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REVIEWS

Participatory monitoring of small-scale coastal fisheries in South America: use of fishers' knowledge and factors affecting participation

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Abstract Participatory approaches to fisheries management are gaining increasing support from researchers, non-governmental organizations, and governments in Latin America, and different forms of participatory monitoring have been implemented over the last few decades. Among several advantages, these initiatives allow incorporation of fishers' knowledge on ecology, fishing practices, social aspects, markets, regulations, into different stages of management. In this paper, we analyze key features of participatory monitoring programs in small-scale coastal fisheries in South America (Argentina, Brazil, Chile and Uruguay) through a literature review complemented by expert opinion. Our review considered the fisheries and variables monitored; objectives, duration, institutional context of the monitoring programs; and factors that affect the extent of fishers' participation and the incorporation of fishers' knowledge. We found 14 case studies described in the literature, most of which correspond to benthic fisheries. Most cases focused on ecological and/or catch and effort variables; few initiatives included social variables. Initiatives were mainly driven by researchers in partnership with fishers and other stakeholders under formal or informal institutional arrangements. Institutional arrangements were largely responsible for the effectiveness of participation. In most cases, fishers' participation in monitoring was fostered as a component of a broader participatory co-management approach. Despite the challenges, participatory monitoring approaches are gaining traction in South America, receiving significant support from researchers in most cases, and from nongovernmental organizations in some cases. Increased governmental support for implementing and sustaining long-lasting participatory monitoring programs would strengthen monitoring initiatives that emerge locally.

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Graphic abstract

Keywords Co-management · Fisheries monitoring · Fishers' knowledge · Small-scale fisheries · South America

Introduction

Natural resource management and conservation programs worldwide follow different approaches, ranging from centralized government-led to those in which communities take the lead—with mixed arrangements in between (Berkes 1994; Pomeroy and Rivera-Guieb 2006). Top-down and government-centered approaches have often proved ineffective, especially when rule compliance cannot be guaranteed (Dietz et al. 2003; McLanahan et al. 2008). This led to a paradigm shift during the 1990s towards more inclusive and collaborative approaches, recognizing the need for users and other interested parties to participate in management decisions and processes (Townsley 1998; Wilson et al. 2003; Pomeroy and Rivera-Guieb 2006; FAO 2009). Among several other advantages, people involved in collaborative exchanges can benefit from collective learning, and social involvement may in turn enhance environmental stewardship (Berkes et al. 1995; Pereira et al. 2013).

Participation is particularly relevant in the case of small-scale extractive activities like small-scale fisheries (SSFs), for social, e.g., social justice, legitimacy, and for functional reasons, e.g., enhanced information, commitment, compliance (FAO 2009). The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (hereafter, SSF Guidelines), for instance, is an internationally agreed instrument that provides guidance to address small-scale fisheries issues worldwide. Principle 6 of this instrument, 'Consultation and Participation,' highlights the relevance of fishers[1]' participation in different stages of decision-making processes (FAO 2015). When fishers participate in data collection and monitoring, their knowledge can inform management decisions in meaningful ways, for example tailoring conservation strategies to the local context. Fishers' knowledge (FK) has been increasingly recognized as a relevant input to management

[1] We use the term "fishers" as a generic term to refer indistinctly to fishermen and fisherwomen.

(Gadgil et al. 1993; Berkes et al. 1995; Seixas et al. 2009; Orensanz et al. 2015). FK extends beyond the ecological domain and consists of the entire body of experiential knowledge and insights that fishers have about a fishery, including the target resource and its ecosystem, the fishing processes and practices, the fishing communities and livelihoods, the governance and markets, and their dynamic relationships (Orensanz et al. 2015). Hence, FK has the potential to inform all components of management, from the design of a management strategy to its implementation, in multiple ways.

Although numerous participatory arrangements and processes to manage coastal fisheries (e.g., diverse co-management schemes) have been extensively studied (Wilson et al. 2003; Pomeroy and Rivera-Guieb 2006; Trimble and Berkes 2015), participation in fisheries monitoring has received less attention. Monitoring of fisheries is "the systematic recording and periodic analysis" (Maine et al. 1996) of information about different dimensions of fisheries. It is a central component of the Ecosystem Approach to Fisheries (EAF) (FAO 2003), needed to evaluate stock status, and how the resource and the fishing activities respond to management interventions. As emphasized by the SSF guidelines, "States should establish systems of collecting fisheries data, including bioecological, social, cultural and economic data relevant for decision-making on sustainable management of small-scale fisheries with a view to ensuring sustainability of ecosystems, including fish stocks, in a transparent manner." Key strengths of the EAF, include its the relevance of long-term policy goals, participatory decision-making structures, and conservation tools (e.g., Marine Protected Areas, tenure systems) to pursue sustainable small-scale fisheries (FAO 2003). Lack or weak monitoring and enforcement, however, remains a key challenge in many world fisheries which tend to be data poor and capacity poor (Ye and Gutierrez 2017; Gianelli et al. 2018). Key strengths of an EAF include its requirement to integrate ecological, social, and economic considerations, and the recognition that people are an integral component of ecosystems and should be involved in management (Röckmann et al. 2015).

Researchers, NGOs, government officials, and groups of users/communities are increasingly proposing participatory monitoring approaches to evaluate the status of fisheries and the performance of natural resource management strategies worldwide (Bunce et al. 2000; Orensanz et al. 2005; Hoon et al. 2008; Sowman 2009). In Latin America, some participatory monitoring programs have been implemented, especially as components of co-management initiatives (e.g., Defeo and Castilla 2005; Orensanz et al. 2005; Moura et al. 2007; Fiorda et al. 2013; Orensanz et al. 2013; Aburto et al. 2014). Even though monitoring is recognized as key to the evaluation and adaptation of management efforts, the initiatives taking place in the region are not well documented and thus, could constitute a focus of further research aimed at improving fisheries management and coastal conservation.

In this paper, we analyze the characteristics of participatory monitoring programs in small-scale coastal fisheries in four South American countries:Argentina, Brazil, Chile, and Uruguay through a literature review complemented by expert opinion. We aim to: (i) identify the monitored fisheries and variables of the social-ecological system; (ii) analyze features of monitoring programs, such as their objectives, duration, institutional context; (iii) analyze the factors affecting fishers' participation in monitoring and the incorporation of FK into management; and (iv) discuss ways to foster fishers' participation and the inclusion of their knowledge into management. Our review provides key insights on ways in which the SSF Guidelines (FAO 2015), especially in respect to principle 6 on Consultation and Participation, are being held in practice in South America.

Methods

Small-scale fisheries focus

The research focuses on small-scale fisheries (SSFs) occurring in coastal areas; continental fisheries were not considered. Globally, the concepts of 'small-scale' or 'artisanal' fisheries differ among regions, cultures or economies (Berkes et al. 2001; Castilla and Defeo 2001; Orensanz et al. 2013). Even though, key commonalities can be observed: they are conducted using small boats or no boats, involve low technology, and are main providers of income and food for the fishing families (Salas et al. 2011). In the four countries analyzed in our study, small-scale fisheries are defined by common criteria, such as (i) the type of

fishing gear used, (ii) the gross tonnage, (iii) the size of the boats, and (iv) socio-economic considerations (e.g., ownership of means of production).

