



Artisanal fishers' perceptions regarding coastal co-management policies in Chile and their potentials to scale-up marine biodiversity conservation

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ABSTRACT

No-take Marine Protected Areas (Nt-MPAs) constitute an indispensable tool for biodiversity conservation. Nevertheless, there are other instruments such as marine coastal co-management policy frameworks which may be also considered as tools for conservation or as ancillary conservation instruments. Using focus groups, semi-structured interviews and survey questionnaires we analysed small-scale artisanal fishers' perceptions towards a coastal co-management regime in Chile and the potential to generate capacities and a social setting to scale-up marine conservation. Empirical evidence from the study shows artisanal fishers have indeed been empowered through the coastal co-management experience; however, there exist heterogeneity in their willingness to participate in the creation of Nt-MPAs, mainly determined by occupational mobility. Chilean artisanal fishers strongly support a bottom-up process in the conservation of marine biodiversity, though the need for top-down steering and guidance is also stressed, especially regarding enforcement.

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1. Introduction

Marine coastal management approaches based on top-down and centralized government interventions have proven to be inadequate [1–3]. As a consequence, during the last decade, researchers and development agencies have promoted a shift towards bottom-up governance of local (communal) resources and the sharing of responsibility between governments and fishers through the use of co-management policy frameworks [4–7]. Concomitantly, many international *fora* have advocated for a significant scaling-up of site based conservation interventions in the form of No-Take Marine Protected Areas (Nt-MPAs) to achieve on the order of 20–30% coverage of the world's major coastal and marine habitats by 2012 [8]. Such targets are overly ambitious, given that most Nt-MPAs are not considered to be managed effectively ("paper" Nt-MPAs) and foremost, that there is resistance from fisher communities to the implementation of this conservation tool [9,10]. As a consequence, if marine conservation is going to scale-up there is a pressing need for efforts to enhance the complementarities between Nt-MPAs and other conservation/management tools (e.g. Territorial user rights fishery policies; TURFs, marine extractive reserves, indigenous landscape management areas), in what instruments of the Convention of Biological diversity have termed "ancillary" marine

conservation initiatives [11]. Accordingly, it becomes important to understand the potential of co-management policies to generate social settings which could support joint sustainable use of coastal resources and biodiversity conservation objectives.

In inshore coastal Chile, co-management takes the form of the Management and Exploitation areas for Benthic Resources (MEABR) policy. Through the MEABR regime the Chilean Under-secretary of Fisheries assigns temporary TURFs to artisanal fisher associations (mostly unions in Chile) in defined geographical coastal areas [12]. The MEABR policy was implemented in Chile as a reaction to the widespread overexploitation of benthic species which occurred during the 1980s (reviewed in [3,13]). The first actual MEABR was formally established in 1997 [12]. As of 2005, 301 MEABR have management plans in place, and 547 have approved decrees issued [14]. To date 1032 km² are assigned as MEABRs in Chile, however, policy uptake has been highly dependant upon the commitment of the Government to promote, popularize and co-finance the implementation of these management areas [15]. In order to have an MEABR fisher unions must contract biological consultants to undertake a baseline study and yearly follow-up direct assessments of managed benthic stock inside the management area; hence, determining yearly Total Allowable Catches (TAC). Unions must also pay an annual fee to government for the right to maintain the management area. They are also required to maintain the MEABR stocks through 'natural seeding' recruitment processes (*sensu* [16]); therefore, no human

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induced restocking is allowed.¹ Additionally, only resources included in management plans can be extracted from the MEABR.

The biological-fishery success of the MEABR policy has been publicised through scientific and government documents which showed a significant increase in abundance and individual size of targeted resources within MEABR in comparison with open-access sites [16–18]. Recently, Gelcich et al. [19] also showed how MEABRs, showing efficient enforcement programmes, sustained greater marine biodiversity than open-access areas. In addition the Fisheries Undersecretary sees MEABR implementation as a positive change in which fisher communities have self-organised, creating partnership with the government, universities and consultants [20]. In this way, artisanal fishing coves are being consolidated responding to government incentives. Studies have identified that livelihood characteristics could influence fishers' attitudes towards the policy [21,7]. In the same vein, research has shown positive shifts in some environmental perceptions of fishers who have engaged with the policy [20,22]. Despite the effort which has been devoted to the generation and implementation of this policy model in Chile, to date there are few empirical studies assessing fishers' perceptions of the policy process and about the possible generation of the social settings (social support), in the artisanal fisher communities, for marine biodiversity conservation.

The plans to scale-up marine conservation in Chile were institutionalized by the government in 2003 via the approval of a National Strategy for Biodiversity (Estrategia Nacional de Biodiversidad). In the process (2001–2003) the National Commission on the Environment (CONAMA) identified 305 key sites in Chile for the conservation of ecosystems (biodiversity conservation). Of these only 28 corresponded to marine sites. The targets of this national plan are set for 2006, 2010 and 2015. For 2006 the marine conservation target consisted on the implementation of three Marine Protected Areas for Multiple Uses (MU-MPA) which should include a core Nt-MPA zone. To date these areas have been implemented, nevertheless, the NT-MPA zones have still not been defined [23]. For 2015 the target is that all MU-MPA should be fully implemented and institutionalised as a network. However a understanding of fishers' perceptions of this process has been largely absent.

