enriched without changing their fundamental structures. The implementation of PE's or similar approaches to ensure the inclusion of stakeholder perceptions could develop to be a "soft" way of participatory management and empowerment respecting existing and traditional decision-making structures of which Constantino et al. (2012) speak. Such an introduction of process advisors and trained local community facilitators has already proved valuable in other contexts of participatory decision-making like urban and regional planning and development projects (Bulkeley and Mol, 2003; Wongbusarakum et al., 2015).

Going beyond CBMRM, developing a training program with focus on individual perceptions could contribute to local capacity building and is applicable to various contexts. The psychological concepts mentioned here are relevant to human behavior in general, also in the contexts of natural disasters, climate change related hazards, prevention, adaptation, rebuilding efforts, and even for health relevant behavior (Rogers and Prentice-Dunn, 1997; Milne et al., 2000; Grothmann and Patt, 2005; Steg et al., 2013a).

Whenever human beings come together, they act based on their perceptions of the world. When conflicts arise in social situations, reflecting such perceptions, making at least some of them explicit, and taking them seriously can help to address concerns and misunderstandings in a respectful way. This may be a truism; yet, it still is overlooked time and time again during the conceiving and implementation of management plans. Paying greater attention to stakeholder perceptions would be a subtle, yet significant addition to current CBMRM practices and could help give rise to more sustainable futures not by relying solely on scientific data, but equally by emphasizing the way we experience ourselves within our natural and social contexts.

AUTHOR CONTRIBUTIONS

AB and KB co-developed the initial idea for the manuscript. KB and OP conceived the research, as well as the idea of Perception Experts, and wrote the main manuscript text. KB provided the psychological background of perception. OP supplied the background on phenomenology of perceptions. AB provided background on CBMRM and practical experience with fishing communities. All authors reviewed the manuscript.

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Multiple Drivers of Local (Non-) Compliance in Community-Based Marine Resource Management: Case Studies from the South Pacific

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The outcomes of marine conservation and related management interventions depend to a large extent on people's compliance with these rule systems. In the South Pacific, community-based marine resource management (CBMRM) has gained wide recognition as a strategy for the sustainable management of marine resources. In current practice, CBMRM initiatives often build upon customary forms of marine governance, integrating scientific advice and management principles in collaboration with external partners. However, diverse socio-economic developments as well as limited legal mandates can challenge these approaches. Compliance with and effective (legally-backed) enforcement of local management strategies constitute a growing challenge for communities—often resulting in considerable impact on the success or failure of CBMRM. Marine management arrangements are highly dynamic over time, and similarly compliance with rule systems tends to change depending on context. Understanding the factors contributing to (non-) compliance in a given setting is key to the design and function of adaptive management approaches. Yet, few empirical studies have looked in depth into the dynamics around local (non-) compliance with local marine tenure rules under the transforming management arrangements. Using two case studies from Solomon Islands and Fiji, we investigate what drives local (non-) compliance with CBMRM and what hinders or supports its effective enforcement. The case studies reveal that non-compliance is mainly driven by: (1) diminishing perceived legitimacy of local rules and rule-makers; (2) increased incentives to break rules due to market access and/ or lack of alternative income; and (3) relatively weak enforcement of local rules (i.e., low perceptions of risk from sanctions for rule-breaking). These drivers do not stand alone but can act together and add up to impair effective management. We further analyze how enforcement of CBMRM is challenged through a range of institutional; socio-cultural and technical/financial constraints, which are in parts a result

of the dynamism and ongoing transformations of management arrangements. Our study underlines the importance of better understanding and contextualizing marine resource management processes under dynamic conditions for an improved understanding of compliance in a particular setting.

Keywords: community-based marine resource management (CBMRM), compliance, enforcement, legitimacy, customary governance, transforming management, South Pacific

INTRODUCTION

The effect of formal and informal rule systems to manage natural resources largely depends on people's compliance behavior (Keane et al., 2008). In other words, rule compliance fundamentally influences the outcomes of conservation and related management interventions. In the marine realm, compliance has been linked to the ecological performance of marine protected areas (Pollnac et al., 2010; Campbell et al., 2012). In a broader sense, non-compliance with environmental regulations can threaten social and economic management objectives (Arias et al., 2015). Therefore, understanding drivers of (non-) compliance is crucial for the design and implementation of marine management efforts.

Compliance can generally be defined as people's behavior that conforms to formal or informal rules which have emerged to influence actions (Tyler, 2006; Hauck, 2008). Within the fisheries context, the literature has highlighted different theoretical and empirical dimensions of compliance (Sutinen and Andersen, 1985; Kuperan and Sutinen, 1998; Hønneland, 1999; Sutinen and Kuperan, 1999; Hauck, 2008; Arias, 2015). Economic analyses of fisheries compliance have stressed that an individual's decision to comply or not with a rule is mainly based on a consideration of the potential economic costs (related to the certainty and severity of sanctions) and benefits of doing so (Sutinen and Andersen, 1985; Hatcher et al., 2000). More norm-based perspectives on compliance have emphasized internal and social incentives for (non-) compliance such as normative values, morality, perceptions of legitimacy and social justice (Hønneland, 1999; Jentoft, 2000; Raakjaer Nielsen, 2003; Hauck, 2008).

The influence of the perceived legitimacy of rules on the rule acceptance by resource users has been widely stressed (Sutinen and Kuperan, 1999; Jentoft, 2000; Keane et al., 2008). Legitimacy aptly refers to the acceptance of decision-making and its outcomes by citizens (Van Tatenhove, 2013). It is related to the "perception that the actions and products of a certain entity are wished for and in accordance with a socially constructed set of norms, values, principles and definitions" (Van Tatenhove, 2011, p. 91). If resource users do perceive the rules and decision-making as legitimate, it is more likely that they choose to comply (De Vos and Van Tatenhove, 2011). The two perspectives, the more normative, i.e., norm-based, and the economic/rational choice view, on compliance are not mutually exclusive (Schlüter and Theesfeld, 2010). Furthermore, compliance is dynamic, changing in response to the local context. Thus, elements of both perspectives, as well as an analysis of how rules developed and what influenced them, are needed to gain a better understanding of compliance dynamics. Such analysis should therefore also question who defines rules and (non-) compliance as well as the power dynamics inherent in these processes (Hauck, 2008).

Moreover, monitoring and enforcement is considered a key part of successful natural resource management (Ostrom, 1990; Gezelius, 2002; Keane et al., 2008) that can contribute to improved compliance behavior. It is often argued that the effectiveness of monitoring and enforcement influences how people evaluate the risks of rule-breaking (certainty and severity of sanctions) and thus determines the deterrent threat—which can influence people's consideration whether breaking a rule is worth the risk (Jackson et al., 2012).

Marine governance and natural resource management systems are contextual, dynamic and continuously adapting to transforming social, political, economic and ecological conditions (Ostrom, 2007; Aswani and Ruddle, 2013). We argue that a better understanding of compliance dynamics, analyzing under what pressures and circumstances compliance can decrease or increase, is useful to gain improved insights into overall governance dynamics. This can be crucial to inform adaptive management of marine resources.

In this article we conduct a study of two cases, located in Fiji and Solomon Islands, for an in-depth analysis of local compliance with local marine resource management. In both Melanesian countries inhabitants have long records of interaction with the marine environment. Customary tenure systems have been the prevailing management regime for inshore fisheries in the South Pacific for a long time (Johannes, 2002; Caillaud et al., 2004; Govan et al., 2009). However, these systems have not been static over time. In the late twentieth century customary marine tenure approaches seemed to be eroding due to various impacts of "westernization," e.g., the introduction of top-down management approaches and new fishing techniques as well as evolving market dynamics (Johannes, 1978). For the past two decades though, a reinvigoration of these initiatives has been ongoing, based upon communities' traditional knowledge and customary rights whilst integrating modern management principles and scientific advice (Johannes, 2002; Cinner and Aswani, 2007). Hence, in current practice, a hybrid that combines customary tenure systems and science-based conservation approaches is often promoted (Aswani and Ruddle, 2013).

In many cases this happens in collaboration with non-governmental organizations (NGOs) and other partner organizations, including from government, which brings in new actors and influences local management practices (Cohen and Steenbergen, 2015). These community-based management approaches have received wide recognition given their potential to promote local food security, sustainable fisheries management, and marine conservation (Govan, 2013; Weeks and Jupiter,

2013). Yet, customary governance and institutions—which are still at the core of these approaches—are being challenged by diverse socio-economic developments as well as cultural changes. This results in transformations, which have long been a feature of the Oceanic region (Aswani and Ruddle, 2013). Additionally, local leaders are constrained in their capacity to enforce local marine tenure rules owing to limited legal mandates. This is due to the fact that these rules, many of which are area-based (e.g., in the form of marine closures), are generally not legally gazetted under national law. In this study we will look at such marine closures, which we refer to as "managed areas."

This study examines the emergent conditions that may challenge compliance with CBMRM—which can ultimately hinder it from achieving the above-mentioned social and ecological aims. We ask two questions: (1) what socio-cultural, economic and legal conditions drive local (non-) compliance within CBMRM? And (2) what challenges, and what supports, the effective enforcement of CBMRM? Previous studies in the region have examined local compliance with fishery rules and regulations (including national-legal; e.g., Pomeroy et al., 2015), where monitoring and enforcement mechanisms vary. Others (e.g., Jupiter et al., 2010) have examined compliance with CBMRM, including by "outsiders"—who do not have customary fishing rights to a given fishing ground. Overall, little attention has been given to a more in-depth assessment of compliance behavior of local villagers who have customary fishing rights within the respective managed area. Given locals' unique rights situation and the limited legal mandate for enforcing marine closures, it is important to elucidate different drivers of local (non-) compliance while scrutinizing the role of local social, political and economic contexts and their dynamism. This is the primary purpose of the present study.

METHODS

Study Sites

Research was conducted at one site in each of Solomon Islands and Fiji (from now on referred to as SI and FJ, respectively). The case study sites were selected purposively, which allowed choosing cases that illustrate features or processes considered relevant for this study (Silverman, 2010). Research sites were selected to feature communities that: (1) directly use local marine resources, (2) have some form of management regime established for a considerable period of time, and (3) where management arrangements have been supported and accompanied by partner agencies as part of conservation and development initiatives. These three factors were considered because they are likely to influence (perceptions of) management and compliance dynamics.

Fiji

In Fiji, the Fisheries Act (Cap. 158) grants native Fijians customary fishing rights in their respective traditional fishing ground (*qoliqoli*) (Minter, 2008). Customary chiefs and clan heads can control access to fishing areas and make decisions regarding local marine tenure. Generally, chiefs and communities have decisive authority over local resource management (Veitayaki, 1998). Fishing areas are clearly demarcated and thus spatially define access rights (Weeks and Jupiter, 2013). Although the Fisheries Act remains the primary piece of legislation for inshore fisheries, customary right holders have unique and exclusive access rights to their traditional fishing ground. This creates a legal pluralist situation that can challenge local enforcement capacities in the face of current CBMRM practice.

In Fiji a village on the island of Ovalau, Lomaiviti Province, served as local case study site (FJ, **Figure 1**). With its ∼350 inhabitants, FJ shares a traditional fishing ground with four other villages, although these have separate managed areas. In this village, marine resources and fishing have traditionally been an important part of peoples' lives. Yet, other livelihoods (mainly small-scale agriculture) are available and additional income-generating activities (mainly through employment in the nearby fish factory, especially for women) are practiced. The village set up a managed area in the form of a periodically-harvested closure in front of the village about 10 years ago, with assistance of a regional network and other partners. The site has generally remained closed to any harvesting activities since its establishment. However, a small section of the managed area has been opened several times for a couple of days in cases of chiefly (or other important villagers') deaths.

Solomon Islands

In Solomon Islands the constitution and fisheries legislation also recognize customary rights. Diverse socio-cultural, historic and economic processes have created differential and contested territorial customary rights systems. As a result, customary marine tenure systems vary regionally and are generally more stratified, decentralized and politically eclectic than in Fiji (Aswani, 1997, 1999).