Data collection and analysis

We searched five online database platforms: Google Scholar, Scielo, Science Direct, Scopus and Web of Science, from November to December 2014, including a search for new publications in June 2017. We used the following keywords in English, Portuguese and Spanish:

Group 1: ["Co-management" OR "Community conservation" OR "Community-based conservation"] AND ["Fisheries monitoring" OR "Fisheries assessment"] AND ["Argentina" OR "Brazil" OR "Chile" OR "Uruguay" OR "South America" OR "Latin America" OR "Southern Cone"]
Group 2: ["Collaborative Monitoring" OR "Community-based monitoring" OR "Participatory monitoring" OR "Collaborative assessment" OR "Community-based assessment" OR "Participatory assessment"] AND ["Fisheries"] AND ["Argentina" OR "Brazil" OR "Chile" OR "Uruguay" OR "South America" OR "Latin America" OR "Southern Cone"]

We searched for scientific articles, books, book chapters, papers presented at conferences, and gray literature such as technical reports. In addition to English, we explored Portuguese and Spanish literature due to its importance for local managers and resource users, and to incorporate literature hardly accessible by the international scientific community. We also checked the reference lists of the selected studies to search for more cases. In June 2017, we carried out a second search to check for new publications on the cases we had previously selected, as some were part of ongoing research projects or were only documented in unpublished reports at the time of the first search. We selected cases of monitoring initiatives (discontinued and/or ongoing) that covered any dimension of fisheries and that explicitly declared to be participatory. The selection included scientific research on the performance of participatory monitoring programs or management processes (with information about monitoring), and research initiatives that fostered the inception of a participatory monitoring program that continued beyond the end of the project.

We first selected 166 references where participatory monitoring of fisheries from the study region was mentioned in the abstract. While the characteristics of the participatory processes were well documented in the literature, with a focus on their outcomes and relevance, the information on the monitoring component, including how it emerged and was conducted, and what role fishers played in monitoring, was scarce. To clarify such information and inquire about potential new cases, we contacted 32 experienced researchers and practitioners from the four countries. This allowed us to increase the list of potentially useful references to 226. After reading the papers and applying the criteria described above, the list was narrowed to 86 references. The combination of peer-reviewed and grey literature and expert consultation reduced the chances for overlooking undocumented cases.

In order to systematize the comparison of the cases found we used the analytical categories proposed by Ross et al. (2002), as described in Table 1: agency (parties that promote the initiative); Use and access regulations (parties' control over the resources); nature of the participants (characteristics of each of the parties); task (the purpose of the initiative); and duration (the time frame of the intervention or initiative). In addition, we considered the extent of fishers' participation in the monitoring initiatives. These categories were used to relate the characteristics of the monitoring programs to their functioning and outcomes.

Results

Cases and monitored variables

We found 14 initiatives of participatory monitoring of small-scale coastal fisheries in the study region: six from Brazil, four from Chile, three from Uruguay, and one from southern Argentina (Fig. 1 and Table 2). The references used for each case are shown in Table 2.

Most initiatives in Argentina and Chile concerned with benthic resources, such as clams, scallops, gastropods, shrimp, lobster, and kelp. Here, monitoring usually focuses on single species, often of high economic value. In Brazil, on the other hand, monitoring focuses on multiple species (e.g., reef fishes), including both demersal and pelagic species and

Table 1 Analytical categories of monitoring programs. The first five are adapted from Ross et al. (2002)

Analytical category	Description and/or guiding questions
Agency	Party or parties that promote the initiative in participatory natural resource management processes. Does the process or need emerge from within government, or among the public, and why?
Use and access regulations	The nature of the parties' control over the resources, such as private ownership, traditional rights, government ownership, mix of tenure systems, use regulations (e.g., gear restriction, closure season), etc.
Nature of participants	Whether the process includes a full set of parties, or only a few; how they are selected (voluntary and self-selected or designated by virtue of resource ownership or stakeholder role) and how they are organized. It is important to recognize specific characteristics of each of the parties, and the histories of trust or antagonism that they may have built up in previous interactions
Task	Planning and strategic decisions (PL). On-going management (OM). Specific issue or conflict (SP). This can define who should be involved and how
Duration	Finite or extended, long- or short-term processes, and how duration affects the design of the process. Are the parties prone to strive for short-term 'wins', or will they focus on long-term cooperation?
Extent of fishers' participation	How participatory is fishery monitoring and how much space is there for sharing knowledge? How does fishers' participation operate (e.g., are they trained by researchers; are they contributing their knowledge)? In what stages of the monitoring program are fishers involved (e.g., design, data collection, use of information)?

*Some of these dimensions are interdependent, for instance, duration with task, and agency with use and access regulations (Ross et al. 2002)

diverse fishing equipment (Table 3). Most monitored variables corresponded to fisheries (catch and effort), ecological/biological, environmental and/or economic (profitability) data. Governance, sociocultural, and/or socioeconomic/wellbeing variables were being monitored in relatively few cases (5, 9, 10, 11, and 13) (Table 3). The "loco" AMERBs case (number 10) involves hundreds of management areas granted to fishers' organizations in which socioeconomic variables at the level of fishing organizations are being registered on an annual basis.

Attributes of the cases

The attributes of case studies are described in Table 4 according to the analytical categories used to understand and describe participatory monitoring initiatives. The categories are presented in a different order from that of Table 1 in order to introduce first the monitoring goals and thus, make our findings clear.

Agency

In most participatory monitoring initiatives (cases 1, 3–9, 12–14) researchers have played a significant role in promoting them, in partnership with other stakeholders and as part of formal and/or informal institutional arrangements. In half of the initiatives (cases 1, 3, 7, 8, 12, 13, and 14), monitoring was introduced in the context of formal collaborations among researchers, fishers and government agencies, in some cases also including other organizations such as NGOs (case 3, 5, 8) or international agencies (case 14). The '*Parcela*' system (case 10) was an exception, representing the only documented case in which informal monitoring emerged from and was carried out by community members without external intervention, as part of a traditional management system.

Tasks

In nearly all cases, the monitoring initiatives were implemented to provide support to management and/or conservation systems, either newly established or preexisting. Information on resource status was used in ongoing management to determine catch quotas, adjust the size of a *parcela* or implement other management measures. In some cases, monitoring has led to ecological certification and to the development of management plans (e.g., cases 1–4, 5, 7–14) strengthening co-management initiatives. Other initiatives have responded to specific information