The broad thrust of our research aims to analyse Chilean artisanal fishers' perceptions regarding a well established fishery co-management regime (i.e., TURFs and MEABRs) and its potential to generate a social setting which may help to support the scaling-up of marine conservation practices. In doing this our objectives are: (1) to understand fishers' perceptions of the TURFs/MEABR policy processes with respect to (a) compliance, (b) enforcement, (c) empowerment, (d) main problems/conflicts and future challenges. (2) To evaluate fishers' perceptions regarding biodiversity conservation associated to MEABRs and fishers view of the MU-MPA plan, specifically the Nt-MPA component, to be implemented in Chile. (3) To assess fishers' determinants of their willingness to participate in the administration and management of an MU-MPA network in Chile. Hopefully these analyses will inform related policy developments aimed at integrating the sustainable use of coastal resources and biodiversity conservation.

2. Methods

2.1. Research sites and settings

Artisanal fisheries in Chile supply a significant fraction of high-valued finfish, benthic invertebrates and algal resources, for local

consumption, although a large fraction is also exported. This activity is important from a social and employment perspective as there are around 50,000 artisanal fishers registered in Chile. Out of these, 22,600 are registered as divers or coastal intertidal food gatherers, which mainly exploit benthic shellfish and algae as part of their livelihood. At least 60 coastal benthic species are exploited in Chile [3, 12], however the gastropod *Concholepas concholepas*, known locally as 'loco' is the most economically important. Hence 90% of existing MEABRs have loco as their main target species. The importance of loco, as a managed flagship-species, means that management practices specific to this species have become the driver for policy developments towards MEABR approaches. Furthermore, it has been decreed (2000) that all the loco gathered in Chile must be extracted through diving exclusively from established MEABRs. During the last five years, around 3000 tonnes (MT) of loco y^{-1} have been landed in Chile worth around US\$ 5–7 million in export values, this amount rising as new unions apply for MEABRs and market demands increase (see [3,21]).

Within Chile, certain areas of coastline are officially designated as 'coves' ('caleta' in Spanish). These are strips of land above the high tide mark that provide certain rights to users such as the right of access to the sea, land a boat, land natural resources and construct certain buildings. Currently there are 425 caletas in Chile [21]. Some caletas are well equipped as artisanal landing ports for finfish and/or shellfish, in urban areas or holiday destination towns, others are rural and relatively isolated. For administrative purposes Chile is divided into 15 regions, and our research considered eight unions in four of these regions (IV, V, VI and X; Fig. 1), representing a range of urban-rural types associated to a variety of livelihood characteristics: (1) Union Cooperativa (urban) and (2) Chigualoco (rural) are located in Region IV (31°55'S; 71°00'W; Fig. 1). The MEABR policy process has been established in Region IV for 7 years; hence, these unions have been managing MEABRs for most of this time and in 2006 were extracting resources for their sixth year. (3) Unions El Quisco (urban) and (4) Algarrobo (urban) are located in region V (Fig. 1), El Quisco was one of the first unions in Chile to engage with MEABR policy. (5) Union La Boca (rural; 33°55'S; 71°50'W), (6) Puertecillo (rural; 33°55'S; 71°50'W) and (7) Matanzas (rural; 33°57'S; 71°52'W), are in region VI (Fig. 1). They applied for an MEABR in 2001, and got their management plan approved in 2003. The situation of these unions is typical of the general situation in region VI, as it was one of the last in Chile to incorporate the MEABR policy. (8) Union Carelmapu (rural; 41°51'S; 73°35'W) is in Region X (Fig. 1) and had its first MEABR management plans approved in 2001.

The studied unions represent fishers with a range of livelihood portfolios as well as dependency on benthic resources and MEABRs incomes (Fig. 1). Fig. 1 shows the percentage of landings of benthic resources and the income of an individual fisher derived from loco harvests within MEABRs for the studied unions. Main sources of income vary between fisher unions and individual fishers and range from exclusive dependence on diving, to dependence on fishing for finfish, gathering algae or other off-sector activities. It is important to highlight that there has been ongoing biological and fishery research activity (which ranges from 4 to 20 years) by the authors of this study in the selected unions. Therefore, a good level of rapport already existed between researchers and these artisanal small-scale fisher communities.²

¹ Re-stocking of the MEABR can be done once at the beginning of the process before the MEABR is officially harvested.

² It could be argued that rapport could lead to assess perceptions that are product of the opportunistic sampling design in which fishers might be trying to please the interviewer with pro-environmental attitudes or positive attitudes towards MEABRs. However, as shown in the results, fishers are extremely critical of MEABRs and of their role in discussions regarding Nt-MPAs in Chile. Thus this is not likely to be the case.