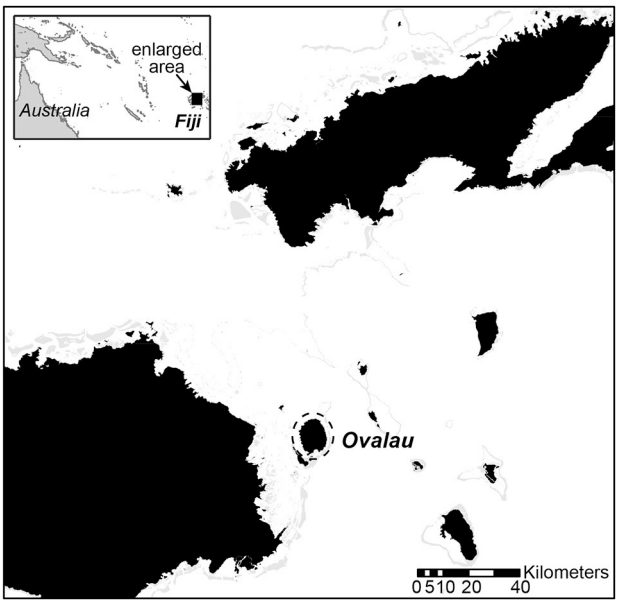

FIGURE 1 | Map of Fiji and research area.

In Solomon Islands, our research was conducted in a village in Roviana Lagoon in the Western Province (SI, **Figure 2**). In this area, customary chiefs and elders control access to and use of marine resources. Villages in Roviana Lagoon are remote and only accessible by boat. Approximately 1,000 people live in SI. Households are highly dependent on marine resources. Fishing is the single or second most important livelihood, together with small-scale agriculture. Local marine resource management consists of a marine closure in front of the village that is permanently closed for all fishing and other marine harvesting activities. This site forms part of a marine conservation and development program initiated in the late 1990s that included 32 management sites across the Western Solomon Islands. The program was established with advice of foreign academic experts and was financially supported through external (international) donors (see Aswani et al., 2007). A community-based organization (CBO), founded in the course of the program, assisted with the management and implementation of the marine closure in collaboration with local leadership (customary and church leaders) and a local resource management committee that was created for this purpose.

Qualitative Data Collection

In this study we wanted to examine the complexities of locals' perceptions and behavior around compliance, while considering the local cultural context, including the meaning of norms and informal rules. Ethnographic data were collected using various qualitative methods (Corbin and Strauss, 2008; Silverman, 2010). We employed semi-structured and key-informant interviews (total $n = 63$; thereof 29 in Fiji and 34 in Solomon Islands), focus group discussions (total $n = 5$; thereof 3 in FJ and 2 in SI) and participant observations. Policy and legal documents (fisheries legislation) served as secondary data sources for triangulation.

FIGURE 2 | Map of Solomon Islands (Western Province) and research area.

Data were collected over a 2 month period in each country, between April and June 2015 in Solomon Islands and between August and September 2015 in Fiji.

A total of 99 persons participated in the study, 48 of which participated in Solomon Islands and 51 in Fiji. Interviews and focus groups involved respondents from different governance levels: village ($n = 76$), province ($n = 4$) and national ($n = 19$). At the national and provincial levels interviews were conducted in English. Interviews and focus groups with village respondents were held in the respective local language (Fijian and Roviana), with the help of local interpreters. Prior informed consent was sought orally from all research participants. Research was conducted in accordance with all ethical standards outlined in the White Paper on Safeguarding Good Scientific Practice by the German Research Foundation (DFG, 2013). An ethics approval was not required according to the DFG guidelines, as well as to our institutional guidelines and the regulations in the study locations. All required procedures for conducting research and obtaining research permits in the study locations were followed closely.

Sampling

At the village level, interviewees were selected purposively to cover a broad range of potentially relevant respondent characteristics and individual perceptions. The following contextual variables were developed for this sampling process: (1) marine resource users; (2) persons involved in local decision-making; (3) age; (4) gender; (5) church denomination (mainly for the Solomon Islands case study, where this emerged as a key aspect for people's role within and perceptions of the community); (6) involvement in other livelihoods apart from fishing (mainly for the Fijian case study, where this seemed to lower direct resource dependency and hence influence views on the marine closure and compliance issues). Interviews were used to get an overview of relevant themes and divergent views regarding local (non-) compliance. Selecting interviewees at the village level was done in an iterative process. Thus, initial analysis and results gained through the interviews were used to elaborate the above-mentioned contextual variables and to select further interviewees as well as key informants. Interviews at the village level were conducted until no new additional information or themes were emerging (i.e., until saturation was reached).

Interviewees may not represent the view of everyone in the village due to the fact that we used non-random sampling. In order to minimize potential biases (e.g., due to personal networks and social relations) during the selection of research participants, we worked with interpreters who were not from the research sites.

Focus groups built upon key themes that emerged from the interviews, allowing for data triangulation. Focus groups were comprised of seven to eight participants each. They were conducted separately for women, men, and in Fiji also for the youth, because there a stronger generational differentiation became apparent. The majority of the focus group discussants were involved in fishing. Some (especially older men) were or had also been involved in local decision-making, and some had a different income source (especially women in the Fijian case study through employment in the fish factory). Focus

group participants were chosen purposefully in collaboration with local field assistants while seeking a good balance of potentially relevant characteristics of the participants (e.g., church denomination in the Solomon Islands case study).

At the provincial and national levels, representatives from relevant ministries or departments (e.g., fisheries and environment), civil society (e.g., NGOs and international organizations) and academia were interviewed. Purposive and snowball sampling was used to identify respondents at these levels. Using a snowball sampling approach runs the risk that only certain opinions are heard due to path dependencies. In order to avoid this fallacy we sought specifically to interview actors with potentially opposing views.

Interview Guidelines and Questioning

For data collection at the village level we used indirect questioning, i.e., asking respondents about the compliance behavior of others and not (necessarily) their own. This was done in order to diminish potential response biases (people giving inaccurate information), as well as nonresponse biases (people refusing to give information) (Arias et al., 2015). Such biases were expected because questions around (non-) compliance touch upon sensitive issues, especially in a small village setting. The utility of such an assessment of what can be referred to as "perceived compliance" as a proxy for actual compliance has been demonstrated in other studies (Arias and Sutton, 2013). Yet, it should be taken into account that theories such as the social norms approach (Berkowitz, 2005) argue that people tend to overestimate the non-compliant and negative attitude of their peers beyond their actual behaviors. Nevertheless, it is also conceivable that a direct approach would not have revealed much non-compliance either, or that interviewees would have belittled their own infringements.

Guidelines were used for the interviews and focus groups at the village level (see Supplementary Material). Through the interviews we first wanted to gain an understanding of the local marine resource management arrangements, changes regarding these arrangements, and peoples' perceptions of them. Therefore, interview questions firstly enquired about: existing and previous local marine resource management, perceptions of their purpose and benefits, issues regarding local decision-making, and peoples' participation in it. Secondly, questions were asked about: perceptions of local compliance with rules, enforcement, and local management of disputes. Similar questions and themes to the ones addressed in the interviews guided the focus groups, though in a more interactive and collective way (Mancini Billson, 2006). For example, participants were asked to discuss reasons for non-compliance and collectively identify and rank the most important drivers of non-compliant behavior, while being asked to explain for whom (which group) these drivers were important and why. Furthermore, participant observations (e.g., attending informal gatherings, a village market, and a church service; going to sea with fishers; accompanying locals on village walks) were used to further contextualize and triangulate information obtained otherwise.

At the provincial and national levels interviews enquired about: respondents' perceptions of the potentials and challenges of local marine resource management in their country, their views on local compliance, enforcement, and the role of the national legislation (and, if applicable, of the respondents' agency) with regards to this.

Data Analysis

Data from all interviews and focus groups were transcribed and analyzed inductively through open, axial and selective coding (Corbin and Strauss, 2008). Qualitative data analysis software (MAXQDA) was used to identify and relate emerging themes and patterns from the transcripts and to link these to secondary data sources (e.g., legislations) as well as to the theoretical and empirical literature. Further information on the codes used for the analysis can be found in the Supplementary Material.

RESULTS

Data from our research reveal that in both study sites many locals—including some who were non-compliant—perceived local non-compliance with the marine closure as a problem with the potential to dismantle the social and ecological effects of these local management efforts. In SI, consensus was reached in the focus group discussions that people from different age groups, gender, and church denominations were inclined to disobey the managed area. In FJ, our data from interviews and focus groups reveal that mainly young male divers who lacked an alternative stable income tended to disobey the marine closure. In FJ, due to its relative closeness to the capital city, the managed area was challenged by external poachers (mostly commercial fishermen with fast boats) besides local non-compliance.

In the following, we summarize the main aspects related to (non-) compliance that emerged from our two cases, before presenting individual results from each case study.

In both case studies, results from the interviews and focus group discussions suggest that lowered perceived legitimacy of local rules (including the marine closures) and leadership was acting as a driver of non-compliance with the local marine resource management. Furthermore, economic incentives, e.g., related to market opportunities to sell fish, influenced non-compliance, too. Additionally, we find that the physical-geographical conditions of the managed areas, mainly related to their size and location, constrained villagers in accessing their primary fishing grounds, and thus promoted non-compliant behavior. Finally, our study reveals different barriers for monitoring and enforcement in the context of the two case studies. In both countries (and both case study sites), managed areas were generally not legally gazetted, and thus enforceable, under national law. This means monitoring and enforcement of local marine management in FJ and SI relied on local villagers and customary governance systems. Yet, in both case study sites these were constrained in a number of ways.

Fiji

Lowered Legitimacy of Rules and Rule-Makers

In FJ our study reveals two sets of aspects that partly constrained perceived legitimacy of the managed area, particularly for young fishermen. Firstly, data from interviews and focus groups reveal that a lack of participation and consultation regarding the local management, particularly about the size and location of the

managed area, lowered perceptions of its legitimacy. Especially male youth, but partly also older women, voiced that they did not feel involved or consulted during the establishing process of the managed area—and thus perceived the managed area as illegitimately constraining their customary fishing rights. In Fiji, the Fisheries Act grants customary rights to fish inside a certain *qoliqoli* (traditional fishing ground) to every native Fijian whose *mataqali* (clan or other subdivision) has been registered by the Native Fisheries Commission. This basically applied to all inhabitants of FJ. Although older male informants expressed, and other sources confirmed, that a consultation process did take place, it might not have involved all actors within the village that currently impacted upon and were impacted by the managed area. The current youth were still too young to witness the establishment process of the managed area 10 years ago, and were hence not part of that consultation. Women did not participate actively during workshops for other reasons (e.g., due to traditional gender roles that constrain women from actively participating in such meetings, or time constraints related to family responsibilities, or work at the fish factory).

Secondly, the current managed area varied from customary tenure arrangements practiced in earlier times with regards to its permanent nature as well as to its (perceived) main purpose. The first aspect relates to a change in the periods of closures. Data from our study reveal that the managed area was set up in a way that locals perceived as a permanent closure. Although customary leadership decided a few times to open one section of the managed area in the past in case of a chief's or another important villager's death, the "general status" of this part of the fishing ground was "closed." In previous times, the general status was "open," with temporal closures of a smaller section of the fishing ground to commemorate when a chief died. Therefore, villagers generally perceived the current managed area as permanent closure. This means the managed area was restricting fishing activities considerably more than previous practices used to. The second aspect relates to the perceived main purpose of the management interventions. Previously, customary approaches had served to impose periodic closures for special cultural and social events (commemoration of a chief's death). Indicated by consensus reached in a focus group discussion, these customary closures were thus perceived as mainly serving the (socio-cultural) purpose of having food for that special occasion and not for resource management. Focus group discussions disclosed that in current practice, locals perceived the aim of the managed area as being more focused on (longer-term) conservation objectives (notwithstanding that these conservation objectives are ostensibly linked to ensuring food security and thus allow for a continuation of the culture of fishing).

Both factors, the lack of participation and consultation as well as perceptions of the altered nature and purpose of the management arrangement, were especially stressed by young fishermen. Among this constituency, they lowered feelings of ownership for the local management initiative and increased the perception that the restriction of their customary fishing rights by the managed area was illegitimate. This in turn then drove non-compliant behavior by this group.

