Ocean & Coastal Management 146 (2017) 67–76

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Fishers' perception: An alternative source of information to assess the data-poor benthic small-scale artisanal fisheries of central Chile

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ARTICLE INFO

Article history:
Received 2 February 2017
Received in revised form
29 May 2017
Accepted 16 June 2017

Keywords:
Fishers' knowledge
Official reports
Retrospective bias
Stock assessment
Territorial user rights

ABSTRACT

Many artisanal fisheries lack of conventional scientific data for stock assessment and decision making, which might explain the overexploitation and collapse of many small-scale fish stocks. Fishers' perception has a great potential to be an alternative source of information as it is present in every fishery, is inexpensive and allows analysis at large spatial scales. However, fishers' perception is influenced by psychological factors that can generate bias. This study compares fishers' perception and direct assessment of current and historical abundances of two benthic species that are targeted in the artisanal fishery of Central Chile (the loco and the keyhole limpet), in order to assess the value of the method for artisanal fisheries. The analysis also considered different management regimes (open access areas and areas with territorial rights) and two periods of time (approximately 15 years apart) to determine the (a) the consistency of fishers' perception for assessment of current abundance and (b) the potential use for retrospective assessment. We also compared official landing reports with direct assessments in order to assess the reliability of fisheries data. Fishers' perception of loco abundance generally agreed with direct assessment in fishing villages, management regimes and periods of time. In the case of the keyhole limpet, fishers perceived abundances higher than those registered in direct assessments. The different patterns observed between resources can be related to the relative importance of each fishery. Fishers were not accurate in recalling past abundances retrospectively and official reports showed dramatic mismatches with direct assessment in catch abundance and composition. Fishers' perception is a potential source of information to assess the current abundance of targeted species. However, it requires case by case investigation and evaluation before it can be applied and the information properly integrated in fisheries management practices.

1. Introduction

Stock assessments provide essential information for policy and decision-making, which in turn, is critical for sustainable management of fisheries (FAO, 2011). However, the data required by conventional stock assessment methods is only available for 25% of the global catch (Branch et al., 2011), and mainly concentrated in fisheries from developed countries (FAO, 2011). In order to expand the assessment of fish stocks worldwide, a variety of new data sources have been made available and new assessment techniques have been explored for data-poor fisheries in the last few years (Costello et al., 2012; FAO, 2011; Hilborn and Ovando, 2014). Nevertheless, the lack of fisheries data remains a problem of concern for advancing sustainable fisheries management, considering that 64% of unassessed fisheries show stock biomass below the MSY (Maximum Sustainable Yield) and 18% are collapsed (Costello et al., 2012). It is remarkable that most unassessed fisheries are small scale fisheries, which represent 96–99% of the world's fisheries, more than half of the global catch for human consumption and half of the global catch in developing countries (FAO and World Fish Center, 2008; Pauly, 2006). The main factor limiting the availability of data for stock assessment in small scale fisheries is the cost of monitoring the large spatial scale over which small boats and food gatherers operate (Paterson, 2010). Therefore, developing alternative methods for gathering fisheries data is crucial to inform decision-making in fisheries in general, and in

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http://dx.doi.org/10.1016/j.ocecoaman.2017.06.007
0964-5691/

small scale fisheries in particular.

One of the emerging alternative methods for stock assessment in data-poor fisheries is fishers' perception (FP). FP research focuses on the knowledge that fishers accumulate while operating in their respective fisheries (Neis et al., 1999; Rochet et al., 2008; Hind, 2014). It uses interviews and surveys as primary approaches to record fishers' perception towards many variables such as abundance and size of species, status of resources and ecological roles of species, which have been analyzed through both quantitative and qualitative methods (Hind, 2014). This source of information has already been used in fisheries management for a wide variety of purposes such as the collection of ecological knowledge (Silvano and Begossi, 2009; Tesfamichael et al., 2014), the assessment of stocks (Otero et al., 2005; Damasio et al., 2015; Tesfamichael et al., 2014), and ecosystem-based management (Gelcich et al., 2016; Holm and Soma, 2016). Thus, FP can contribute to increasing the scientific knowledge of stock status especially in areas with limited resources to fund scientific and management activities (Ainsworth et al., 2008). Moreover, by recovering fisheries data from the past, FP can also contribute to overcoming the shifting baseline syndrome, which refers to the fact that each generation of fisheries scientists take as a reference the abundance or the species composition occurring when they initially started to evaluate changes in stock (Pauly, 1995). This problem becomes critical in unassessed fisheries, most of them already overexploited or fully exploited (Costello et al., 2012), for which local ecological knowledge is often the only record available to reconstruct historical abundances (Ainsworth et al., 2008; O'Donnell et al., 2010a; Taylor et al., 2011).