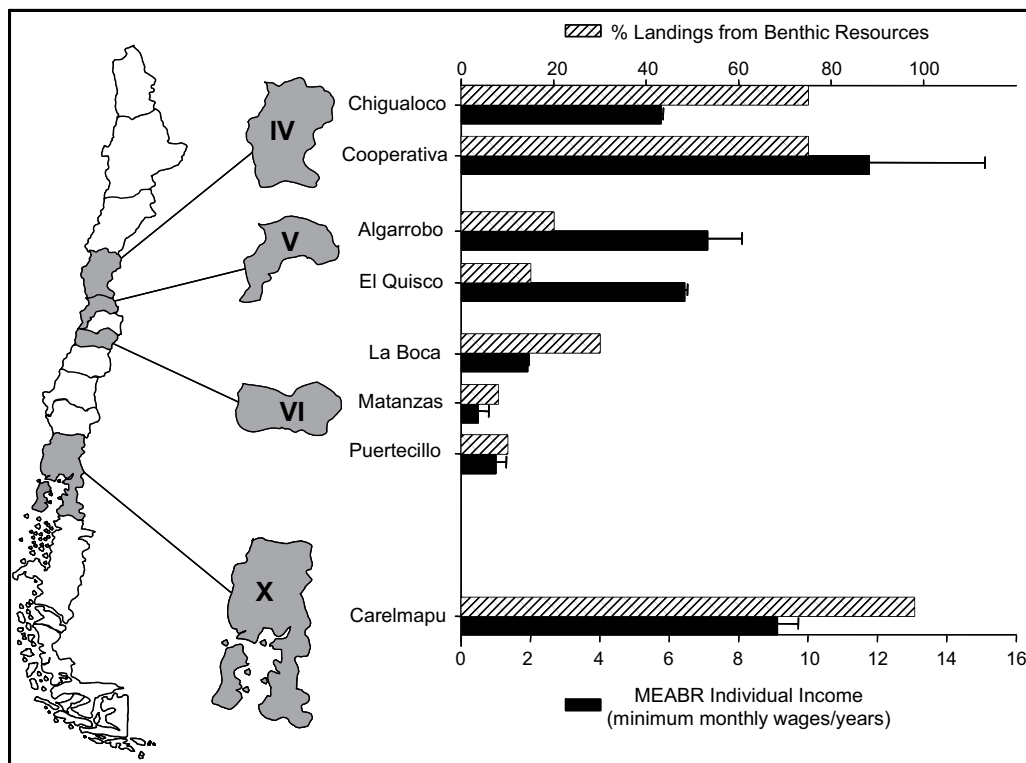


Fig. 1. Map showing the regions in Chile, the location of studied unions, the importance of benthic resources in the landings of these unions (dashed columns) and average (last 3–4 years) income an individual fisher receives from loco in MEABRs as the number of minimum monthly wages a year (black columns). Error bars represent standard deviations.

2.2. Field methods

The general methodological approach used in this study is based on semi-structured interviews and focus groups. The information gathered through these techniques was then used to generate questionnaires in order to provide a quantitative base for statistical analysis. We conducted fieldwork between June – October 2006, which comprised three main stages. In the first we conducted interviews with the Directorate of every fishing union (3–4 members), including the President, Vice-president, Secretary and Treasurer. Additionally semi-structured interviews were held with a random sample of 4–5 members of the fishing union. Some interviews were recorded and in other cases notes were taken as they progressed. In a second stage we carried out two focus groups in every small-scale fisher union studied (16 focus groups). Fishers (not the directorates) belonging to the unions, irrespective of their livelihood portfolios were invited to the focus groups. Focus groups dealt mainly with the degree to which resource management goals have been accomplished and the main problems fishers have had with MEABR implementations. Some of these focus groups were taped on video and in others a second researcher took notes.

In a third fieldwork stage questionnaires were administered in a face-to-face manner (in Spanish). In general, the selection of participants for the questionnaires included the Directorate of the union (see above), members from the unions Resource Management Commissions (4 or 5 fishers) and a random sample of around 18–20 artisanal fishers which were members of the fishing union, per caleta. Questionnaires included a section on basic social and economic information and a section on livelihood strategies. Questionnaires consisted mainly of Likert type statements with anchor points 1 = strongly disagree and 5 = strongly agree. Statements concerned fishers' perceptions surrounding (1) compliance, (2) enforcement, (3) empowerment, (4) main problems and future challenges of the

MEABR policy (5) biodiversity conservation associated to MEABRs (6) marine conservation through Nt-MPAs in Chile and (7) willingness to participate in the administration and management of a marine conservation network formed by Nt-MPA in Chile.

2.3. Data analysis

Perceptions: we analysed questionnaire responses according to: (1) main livelihood strategies (i.e. divers, fin-fishers, intertidal food gatherers or fishers who depend mainly on other off-sector activities such as agriculture, construction or forestry for their livelihood). (2) Total percentage of agreement or disagreement with the statements. Comparisons between fishers' responses related to livelihood strategies were analysed with Kruskal–Wallis and Dunn's pairwise tests.

Willingness to participate: to identify individual determinants for fishers' willingness to participate in the planning and management of a marine conservation network, which includes the creation of Nt-MPA in Chile we used a back step multiple regression. Perception scores were used as the dependent variables. Independent variables used include: geographical position (urban/rural), age, days spent at sea each month, ownership of fishing gear, if the fisher had been a union director, assistance to MEABR training courses, occupational mobility and the percentage of income from diving. Data were tested for normality with Kolmogorov–Smirnov analysis.

3. Results

Fishers' perceptions: in the initial fieldwork stage a total of 41 semi-structured interviews were held with fishers' from eight different fishing unions which represent a range of livelihood strategies. In addition, two focus groups with 4–6 participants each

Table 1

Average response values towards statements which have relation to fishers compliance with MEABRs policy. Responses are grouped for different livelihood strategies and different geographic realities.^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-fisher	Gatherer	Other	P	Agree	Disagree	NAD
It is important for me to follow the rules imposed by my union and comply with harvest dates and the law.	3.6 (0.7)	3.7 (0.8)	3.8 (0.6)	4.0 (0.7)	>0.7	80.3	8.5	11.3
My family feels it is important for me to comply with MEABR regulations.	3.6 (0.8)	3.6 (0.9)	3.7 (0.9)	3.7 (0.7)	>0.7	78.9	9.9	11.3
Governments' financial support has been crucial for the development of MEABRs.	3.9 (1.0)	3.4 (1.5)	3.8 (0.5)	3.5 (1.6)	>0.2	69	27.5	3.5
I comply with the necessary paperwork in order to harvest from the MEABRs.	4.4 (1.0)	4.4 (1.0)	4.8 (0.4)	4.2 (0.7)	0.17	90.8	8.5	0.7
I follow my unions rules regarding Total Allowable catch and size limits within the MEABRs.	4.4 (1.0)	4.5 (0.8)	5.0 (0.0)	4.3 (0.8)	0.10	90.8	8.5	0.7

P, probability.