Market and Income Opportunities as Incentives

There was consensus among respondents that in FJ especially young men resorted to poaching as (small-scale) income generating activity. They mainly did so when they did not have an alternative source of income, such as work in the near-by fish factory. Because the catch per unit effort (CPUE) was (perceived) higher inside the managed area, fishing there promised a fast catch and easy cash when selling the fish, which happened mainly on local markets.

Physical-Geographical Conditions of Marine Closures

In FJ the managed area was located right in front of the village, stretching from the shore to the outer reef slope. This area had been chosen because indigenous ecological knowledge indicated that it was especially ecologically relevant. Yet, its location clearly limited the accessibility of the (permitted) fishing grounds. It implied that local fishers either had to walk long distances during low tide or that they needed a boat—which were rare. There was only one bamboo raft and two fiberglass boats available in the village; the latter came with costs for the fuel. These limitations to access the fishing grounds outside the managed area, implying more time and money investments, were an impediment to compliance with the managed area. Respondents throughout the interviews agreed that this could further promote fishing inside the managed area. This was more likely when coupled with the above-mentioned economic incentives, and applied especially to young fishermen who lacked an alternative livelihood or income.

Barriers for Monitoring and Enforcement

Although most managed areas are not legally gazetted in Fiji, they do receive partial legal back-up under the Fisheries Act under two scenarios. Communities can "arrest" a poacher who is caught fishing inside the managed area and take this person to the police or closest fisheries office if: (1) it is a licensed fisher who is not respecting the managed area (more commonly applies to commercial fishers from outside the village who do not have customary fishing rights in this area), because license conditions prescribe that local (customary) management rules ought to be respected, or (2) someone is selling fish (no matter where the fish was caught) without having a license. Nonetheless, these scenarios have limited applicability to local non-compliance where people draw on customary fishing rights to engage in subsistence fishing. Under the current Fisheries Act small-scale sale of catch that exceeds subsistence needs has so far been tolerated for customary fishing right holders. This is why the second scenario does usually not apply to local poachers. Yet, this issue has been recognized as a gray area and will probably be addressed in the course of reviewing the fisheries legislation—a process that was initiated in 2006 and is still ongoing.

Institutional Constraints

In FJ it is common to announce local poachers in village meetings or during church services. Commonly the chief or village headman speaks to that person to issue an oral warning, too. Nevertheless, respondents agreed that the deterrent threat of these penalties was not very high, especially because there were no graduated sanctions (nothing more serious happens

if that person poaches again). Further enforcement efforts of local marine resource management initiatives remained limited. In order to enforce managed areas under national law—in Fiji under one of the two scenarios described above—the police or another state authority would need to get involved. In Fiji local voluntary fish wardens are appointed to monitor local marine tenure rules (managed areas). At the same time these wardens are tasked with monitoring local compliance with national regulations, such as species restrictions and mesh size of nets, under the Fisheries Act. Fish wardens can be appointed by the Minister of Fisheries after receiving training by the Department of Fisheries. They are not paid nor do they receive any substantial financial support or equipment. Not all villages in Fiji have fish wardens—it rather depends on the initiative of the village itself and/or supporting partner organizations. Fish wardens or local leadership who want to report infringers to the police need to keep and demonstrate evidence of the infringement (e.g., confiscated catch, gear, boat). Yet, besides the training that fish wardens receive by the Department of Fisheries, they are not trained as prosecutors, and thus not familiar with the details of keeping evidence. Additionally, fish wardens often face police officers who are not aware of the fisheries legislation or who are reluctant to investigate and prosecute fisheries crimes.

Furthermore, findings from FJ show that, in former times, the temporal closures on fishing areas declared by customary leaders were more strongly related to a socio-cultural purpose and tradition (chiefly deaths). As a result, these taboos were more respected than current managed areas because "it [was] part of tradition and [breaching it] would go directly against the chief," as expressed by one respondent in FJ. The current managed area had been supported by partner organizations that have more clearly brought in conservation objectives as part of a sustainability discourse. Consequently, locals perceived the managed area in FJ less as a strict taboo in the traditional sense. Thus, offenses were perceived to oppose rules that had been influenced by external actors, instead of directly opposing a chiefly decision.

Socio-Cultural Constraints

Our study reveals various socio-cultural constraints for local monitoring and enforcement in FJ. Firstly, fish wardens were constrained in reporting local infringers due to the strong network of clan and family relationships they were embedded in. This means fish wardens usually knew local infringers well and might therefore have been reluctant to report non-compliant behaviors, as this might have negatively impacted their own social relations. The same limitation applies to chiefs and clan heads, who would decide about consequences to take against local poachers if these were reported by the fish wardens or other community members.

Secondly, the selection process for appointing fish wardens did not seem to be transparent and not everyone within the village was aware of the identity and the role of the wardens. This further impeded their work because some people might not have recognized their authority at all, or (again), perceived it as less legitimate.

Technical and Financial Constraints

In FJ villagers agreed that the area of the marine closure was too big to monitor from the shore, and monitoring would thus require patrols by boat. Yet, boats and/or money for fuel for the boats were lacking. Detection of infringers was further made difficult because poaching occurred at night most of the times. Additionally, respondents throughout interviews agreed that two fish wardens for the managed area were not sufficient, especially given that both of them were active fishermen, too. This means that many times they were involved in harvesting activities themselves while not being able to solely concentrate on monitoring the managed area.

Solomon Islands

Lowered Legitimacy of Rules and Rule-Makers

In SI data from our study disclose that two developments generally lowered the perceived legitimacy of local leadership, which included chiefs and the council of elders who made decisions about marine tenure, persons who implemented these (e.g., rangers), and the church. One of these developments was associated with the (perceived) misuse of money; firstly in relation to logging activities that were ongoing on the main island opposite the village, but also with regards to the management of the managed area. Since inhabitants of the community owned the land where the logging company was operating, they had been receiving a substantial amount of "royalty payments" on a regular basis. This money was given to some of the leaders ("trustees") to share it among the community. A large proportion of interviewed villagers perceived that this did not happen in a transparent and equal way. This caused perceptions of unequal benefits and procedural unfairness in SI, and was given as a reason for non-compliant behavior as a payback strategy against the leaders.

Similarly, many locals perceived that the money that was given by international donors to support the local CBO and resource management committee (including local rangers) was not being used transparently and in a way that was beneficial to everyone. Particularly some women expressed their growing mistrust toward the (predominantly male) leadership, highlighting that they no longer followed rules (i.e., the managed area) made by this leadership. As one woman pointed out when asked about conflicts with regards to the managed area: "Yes, there were also conflicts, especially with the money. These people [referring to the local leadership] are not reliable. [...] They are not transparent. [I] was one of these poachers [...]. [But] I was not poaching, [I] was showing that [I] was not happy about the decisions [the leadership was taking], so when they [rangers] came up, [I] would tell them '*you tell me where the money went, and then I stop fishing in this area.*"' In SI women actively participated in fishing and harvesting of other marine resources (mainly shells), thus providing an important food source for their families. Yet, they hardly took part in local decision-making processes, including with regards to the management of marine resources, and were underrepresented in leadership committees such as the council of elders. Over the last century chiefs were mostly male, too.

The second development that led to diminished, and divergent, perceptions of the legitimacy of the council of elders and leadership in SI was related to the division of the predominant local church. In SI religious leaders played an important role within customary governance processes for a long time and were involved in ongoing conservation and management initiatives. The leader of the predominant local church gave his blessing for the managed area years back (in 2005), which was of great importance and meaning for locals in order to respect it as conservation area. Later, when this spiritual leader fell sick, discussions about his succession turned into a conflict between the two competing aspirants and their respective supporters. The church members were divided into two groups. The division affected the council of elders and other leadership meetings, too, because most of their members belonged to one or the other group. Since the death of the (former) spiritual leader in 2014, animosities between both groups increased further. The schism not only generated divergent views as to which spiritual leader to follow from now on, but also doubts about the acceptability of leadership, such as the council of elders, and their decisions. Data from interviews and focus groups reveal that it also generally deteriorated feelings of shared group membership and identity as well as trust within the community. This further diminished cooperative and prosocial behavior—including with regards to the managed area, where this led to more non-compliance.

A further aspect that is enhancing heterogeneity of the local population and adding to socio-cultural diversity is the fact that in SI, many people from other tribes and provinces were marrying into or out of the village. This was referred to as "intermarriage" and was a common theme coming up throughout interviews with diverse respondents. Although intermarriage does not necessarily lead to disunity, it was mostly raised as potential problem that had detrimental effects including on compliance with the managed area. An older fisherman in SI expressed: "[...] Those people who are married here, because they have different traditions and "*kastoms*" in their respective homes, they just don't tend to follow [the rules set by the local leaders, such as the managed area]."

Our study shows that people's decisions to comply were influenced by the perceived compliance behavior of others in the community and perceived unequal distribution of benefits (from rule-breaking), as this statement by a male respondent in SI underlines: "I support not to fish in conservation areas. But if I keep on talk talk talk to members of the community not to go out [to fish inside the managed area], and people do not listen to me, do you think I will keep on talking talking talking? I will also want to have fish. In turn I will go and fish [inside the managed area], too."

Finally, and similarly to findings from FJ, results from a focus group in SI reveal that locals perceived the current marine closure as an alteration of former customary practices and temporal closures. This was firstly due to its permanency, and secondly, due to a perceived shift from a socio-cultural purpose toward a stronger focus on conservation objectives.

Market and Income Opportunities as Incentives

In SI there was consensus throughout the focus group discussions that poaching within the managed area for an income intensified when new market access opportunities arose—through middlemen and ships of the logging company operating nearby. The latter offered access to the market of the island's capital because villagers could put their coolers with fish for free on the logging ships when they made their way to the capital harbor, and sell it there. In SI alternative sources of cash income apart from fishing for sale were limited to marketing of local products, including copra, and operating small stores. Hence, for people wishing to earn some money (e.g., to pay school fees for their children or for church contributions) instead of living merely on a subsistence basis, poaching and selling the fish became more attractive. Again, there was consensus among respondents that the CPUE inside the managed area was higher (which is also related to the biophysical and ecological characteristics of that area), which further incentivized fishing inside the area for an "easy catch."

Physical-Geographical Conditions of Marine Closures

In SI the managed area was located directly in front of the village, too. The location of the marine closure had been decided based upon: indigenous ecological knowledge, scientific ecological surveys, and ease of monitoring (due to its proximity to the village), and the decision happened in consultation with the local leadership. Interview respondents similarly agreed that some (in this case especially older) people poached because they were "too tired to go far out to fish." Further, female respondents raised the complaint that the closure particularly constrained their fishing activities because it was set up in an area where mainly women used to fish. As one (female) respondent put it: "That is the number one place where [women] used to fish!" She further explained, and other respondents confirmed, that this was due to the area's closeness to the village. Women, due to their multiple responsibilities in the household and involvement with child care, could not afford to spend long hours fishing or go to more distant fishing grounds.

Institutional Constraints for Monitoring and Enforcement

In SI an interview respondent expressed that, apart from national laws that prohibited most customary penalties, the influence of missionaries and Christian imperatives weakened the effect of customary sanctions. This is related to the concept of "forgiveness" that was introduced by Christian missionaries in the early twentieth century. An old fisherman in SI explained: "Before missionaries came and before the church was here, our traditional governance [was] much more feared [...]. Because we only had one rule with[in] our traditions: you do something wrong which is against our traditions, we will kill you. [In the course of Christianization these penalty systems were weakened]: so when you break rule in our traditional way, the church comes in. That is forgiveness. When the church comes in, there is no longer value for our traditions." On the other hand, the involvement of the religious leaders in the marine conservation program in SI also served as a vehicle for reviving traditional

systems and strengthened traditional leadership. Before the schisms of the local predominant church the fear of the spirit of the spiritual authority was very strong. But as the strength of this leadership weakened, so did the fear of retribution.