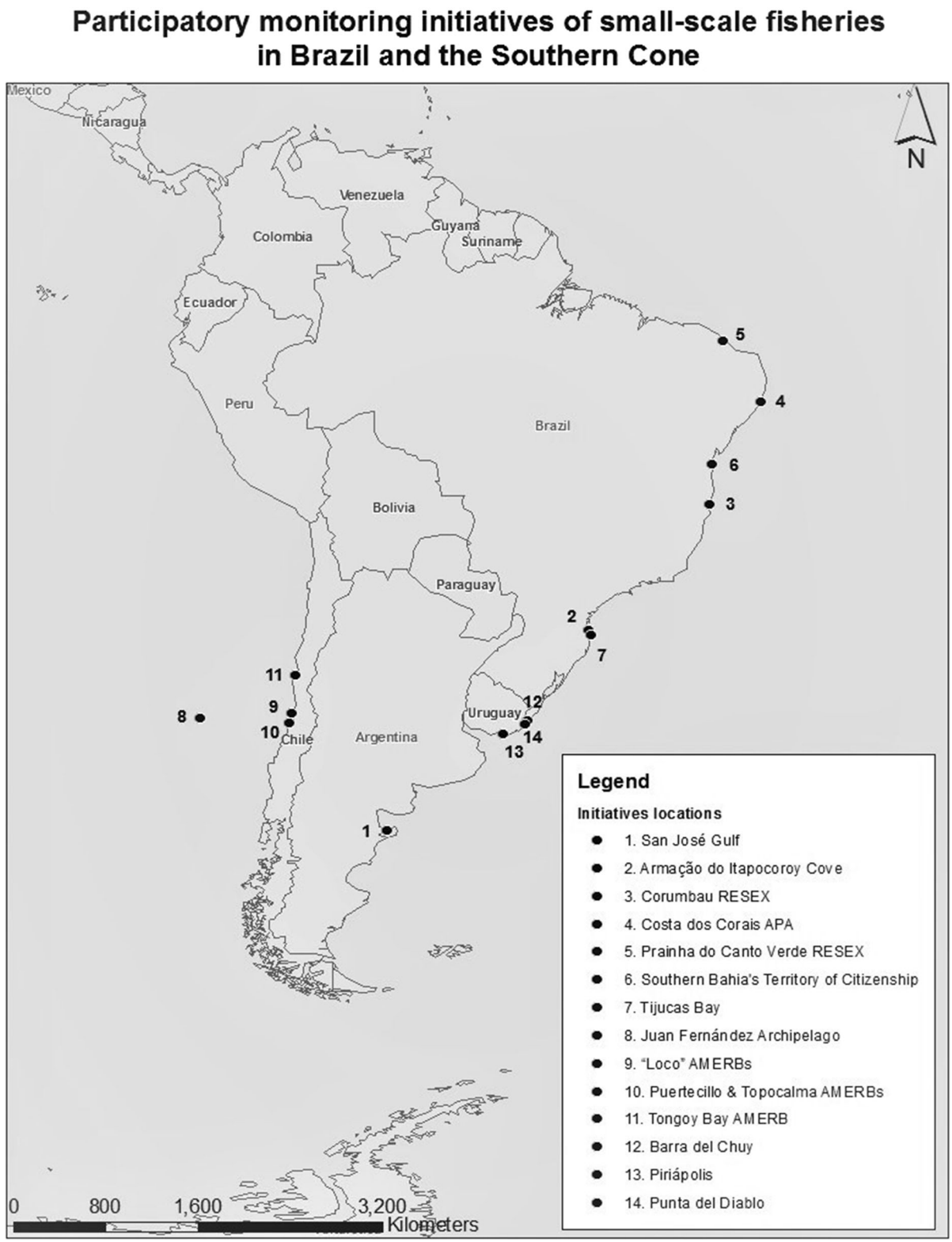

Fig. 1 Study area and location of case studies

Table 2 Cases of participatory monitoring of small-scale coastal fisheries in Argentina, Brazil, Chile and Uruguay, and references used

Case study	Bibliographic sources
Argentina	
1. San José Gulf (Southern Argentina)	Cinti et al. 2003, 2011; Fiorda and Parma 2015; Orensanz et al. 2003, 2005, 2007, 2013, 2015; Parma et al. 2003
Brazil	
2. Armação do Itapocoroy Cove (South Brazil)	Medeiros et al. 2007
3. Corumbau Marine Extractive Reserve (RESEX[a]) (Northeast Brazil)	Alves 2009; Alves et al. 2012; Beckenkamp and Dutra 2009; Dutra et al. 2011; Francini-Filho and Moura 2008; Moura et al. 2007, 2009; Previero et al. 2013; Rodrigues et al. 2007; Santos 2012
4. Costa dos Corais Environmental Protected Area (APA)[b] (Northeast Brazil)	Ferreira et al. 2000, 2003; Maida and Ferreira 1997; Moura et al. 2007
5. Prainha do Canto Verde (RESEX) (Northeast Brazil)	Almeida 2002; Chaffee 2000; Chaffee and Phillips 2000; Schärer et al. 2010
6. Southern Bahia's Territory of Citizenship[c]-Environmental Protected Area (APA) (Northeast Brazil)	Malafaia et al. 2014
7. Tijucas Bay (South Brazil)	Bonilha et al. 1999; Foppa et al. 2011; Hoinkis et al. 2007; Matarezi and Bonilha 2000; Medeiros et al. 2007, 2015
Chile	
8. Juan Fernández Archipelago (Central Chile)	Arana and Scott 2014; Ernst et al. 2010, 2013; Orensanz et al. 2015
9. "Loco"[d] AMERBs (along Chile)	Aburto and Stotz 2003; Aburto et al. 2014; Aviléz and Jerez 1999; Bandin and Quiñones 2014; Castilla and Fernández 1998; Castilla and Defeo 2001; Castilla et al. 2007; Castilla and Gelcich 2008; Cinti 2006; Defeo and Castilla 2005; Defeo et al. 2009a; Defeo et al. 2016; Gelcich et al. 2006; González et al. 2006; Moreno and Revenga 2014; Navarrete et al. 2010; Orensanz et al. 2013; San Martín et al. 2010; Sanctis and Chavés 2014; Schumann 2007, 2010a, b, 2011
10. Puertecillo and Topocalma "Parcela"[e] and AMERB systems (Central Chile)	Araos-Leiva 2006; Araos-Leiva and Ferraira 2013; Araos-Leiva 2007; Estudios Marinos Ltda 2003, 2006; Gelcich et al. 2006, 2015; Orensanz et al. 2013
11. Tongoy Bay AMERB (Northern Chile)	Aburto and Stortz 2003, 2013; Aburto et al. 2014; Schumann 2007
Uruguay	
12. Barra del Chuy (Rocha)	Brazeiro and Defeo 1999; Castilla and Defeo 2001; Crossa et al. 2015; Defeo 1996a, 1996b, 1998, 2003; Defeo et al. 2009b, 2009c, 2016; Defeo and Castilla 2005; FAO 2015; Gianelli et al. 2015; Guillotreau et al. 2017; Horta et al. 2014
13. Piriápolis (Maldonado)	Bentancur et al. 2014a, 2014b; Trimble 2013; Trimble and Berkes 2013
14. Punta del Diablo (Rocha)	Arismendi 2011; Carriquiry and Arismendi 2012; Segura 2006; Segura et al. 2008

[a]RESEX (*Reservas Extrativistas*) is a type of protected area established by the Brazilian government that aims to preserve traditional livelihoods and to foster the sustainable use of natural resources

[b]Environmental Protected Area (*Área de Proteção Ambiental or APA*) is another type of protected area in Brazil, which aims to protect biodiversity, regulate human occupation and ensure the sustainable use of natural resources

[c]Territory of Citizenship is a geographically defined, usually continuous, physical space characterized by multidimensional criteria such as type of environment, economy, society, culture, politics and institutions, and a population with relatively distinct social groups, which relate internally and externally through specific processes, where one or more elements that indicate identity, social, cultural and territorial cohesion can be distinguished (SEPLAN 2017)

[d]"Loco" is the common name of a gastropod species (*Concholepas concholepas*) of significant value for the Chilean artisanal fishing sector. AMERBs stand for Management and Exploitation Areas for Benthic Resources (*Areas de Manejo y Explotación de Recursos Bentónicos* or AMERBs in Spanish), a system of marine territorial use-rights in fisheries (TURF) for the management of benthic resources harvested by artisanal fishers

[e]The *parcela* (plot) system is a traditional tenure system for the harvesting of brown algae from the intertidal and shallow subtidal zones of rocky shores found in several Chilean coves, notably in Region VI (Orensanz et al. 2013)