^a The numbers represent the average response (\pm S.D.). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

were held per union. A total of 160 questionnaires were administered, however only 143 were fully completed and were used in the analysis. No single union dominated all responses to questionnaires; union Carelmapu represented 18% of all total questionnaires while union Algarrobo represented 12%. All other unions contributed with ca. 13% of responses.

3.1. Compliance

Fishers' perception regarding compliance with policy requirements is perceived to be good. Co-financing agreements for baseline studies which establish the fishery TAC have had high levels of compliance and fishers perceive it is something important to do in order to maintain an MEABR (i.e. focus group union El Quisco). In fact, 80% of all surveyed fishers agreed with the statement, "It is important for me to follow the rules imposed by my union and obey harvest [TACs extraction calendars] and the law." Fishers agree to follow the rules irrespective of their livelihood strategies (Table 1). This pattern is also found when fishers are consulted about the opinion their family has about the need to follow MEABR regulations (Table 1). It is important to highlight that the support from government institutions to pay initial MEABR baseline studies has had an important role in promoting this compliance. As a fisher from Carelmapu explained: "The support of the government to fund 75% of initial baseline MEABR studies has been very important for us to engage [with MEABRs]." Government support as important aspects of engaging with MEABRs policies, can be further demonstrated as in addition, 69% of surveyed fishers agreed with the statement

"government's financial support has been crucial for the development of MEABRs".

Legally fishers must maintain their MEABR through "natural seeding" and exclusively extract benthic resources included in their management plans. The level of compliance towards this aspect is unknown although it is clear from fishers' interviews that some level of man-made restocking occurs in management areas. During interviews this aspect is always attributed as being done by "other unions". As a fisher from Carelmapu explained: "Some unions do try to re-populate (man-made restocking) their management areas. But we have learned this is not a good strategy". When interviewees were asked why they would not restock their area, the main response was that loco would eat up all the food and not grow enough (Table 2). In our interpretation, what is behind this local ecological knowledge is the concept of "fishery carrying capacity" for a managed area.

3.2. Enforcement

The lack of logistical support, mainly to stop and prosecute poachers, and in this way achieve an effective enforcement of the MEABR, was the main problem mentioned by fishers in all interviews and focus groups. In fact, within the questionnaire, when fishers were asked regarding the main current problem they have with the MEABR, 75% mentioned encroaching (theft) from other fishers. Enforcement of MEABR is a problem, especially if we consider that 95% of fishers think, "fishers who are caught stealing from the MEABR should be punished more severely", with no

Table 2

Average response values towards statements which have relation to fishers perceptions of the enforcement of MEABRs. Responses are grouped for different livelihood strategies and different geographic realities.^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-Fisher	Gatherer	Other	P	Agree	Disagree	NAD
Fishers who are caught stealing from the MEABR should be punished more severely.	4.6 (0.8)	4.6 (0.4)	4.8 (0.3)	4.8 (0.4)	>0.4	95.1	2.8	1.4
The fisheries service should give more support to stop encroaching within MEABRs.	4.7 (0.7)	4.7 (0.4)	5.0 (0.0)	4.6 (0.8)	>0.3	97.2	2.8	0
Stopping fishers outside the union from poaching is an important cost of having a MEABRs	4.8a (0.5)	4.7a (0.4)	4.0b (0.0)	4.1b (0.8)	>0.001*	97.2	2.1	0.7
MEABRs have created problems between fisher unions due to access to resources and diving grounds	3.5a (1.3)	3.3a (1.7)	2.5b (1.5)	2.1b (1.4)	0.001**	53.5	45.8	0.7
Stopping fishers from my union from poaching is a hard thing of having a MEABR.	1.9 (1.2)	1.9 (1.3)	1.6 (1.2)	2.1 (1.3)	0.49	16.9	80.3	2.8

P, probability

*Significant differences Kruskal–Wallis ($H = 47.59$, D.F. = 3), pairwise Dunn's test those syndicates that are not significantly different share the same letter.

**Significant differences Kruskal–Wallis ($H = 15.67$, D.F. = 3), pairwise Dunn's test those syndicates that are not significantly different share the same letter.

^a The numbers represent the average response (\pm S.D.). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

Table 3
Average response values towards statements which have relation to fishers' perceptions of the empowerment gained through the MEABRs. Responses are grouped for different livelihood strategies and different geographic realities.^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-Fisher	Gatherer	Other	P	Agree	Disagree	NAD
I didn't increase my income significantly with the MEABR but the union was empowered and collective work has increased	3.8a (1.4)	3.3a (1.0)	1.2b (0.4)	3.7a (1.0)	<0.001*	64.1	29.9	6
The inclusion of MEABRs has been important to generate new ideas (business, conservation etc.) within the union.	4.1a (0.9)	3.5b (1.0)	2.7b (1.1)	3.6b (1.2)	0.001**	79.6	19.7	0.7
Fishers unions could carry out the work of consultants in an efficient way.	3.7a (1.3)	2.8b (1.2)	2.7b (1.4)	3.1a,b (1.3)	0.001***	57.7	39.4	2.8
There is an active participation of fishers in planning the future of the MEABR policy.	2.4 (1.2)	2.5 (1.3)	2.5 (1.0)	1.8 (1.3)	>0.16	27.5	68.3	4.2
An important aspect of having a MEABR is a gain in representation.	3.6 (1.1)	3.5 (1.2)	3.6 (1.1)	3.3 (1.0)	>0.6	64.1	20.4	14.8

P, probability.