In general, the perceived risk of sanctions for non-compliance with the managed area was very low in SI, and therewith the deterrence threat for rule-breaking. Previously, non-compliance with the managed area used to be addressed in village meetings and/or church gatherings to publicly announce and warn offenders. This became less common since the schism and the resulting division of the community, because generally less village and leadership meetings took place since then. Also, the effect of verbal warnings and public announcement recently decreased due to the community division and resulting divergent views on the legitimacy of leadership which made these announcements.

Socio-Cultural Constraints

In SI the church schism and related division of the community also affected monitoring activities of the local rangers who used to detect and "arrest" (stop/talk to) local infringers who fished inside the managed area. Back then, incidents were reported to the local resource management committee and/or to the council of elders who would then announce it in respective meetings. When data for this study were collected, these rangers were no longer active and no one else took on the responsibility of monitoring. This was partly due to the mentioned socio-religious division of the community, as well as to other disputes around (the perceived misuse of) money and logging, which significantly weakened the role of the supporting CBO and the rangers.

Technical and Financial Constraints

In SI villagers and rangers had access to wooden canoes that can be used for monitoring the managed area. However, lack of funding for the CBO that was previously supporting the management and equipping rangers, e.g., with torches for their night shifts, is another reason, besides the ones mentioned above, that was recently constraining monitoring activities. Rangers had previously complained about a lack of regular salaries. A self-sufficient and sustainable structure to finance monitoring activities was envisaged by the supporting external partners in SI but did not succeed. Still, other (mainly female) interview respondents conveyed their impression that rangers were receiving payments for their work in the past, which in their eyes increased (financial) inequalities in the village.

DISCUSSION

Natural resource governance and management systems adapt to and are conditioned by the larger social, political and economic realms they are embedded in Aswani and Ruddle (2013). Compliance with these systems is equally dynamic. Recognizing this dynamism, and analyzing under what pressures and circumstances compliance can decrease or increase, can help to understand how to tackle problems in adaptive management of marine resources. In order to do so, we have taken a snapshot of (non-) compliance in two case studies in Melanesia.

Compliance has been recognized as fundamental for successful marine conservation (Keane et al., 2008; Arias et al., 2015; Cinner et al., 2016). Therefore, understanding drivers of (non-) compliance as well as barriers to enforcement is crucial in the assessment of marine management. In this study we find that people's compliance behavior is influenced by many factors. Non-compliance is partly driven by lowered perceived legitimacy of local decision-making and its outcomes. Furthermore, financial incentives and the physical-geographical conditions of the managed areas—constraining access to primary fishing grounds—can make fishing inside these areas more attractive or necessary. Finally, data from our study reveal that enforcement is impeded through various (institutional; socio-cultural; technical/financial) constraints, so that the deterrence threat for rule-breaking is rather low. These findings are consistent with other empirical studies and theoretical literature on compliance that have highlighted that both economic motivations as well as normative and social aspects—including around the process of how and by whom rules were set up—influence people's decision to comply (or not) (Gezelius, 2003; Hauck, 2008), and that monitoring and sanctioning is crucial, too (Ostrom, 1990; Gezelius, 2004; Keane et al., 2008).

These drivers and factors can act together and add up to impair effective management. For example, in FJ we find that young fishermen were more likely to poach when they did not have an alternative livelihood or other income. They did so more readily: firstly, because they felt that the managed area was illegitimately constraining their customary fishing rights (partly because they did not participate in its establishment process), and secondly, because they knew that potential penalties were unlikely (since they were making use of their customary fishing rights and did not have to fear sanctions under national law). In SI more people were poaching, and increasingly did so to make money as a consequence of easier market access, because perceptions of the legitimacy of leadership diminished as a result of the schism and perceived money misuse. Also, the community division resulting from the schism had weakened the role and endeavors (as well as acceptance thereof) of leadership and rangers with regards to monitoring and enforcing the managed area. Nonetheless, in SI the leader of the predominant local church had previously been a vehicle of the conservation initiatives, which first increased their perceived legitimacy amongst villagers. This again points to the dynamism of governance and local leadership, as well as their potential vulnerabilities. It is conceivable that a revitalization of this leadership will result in the re-establishment of the managed area and its rules and monitoring. This highlights the need to develop "fallback systems," especially when conservation initiatives build upon such local leadership structures.

Contextualizing Drivers of Non-compliance

In FJ the fact that current young fishermen were too young to witness the establishment process of the managed area, and

thus did not participate or feel involved in decision-making for local marine resource management, turned into a driver for non-compliance for this particular group. Women were generally less involved in the consultation about the managed area, too. But because many women were employed in the fish factory, they did not perceive this as negatively as young fishermen, who depended more directly on fishing for their livelihood. Also, young local fishermen had witnessed commercial fishermen from the capital city poaching in the managed area. This might have further encouraged young local fishermen to fish inside the managed area because in the face of such a race for fish locals may have wondered why they should obey the marine closure if others were reaping the benefits. Other studies have similarly revealed that young age, which often goes along with less participation in the process of developing the rules, can lower support for and compliance with such rules (e.g., Schlüter and Madrigal, 2012; Madrigal-Ballestero et al., 2013). This highlights the importance of participation with equal access for and representation of all groups affected to generate legitimacy and increase rule acceptance (Jentoft, 2000; Van Tatenhove, 2013). In the cases studied here it was obviously not practically feasible to involve future fishing generations in the participation process 10 years ago. Yet, it shows that participatory, outreach and consultative processes should take place continuously and repeatedly to renegotiate management arrangements if necessary. In order to do so, funding programs that support partner organizations engaged in CBMRM would need to consider longer-term funding cycles and perspectives.

Van Tatenhove (2011, 2013) describes the process of increasing rule acceptance through participatory measures as "input-legitimacy," whereas "output-legitimacy" refers to whether decision-making succeeds in promoting common welfare for all people affected by these decisions. In SI the perceived misuse of money on behalf of the leadership and people involved in the management of the managed area led to perceptions of unequal benefits, lowering output-legitimacy. The experience of procedural unfairness through such unfair decision-making and/or outcomes thereof can erode "feelings of shared group membership with the authority concerned" as well as the identification with the rules that this authority establishes (Jackson et al., 2012, p. 1053). The previously-quoted statement by a fisherwoman in SI shows that this was the case, as she expressed that she perceived fishing inside the managed area no longer as poaching, but as a way to show her disagreement with the rules and with the unfair behavior of leadership.

Generally, trust and cooperation among resource users are proven to be crucial for effective local governance of common-pool resources (CPRs) and make a sustainable use of CPRs more likely (McCay and Acheson, 1987; Gibson et al., 2000; Basurto et al., 2016). This elucidates why a decrease in trust, including toward leadership, and cooperative behavior within the community that followed from the schism, recently diminished compliance with the marine closure in SI. Intermarriages were adding to this because they can counteract feelings of shared group membership toward leadership and increase tenurial claims over fishing access. This intensifies fishing pressure and potential conflicts over (access to) resources. Also, people from outside of the community bring in their own tribal identity and traditions, which are very diverse across Solomon Islands (Aswani, 2002). Finally, an increasing number of people (temporarily) migrate out of the communities for marriage or employment, but they uphold their customary rights. This can result in increased non-awareness of "outside rights holders" with regards to local rules and management arrangements. All together, these factors might imply less respect for the local customary leaders and the decisions made by them. Although the schism and intermarriages revealed in SI can be seen as rather case specific phenomena, they also demonstrate the high degree of stratification and contestation of socio-political and tenurial systems in Solomon Islands (Aswani, 1999). Furthermore, the case demonstrates the dynamic and dual role that the church can play in local marine management, as pointed out before.

In both case studies villagers perceived the marine closures as being more focused toward achieving conservation objectives, instead of serving primarily cultural and social purposes like former customary closures used to (Cinner and Aswani, 2007; Foale et al., 2011). Management had shifted from periodic closures to periodic openings/permanent closures, which limits the flexibility of these marine tenure systems (Hviding, 1998). Both management sites had been partly supported by and/or implemented in collaboration with external partners. They exemplify the hybrid approach that lays the basis for much of the current CBMRM practice that merges customary management and traditional ideas with conservation practice and sustainability discourses. Yet, locals distinguished between these practices and the underlying objectives, as other studies have found, too (Jupiter et al., 2014; Cohen and Steenbergen, 2015). Our study shows that this is likely to affect perceptions of legitimacy of these rule systems and thus local compliance with CBMRM. Also, violations of rules that were externally influenced were considered less severe than a breach of customary norms and taboos. These aspects should be considered by partner agencies that work with communities in the frame of CBMRM initiatives.

Market access and the lack of alternative livelihoods were increasing non-compliance in both case studies. Numerous studies have highlighted market access and proximity, and the commercialization of marine resources, as key drivers for resource (over-) exploitation, with the potential to affect local management regimes (Aswani, 2002; Cinner and McClanahan, 2006; Brewer et al., 2009; Cinner et al., 2012, 2016). Similarly, the reliance on fishing as single livelihood has been proven to negatively affect local compliance with marine conservation areas (Arias et al., 2015). On the other hand, evidence also suggests that high dependence on marine resources at the community level can be a contributing factor for sustainable local marine resource management (Cinner et al., 2016). The apparent contradiction may be explained by the potentially contrasting effects of dependence on marine resources at the household and the community level. While communities with a high overall reliance on marine resources can be compelled into collective action by this dependency (Ostrom, 2009), individual households within a community might be more strongly compelled to break

the rules if marine resources constitute their sole option to generate income and sustenance.

The location and size of the managed areas restricted access to the most accessible (and productive) fishing grounds in front of the villages. In both cases location and size were decided based upon indigenous ecological knowledge. The locations of the closures were also selected due to their proximity to the villages and so to enhance feasibility of monitoring. Yet, because the managed areas constrained villagers in their ability to fish, this proximity partly turned into an additional driver for non-compliant behavior in both case studies. This illustrates how a feature that was initially seen as an advantage can turn into disadvantage when conditions and context change. Furthermore, it shows that there can be critical trade-offs between achieving ecological objectives and social acceptance (compliance) with regards to managed areas. Ecological requirements for conservation might require a certain spatial and geographical scale for management, which might not in all contexts be socially acceptable (Johannes, 2002; Foale and Manele, 2004; Mills et al., 2010), and hence less complied with. Besides, it points to the fact that the costs and benefits of conservation efforts might be unevenly affecting different social groups (see Eder, 2005 for a case study from Philippines). In SI especially older people and women were constrained by the managed area. In FJ particularly young fishermen who needed to fish because they were lacking an alternative income, but who at the same time did not have a boat to reach more distant fishing grounds, were bearing a higher burden. In this light the importance of continuous participative and communicative measures in order to increase ownership, legitimacy and support of management rules (Jentoft, 2000; Pomeroy et al., 2015) becomes even more evident. Such measures should take into account differentiated impacts of management efforts on diverse social groups (Gurney et al., 2015) and potentially adapt marine management to ensure more equitable arrangements.

At the same time, the just-mentioned reasons for non-compliant behavior again highlight the importance of acknowledging the wider social and economic context of illegal fishing practices and non-compliance. For examples from Indonesia, where existing local elites and complex patronage (patron-client) networks have contributed to non-compliance with marine management rules, and thus hampered conservation efforts, see Lowe (2002), Ferse et al. (2012), and Kusumawati and Visser (2016).

Addressing Barriers to Monitoring and Enforcement

Customary governance systems are not static over time but have always operated within dynamic socio-cultural, political and economic contexts (Aswani and Ruddle, 2013). This has similarly affected legal and institutional aspects of monitoring and enforcement, such as penalty systems. Also, as the Solomon Islands case study demonstrates, some institutions that strengthened customary tenure systems in a certain setting can have a different effect when the context changes.

At the same time, findings from FJ and SI reveal that diverse socio-cultural constraints can limit local monitoring and enforcement efforts, especially in a setting where socio-cultural relationships between tribes, clans and families are highly complex and an important social capital, as well as a crucial aspect of local culture and identity. This shows how socio-cultural values that remain from customary systems and traditions can also potentially hinder the effective implementation of hybrid management arrangements if enforcement responsibilities solely rely on the local level.