Table 3 Resources, fishing modality and variables monitored in case studies

Case study	Resources: fishing equipment	Monitored variables
Argentina		
1. San José Gulf	Scallop (*Aequipecten tehuelchus*): hookah diving	1. Stock assessment through visual counting of scallops along transects (density and size structure 2. Catch, effort, catch per unit of effort (CPUE), fishing ground observations (location, depth, substrate), among others (weather condition, selling price), through a voluntary logbook program
Brazil		
2 Armação do Itapocoroy Cove	Local small-scale fisheries in general (resources and gears not specified)	Environmental variables: water temperature and transparency, sea conditions (waves, currents, and tides), salinity
3. Corumbau RESEX	Lobster: covo (a type of trap) and jequiá (trap with a cone of sticks) Shrimp: trawling Reef fish: harpoon, gillnets, hooks and lines and cast nets	Catch, effort, structure of reef fish assemblages
4. Costa dos Corais APA	Reef fish: cast net, line and harpoon Lobster: lobster net and covo Octopus: traps (pot)	Catch, effort, CPUE, seasonality, environmental variables (wind direction, tide, water temperature and transparency, salinity), location of fishing grounds, tourist flow. Inside and outside no-take area: abundance of fish, octopus and lobster
5. Prainha do Canto Verde RESEX	Lobster: *covo*	Fishers' ownership of fishing vessels, participation in management, awareness of fishery regulations, use of permitted fishing equipment, illiteracy and education, job satisfaction. Catch, effort, costs, investments, sources of income/funding
6. Southern Bahia's Territory of Citizenship APA	Reef fishes: hook and line	Catch, effort, CPUE, location of fishing grounds, biometrics and gonad weight
7. Tijucas Bay	Small-scale fisheries (not specified)	Catch, effort, fishing conditions (surface water temperature, salinity, water transparency, currents) and fishers' observations on the state of the sea
Chile		
8. Juan Fernández Archipelago	Spiny lobster (*Jasus frontalis*): traps	Catch, effort, CPUE, location of fishing grounds, seasonality
9. "Loco" AMERBs	Muricid gastropod ("*loco*") (*Concholepas concholepas*) and other benthic resources: hookah diving	Stock assessment through visual counting of loco and other invertebrates along transects (size and density). Catch, effort, and CPUE. Benthic community information. Socioeconomic information of fishers' associations. Commercial information. Profitability of the area

Table 3 continued

Case study	Resources: fishing equipment	Monitored variables
10. Puertecillo, Topocalma and other communities of Cardenal Caro Province (Region VI, Chile)—"*Parcela*" and AMERB system	Kelp (*Durvillaea antarctica*): hand gathering	Inside parcelas: Yearly biomass and yields from each individual parcela (informal records by each member). Monitoring based on algae gatherers' traditional ecological knowledge (TEK)
		In AMERB (includes algae and shellfishes): standard indicators for AMERBS - Idem case 9
11. Tongoy Bay AMERB	Surf clam ("*macha*") (*Mesodesma donacium*): hand gathering	Quantification of surf clam banks and landing data
Uruguay		
12. Barra del Chuy	Yellow clam (*Mesodesma mactroides*): gathered by hand or using shovels	Catch, effort, CPUE, abundance, biomass, size, gender participation, unit prices, revenues per unit of effort
13. Piriápolis	Brazilian codling (*Urophycis brasiliensis*): traps and hooks and lines	Catch, effort, CPUE, costs, sea lions' impact on catches and/or gear damage
14. Punta del Diablo	Red shrimp (*Pleoticus muelleri*): trawling net	Catch, effort, CPUE, by-catch

demands to address some issue. Examples are: (i) the evaluation of new fishing devices/gears (cases 13 and 14); (ii) the production of knowledge on reproductive behavior of target resources (case 6); and (iii) gathering information on environmental processes and target species habits and habitats to support management (case 4). In cases 1, 9, 11 and 12, monitoring started after a severe resource crisis. In case 6, monitoring was part of a collaborative research project (to enrich science with local knowledge), without an immediate link to management applications.

It is noteworthy that incorporation of fishers' knowledge (FK) was explicitly included as one of the monitoring goals in only four instances (cases 1, 6, 7, 8), in addition to the *parcela* system (case 11), where monitoring is entirely based on FK. Notwithstanding, all initiatives attempted to foster fishers' participation in monitoring programs as well as in other management stages (with implicit consideration of FK in some cases).

Nature of participants

Most monitoring initiatives include multiple parties, such as researchers interested in fisheries or environmental management and sustainability (all except case 11), conservation-oriented international or local NGOs/agencies (cases 3, 5, 8, 12, and 14), small-scale fishers (all cases) and consultants and technical staff from governmental agencies with fisheries or conservation mandates (11 cases). It is noteworthy that in many cases the initial contact with fishers was made by researchers (cases 2, 11, 12, 13 and 14) and/or NGOs (cases 3, 5 and 8); Government agencies were also involved from the beginning in many instances (cases 1, 4, 6, 7, 9, 11, 12) or provided support to the initiatives later in the process (cases 3, 5, 13, 14).

Monitoring efforts usually involve organized fishers, but also fishing families or individual fishers. Fishers collaborate voluntarily or due to commitments to formal or informal (tacit) partnerships or collaborative agreements. Fishers enroll in participatory management both in well-established (the AMERBs system) or more incipient co-management arrangements (Argentinean or Uruguayan cases). In some cases, a monetary incentive is offered to fishers participating in monitoring as a compensation for their time and effort. This was the case of Corumbau RESEX and Southern Bahia's Territory of Citizenship initiatives in Brazil (cases 3 and 6), where fellowships were granted to selected experienced fishers. In the scallop fishery of Argentina, costs incurred during surveys were covered by the fisheries agency, but the monetary compensation for the days of work was

Table 4 Characterization of the case studies according to Ross et al. (2002) analytical categories and participation of fishers in monitoring

Case study	Agency	Task	Nature of participants[a]	Use and access regulations	Duration	Monitoring stages with fisher participation
Argentina						
1. San José Gulf	Researchers and organized fishers mainly, driven by the need to increase management effectiveness and deal with fisheries crisis	Estimate scallop abundance to determine catch quotas (OM). Reinforce co-management enriched with FK (OM/PL)	Researchers, organized fishers (15–20 families), and technical staff of management agencies with constructive relationship consolidated over 20 years	Protected area: Península Valdés Natural Protected Area and UNESCO World Heritage Site State regulations and nonbinding technical committee Limited entry	Stock assessment: 2001–2017. Since 2007 with fishers' participation Voluntary logbook program: 2002–2004, discontinued due to lack of funding	Design of methodology Data collection Data analysis and quota recommendation
Brazil						
2. Armação do Itapocoroy Cove	Researchers and fishers (outreach project), driven by the need to increase management effectiveness and awareness for conservation	Educate the public on environmental issues (PL) Estimate local support capacity for aquaculture (PL/SP)	Researchers presented the project to organized fishers (12 families)	Private, with state regulations: Mollusk farming area	Pilot project: 1997–2007, expanded to other locations (see initiative 8)	Fishers as a source of information Data collection (by one selected family, with guidance from researchers)
3. Corumbau RESEX	Researchers and fishers' mainly, with participation of the government and NGOs, driven by the need to increase management effectiveness	Determine catch quotas (OM) Provide information for marine conservation in the RESEX (PL)	Well-organized fishers (~ 230 families), previous interactions with NGO staff and researchers	Protected area: RESEX grants exclusive use-rights to organized resource users through a contract for 20 years (renewable)	With funding: 2002–2006, with higher participation of fishers in 2005 and 2006 Voluntarily: 2006–2008	Selected fishers hired to collect data from voluntary participants Access to data
4. Costa dos Corais APA	Collaborative research project (university, governmental and funding agencies) driven by the need to provide a scientific basis for management	Support the development of the APA management plan (PL) Estimate fish stock status (OM)	Organized fishers, researchers, the government, and international agencies with a history of previous collaborative interactions	Protected area: Environmental Protected Area (APA)—includes zones with distinct degrees of resource use restrictions (e.g., on fishing gear type and target species)	1997–2001: Two years of monitoring resulted in the implementation of a no-take area in 1999, with fishers' support. Monitoring continued for two more years	Design of methodology Two fishers hired and trained to collect data Use of information (e.g., establish a no-take area)
5. Prainha do Canto Verde RESEX	NGO working in close collaboration with the local community, driven by the need to deal with fisheries crisis and aiming at certification by the Marine Stewardship Council	Support the Fisheries Management Plan (PL) Assess the sustainability of the lobster fishery (OM)	The community (~ 1200 residents) has a 20-year history of interaction with NGO. Partnerships with researchers and the government are voluntary and well established	Protected area: RESEX	Landings monitoring: 1995-present Socioeconomic monitoring (certification): 2008–2010	Design of methodology Data collection Use of information