*Significant differences Kruskal–Wallis ($H = 19.04$, D.F. = 3), pairwise Dunn's test. The syndicates that are not significantly different share the same letter.

**Significant differences Kruskal–Wallis ($H = 20.04$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

***Significant differences Kruskal–Wallis ($H = 15.76$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

^a The numbers represent the average response (\pm S.D). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

differences regarding fishers livelihood (Table 2). In general fishers perceive they have been left alone with the duties of enforcement, including stopping encroachment within MEABRs, and are advocating for more support from the fisheries service. In fact, 97% of fishers agreed with the need for more support from the fisheries service (Table 2). Violence between fishing unions and fishers who steel from MEABRs is becoming an important issue, as a fisher from Puertecillo says “We call SERNAPESCA [fisheries service] when we see boats in our area but they never send anyone. We now have to fight to defend our resources ourselves”. Enforcement regarding fishers from outside the union is a major cost of having a MEABR, as stated by ca 97% of interviewees. However, enforcement within the union members is easier, as reflected by 83% of total interviewees disagreeing to this as one of the hardest aspects of managing a MEABR (Table 2).

3.3. Empowerment

Results of focus groups show fishers perceive empowerment through the responsibilities of managing resources. This can be exemplified by 64% of fishers agreeing with the statement “I didn't increase my income significantly with the MEABR but collective work has increased”. The subgroup formed by divers scored significantly higher values (strongly agree) towards this statement, while the group of intertidal food gatherers scored an average score of 1.2, therefore disagreeing with the statement (Table 3).

MEABRs are perceived by fishers as a positive asset, especially to generate new ideas, as gathered from fishers' response to the statement “The inclusion of MEABRs has been important to generate new ideas (business, conservation, etc.) within the union”. A total of 79% of fishers agreed with the statement while the divers scored significantly higher values (Table 3).

Interviews show that there is an increasing sense that the yearly follow-up studies (which at present do not have government financial support) are not necessary and could be replaced by studies every 2 or 3 years. Fishers must still comply with this regulation but many union Directorates are beginning to express the view that fisher unions themselves should be trusted to execute these follow-up studies “we [artisanal fishers] are already doing all the diving and measuring [for the studies]; the consultants only sign a quota, send it to the SUBPESCA (undersecretary of fisheries) and earn the money ... we can do the work” (Juan Machuca, President union La Boca). This is supported by survey results, where 57% of fishers agree with the statement “the fisher union could carry out the work of the consultants”. When fishers are divided into livelihood categories divers are significantly more in

favour of this idea, while intertidal food gatherers do not feel this is possible for them (Table 3).

Although many fishers feel MEABRs have been helpful to the generation of new business ideas, cooperation and to help self organize, 68% of surveyed fishers disagree with the statement “There is an active participation of fishers in planning the future of the MEABRs policy,” with all fisher livelihood groups averaging scores under 3 (Disagree). Nevertheless, 64% of fishers feel that the fact of being involved in MEABRs might help them play a role in planning in the future of MEABR policy (Table 3).

3.4. Main problems and future challenges

In general fishers talk about financial success of MEABRs during the first 2–3 years of establishment of the policy. However survey results, show that 85% of fishers disagree with the statement “I increased my income significantly through the MEABR”. This perception was shared by fishers with different livelihood strategies (Table 4).

An important problem mentioned by fishers' deals with the fact that open-access fishing sites are becoming scarce and over-exploited, probably related to the high number of areas decreed by the government. Thus fishers who have historically maintained a livelihood as divers indicate that this lifestyle is at risk. For example, one diver from Los Vilos stated: “There is an indiscriminate extension of the areas ... there is nearly nowhere to go and dive, everything is a MEABR and the historical zones³ left have collapsed...”

This attitude can also be observed through fishers' response to the statement “Open-access grounds are a critical component of fishers' livelihoods” in which divers score 4.8 (agree), significantly higher than fin-fishers or intertidal food gatherers (Table 4). This is a problem and 87% of fishers agree with the statement “there will soon be no open-access fishing/diving grounds in Chile”.

In general fishers seek further devolution of management authority in order to face the challenges imposed by the policy. This is exemplified by 92% of fishers directly stating this is an important step towards MEABRs being successful (Table 7). This management freedom would include experimentation with harvest methods or target species (96% of all surveyed fishers agreed on this as a positive change) as well as the exploitation of new species. Another important indication that fishers want to work to develop MEABRs further is that focus groups showed there are always locally based

³ These are areas which are not MEABRs and which are open for all registered artisanal fishers and recreational divers. In these areas fishing for any species except loco is allowed.

Table 4

Average response values towards statements which have relation to fishers' perceptions of the main problems and future challenges with MEABRs. Responses are grouped for different livelihood strategies and different geographic realities.^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-Fisher	Gatherer	Other	P	Agree	Disagree	NAD
The MEABR policy includes too much paperwork and bureaucracy in order to apply and harvest from the areas	3.9 (1.7)	4.2 (1.5)	5.0 (0)	4.5 (1.3)	0.19	77.5	19	3.5
Fishers should have more freedom to manage their MEABRs if these are to be successful	4.6 (0.7)	4.4 (0.7)	4.7 (0.9)	4.3 (1.0)	0.19	93.7	5.6	0.7
The fisheries Under Secretary have a clear vision of the future of MEABRs	1.8 (1.0)	2.3 (1.3)	1.9 (0.9)	1.5 (0.8)	>0.1	11.3	73.9	14.8
Open-access grounds are a critical component of fishers livelihoods	4.8a (0.6)	3.8b (1.2)	2.7b (1.1)	4.4a (1.0)	<0.001*	88	12	0
There will soon be no open-access fishing/diving grounds in Chile	4.2 (0.9)	4.0 (0.9)	4.4 (0.5)	3.8 (1.2)	>0.2	87.3	10.6	2
I increased my income significantly through the MEABR	1.3 (0.7)	1.2 (0.5)	1.0 (0)	1.2 (0.6)	>0.5	0	88	12

P, probability.