Customary fishing rights, which are recognized by national law as part of customary law, are at the core of the local marine resource management schemes studied here. Yet, the local management arrangements (marine closures) as such were not legally recognized by any national law. This has created a legal pluralist situation where different legal ideas and systems exist within a single setting (Scaglion, 2004; Hinz, 2008; Jentoft et al., 2009). It is crucial to evaluate how customary and state law interact or to which extent one of them is dominant (Jentoft, 2011). Generally, customary institutions and law remain the core means to resolve disputes in rural communities in Pacific societies until now (NZLC, 2006), including in the context of marine resources. Hence, they play a key role for the enforcement of marine tenure systems. In the past, customary penalties for breaking taboos included beatings, banishment or destruction of property. Breaching marine customary taboos, such as marine closures, was mainly punished by compensation payments in form of traditional money or livestock, social alienation or exclusion (Cinner and Aswani, 2007; Jupiter et al., 2010). Yet, the national legal systems have largely constrained the customary penalty systems given that nowadays most customary penalties are prohibited under national law. This effectively made the customary approaches less powerful.

In the cases studied here, customary law was locally decisive for managing the use of and access to marine resources. Nevertheless, in the current settings the customary systems alone were no longer capable of enforcing these local rules and to sanction non-compliance. This was partly due to national laws that restricted the customary penalty systems, without (yet) providing an adequate substitute. This does not only show how modern legal systems can potentially lead to a (partial) erosion of customary management (Cinner and Aswani, 2007). It also highlights the need to clearly define and establish the roles and responsibilities of other (including government) actors involved in current CBMRM practice in order to ease their implementation and effective enforcement. In FJ and SI, sanctions that were practiced in cases of local non-compliance, such as oral warnings and public announcements, were showing limited success. Furthermore, those in charge of supervising compliance with local rules can be challenged by conflicting allegiances in pursuing their tasks, as is exemplified by the fish wardens in FJ. A similar situation was observed in an East African setting by de la Torre-Castro (2006), who cautioned that the local context, in particular the cultural setting, kinship and alliances, need to be carefully considered in the design of co-management institutions.

Previous studies have noticed similar shortcomings of local enforcement in local marine resource management in the

South Pacific, while also highlighting financial and technical constraints for local monitoring (Minter, 2008; Jupiter et al., 2010; Pomeroy et al., 2015). These studies have called for communicative measures, such as awareness programs and conflict resolution exercises, as well as improved administration under the fisheries legislation and increased law enforcement. The latter aspect might imply registering local management plans and penalty systems under national legislation. The new Fisheries Management Act of Solomon Islands (enacted in 2015, implementation is underway) offers communities the right to do so. It shall thus help to make local rules and penalties legally enforceable. This could contribute to restrengthening local enforcement capabilities while involving government actors more directly in enforcement efforts, too. Yet, the limited financial, personnel and time resources of the government to exercise these responsibilities and therewith reach out to the local level should be kept in mind. Also, such "legalization" should account for the flexibility of marine tenure systems in their continuously evolving forms and allow for adaptive management (Hviding, 1998).

Although voluntary compliance is preferred and likely to increase through participatory and communicative measures that enhance legitimacy (Jentoft, 2000), a certain degree of enforcement is often necessary (Arias, 2015) to create or increase the deterrent threat for rule-breaking. Effective sanction mechanisms are also crucial to avoid "contingent compliance," because individuals base their decision (not) to follow rules on the (perceived) compliance of others, too (Pomeroy et al., 2015), as our study shows as well.

Furthermore, the importance of having graduated sanctions for successful CPR management has been highlighted (Ostrom, 1990). Graduated sanctions are flexible to the seriousness and context of the offense (increasing with the frequency and severity of the infringement) and might hence be perceived as more legitimate. The existence of graduated sanctions has been positively related to resource users' compliance behavior (Cinner et al., 2012). However, in both case studies, graduated sanctions were not provided for in the current setting. Generally, sanctions could include social sanctions—which have been proven successful in inducing community cooperation and compliance (Ostrom, 1990). The design and perceived fairness of the enforcement system are again likely to influence perceptions of legitimacy (Pomeroy et al., 2015). Sanction mechanisms should thus also be formulated in a participatory manner, e.g., through consultations on which sanctions could be locally feasible and desirable.

CONCLUDING REMARKS

Our study reveals multiple drivers for local non-compliance with local marine resource management in two case studies in the South Pacific. In other words, this article outlines that locals fished inside the marine closures studied here for a number of different reasons and exposes how these reasons were influenced by dynamic social, political and economic contexts.

Perceived legitimacy of decision-making and decision-makers was considerably influencing compliance behavior in our case studies. To address this driver of local (non-) compliance, broad participatory, transparent and communicative efforts are crucial (see also Ferse et al., 2010). These should involve women and youth—both groups are often less involved in local decision-making. Incentives to break rules due to market access and/or lack of alternative livelihoods can be difficult to tackle as they mostly lie beyond the local reach. Yet, it becomes clear that the governance system needs to react when such external factors change. This might imply the development of new rules.

Our results show that multiple drivers of (non-) compliance interact. Hence, when legitimacy of local management rules and leadership is high/increased, it may more readily outweigh other incentives for rule-breaking. Vice versa, when the strength of local leadership is decreasing this might negatively affect compliance dynamics. Our study highlights that drivers of (non-) compliance are highly contextual. They react to and depend on the broader dynamics of marine governance systems. In other words, if the context of the governance system changes, this can affect rule compliance decisively. We therefore argue that it is important to build fallback mechanisms into governance arrangements that allow for adaptive management of marine resources.

By showing that perceptions essentially shape people's compliance behavior, our study brings to attention the importance of assessing local perceptions of local rules, objectives and outcomes of resource management processes, as well as of people and actors involved in management. This also underlines the importance of qualitative research in the context of marine resource management (see also Barclay et al., 2017). In sum, while the scope of this research with its focus on two case studies appears limited, our study reveals under what pressures and circumstances compliance can decrease or increase. This understanding can inform future design and implementation of adaptive CBMRM and thus suggests applicability of the findings to the broader context of CBMRM in the region and beyond.

AUTHOR CONTRIBUTIONS

JR conducted the field research and data analysis and wrote the initial manuscript. All authors contributed substantially to revisions by providing theoretical, analytical, and empirical input.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fmars.2017.00172/full#supplementary-material

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Chinese Trader Perceptions on Sourcing and Consumption of Endangered Seafood

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Growing trade networks through globalization have expanded governance of local environments to encompass multiple scales. The governing role of market actors, such as traders and consumers in importing countries, has been recognized and embraced for sustainable seafood sourcing and trade. The perceptions that affect the conduct of these actors are a potential influence on governance of distal environments. In this paper we investigate the perceptions of sea cucumber traders in China. Sea cucumbers are an important global fishery commodity predominantly traded to China, the world's largest seafood market, and seven traded species are endangered globally. We examine what traders and consumers in China perceive as important issues in seafood markets, and where they perceive the responsibility for sustainable fisheries to lie, to interpret what scope there is for sustainability to become an important issue in China's seafood markets. We find that clusters of perceptions about cultural status, quality, health and food safety, and country of origin influence decisions that consumers make. These norms are rooted in sociocultural practice and drive current trade strategies. While traders do want to mitigate risks and secure supplies, food safety, product quality and country of origin are viewed as more important concerns than stock sustainability. Responsibility for sustainable fishing is perceived to be that of national governments in production countries. Trading practices and consumer perceptions together pose a serious challenge to sustainable seafood markets, further confounded by clandestine cross-border gray trade into China.

Keywords: sea cucumber, China, seafood trade, sustainability, food safety, environmental governance, sustainable seafood movement

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INTRODUCTION

Environmental governance is strongly affected by what actor groups perceive the important issues to be, and who they perceive as being responsible for addressing those issues (Robbins, 2004; Lakoff, 2010; Bennett, 2016; Beyerl et al., 2016; Cox and Pezzullo, 2016). How these perceptions influence governance has been explored in diverse fields. Work on "mental models," behavioral economics and psychology has focused on understanding individual representations of the external environment (Jones et al., 2011; Beyerl et al., 2016), while much work in social anthropology and political ecology has examined how broader socio-political contexts and relationships contribute

toward the perceptions that shape environmental governance (Li, 2007; West, 2016). In this context, "governance" is viewed not as the sole domain of governments, but more broadly to encompass multiple scales and actors. We use Kooiman et al.'s (2005, p. 17) definition of governance as "the whole of public as well as private interactions taken to solve societal problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them." For example, small-scale fisheries governance is heavily influenced by diverse perceptions about the value of biodiversity and the environment (Foale and Macintyre, 2005), the state of the environment (Beyerl et al., 2016), the role of governance agencies (Jentoft, 2000), and social relations among stakeholders (Coulthard et al., 2011). With an increase in fisheries trade and the increasing role of private actors in certification and ecolabels, perceptions of consumers and traders can also have significant influence on environmental governance via international seafood markets. Consumer and retailer perceptions in international markets about the relative importance of sustainably caught fish can lead to the introduction of certification and ecolabels, which have influenced the development of fisheries management in source countries (Gutierrez et al., 2016). China is the world's largest seafood market, and the perceptions that influence decisions among traders in this market are important to understand. In this paper, we draw on interview data on sea cucumber trade in Hong Kong and mainland China to examine if and how consumer and trader perceptions about sea cucumbers and the sustainability of sea cucumber fisheries affect environmental governance.

Conventionally, sustainable fishing has been perceived as the responsibility of governments and fisheries management institutions in producing countries. Contemporary globalization of social-ecological systems through markets, however, has caused vulnerabilities to people and environments that are difficult for national governments in producing countries to regulate (Berkes et al., 2006; Liu et al., 2013). For example, more than 50% of terrestrial and marine species threats in Malaysia and Papua New Guinea (PNG), two iconic global biodiversity hotspots, are linked to global trade (Lenzen et al., 2012). Seafood is the most highly-traded animal protein (Rabobank, 2015), so patterns of fisheries production and sustainability can thus be strongly influenced by the preferences and perceptions of actors (e.g., consumers and traders) in locations far from the original site of production. Modern market pressure is one of the central drivers of the status of biomass in marine environments and a central challenge to developing more sustainable production (Cinner et al., 2013; Kittinger et al., 2015). The sustainable seafood movement (SSM) has consequently developed as a way to effectively link market actors along the entire supply chain with the general discourse and specific aspects of sustainability, responding to the lack of effective measures related to the problem of declining fish stocks by governments (Gutiérrez and Morgan, 2015). It has expanded rapidly in recent years (Bush et al., 2013). The largest eco-label for seafood, the Marine Stewardship Council (MSC), now covers 306 certified fisheries in over 30 countries with a total of 9.5 million metric tons of seafood caught annually, representing approximately 10% of the global harvest (MSC, 2016a). The perception in some countries that market actors are part of environmental governance—a central idea underlying the SSM—has therefore had a significant impact on global fisheries.

As the world's leading consumer of food fish—up to 38% of global food fish by 2030 according to one source (Kobayashi et al., 2015)—the Chinese market is of particular importance for marine resource governance. The amount of seafood consumed per capita in China has been rising steadily over the past several decades, especially since the early 1980s when China's economy began to boom: from less than 5 kg in 1980 to almost 35 kg today (FAOSTAT, 2016)[1]. China is therefore a hugely influential market in global seafood consumption. Yet the perceptions, priorities and assumptions that drive the Chinese market are quite different to those of more well-documented markets in the USA and Europe, and remain comparatively under-examined.