Table 4 continued

Case study	Agency	Task	Nature of participants[a]	Use and access regulations	Duration	Monitoring stages with fisher participation
6. Southern Bahia's Territory of Citizenship—APA	Participatory research project initiated by researchers and technicians of government agencies	Support the appreciation of traditional knowledge (PL) Gather biological data of fish species (OM)	Researchers and staff of government agencies	Protected area: APA Territory of Citizenship: recognizes traditional peoples but does not imply rights or duties with regards to fisheries	2011 to 2012. Monitoring discontinued when the project finished	Two fishers hired and trained to aid in monitoring Discussion of results Feedback to the community on the work accomplished
7. Tijucas Bay	Fishery management program financed by the government and developed with participation of fishers and researchers	Assess catch and effort to develop an action plan for the use of fishing resources (PL) Support fishers' involvement in management (PL)	Previous interactions among the government, researchers and organized fishers	Buffer zone of a no-take protected area: Arvoredo Biological Reserve State regulations: closure of shrimp harvest during breeding season	2002 to 2003. Monitoring discontinued when the project finished	Design of methodology Seven monitors selected by participants to collect data Discussion of management strategies
Chile						
8. Juan Fernández Archipelago	The fishers syndicate, in collaboration with researchers and NGOs, to reduce monitoring costs, to document customary tenure and to support fisheries certification	Document the traditional tenure system (PL) Develop an abundance index to assess stock status (OM)	Strong interactions among researchers, NGO staff and fishers organized as a syndicate. The fishery is vital to the island community ($\sim$ 630 inhabitants in the main island	State regulations: legal size, season, and no catch of egg-carrying females Informal tenure of fishing spots Protected area: Juan Fernández Multiple-use Marine Protected Area, demanded by the fishers' syndicate	Annual landings records started in 1930. Since then, a series of projects monitored several fishing seasons. The voluntary logbook program is running since 2006	Design of methodology Data collection Discussion of siting of protected area
9. 'Loco' AMERBs	Researchers, the government and the fishers, driven by resource crisis. It ended up in the crafting and implementation of the AMERB policy (and participatory monitoring)	Evaluate resource status to determine catch quotas (OM) Foster co-management through participatory monitoring (PL)	Previous interactions existed between the government, researchers and fishers. The formal requisites of AMERBs were mainly designed by managers and researchers. Fishers had to adhere to the system to continue fishing 'loco'	AMERBs: grant exclusive-harvest rights for specified resources to formally organized fishers. Membership and distribution of benefits and work arranged within each fisher union. Approximately 416 decreed AMERBs for loco (among other target resources) in the country in 2018	Annual estimation of resource abundance required once the AMERB management plan has been approved First AMERB granted in 1997	Varying degrees of fishers' involvement in monitoring across AMERBs. Consultants choose sampling design and conduct data analysis

Table 4 continued

Case study	Agency	Task	Nature of participants[a]	Use and access regulations	Duration	Monitoring stages with fisher participation
10. Puertecillo and other communities of Cardenal Caro Province: "*Parcela*" and AMERB system	The *parcela* system emerged in several fishing communities driven by the need to solve access conflicts to kelp resources. In Puertecillo, informal use-rights agreements were backed by the maritime authority until 1982, when the syndicate became the main guarantor	Assess quality, yields, and growth/ reproduction of kelp beds to decide harvesting times/sites (OM)	Fisher families participate in kelp harvesting and processing with benefits shared beyond family bonds (600 algae and shellfish gatherers operated in the Province and $\sim$ 40 in Puertecillo)	Traditional tenure system: fishing areas (*parcelas*) customarily allocated and inherited along family lines AMERBs: since the 2000s—affected traditional management practices	In Puertecillo, the system dates back 100–150 years In Topocalma, the system was introduced in the 1950s or 1960s Monitoring inside AMERBs started in 2000s	Design of methodology Data collection Use of results
11. Tongoy Bay AMERB	Fishers, researchers, government agents and the navy collaborated in developing and implementing a management plan with annual assessments and catch quotas (AMERB requisites)	Estimate resource abundance to determine catch quotas (OM) Reinforce co-management (PL)	Previous interactions among researchers and fishers facilitated this collaboration and helped increase fishers' participation. The management plan and annual monitoring are requisites of the AMERB system	Open access until 1999, when an AMERB to exploit surf clams was granted to a fishers' association	Since 1998, interrupted during 2004–2007 due to collapse of the surf clam fishery and loss of fishers' incentives. Collaborative monitoring reinitiated in 2007 to avoid losing the AMERB	Data collection Data analysis (developed their own database, with researchers support) Use of results (negotiation of quotas with the government)
Uruguay						
12. Rocha (La Coronilla, Barra del Chuy)	The government, researchers and local fishers driven by resource crisis. First initiative led by researchers, followed by a co-management project led by the government with international support	Estimate resource status to determine catch quotas and evaluate the effects of the closure on the resources (OM) Reinforce co-management and improve fishers' livelihoods (PL)	Researchers and fishers had interacted previously during research field activities. Coastal marine authorities, scientists and a small group of fishers collaborated voluntarily	Pilot closure between 1994–2008 Regulations since 2009: monthly total allowable catch, limited fishing licenses, individual quotas and spatial management scheme	Scientific experiment: 1987–1990 Co-management period (including monitoring): 1990–1993 Closure: 1993–2007 Pilot governmental project (co-management): 2009–2015	Design of methodology (since 2009) Data collection Data analysis
13. Piriápolis	Participatory research project initiated by a researcher. Monitoring driven by fishers' concerns about Sea lion damage of fishing gear	Design and monitor the performance of a new gear able to resist sea lions (SI) Reduce wildlife damage to fishing equipment	Researcher organized fishers, government agencies, other researchers, and NGOs. Participation was voluntary. (between 28 to 60 boats—depending on the season, crew of 3)	Small-scale fisheries regulated through seasonal closures	Monitoring was planned to take place during a short period (2014–2016) to evaluate the performance of the new fishing gear	Design of methodology Data collection Data analysis, and Use of information to evaluate and adapt fishing equipment. Process enriched by fishers' knowledge

Table 4 continued

Case study	Agency	Task	Nature of participants[a]	Use and access regulations	Duration	Monitoring stages with fisher participation
14. Punta del Diablo	Government, international agencies, researchers, and fishers, driven by the need to reduce by-catch in an artisanal shrimp fishery	Design, monitor, and evaluate a device to reduce by-catch in the shrimp fishery (SI/OM)	Researchers and organized fishers (13 families) with a history of previous interactions, supported by the Uruguayan Fisheries Agency	Protected area: Some fishing grounds overlap with the Cerro Verde Marine Protected Area State regulations: closed seasons and gear regulations	Monitoring took place in 2005–2006 Short-term initiative to evaluate the device	Design of methodology Data collection

Initials in Task column stand for: PL: Planning; OM: on-going management; SP: resolution if specific issue or conflict

[a]See resources and gear in Table 3

lower than fishers' expectations based on an average day's fishing.