*Significant differences Kruskal–Wallis ($H = 52.46$, D.F. = 3, $p = 0.001$), pairwise Dunn's test. The unions that are not significantly different share the same letter.

^a The numbers represent the average response (\pm S.D.). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

ideas for the improvement of MEABRs. Also, 88% of interviewed fishers would not give up being an artisanal fisher for another job which offered similar constant income during the year.

3.5. Achievement of biodiversity conservation associated to MEABRs

Positive aspects associated with MEABR as perceived by fishers, relate with their role in maintaining benthic resource and reef fish diversity (Table 5). In fact, 95% of interviewed fishers' perceive "MEABR act as reserves for benthic resources" and 74% agree to the fact that "MEABR act as reserves for reef fish". Fishers who depend on diving to maintain their livelihood agree with this statement in a significantly higher way (Table 5). On the other hand *ca* 75% of fishers' agree with the fact that "MEABR have been important to conserve intertidal seeding grounds" and that "MEABR act as intertidal reserves" with food gatherers agreeing in a significantly higher way (Table 5). Finally, 85% of fishers agree to the fact that it is important to conserve non-target species within the MEABR.

3.6. Perceptions towards Nt-MPAs

In semi-structured interviews and focus groups fishers showed a basic understanding of why the MEABR policy was established, their role in the process and their main purpose. However, when fishers were asked about the role of Nt-MPA 85% indicated a lack of understanding of the benefits associated to this management instrument in comparison to MEABRs and have little clarity

regarding the areas in Chile where these could be established. In fact 99% of all surveyed fishers disagreed with the statement "I have received information about the plans for MPAs [Nt-MPA or MU-MPAs] in Chile for the next 10 years". In addition to this lack of information, fishers perceive the increasing lack of open-access fishing grounds makes the inclusion of Nt-MPA areas highly controversial. In fact 87% of surveyed fishers agree to the statement "I am worried about the establishment of too many no-take marine reserves in Chile" (Table 6). Additionally 73% agree with the statement that "Marine reserves [Nt-MPAs] will be a source of conflict between my union and authorities," with both of these statements being supported at a significantly greater extent by the group of fishers who mainly dive for a livelihood (Table 7).

Despite the current lack of participation of interviewed artisanal fishers regarding Nt-MPAs, 92% perceive that "If Chile is going to implement Nt-MPAs artisanal fishers must play an important role in planning", and 65% perceive contacts with conservation NGOs could be beneficial (Table 6). Thus stakeholder participation is potentially possible.

3.7. Determinants of fishers' willingness to participate in Marine conservation

When a backward stepwise multiple regression was used to relate contextual variables and fishers willingness to participate in the creation or administration of a Nt-MPA network, occupational mobility and the percentage of income from diving were selected as

Table 5

Average response values towards statements which have relation to fishers' perceptions of the achievement of biodiversity conservation associated to MEABRs. Responses are grouped for different livelihood strategies and as percentage of agreement and disagreement of the whole sample ($n = 143$).^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-Fisher	Gatherer	Other	P	Agree	Disagree	NAD
It is important to conserve non-target species within the MEABR	4.5a (0.8)	4.0b (0.5)	3.2b (1.2)	4.5a (0.5)	<0.001*	85.2	7.7	4.9
The people I care about (sons, family) think marine conservation is important	4.5 (1.0)	4.8 (0.7)	5.0 (0)	4.8 (0.7)	>0.2	88.7	5.6	5.6
MEABRs act as reserves for benthic resources	4.6a (0.6)	4.5a (0.9)	4.2b (0.4)	4.6a (0.7)	0.008**	95.1	4.2	0.7
MEABRs act as reserves for reef fish.	4.1a (1.0)	3.5b (1.4)	3.1b (1.6)	4.4a (1.0)	0.031***	74.6	20.4	4.9
MEABRs have been important to conserve intertidal seeding grounds	3.6 (1.0)	4.2 (1.0)	5.0 (0.0)	3.6 (1.2)	<0.001****	76.8	16.2	7
MEABRs act as intertidal reserves	3.6 (1.1)	4.2 (1.1)	4.7 (0.9)	3.7 (1.5)	<0.001****	72.5	22.5	4.2

P, probability.

*Significant differences Kruskal–Wallis ($H = 25.85$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

**Significant differences Kruskal–Wallis ($H = 11.74$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

***Significant differences Kruskal–Wallis ($H = 20.04$, D.F. = 3, $p = 0.001$), pairwise Dunn's test. The unions that are not significantly different share the same letter.