In this paper we assess interviews with sea cucumber traders to examine how Chinese trader and consumer perceptions affect environmental governance in the frame of this international seafood trade. The sea cucumber trade is a particularly useful case to explore because the sourcing network connects Chinese consumers to global production in small-scale fisheries in poorer nations, as well as more developed industrial fisheries in developed countries, and high-technology aquaculture. Sea cucumbers have long been consumed in China as an item in banquets and as a health food. As the middle classes have expanded in China, sea cucumber consumption has also increased. Domestic production of sea cucumbers has escalated rapidly since the early 2000s (Fabinyi and Liu, 2014), while imports have also expanded. Between 1996 and 2011, the number of countries serving the Chinese sea cucumber market expanded from 35 to 83 and over 90% of the world's tropical coastline now lies within countries that export sea cucumbers to Hong Kong (Eriksson et al., 2015). This surge in consumption has had significant effects for countries that supply the market (Eriksson and Clarke, 2015), and seven traded species are endangered (Purcell et al., 2014b). Globally, at least 38% of sea cucumber fisheries are considered overfished and 24 countries have closed or attempted to close their sea cucumber fisheries due to overfishing (Purcell et al., 2013). Although the majority of the sea cucumber market in China is in dried form—*bêche-de-mer* (BDM)—there is also a growing market for frozen and fresh (live) sea cucumbers (Purcell et al., 2014a). The traditional drying process is low-tech and enables stockpiling in production locations without refrigeration. This method has facilitated export from some of the least developed and most remote tropical islands of the world (Kinch et al., 2008).

We recognize that the trade in sea cucumbers has highly significant effects on other societally important concerns, such as local economic development and poverty alleviation (Barclay et al., 2016), but the focus of this study is on the question of environmental sustainability within the international seafood trade sector. We do not adopt a formal definition of perceptions in this study, but use the term in a general sense to refer to "the way in which something is regarded,

[1]FAOSTAT Database. Available online at: http://faostat3.fao.org/browse/FB/CL/E).

understood or interpreted" (Oxford Dictionary, 2016). The paper examines perceptions about sea cucumber consumption, specifically relating to banqueting, food safety and health, and quality and country of origin. It then addresses perceptions about the governance of sea cucumber fisheries, including perceptions about environmental sustainability and trade regulation. We ask the following questions, which we return to in the Discussion section:

(1) What do traders and consumers in China perceive as important issues in sea cucumber markets?
(2) Where do traders and consumers perceive the responsibility for sustainable sea cucumber fisheries to lie?
(3) What scope is there for sustainability to become an important issue in China's sea cucumber markets?

METHODS

In September 2015 in China, interviews were conducted at major wholesale markets for dried seafood, where sea cucumbers are sold: Sheung Wan in Hong Kong, Yidelu in Guangzhou, Jingshen in Beijing, and Tongchuan in Shanghai.

Interviews were conducted together with a research assistant (one in Guangzhou and Hong Kong, one in Beijing, and one in Shanghai) in order to interpret from Cantonese when the interviewee did not speak Putonghua (sometimes called Mandarin), or to assist in the translation of some Putonghua when necessary. Interviews in Hong Kong and Guangzhou were conducted in a mixture of Cantonese and Putonghua, while interviews in Beijing and Shanghai were conducted in Putonghua. Some interviews extended up to an hour, while most lasted for approximately 30 min. Interviews were conducted until effective saturation of information took place, i.e., each new interview yielded little or no new data (Morse, 1995). In all, 30 traders or representatives of trade organizations were interviewed in detail (see **Table 1** and Supplementary Material). More interviews were undertaken with traders in Hong Kong and Guangzhou compared to Beijing and Shanghai because of the disproportionately large number of traders who specialized in sea cucumbers in these locations, reflecting their importance as key trading nodes. Interviews were semi-structured (Bernard, 2006), and focused on a range of topics related to the trade, including trade structure, buyer preferences, pricing and market trends, and marine resource governance in China and in source countries. Observations were also conducted, as well as many brief informal conversations with traders and price checks at retail outlets. Most traders of sea cucumber trade with a broader portfolio of dried seafood products that includes abalone, fish maw, scallops, and shark fin. Traders specialize in one or more of these products to differing degrees; 10 of the traders we interviewed focused predominantly on sea cucumber. Our interviews focused on wholesale trading operations which specialized in sea cucumber, and which were of relatively larger scale, with an office in the market and several employees.

Interviews were also carried out with three key informant researchers from Australia and Hong Kong, identified by the authors as experts with detailed knowledge of the sea cucumber trade in Hong Kong and China. The topics for these interviews included similar questions used for the traders in order to triangulate their responses, and questions on particular areas of their expertise (e.g., environmental regulations, trading practices between Hong Kong and China). We did not directly interview international consumers themselves but asked traders, as key informants, for their views on consumer demand.

Because of the sensitive nature of some of the interview questions in relation to trade practices, they were not recorded, but detailed notes were taken. These notes were then qualitatively analyzed for patterns that emerged (Bernard, 2006).

The paper also draws on some unpublished data from 20 earlier interviews with Beijing seafood restaurant operators in 2012, and two interviews with traders of dried seafood products in Beijing in 2014 (see Fabinyi and Liu, 2014, 2016, for full elaboration of the methods used in the earlier studies). We also draw on existing published research on sea cucumber consumption and trade, and other secondary data, such as technical reports.

This study was carried out in accordance with the recommendations of the University of Technology Sydney Human Research Ethics Committee with informed consent from all subjects. All subjects gave verbal informed consent. The protocol was approved by the University of Technology Sydney Human Research Ethics Committee (reference number 2014000548). The Committee only required verbal consent, not written.

TABLE 1 | Interviews in Hong Kong and mainland China.

Location	Number of interviews
Hong Kong	12
Guangzhou	9
Beijing	4
Shanghai	5

RESULTS

Table 2 provides a summary of perceptions about sea cucumber consumption and marine resource governance in China and their environmental and socio-economic implications.

Perceptions about Sea Cucumber Consumption in China

General Consumption Preferences

Two major types of sea cucumbers are distinguished by Chinese traders, and consumption preferences differ depending on geographical location (**Figure 1**). Japanese spiky sea cucumbers, *Apostichopus japonicus*, are found in temperate waters in parts of China (especially Liaoning and Shandong provinces) and neighboring countries such as Korea, Russia, and Japan. While they are often captured in the wild, they are also cultured in large quantities (Chen, 2003; Han et al., 2016a). Commonly referred to as *cishen*, (spiky sea cucumber), the most highly

TABLE 2 | Summary of perceptions in China that influence BDM consumption and governance.

Perception	Environmental and socio-economic implications
CONSUMPTION	
Banqueting culture provides impetus for luxury consumption.	Social pressure to consume.
Increasing middle class wanting to buy luxury foods.	Increasing demand for sea cucumbers.
Consumer preference for food perceived as healthy, driving everyday consumption.	Rapidly increasing market for mid- and low-value product.
Sustainable fisheries not seen as an important quality of sea cucumbers as a product.	No pressure on traders by retailers to ensure sustainable sourcing.
Quality of processing and country of origin are important.	Currently not connected to environmental governance, but this could change if traceability improves.
GOVERNANCE	
Sustainability not seen as the responsibility of market actors.	No pressure by traders on suppliers for sustainably caught product.
Informal social norms and networks take precedence over formal trade laws.	The gray trade undermines traceability, transparency and rule of law, all necessary for any regulations on sustainability that could potentially be introduced for imports into China.

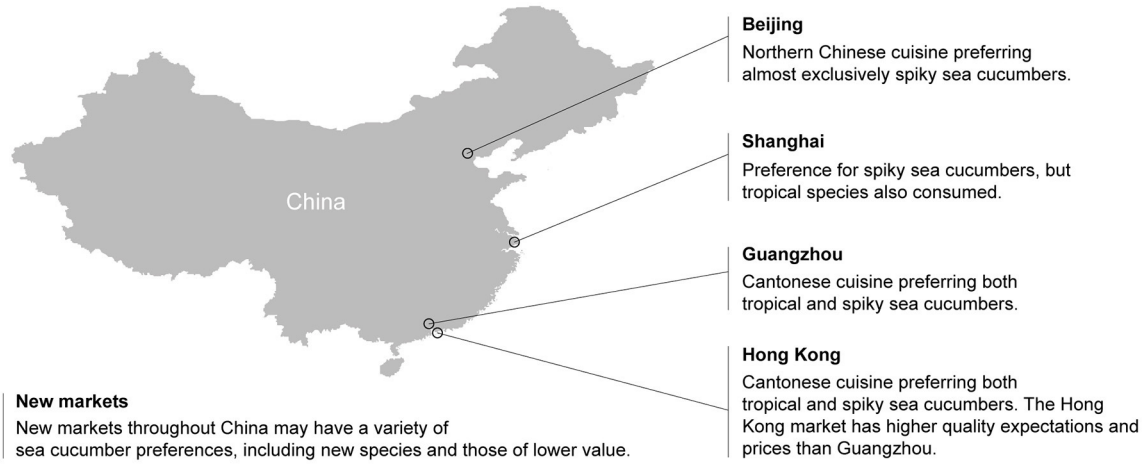

FIGURE 1 | Major markets where the study was conducted. Descriptions outline general consumer preferences.

valued individuals of these sea cucumbers reach the highest prices on the markets and are regarded as the best of all sea cucumbers (prices of USD316–1,892/kg). This is for several reasons: their spiky appearance is viewed as appealing (the longer the spikes, the better); they are of a suitable size to be served individually, whole; and they are regarded as having better nutrition and health benefits than other types of sea cucumbers. In much of northern China, these temperate sea cucumbers dominate the market.

In contrast, tropical sea cucumbers include a far greater diversity of species and are sold in far greater quantities in southern Chinese markets. While *A. japonicus* is also the most highly-priced type of sea cucumber in southern markets, unlike in northern markets there are also significant numbers of tropical sea cucumbers. Their popularity in southern markets is likely due to their natural distribution in the south, as well as the historical linkages of southern Chinese communities with source locations of tropical sea cucumbers (e.g., in Southeast Asia) (Tagliacozzo and Chang, 2011). These larger tropical sea cucumbers are also sometimes served whole, but are more often sliced up. They can be served individually or with other ingredients.

The prices of sea cucumbers vary significantly—from less than USD64/kg for dried, cheaper species of lower quality, to more than USD1,800/kg for high-value species of excellent quality (**Table 3**). *A. japonicus* was the most expensive type of sea cucumber in all locations, followed by sandfish (*Holothuria scabra; H. lessoni*) (price of USD64–359/kg) and teatfish (*H. fuscogilva, H. nobilis, H. whitmaei*) (price of USD96–319/kg). Other types of tropical sea cucumbers commonly sold include prickly redfish (*Thelenota ananas*), South American sea cucumbers (*Isostichopus fuscus, I. badionotus*), and curryfish (*A. herrmanni*) (prices of USD96–294/kg). Purcell (2014) has conducted a more comprehensive survey of tropical sea cucumber prices in southern China.

Banqueting

Sea cucumbers were and are consumed for two major reasons: as a luxury status item, and as a health product. Records of sea cucumbers as part of royal cuisines have existed since the

TABLE 3 | Prices of selected sea cucumbers in USD/kg, September 2015.

Common english name	Scientific name	Hong Kong wholesale price	Hong Kong retail price	Guangzhou wholesale price	Beijing wholesale price	Shanghai wholesale price	Conservation status
Japanese spiky sea cucumber	*Apostichopus japonicus*	528–1,636	506–1,851		948–1,892 (from Japan)	316–1,264	Endangered
Sandfish, golden sandfish	*Holothuria scabra, H. lessoni.*	196–338	84–359	64–156	128–220	96–252	Endangered
White teatfish, black teatfish	*H. fuscogilva, H. nobilis, H. whitmaei*	191–319	166–294	96–156	128–156	96–152	Endangered/Vulnerable (*H. fuscogilva*)

The column on conservation status was taken from the IUCN Red List (IUCN, 2016). For these species, high quality products are consumed in banquets and mid- to lower- quality products are consumed at home and for family occasions.

Ming Dynasty (1368–1644), and they became more prominent during the Qing Dynasty (1644–1912) as one of the "eight great sea delicacies" (Yang and Bai, 2015, p. 9). In contemporary times, the most highly-priced sea cucumbers form part of luxury seafood banquets, served (often in a soup) together with other delicacies such as shark fin, bird's nest soup, reef fish, lobster and abalone. In China, such banquets are central for professional and social advancement. The social relationships and "connections" (*guanxi*) necessary to "get ahead" can only be formalized through the shared experience of eating together (Mason, 2013; Harmon, 2014). The emphasis in such banquets is to give "face" (*mianzi*) to guests, and a key way to give face is to offer "face dishes" (*miancai*). Expensive dishes such as those containing sea cucumber therefore serve the function of showing the guests that the host values and honors them. These banquets provide the social context for the consumption of high-value sea cucumbers.