A long history of interaction among parties was observed in cases that emerged with a strong bottom up component (case 5) or in cases in which fishers were highly engaged (initiatives 1, 5, 7, 8 and 12). Previous exchanges and constructive relationships built over the years were instrumental in the launching and success of monitoring programs. Strong collaboration among parties was observed when participants shared a common goal from the beginning of the discussions that eventually led to a recognized need for monitoring (such as in cases 1 and 13). By contrast, weaker collaboration was observed in initiatives conceived with less meaningful involvement of fishers (e.g., case 9).

Use and access regulations

Most participatory monitoring initiatives occur in non-open-access (i.e., regulated) systems, with some level of access rights/resource use restrictions, regulated by the government and/or by local agreements (case 1, 3–12, 14). In the San José Gulf of Argentina (case 1), participatory monitoring was implemented in the context of a limited-entry program established after the collapse of a scallop diving fishery under open access; other management measures introduced included a total allowable catch and individual quotas for each participating boat. In Brazil, four cases occur inside protected areas, further discussed below. In Chile, there are traditional informal (but locally legitimated) traditional rights-based systems (cases 8 and 10) and a formal system of Territorial Use Rights in Fisheries (TURF) introduced by the government (the AMERB system; cases 9 and 11); there is also coexistence of formal and informal mechanisms such as in the *parcela* system (case 10). In the *parcela* traditional system, monitoring of seaweed production made possible the adjustment of *parcela* layouts based on individual yields and allowed for a more equitable distribution of *parcelas* (Francisco Araos-Leiva, Hernán Venturino and Luis Ariz, personal communication). The lobster fishery of Juan Fernández Archipelago is another traditional rights-based system where participatory monitoring was collaboratively designed to provide reliable indicators of stock status (catch per unit of effort) rooted in local practices (hence meaningful to the fishers), also fulfilling information required by the fisheries authority. In this case, fishers adhered voluntarily to the monitoring program.

In the AMERB system, in contrast, annual estimation of abundance of target resources within each AMERB is a formal requirement by the government in order to authorize annual catch quotas. A certified consultant must be hired by the fishers' organization that holds the AMERB in order to coordinate the resource surveys (República de Chile 1995), which are usually conducted with fishers' participation (varying levels among individual AMERBs), although not a formal requisite. Monitoring reports must be submitted to the centralized federal fisheries agency[2] which

[2] Undersecretary of Fisheries and Aquaculture of Chile, SUBPESCA.

approves or rejects the proposed strategies and suggested annual quotas (San Martín et al. 2010; Schumann 2010a). Decision-making occurs at the federal level, far from the fishing communities.

Interestingly, several participatory monitoring initiatives have taken place inside Protected Areas (PAs) (cases 1, 3, 4, 5–8, 14) with diverse institutional formats and degrees of fishers' involvement in management and decision making. In Brazil, for example, most initiatives occur within PAs with sustainable use of natural resources (IUCN category VI) known as Extractive Reserves or RESEX (cases 3 and 5) and Environmental Protected Areas or APAs for its Portuguese acronym (cases 4 and 6). Extractive Reserves have a strong bottom-up component in which decisions are taken by a Deliberative Council with majority representation (50% + 1) of traditional fishing groups/communities. Nonetheless, because of budgetary limitations, monitoring of the two RESEX described in this study has been mainly led by agents external to the agency in charge of RESEX management (ICMBio), in collaboration with some fishers. Differently from RESEX, APAs have a management council (Brazil 2000) and fishers' participation in management is limited. The program of case 4, which takes place inside an APA, has received significant support from the environmental authority in charge of the APA management. Case 5 is an interesting example of monitoring implemented in the buffer zone of a no-take PA, the Arvoredo Biological Reserve. The management plan of the reserve fosters research and socioeconomic monitoring in the buffer zone. At the country level, a formal requirement to regularly monitor and evaluate the effectiveness of management efforts inside protected areas (Conservation Units as per the Brazilian legislation) exists (Brazil 2000), but very few PAs have a monitoring program designed and operating (Santos and Schiavetti 2014).

In Argentina, fisheries governance up to 12 nautical miles off the coast is decentralized, under state jurisdiction. This brings decision-making closer to the fisheries, a situation that favored collaboration among fishers, researchers and government agencies. Although the management plan of the Valdés Península Natural Protected Area (which includes San José Gulf) specifies that management and monitoring programs ought to be developed for each extractive/commercial activity occurring inside the area, in practice, participatory stock assessments have been mainly pushed by fishers themselves, researchers and technicians from the provincial fisheries agency, with sporadic involvement by the PA managers. Although fishers had an active role during the elaboration of the initial management plan, they have no place in current decision-making regarding the PA; fisheries and PA management run through separate channels, with deficient coordination. State support for monitoring and enforcement has weakened over time in San Jose Gulf and poaching has escalated (Fiorda et al. 2013; Orensanz et al. 2013).

In Uruguay, the law defines closed seasons for some fish species and gear restrictions (Uruguay 1997). The participatory initiatives documented here are not located inside a PA except for case 14, which was established inside the Cerro Verde Protected Area, a PA with no management plan yet, hence, with no implications for local fisheries. What stand out in the Uruguayan cases are the efforts towards the implementation of co-management arrangements, with varying degrees of fishers' participation. The Uruguayan government is undergoing a transition in fisheries management towards co-management and participatory approaches (Defeo et al. 2016).

In summary, the sample of cases analyzed that operate inside PAs does not appear to show a clear pattern regarding the role of PA managers in fomenting/initiating the participatory monitoring initiatives occurring inside the PA borders; however, they usually have a supportive role.

Duration

The timeframe of the monitoring programs varied from one year to some decades, depending on the program's goals, the availability of funding and the level of engagement of participants. Nearly half of the monitoring initiatives were able to persist 10 years or more, either continuously (e.g., cases 1, 2, 5, 8–10) or with some interruption (e.g., cases 11 and 12). Most of the long-term initiatives were those in which fishers had an active role and perceived the need for monitoring as a tool to improve or better manage their activity (e.g., cases 1, 5, 8 and 10). Long-term monitoring programs were usually implemented through long-term collaborations between research institutions and funding agencies (e.g., cases 1 and 2), or emerged from local initiatives with the support of

external collaborators (e.g., cases 8 and 10). Case 5 is intermediate in that a local NGO with strong roots in the community emerged to foster local fisheries sustainability and potentially apply for a Marine Stewardship Council certification of the lobster fishery.