****Significant differences Kruskal–Wallis ($H = 8.8$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

*****Significant differences Kruskal–Wallis ($H = 28.92$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

*****Significant differences Kruskal–Wallis ($H = 16.92$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.

^a The numbers represent the average response (\pm S.D.). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

Table 6Average response values towards statements which have relation to fishers' perceptions of marine biodiversity conservation through Nt-MPAs in Chile.^a

Statement	Livelihood					Percentage of total		
	Diver	Fin-Fisher	Gatherer	Other	<i>P</i>	Agree	Disagree	NAD
Marine reserves (no-take zones) will be a source of conflict between my union and authorities	4.2a (1.1)	3.4b (1.3)	3.0b (1.3)	3.5b (1.3)	<0.001*	73.9	23.9	2.1
I am worried about the establishment of too many no-take marine reserves in Chile	4.7a (0.8)	3.8b (1.1)	4.6a (0.9)	3.8b (1.4)	0.001**	88	11.3	0.7
If Chile is going to implement Nt-MPAs fishers must play an important role in planning	4.5 (1.0)	4.5 (0.8)	5.0 (0.0)	4.8 (0.4)	0.4	92.3	4.2	3.5
I have had contact with conservation groups and NGOs	1.5 (0.8)	1.2 (0.5)	1.2 (0.6)	1.7 (1.0)	0.10	0	77.5	22.5
Conservation groups and NGOs are useful for fishers	3.7 (1.3)	3.8 (1.3)	4.5 (0.9)	4.0 (1.1)	0.30	65.5	20.4	13.4
I have received information about the plans for Nt-MPAs or MU-MPAs in Chile during the following 10 years	1.1 (0.5)	1.2 (0.42)	1.1 (0.3)	1.0 (0.0)	0.18	0.6	99.4	0

P, probability.*Significant differences Kruskal–Wallis ($H = 22.32$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.**Significant differences Kruskal–Wallis ($H = 45.87$, D.F. = 3), pairwise Dunn's test. The unions that are not significantly different share the same letter.^a The numbers represent the average response (\pm S.D). Anchor points 1 = strongly disagree, 3 = neither agree nor disagree, and 5 = strongly agree.

the only variables which produced a significant model ($p < 0.05$; adjusted $r^2 = 0.53$). Table 7 shows the first step of the regression in which a greater income from diving and less occupational mobility would explain 53% of fishers' willingness to participate in planning and managing a Nt-MPA.

4. Discussion

A key lesson from international experience is that marine policy receives its legitimacy from the stakeholders and is successful only if it concentrates on delivering tangible outcomes that have public support [24]. Thus, in order to be viable, Nt-MPAs need to be more inclusive of stakeholders who bear the costs of their creation [9,25]. According to results of this study regarding the MEABRs experience, scaling-up Nt-MPAs (included within MU-MPAs) in Chile will need to rely heavily on compliance, as enforcement is extremely difficult along the extensive Chilean coast. In this sense, as suggested by other authors [26,27] early buy-in of all stakeholders to the objectives of Nt-MPAs and its cost/benefit streams is essential. Although this is not currently happening in Chile, our results show how the artisanal fisheries sector could provide an important platform of human and social capital to build marine biodiversity conservation initiatives along Chile. So far, in Chile artisanal fishers have accepted the challenge of resource management and this has translated into a reinforcement of unions and a strengthening of leadership. This has led to the implementation, by fishers themselves, of surveillance procedures to stop poaching within MEABRs and to establish participatory rules within their communities. Lessons from artisanal fishers experience regarding the difficulty of enforcement, the potential for collective work within the fishers workforce, the threats fishers perceive regarding Nt-MPAs and the lack of information regarding Nt-MPAs in Chile reveals important knowledge for the future implementation of marine conservation initiatives in Chile, hopefully this information will allow policy-makers to anticipate and deal with future problems in advance.

In Chile, artisanal fisher communities have been empowered, for example in Carelmapu and the V region of Chile, innovative strategies that account for fishers' entrepreneurship include attempts to sell managed resources collectively between associations and to actively generate summer tourism companies [3]. These initiatives, although so far exceptional for some areas of the coast of Chile, show how the MEABR policy has opened new ways for small-scale fishers' long-term engagement as resource managers and how it has encouraged self-empowerment to solve overexploitation fishery problems. Not only has the empowerment of these fisher communities allowed them to develop their roles as rational fishers

increasing GDP and/or producers in global markets [28], but having a MEABR in Chile has also given fishers power to use this as a negotiating tool in environmental problems (i.e. outfall pipes, mining and cellulose installations, thermoelectric plants [22,29]).

Results suggest that in Chile artisanal fishers have the potential to become key co-administrators of marine biodiversity conservation initiatives. However, there is heterogeneity in fishers' willingness to participate in the creation and administration of these coastal areas. Fishers with less occupational mobility, and with a higher dependence on benthic resources to sustain their livelihoods, are willing to participate in a significantly higher extent. Thus, groups of fishers that have a greater dependence on benthic marine resources should be targeted and included to early marine biodiversity conservation planning stages.

Fishers' ecological knowledge, regarding MEABR functioning in terms of species refuges and even "carrying capacity" of areas, provides another important set of information. In general all surveyed fishers view MEABR as important nursery grounds and refuges, which is consistent with ecological and fishery research studies [18,19]. However, fishers' perceptions of the benefits of MEABRs for non-target species are significantly different for divers and intertidal food gatherers. Divers perceive MEABR providing important benefits for benthic resources and reef fish, while intertidal gatherers perceive major benefits in intertidal zones, which act as important seeding grounds for commercial species. This is important as species diversity of reef fish and benthic species has been shown to be greater inside the management areas than outside [19] and further that larvae production is greater within areas than outside [18]. Therefore through harvesting, by diving or intertidal gathering, fishers would be more aware of the impacts of their actions on the habitat, and in this way appreciate their environment while at the same time seeking to make a profit from production [30]. This has important consequences for the changing of attitude of Chilean artisanal fisher communities [22] and

Table 7

Results of a multiple regression between fisher variables and their willingness to participate in the creation or administration of a MPA network.