Recently, however, the luxury sea cucumber market has witnessed a downturn. First, the government's anti-corruption campaign (Jeffreys, 2016) is viewed by traders to have had a significant effect on the sales of dried seafood generally. Hong Kong traders of dried seafood widely reported reduced profits over the past 2–3 years. One Hong Kong trader advised that the price of most kinds of BDM had dropped by 30–50% in the past year or so; others did not give specific figures or estimates but noted that demand had dropped, especially from mainland China. Guangzhou-based traders similarly noted how Japanese spiky sea cucumber had dropped from USD1,892/kg to USD1,260/kg in the course of 2015. Beijing traders reported significant declines in sales over the past years (see also Fabinyi and Liu, 2016). One Beijing trader spoke of an 80% drop in sales; another described a 70–80% drop in sales. Several dried seafood traders had closed since 2013. The anti-corruption campaign began shortly after Xi Jinping's ascent to the leadership in late 2012, and has continued and even intensified since then. One of the specific targets of this campaign was government officials using public funds at banquets. While sea cucumbers are not exclusively eaten at such banquets, a considerable proportion of them are. Secondly, another factor relating to demand has been the slowdown in the Chinese economy. Due to government policies aiming to transition to a slower but more sustainable economic growth pattern, since 2011 the growth rate of the Chinese economy has been slowing. However, the market for many of the mid- and low value sea cucumbers will likely continue to expand, especially in new markets throughout China, largely due to their popularity as a health product.

Health and Food Safety

Sea cucumbers are also consumed for perceived health benefits, and they have been long documented in handbooks of Traditional Chinese Medicine (Yang et al., 2015). The name, *haishen*, literally means "sea ginseng," and sea cucumbers are regarded as being especially good for kidney function and against impotence. Chefs and traders that we interviewed cited the numerous benefits of eating sea cucumbers: "Sea cucumbers have the function of self-repair and regeneration. So eating them will have a positive effect on our health. And it is a zero cholesterol, low fat food," noted one. Another described how "if you eat it for a month, your immunity will be enhanced, and cancer cell growth will be restricted." Others spoke of the positive effects of sea cucumber consumption on skin, their anti-aging properties, and their high levels of vitamins. Sea cucumbers are often sold in pharmacies, next to other traditional Chinese medicines. They are also sometimes incorporated into different products such as soap, "Holothurian wine," and capsules (**Figures 2A,B**; see also Purcell et al., 2014a). Scientific research is ongoing to try to confirm the health benefits of sea cucumbers (Kiew and Don, 2012).

The importance of health as a driver of sea cucumber consumption is linked to strong concerns about food safety in China. Consumers are very keen to eat food that is considered safe, because of the high prevalence of food safety crimes and scandals in recent years in China (Klein, 2013). An example of a prominent food safety concern in the marine sector is the use of antibiotics and other chemicals in aquaculture. This can be seen in product marketing: some farmed *A. japonicus* sea cucumbers, for example, are sold with the national Chinese organic certification in Beijing, which is administered by the China Organic Food Certification Center under the Ministry of Agriculture. Much of the frozen sea cucumbers and other types of seafood sold in Beijing supermarkets are sold with labels emphasizing "pollution-free," "natural" characteristics

FIGURE 2 | Holothurian wine **(A)**; capsules with contents of sea cucumbers **(B)**; frozen sea cucumber from a supermarket **(C)**; "Australian bald" sea cucumbers sold in Hong Kong **(D)**.

(**Figure 2C**). Some sea cucumbers have labels asserting they are "non-additive" and "chemical free" "to assure consumers that no additives have been used to artificially increase the reconstitution ratio of the product" (Purcell et al., 2014a, p. 49). One Beijing-based trader described the potential for "green" labeling that focused not on environmental sustainability of the production, but on food safety: "in the past nobody asked about these things, but more and more people do now."

Because of these strong associations with health, many people and families in China also consume sea cucumbers in less formal restaurant settings, among family gatherings, or regularly at home. Traders also noted that unlike shark fin, sea cucumber could be easily prepared at home by people with no formal training. There is therefore also a very large market for lower-valued sea cucumber that is consumed by diverse groups of people.

Quality and Place of Origin

A central factor affecting the price of sea cucumbers is the quality of the processing (Purcell, 2014). Most traders stressed the importance of good processing, and many traders simply stated that they would only try and buy good-quality sea cucumbers, and avoid those that were poorly processed. Dryness was the most important factor mentioned by many traders; related to this was the expansion rate (i.e., how much they convert from dry to wet weight). Other characteristics looked for by traders included the way the sea cucumber was cut; the saltiness (the less salty the better); the size; the shape (straight and symmetrical, not curly); and the extent of damage. These characteristics determine the "grade" of the sea cucumber, and their eventual price.

Linked to these perceptions about the quality of sea cucumbers are perceptions about country or region of origin. Products from PNG and some Southeast Asian countries, for example, had a poor reputation for processing. Most traders suggested that the quality was very low, due to poor processing (e.g., poor handling of catch, poor drying, poor cutting, bad shape, high salt content). One trader noted that because of the poor quality of PNG products his company had stopped buying from there. Only one trader suggested that the quality of PNG products was high, citing the high quality of the "seawater" in PNG, meaning that it was low in industrial pollution compared to many production locations around Asia. In Beijing and Shanghai, most traders had not heard of PNG, and did not know where it was geographically located.

In contrast, place of origin branding is used for certain countries that are perceived to produce high quality seafood products. Different seafood products are associated with different countries. The best abalone and rock lobsters are perceived to come from Australia, for example, whereas the best salmon is perceived to be from Norway. For *A. japonicus*, Japanese sea

cucumbers are regarded as the best quality, and within Japan, sea cucumbers from the northern region of Hokkaido are viewed as particularly high quality. Within China, cultured *A. japonicus* from Liaoning and Shandong provinces are viewed as the best sea cucumbers. For tropical species, Australian sea cucumbers are regarded as the best.

Because of this reputation for quality based on place of origin, traders regularly advertise their tropical sea cucumbers as being Australian when there is no way of telling the actual origin of the product. Almost all of the sandfish (*H. scabra*) sold in Hong Kong, for example, is simply marketed as "Australian bald sea cucumber" (**Figure 2D**). These include undersized sea cucumbers that are unlikely to be from there because of the sizing requirements for Australian fisheries (e.g., 20 cm in Queensland; DEEDI, 2011). By contrast, despite the high numbers of these types of sea cucumber exported to Hong Kong from countries such as Philippines and Indonesia (Conand et al., 2014), no branding from these countries was observed. Such practices indicate that mislabeling is likely widespread, and that traders exploit consumer preferences for Australian products and the weak system for seafood traceability in China (Xiong et al., 2016).

Perceptions about Governance of Sea Cucumber Trade

Stock Sustainability

Consumer preferences for food that is considered safe and healthy significantly overshadow any concerns about stock sustainability that may be present. A recent survey of 300 middle-class seafood consumers in Beijing and Shanghai, for example, found strong support (mean score 3.7 out of 5) for the statement that "Compared to sustainability, I am more concerned about food safety when consuming seafood products" (Fabinyi et al., 2016, p. 7).

Many traders acknowledged problems of environmental sustainability, including with sea cucumbers—some noted, for example, that the supply of sea cucumbers from certain locations was becoming more difficult to source, and many Hong Kong and Guangzhou-based traders knew of management measures in other countries. One Hong Kong trader who had had long dealings with exporters in PNG, for example, was very supportive in principle of the need to manage PNG's sea cucumbers, saying that this was "good for the country" and "good for the livelihoods of villagers." Other traders agreed with the broad notion that countries should sustainably manage their fisheries, and saw advantages to their business because of this. Four traders, for example, suggested that it could help to stabilize prices, while two others suggested it could help to stabilize supply. As one noted, "if they are sustainably managed, of course this will stabilize the supply, and eventually the price." One Guangzhou-based trader suggested that sustainable management was a good idea "because sea cucumbers are slow to grow" and hence are vulnerable to overfishing. Overfishing was therefore recognized as a problem by some traders because of its impact on supply.

Other traders were less concerned about environmental sustainability: "I don't care about these things; if there are no sea cucumbers left there [in PNG] I can just go and buy them from somewhere else" one Guangzhou trader stated. Another one stated that "it would be better to catch them all at one time; it's not my business if there are no sea cucumbers for harvesting anymore." One Guangzhou trader advised that "there are still lots of sea cucumbers in the wild, and sustainability is not a concern compared to shark fin. So sustainability wouldn't be helpful for me to improve the business." This last comment refers to the widespread perception in China that sharks are threatened, in part due to an intensive environmentalist campaign featuring celebrities (Fabinyi et al., 2016). Because there is no such widespread perception in China about the threatened status of many types of sea cucumbers, there is no perceived gain to marketing them as "environmentally sustainable" in the manner promoted by the SSM.

Nearly none of the traders were willing to seriously engage with sustainability actions and initiatives, or said that certification schemes could improve their business. Only one Hong Kong-based trader suggested that eco-labeling may attract the interest of buyers. One other Guangzhou based trader noted that eco-labeling "may attract traders whose target customers are from high end. I think it may be good for branding, but it would need a long time to set the image." Most traders were instead very skeptical about the potential of eco-labels to improve their business, had not heard of the MSC, for example, and were not interested in MSC certification. As one trader stated, "I don't think it can improve my business and I think buyers and customers from Hong Kong and China don't care about this." Others expressed a high level of cynicism toward such schemes: one trader, for example, asserted that "everyone knows that these certifications are just bought by companies anyway, and aren't actually worth anything, so no-one will pay extra for them." Cynicism toward abstract institutions such as certification and indeed the food system more broadly is widespread in China (Hanser, 2010; Klein, 2013). As we discuss in the Discussion and Conclusion, however, the status of the MSC and the discussion of sustainability issues in China does have the potential to change.

Others focused on the more general issue of responsibility for sustainability. One Guangzhou trader, for example, pointed out that private certification is unnecessary for seafood products, because "the Chinese government is already very strict with regulation."Another Guangzhou-based trader suggested that "most countries already have sustainable management in place, so these types of certification aren't necessary." As another Guangzhou-based trader put it: "Of course this [sustainability] is a very big problem. But I just sell these products. It's the responsibility of governments to regulate their fisheries properly." The implication of such comments is that the responsibility for sustainable management of fisheries is perceived to be the role of governments (Fabinyi et al., 2016). From this perspective, sustainability is associated with state regulatory frameworks and is not perceived as something markets should or even could deliver.

Trading

Perceptions about trading practices have a strong influence over the extent to which this trade can be effectively governed for sustainability (Clarke, 2004). The structure of the sea cucumber

trade in Hong Kong and mainland China is complex, subject to change over time, and enmeshed in a broad range of other economic and social institutions.

Considerable uncertainty remains about trade routes, which tend to be fluid, opaque and diverse. One key route is from source countries into Hong Kong, re-export to Guangzhou, and then throughout mainland China. This is because Hong Kong is a free port with no tariffs but sea cucumber imports to the rest of the country attract tariffs of up to 30% (depending on the trade relationship of the country of origin with China). Officially, seafood transferred from Hong Kong to the mainland is subject to the tariff. Sea cucumber, along with other forms of seafood, thus appears to be transported into China through clandestine channels to avoid the tariff. The majority of Hong Kong-based traders reported selling most of their products to mainland China. When selling to mainland Chinese buyers, Hong Kong-based traders advised that buyers from the mainland take responsibility for transportation to mainland China. As one trader described: "once we have sold the product to them, everything, including both the physical logistics of getting the product back to China, and the legal implications, is completely their responsibility. We don't ask too many questions. Every country has its own way of doing business, and that is how they request for us to do business." In this way, responsibility for trade legality is perceived to be that of the trader in China.