Four programs (cases 4, 6, 13, and 14) were designed to last a short period (1 to 3 years) seeking to address a specific goal, as explained above, usually as part of collaborative research projects (cases 4, 6, and 13). Other monitoring programs were interrupted due to cuts in financial support (the voluntary logbook program of case 1, and case 3), due to resource collapse (case 11) or due to mass mortality of the target species as a result of environmental factors (case 12).

The extent of fishers' participation in monitoring initiatives

The selected cases are all participatory monitoring programs of small-scale fisheries. However, different degrees of participation can be observed. In about half of the cases the fishers participated in diverse stages of monitoring, including the design of the monitoring program, the actual collection of data and the discussion of results (cases 1, 5–8, 10–14). In a few instances, they participated also in data analysis (cases 11, 13 and 14) or decision-making based on the information gathered (cases 1 and 7). Participation of fishers and knowledge sharing were favored in cases where monitoring initiatives had a strong bottom-up component, or in which a long-term collaboration among parties previously existed. Usually, fishers' participation and knowledge sharing increased in such programs throughout the years, due to a shift towards collaborative practices in fisheries management, the building of trust and an increased awareness among participants of the importance of monitoring.

In five out of the 14 cases, data collection was the main phase in which fishers participated. In one case, this was the only stage of participation (case 2). In other cases, they also participated in the design of monitoring (case 4), the discussion of results (cases 9 and 12) or received the monitoring results at the end of the assessment (case 3). These five cases feature the lowest degree of participation, with scarce or no incorporation of FK into fisheries monitoring.

Discussion

The array of case studies found in the literature suggests a relatively scarce number of participatory monitoring programs of small-scale coastal fisheries implemented in the region, considering its geographic extension (see Salas et al. 2011, 2018). Moreover, in about one third of the cases, participation was mainly restricted to data collection. In Brazil, most experiences emerged in the context of research projects or NGO-led initiatives with a strong participatory focus. In Chile, two of the more enduring initiatives involved organized communities with traditional forms of management in place. The rest of the cases are AMERBs (TURFs for benthic resources), in which monitoring is a requirement of the AMERB nationwide policy, although participation is not mandatory. Fishers' participation in AMERBs monitoring varies along the country, but it is often limited to conducting diving surveys according to a pre-established design, without pre or post surveys' participation (San Martín et al. 2010; Schumann 2010b; Orensanz et al. 2015). In Uruguay, the number of documented cases is non-negligible given the smaller extent of its coasts and fisheries. All the three cases were part of larger efforts to implement co-management with active participation of multiple sectors (fishers, government, technicians/researchers, others). In Argentina, the only case found stands out as a long-lasting partnership (almost two decades of monitoring) between organized fishers, researchers and technicians from the fisheries agency, in which fishers' knowledge is readily incorporated starting from the design stage.

In our review, publications that addressed monitoring as a process, describing important characteristics that could help generate and share relevant lessons (e.g., triggers, methods, participants, reason for failure or success, institutional context, overall performance) are scarce; exceptions include Parma et al. (2003), San Martín et al. (2010), and Schärer et al. (2010). In general, the literature focuses on the results of monitoring (the data gathered) and their implications for management. To overcome this limitation, we established contact with stakeholders involved in the monitoring initiatives to confirm information and fill in gaps in order to better understand the cases. We argue that sharing how monitoring programs have performed is as important as communicating monitoring results.

Different forms of participation may occur and be fostered. We highlight institutions that formally require

participation in natural resource management, such as AMERBS in Chile and RESEX in Brazil. However, we also identified a mismatch between participation legally required and what happens in practice. RESEX and AMERBS are proposed as co-management regimes, formally prioritizing participation. However, in these cases, de facto management can proceed with a low level of participation due to financial restrictions, lack of human resources or lack of will on the part of stakeholders or decision-makers. Similar mismatches were found by Agarwala and Ginsberg (2017) based on a meta-analysis on formal and informal management regimes of natural resources. Moreover, the authors showed that de facto (i.e., that develops in practice) participation in the management of natural resources is more likely to result in positive outcomes for the sustainability of resources, despite being vulnerable if not supported by authorities.

If we turn now to the aspects contemplated in monitoring programs, the variables most often monitored were related to catch and effort, ecological/biological dimensions, environmental and/or economic (profitability) dimensions of fisheries. In only a few cases, governance, sociocultural, and/or socioeconomic/wellbeing variables were monitored. The scarce attention to variables of the social and institutional domains is a problem observed in fisheries management in general around the world (FAO 2015). This was noticeable in the monitoring stage of the systems analyzed in this review. Monitoring is a key phase that provides information to inform and adapt decisions that involve and affect social, ecological, and other key dimensions of fisheries. The need to extend monitoring beyond ecological/fisheries data has being emphasized for at least two decades (FAO 1999, 2003). Fisheries are social-ecological systems where conservation of stocks and their environment are as important as human needs to support the sustainability of conservation measures and fisheries management strategies (Berkes 2011). As Garcia et al. (2008) state: "the indicators of relevance for a particular evaluation program depend on the context, the nature of the fishery and, above all, on the question initially raised or problem to be solved, the solutions proposed and their expected outcome". The specific issues affecting small-scale fisheries and the specific objectives retained for them imply giving attention to indicators relating to sustainability, food security, poverty, empowerment, resilience, adaptability, vulnerability, and livelihoods, among others, in addition to conventional fishery indicators (Garcia et al. 2008).

Moreover, fishers' knowledge offers an overlooked potential to identify appropriate governance fit for both social and ecological systems, as it provides context-specific information on both biophysical features of fishing stocks and marine environmental, along with preferences, values and needs of fishing communities (Epstein et al. 2015; Ignatius et al. 2019). Biological and ecological characteristics of fishery resources and the cultural and social norms within a fishing community may shape monitoring procedures and indicators to better suite local conservation and provide sustainable livelihoods for coastal communities. The case of benthic resources, common in Chile and Argentina, illustrates how the reduced scale of fishing operations and the sedentary nature of the resources facilitates the establishment of clear boundaries for grating tenure and monitoring local stocks (Castilla and Defeo 2001). This is in sharp contrast with the migratory fish stocks monitored in Brazilian and Uruguayan cases, which require cross boundary governance. Fishers knowledge regarding the specific of the size of the fishery unit, for instance, is a relevant asset to deal with fit in scale-related issues, as observed by Ostrom (2009).

In our sample, Prainha do Canto Verde in Brazil (case 5) was a notable example of a well-documented long-term participatory monitoring program that addressed socioeconomic/governance information. Almeida (2002) assessed fishers' participation in management, awareness of fishery regulations and job satisfaction, among other variables. Also, in Brazil, ICMBio (2017) has recently reported details of fishers' participation in monitoring processes in another two cases inside PAs as part of the Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon).[3] In Chile, the AMERB policy requires the registration and reporting of socioeconomic information to authorities by the consultants in their annual stock assessment reports. However, only a few indicators of fishing organizations[4] are requested

[3] SocMon is a global initiative aimed to establish local programs of socioeconomic monitoring in coastal areas, to complement biological and ecological monitoring.

[4] Indicators include total returns obtained by the organization from resources extracted inside AMERBs, total costs, benefit/cost ratio, and average gross returns per member (solely considering AMERB catches).

through a form provided by the centralized fishery agency, which is often filled out by the consultant with the help of the leadership of each organization. The Chilean fishery law (República de Chile 2013) demands that management committees ought to be created with representation from all relevant stakeholder groups (see Gelcich et al. 2015). These may provide an opportunity to incorporate community information more directly (e.g., socioeconomic), empirical local knowledge and diverse perspectives into management. In Uruguay, the long-term partnership between researchers, the government and local fishers at Barra del Chuy is an example of how governance structures such as co-management, may reinforce participatory processes over time, and adjust monitoring procedures to the local reality by incorporating fishers' input (see Gianelli et al. 2018).