Variables	<i>B</i>	<i>t</i>	<i>P</i>
Urban/rural	0.058	0.90	0.36
Age	−0.037	−0.55	0.58
Days at sea per month	−0.033	−0.41	0.67
Owner of fishing gear	−0.037	−0.61	0.53
Directorate of union	0.050	0.69	0.49
Capacitating courses	−0.008	−0.11	0.90
Occupational mobility	−0.263	−3.69	<0.001
Income from diving	0.606	7.45	<0.001

highlights the need for active participation of fishers through their own activities in all stages, from planning, design, implementation and management of marine conservation activities.

4.1. Scaling down before scaling-up marine conservation

Based on our current understanding of the Chilean situation, before scaling-up marine conservation in Chile it might be necessary to “scale down”: first supporting and consolidating numerous local initiatives to establish marine Nt-MPAs and MEABR which remain fragile. There is a need to ensure that existing initiatives are supported by local governance frameworks before attempting to replicate or expand the area of coverage.

In Chile, to deal with the scaling-up of marine conservation through MEABR, Nt-MPA, Nt-MPA within MU-MPAs or other marine conservation-management approaches, there is the need to include fishers ecological knowledge generated from the resource management experience (MEABRs), explicitly within future management practices, as an ever evolving feedback process. Regarding MEABRs experience this approach should facilitate a shift from the current coastal benthic resources co-management approach used in Chile towards an adaptive co-management approach [31]. We specifically propose the need to include directives in MEABRs policies for participatory research⁴ as key elements for the successful adaptation of MEABR (or any co-management policy) to local realities. These would kick-start learning-by-doing feedback links for policymakers and fishers, and sharpen participatory management, which is key to the sustainability of marine biodiversity conservation arrangements. In order to initiate these changes, it would be necessary for the government to assess the MEABR policy process along the Chilean coast, in order to consider the possibility of granting further management authority to artisanal fishers.

Currently the management procedures within MEABR policy implicitly establish that the UnderSecretary of Fisheries sets and controls management objectives. It also determines that research based biological knowledge is the basic knowledge to be included in the MEABR process and evaluation of this fishery [32] excluding options for experimentation within MEABR based on local knowledge. This generates social discontent/unrest among the interviewed fishers. In fact 94% of fishers agree to the fact that “fishers need more freedom to manage their MEABRs”. *Currently in Chile small-scale fisher unions are lobbying to gain more independence to manage the MEABR and support with policing the areas* (President Union, Carelmapu). This independence is focused on the ability to involve some degree of experimentation and moving of resources around within MEABRs. Presently this is not permitted in the policy and is therefore illegal. This is unfortunate as participatory research in support of adaptive management has become almost commonplace in some developing countries [33], under the premise that the participation of resource users and other stakeholders is important not only in the management of resources, but also in research orientated towards the generation of information and innovations that shape how resources are understood and exploited [34]. These processes should be guided by pilot experimentation, as was the case for the establishment of MEABRs [12]. Chile has the expertise, knowledge, scientists and technicians, together with a well-organised community of artisanal fishers, to do so. Learning from these experimental approaches will provide valuable information

for local management and research interests. As suggested for other natural resources domains, research and development can no longer be the exclusive domain of scientists [35]: “sound fishery science is necessary, but not sufficient, condition for the sustainability of marine resources” [6]. Fishers should be able to demonstrate the benefits of adapting policy to their own conditions through experimentation. Researchers, social and natural scientists, and managers would gain from artisanal fisher experimentation because they will observe the results of numerous experiments over a wide range of conditions between and within years, allowing them to generalize about outcomes of experiments and to develop or amend management approaches accordingly [33,34].

The future outcome of the Chilean attempts to implement MU-MPA which include Nt-MPA zones will depend on the success of including fishers in the process. Fishers are willing to participate; however, to date their perceptions of the process is that it has been one-sided, driven mainly by biodiversity conservation agendas with little or no input from local fisher communities. The core fact is that fishers have not been given the chance to design and run their own projects, which in turn would help establish relationships of trust between fishers and conservation groups. In the established Chilean policy the implementation of MU-MPA could be used to facilitate and highlight the role of bridging organizations [36] as a model to achieve marine biodiversity conservation. MU-MPA could become a way for effective participation of fisher communities in which tradeoffs between marine biodiversity protection and assured access to resources could play important roles. We must highlight however, that success is not guaranteed and that failure would stem from managing stakeholders showing deplorable self-interest, seeing adaptive policy development as a threat to existing research programs and management regimes, rather than opportunity for improvement [37].

5. Conclusion

Networks of MEABRs in combination with MU-MPAs which include Nt-MPAs as those suggested by [3,9] can be viewed as a conservation-management tool which could contribute to policy coherence and establish a collaborative framework that would help legitimise marine conservation practices through public participation. The lessons from this empirical study are that in Chile co-management practices have provided a learning platform for artisanal fisher communities. This helps to establish a social setting in which local fisher communities may become important actors for supporting marine conservation, so long as it involves meaningful local involvement. Thus, in Chile there is a strong potential for bottom-up processes in marine conservation, though the need for top-down steering and guidance is also stressed, especially regarding support for enforcement.

Ethical statement

I certify that this manuscript has not been submitted elsewhere. Data gathered from stakeholders were informed about the objectives and dissemination of the study results. The study complies with the FONDECYT ethical codes.

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⁴ In the context of this discussion, we refer to participatory research as the research which is done by fishers or guided by fishers. We exclude passive forms of fisher participation as completing questionnaires or participating in focus groups from this definition.

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