Guangzhou is the major trade hub for sea cucumbers brought into mainland China from Hong Kong. There are approximately 1,000 members of the Guangzhou Dried Seafood and Nut Industry Association (GDSNIA), the primary trade association in the Yidelu market area. When asked about potential opportunities for exporters to export directly to Guangzhou (bypassing Hong Kong), Guangzhou-based traders simply advised that this would be a more expensive way for exporters to do business, and that it would be much cheaper for exporters simply to sell in Hong Kong in order to avoid the taxes. Some Guangzhou-based traders pointed out that they did not need to invest overseas and buy directly because it was far easier for them to just go to Hong Kong and inspect the goods there: "Why should we go overseas, with all of the risks, when we can just go to Hong Kong and check the product quality?" The GDSNIA explained that it advised all of its members to do business completely legally, but acknowledged that it did not control the way its members did their business.

How the sea cucumbers are imported into Guangzhou, and the regulations that are supposed to govern the cross-border trade, was not something traders wanted to talk about in detail. This is understandable, given recent high-profile cases of prosecution against seafood traders in Guangdong province, and even more recent crackdowns by the central Chinese government against smuggling (Godfrey, 2014, 2015). Some traders advised that sea cucumbers were hidden within other cheaper types of seafood that would be subject to lower taxes. Others noted that vehicle transports into mainland China are only rarely inspected in any detail. There is also the possibility of "parallel goods trading," which involves the practice of transporting small quantities of goods across the border in very high frequencies (Chan, 2015). Vietnam is another possible gray trade route into China (To and Shea, 2012; Eriksson and Clarke, 2015). Some Guangzhou-based traders simply advised that these matters were all the responsibility of a "logistics company," and that they did not know about any of the customs regulations. Smuggling practices have also been documented at point of export from producing countries to evade regulation and trade tariffs (e.g., The Hindu, 2016).

In such an environment, where formal governance institutions are weak and the trade is clandestine, perceptions about social relationships and informal institutions take on new significance (Nee and Opper, 2012). Of particular importance is the perception of trust among business partners, which is more important than obeying the formal regulations regarding tariffs. This trust is in many instances cultivated over long-term family relationships that are built up over time (Cheung and Chang, 2011). Most of the seafood traders in both Beijing and Shanghai, for example, are also of either Guangdong or Fujianese origin, and many have family or long-term links with traders in Guangzhou. The importance of these types of social relations in professional contexts has been discussed in a great deal of literature in Chinese anthropology and sociology (e.g., Fei, 1992 [1947]; Wank, 1999). *Guanxi*, or the establishment of social relationships via trading of gifts, favors and banquets, for example, remains an indispensable part of professional success in contemporary China (Yang, 1994). These perceptions about the nature of social relationships are therefore central not only in creating demand for sea cucumbers in banquets discussed in 3.1.2, but also as part of the social relations needed to successfully engage in the sea cucumber trade—including the illegal gray trade. The gray trade, founded on these social relationships, is a significant barrier to sustainability and improved environmental governance of the sea cucumber trade (Wu and Sadovy de Mitcheson, 2016).

The importance of trust among business partners extends to source countries. In many cases, such exporters of seafood also tend to be of Chinese background (Tagliacozzo and Chang, 2011). Chinese traders who invested in overseas source countries for sea cucumbers emphasized the necessity of having a trusted local partner: "We have a trusted partner [in South Asia] who we buy from, and we finance him. He has a good relationship with the people on the ground, he knows the government, he knows the local people and the local traders. He is much better suited to working with these matters. But we have been working with him for years. If you were to come into my office and propose this sort of thing straightaway, that wouldn't be possible after just 5 minutes." Social norms and networks, and how they are perceived to operate, are therefore factors that strongly influence possibilities for governance of the trade.

DISCUSSION AND CONCLUSION

What Do Traders and Consumers in China Perceive as Important Issues in Sea Cucumber Markets?

We asked three questions at the onset of our analyses. When answering the first question we note that there is a range of perceptions in China that contribute to the nature of the sea cucumber trade and demand for sea cucumber products. The

diversity of consumers across Chinese provincial cuisine, social class and occasion, and a matching wide range of products on offer to cater for each of them, illustrates an immense complexity and challenge for understanding market drivers and the effects of sustainability initiatives. We also emphasize that these perceptions are not time-bound characteristics of a certain culture or society, and we do not intend to imply that the Chinese market cannot be concerned with environmental sustainability at all. Chinese consumer preferences for lower-trophic level freshwater fish such as carp, for example, is a perception that arguably has more positive effects for the sustainability of fisheries (Han et al., 2016b). We also note that while we did not directly interview consumers themselves in this study, our assertions about consumer preferences are based not only on responses from traders but also earlier research conducted with consumers and restaurant operators (Fabinyi and Liu, 2014; Fabinyi et al., 2016). Traders are in many cases also consumers of sea cucumbers.

Trader perceptions and consumer preferences constitute a part of social practices that have significant influences on environmental governance (**Table 2**). In the Pacific, for example, discussions are taking place about whether it is possible to market and brand Pacific BDM to appeal to consumer preferences (IUCN, 2015). The social context of banqueting and giving gifts—driven by dominant perceptions about how to achieve success in professional and societal contexts—has provided social pressure to consume high-value sea cucumbers. The increasing demand for healthy and safe food in China means that the market for mid- and low-valued types of sea cucumbers consumed in everyday meals outside of banquets—driven by a widespread perception in China that sea cucumbers are good for health—is rapidly expanding. The speed of modern expansion has caught new source countries unprepared, and many do not have the capacity to effectively manage their fisheries in the face of such pressure (Eriksson et al., 2015). Consumer preferences for sea cucumbers from certain countries seem to be driven by perceptions about the quality of seafood in these areas. However, mislabeling and a lack of traceability means that the stronger fisheries regulations in some desired source countries—such as Australia—do not necessarily lead to increased demand for actual Australian sea cucumbers that are more sustainably fished. When we summarize and interpret the consumer and trader perceptions from our study, we find that while markets are dynamic there is no clear indication that sustainability is going to become an important feature in the short- to medium- term.

Where Do Traders and Consumers Perceive the Responsibility for Sustainable Sea Cucumber Fisheries to Lie?

In China, the perception that consumers and retailers are active participants in and responsible for sustainable resource management is not widespread (Fabinyi et al., 2016). Instead, the responsibility for ensuring sustainability is seen to lie with the governments of fishing countries, and not the importing governments. Although China is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), this is patchily enforced (Wu and Sadovy de Mitcheson, 2016) and there are no comparable regulations to those of the EU regarding Illegal, Unreported and Unregulated (IUU) fishing (Miller et al., 2014). Clandestine forms of trade to avoid tariffs are widely practiced, so that profits based on social networks and relationships are seen as preferable to following abstract state laws on tariffs that are poorly enforced. While these perceptions and practices about trade are not directly focused on environmental sustainability, they have the effect of seriously diminishing traceability and transparency, and hence the capacity to successfully govern trade. This means that even if the Chinese government were to start regulating more strongly for sustainability of imports (such as through improved enforcement of CITES regulations), the trade would first need to be brought into the legal sphere through enhanced regulation of the gray trade. Taken together with the perceptions on sea cucumber consumption discussed earlier, these perceptions about trading practices and governance have indirectly contributed to the decline and in some cases collapse of sea cucumber fisheries (Purcell et al., 2013).

What Scope Is There for Sustainability to Become an Issue in China's Sea Cucumber Markets?

Despite the fact that twenty-first century seafood consumers are increasingly materially connected to the distant environments from where products originate (Rabobank, 2015), complex multi-level supply systems tend to camouflage patterns of exploitation and sustainability that have the potential to influence consumer perceptions (Crona et al., 2016). Actors at the recipient end of supply chains are geographically removed from sourcing environments and activities, so their perceptions may not be influenced by direct experience and there is little consumer-facing traceability. Perceptions about environmental sustainability in China do not currently translate into market pressures toward sustainably caught seafood and its trade. While there is awareness of environmental problems, traders are not incentivized by consumer preferences to sell sustainably caught seafood as they are in some other countries and for other seafood. Consumers perceive environmental issues that affect them personally, such as pollution, as more important than issues of stock depletion in source countries. Improving the environmental sustainability of fisheries can improve the food safety and quality of products; however, our interviews with traders and previous research on consumer perceptions show that traders and consumers do not link these factors, but see food safety and quality as quite separate from environmentally sustainable fishing.

In 2004, Clarke (2004) found that stock sustainability was not a key factor of consideration for sea cucumber traders and emphasized that it seemed unlikely that sustainability initiatives would come from the trade domain. The narratives by traders interviewed 11 years later in our study still center on the same issues as those in Clarke's study. The trade hence seems continuously driven along its current trajectory with social structures and norms that are essentially the same as they were

in 2004. This raises a key question on how perceptions can be influenced and changed to better account for sustainability issues.

There is currently a great deal of work undertaken to increase awareness and potentially change perceptions of market actors within China. Consumer awareness campaigns, for example, have worked with celebrities to spread the idea that sustainability is a problem in shark fisheries. Jeffreys (2016) argues that these campaigns have had minimal impact on consumption practices because they do not address the social norms, pressures and expectations associated with buying shark fin. However, while consumer awareness may not be sufficient on its own to introduce sustainability into seafood markets, it is likely to at least be part of a transition to sustainable seafood markets. In this regard, there may be considerable scope for campaigners to provide awareness about the endangered wild status of many high-profile types of seafood consumed in China, such as sea cucumbers. Similarly, given that food safety is a far more dominant concern in the Chinese market, expanding the notion of "environmental sustainability" to make linkages to food safety where possible may be another potential avenue to influence consumers. There are also many other activities taking place in China that work with additional actors other than consumers in the seafood market, such as restaurants, hotels, supermarkets and other retailers (e.g., Zhou, 2016). It will be important to observe how such interventions unfold in the near future.

More broadly, this paper has contributed to the discussion concerning how to respond to the environmental sustainability challenges presented by globalization. Researchers from numerous fields have highlighted how what happens in one location can have environmental implications in another location (Berkes et al., 2006; Liu et al., 2013; Eriksson et al., 2015). The SSM was developed in part to respond to this challenge, linking actors across the length of the market chain through transparency institutions and infrastructure (Mol, 2015) embodied in certification. From this perspective, market actors around the world are viewed to be just as responsible for environmental governance through establishment of sustainable seafood markets as the government-based fisheries managers of countries where the seafood is produced (Oosterveer and Spaargaren, 2011). Producers of seafood invest in having their operations certified as sustainable, while wholesalers, retailers and consumers can exercise their market power to choose sustainably caught seafood. The rapid rise of this SSM has been affected by many geographically and historically specific factors (Gutiérrez and Morgan, 2015). Non-governmental environmental campaigns, media and scientific coverage has been focused in some areas and not others, and has changed over time. For example, awareness of the MSC label can vary widely globally, from 13% in Canada up to 71% in Switzerland (MSC, 2016b). More generally, the perception that market actors can be responsible for environmental governance through establishing and regulating sustainable seafood markets is also geographically and historically specific, and can change if broad cultural perceptions around sustainability and consumption shift, for example as a result of media campaigns.

The perceptions among Chinese traders and consumers that we have described above pose a significant challenge to the SSM. The ways in which consumer and trader perceptions interact with influences on the trade highlight that on their own, market-based initiatives may currently struggle to provide the sorts of environmental governance impacts needed to ensure that sea cucumbers are harvested more sustainably (Jacquet et al., 2010). We suggest that this provides further evidence that the social context in which the SSM operates needs to be closely considered (Gutiérrez and Morgan, 2015; Adolf et al., 2016; Gutierrez et al., 2016). In particular, the ways in which market-based initiatives interact with the state, and the extent to which the perception that market actors can be responsible for market governance is shared across society, will be crucial for improved environmental governance through sustainable seafood markets. For China, we have argued that market-based initiatives have been hampered by limited government success in areas such as regulating the gray trade and improving traceability, and by a widespread perception that market actors are not primarily responsible for environmental governance. Ultimately, the success of the market-based SSM will be determined by the presence of regulating and enabling conditions in states and societies.

AUTHOR CONTRIBUTIONS

KB and MF conceived the research. MF conducted the fieldwork. MF, KB, and HE analyzed the data. MF, KB, and HE wrote the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fmars.2017.00181/full#supplementary-material

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