Our review highlights the scarce attention given to socioeconomic/governance indicators in the study region, and the need to advance in this regard to gauge progress in fisheries sustainability from social, economic, governance and cultural perspectives. Environmental variables were also rarely monitored compared to fisheries variables. These findings stresses a need for fisheries management agents, institutions and organizations to make progress in incorporating cultural aspects of fishing practices and communities, equity concerns in the fishing sector, and traditional/local knowledge in their decisions, as suggested by the SSF Guidelines (FAO 2015). We understand that participatory monitoring processes can be a complementary step to further address the highlighted issues, adding efforts to continue to change the historical top-down forms of management in fisheries and conservation in South America and beyond.

Fostering fishers' participation and inclusion of fisher knowledge in monitoring programs

In the cases analyzed in this review, several conditions have facilitated the establishment and maintenance of participatory monitoring programs, which may help to put in practice the principles of the SSF Guidelines (FAO 2015) in South America:

1. *Presence of tenure systems based on the granting of use rights* (formal, informal/traditional or mixed), which imply some degree of shared responsibilities and delegation of management authority to local groups/communities, where users' participation and collaboration among sectors is more likely to take place. Also, several cases were implemented inside protected areas (other form of institutional arrangement) that attract the attention of sectors of society which demand and/or activate the implementation of monitoring programs. This reveals the key role of governance and institutional fit (Epstein et al. 2015) in favoring participatory processes based on enabling institutions (e.g., some RESEX arrangements), participatory rulemaking-systems (e.g., traditional tenure, POPA group in case 13), and flexible rules (e.g., adaptive management based on monitoring results, such as in case 5).
2. *Previous fruitful interactions among sectors* (e.g., government agencies, fishers' organizations, researchers/technicians, NGOs) in which mutual trust, reciprocity, and understanding of each other's roles, interests, and capabilities, are built and strengthen. A two-way communication (not only from scientists/officials to the fishers) and openness to listen and discuss issues are key elements of meaningful partnerships. In addition, long-lasting partnerships provide an effective channel to share and apply fishers' knowledge (Orensanz et al. 2015).
3. *Clear objectives of monitoring programs and shared perceptions of the need for monitoring*. When there are clear needs perceived as relevant (e.g., quota estimation or other information key for decision making), it is more likely that the involved parties will commit to do it and sustain it. Fishers must see benefits from participating in monitoring in order to feel part and motivated to collaborate. Fishers' agency usually emerged in a context of resource crisis and/or under ineffective management that affected the fishing community. Fishers' intrinsic motivation is more likely to be augmented if fishers are involved from the beginning in monitoring programs and along the whole process (objectives and variables definition, data gathering and processing, discussion of results and decision-making). Motivation also increases when fishers' knowledge and preferences are considered. On the other hand, when monitoring is driven by research questions or policy directives

without proper consultation/involvement of fishers, it risks being short-lasting. In such cases, monitoring is often tightened to a project or a program and is likely to be discontinued when funding ends.

4. *Organized fishers and leadership*, which facilitates the inclusion of the fishing sector in formalized institutional arenas for management and decision making. Organization has been instrumental to channel the demands of the fishing sector more effectively, such as claims for fishers' rights to meaningful participation.
5. *Favorable conditions to operationalize monitoring*, like funding, human resources/capacities, and an adequate distribution of roles and duties to carry it out. The duration of a monitoring program may vary according to its goal. Programs that are designed to perform in the long run face increased challenges. Several of the long-term case studies were interrupted when budgets were cut, or research projects finished. Monetary compensation may motivate fishers' participation; if monitoring is not related to fishers' own interest, then participation is likely to discontinue even with compensation. Hence, a long-term program usually requires motivation in addition to financial and technical support.

Studies from other parts of the world including the Philippines (Uychiaoco et al. 2005), East Africa (Obura 2001; Obura et al. 2002), Hawai (Schemmel and Friedlander 2017) and México (Fulton et al. 2019), highlight the value of participatory monitoring for improving fisheries management and marine conservation. These studies also acknowledge that participatory monitoring have facilitated information communication, multi-stakeholder cooperation and management actions (e.g., improved enforcement) in addition to data collection on status of resources or protected areas. Fulton et al. (2019), whose work was based in Mexican fishing communities, highlight that empowering community members to collect data in a standard way creates responsibility, pride, and a deeper understanding of the ecosystem in which they live and work, providing both social and ecological benefits to the community and marine ecosystem. Our results for South America provide additional evidence in support of these authors' findings, reinforcing the idea that participation in any stage of management can act as a powerful catalyst for collaborative action in several other dimensions (notable cases are San José Gulf, Prainha do Canto Verde RESEX, and Piriápolis).

The incorporation of fishers' knowledge and expertise into the Ecosystem Approach to Fisheries (FAO 2003) lacked clear guidelines and had not been encouraged at a global level (Fischer et al. 2015). Our review contributes towards this effort by exploring the context in which participatory monitoring cases emerge and are sustained, and the context in which FK is used in this management phase. Our results suggest that in cases in which fishers' participation was active, knowledge exchange and FK incorporation into monitoring took place in meaningful ways (e.g., Prainha do Canto Verde RESEX, Piriápolis, San José Gulf). In Latin America, although much of the FK input to management is undocumented, knowledge exchange occurs in every multisectoral encounter, either informally or as part of formalized arenas for collaborative research or management (Orensanz et al. 2015).

The continuity of participatory monitoring programs depends on funding and commitment from all parties. Our reviewed cases exhibit weaknesses in most if not all these regards. In many cases, the inception of participatory monitoring has been pushed by researchers, helping to mediate dialogue between fishers and the government (e.g., Corumbau RESEX, Prainha do Canto Verde RESEX, San José Gulf), and in only a few cases the fishers took the lead to demand participation in management and evaluate resources through monitoring (see for example Orensanz et al. (2007) for the San José Gulf case). In Brazil and Argentina, government agencies had a supportive role adhering to—but generally not promoting—the initiatives. Many cases have been designed with short-term objectives in mind, but even those with long-term objectives usually have partnerships that are institutionally weak, whose performances are highly vulnerable to political swings, in addition to shortage of funding. In some cases, the willingness of government agencies to allow participation may also depend on the personal vision and values of the staff in charge of fisheries and/or protected area management (Seixas and Vieira 2015); this circumstance may have significant consequences in a context of weak institutionalization.

South American experiences can certainly benefit from lessons elsewhere. Based on cases from Mexico,

Fulton et al. (2019) highlight key factors to make fishers participation economically viable and for keeping the fishers well motivated. These include the need for a constant source of funding (including a stipend for fishers to compensate the forgone fishing days), a multidisciplinary team working together, and an active participation of fishers in the evaluation of results and the elaboration of management recommendations. Obura et al. (2002) also emphasize for the African cases that in a context of limited resources, monitoring has a much higher chance of success if carried out as a collaborative effort in which the institutional and financial basis are provided. Even though all the countries analyzed in this review have the institutional basis for fostering participatory monitoring under the premises of the Ecosystem Approach to Fisheries, long-term funding needs to be secured and partnerships need to be strengthened for the continuity of fishers' (and other parties) meaningful involvement in ongoing and future efforts.

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