Despite the potential of FP to assess exploited stocks and reconstruct historical fisheries data under data-poor scenarios, a major drawback is the bias that several psychological factors may introduce on fisher's perception (O'Donnell et al., 2010b; Paterson, 2010). For instance, fishers tend to report greatest declines in species that are most important to them (Ainsworth et al., 2008). Also, the largest declines are often perceived by older fishermen (Daw, 2010) and rare events are easier to recall than normal circumstances in retrospective interviews (Daw, 2010; O'Donnell et al., 2010b). As a consequence, FP can be less precise than scientific survey data, but it has the double advantage of being inexpensive and of providing greater spatial resolution (Ainsworth et al., 2008). FP can also provide a wide historical perspective and additional information on social, economic and ecological aspects of fisheries (Daw, 2008) that cannot be achieved with other scientific methods. In summary, FP may be used to provide information for both commercial and non-commercial species, to acquire more knowledge in information-poor fisheries (Paterson, 2010), and it can also provide critical information (e.g., fishing practices, fishing effort, spatial distribution of the fishery) to help interpret catch rate (Hutchings, 1996; Neis et al., 1999). Nevertheless, the use of fishers' perception in mainstream fisheries science is still marginal when compared with conventional approaches (Hind, 2014).

Globally, there is an overall lack of studies assessing the status of fish stocks (Costello et al., 2012). Similarly, only a small fraction of marine fisheries are assessed in Chile (Leal et al., 2010), affecting policy and decision-making (Salas et al., 2007). Although over 140 marine species are currently exploited in Chile (including insular territories) (SERNAPESCA, 2014a), only 25 fisheries (18 species), mostly industrial, were assessed in 2015 (SUBPESCA, 2015). Currently, the Chilean artisanal fisheries are gaining greater economic importance in relation to industrial fisheries, making as much as 59.4% of the total catches (SERNAPESCA, 2014b). Besides, artisanal fisheries play an important social and economic role because they provide food and livelihood to thousands of people spread all along the coast of Chile (Leiva and Castilla, 2002). However, most artisanal fisheries are largely unassessed at spatial scales that are relevant to management (SUBPESCA, 2015).

The benthic artisanal fisheries operating in Chile are managed under two fishing regimes, based on access to fishing grounds: open access (OA) and entry restriction areas, widely known as Territorial User Rights for fisheries (TURFs). TURFs were established in Chile after the overexploitation of the Chilean “abalone” (loco; *Concholepas concholepas*) (Castilla, 1994). Approximately 800 TURFs are legally decreed in Chile, from which 450 are currently operating. The rest of the TURFs have either been abandoned or have never been active (Gelcich et al., 2016). In order to get a TURF, fishers' unions must develop an initial assessment of the target species and propose a management plan. The renewal of the TURF concession by the Undersecretary of Fisheries depends on the approval of annual (in most cases) stock assessments. Fishers' unions must pay for each stock assessment and are also responsible for regulating the extraction of the total allowable quota for each resource and for surveillance (Meltzoff et al., 2002). Locos, keyhole limpets and sea urchins are among the most common target species in TURFs. A larger set of species are targeted in open access areas (OA; e.g., crustaceans, bivalves, gastropods, sea urchins, tunicate, several algae). In OAs, fishers holding a valid fishing license can extract benthic resources in accordance with nationwide regulations (e.g., minimum legal size, reproductive bans) that also apply to TURFs. However, a nationwide ban has prohibited the extraction of locos from open access areas for more than two decades. The consequences of the ban for loco recovery has not been evaluated since the status of locos and other resources in open access fishing grounds is largely unknown, even though more of the coast falls under this open access regime. Most stock assessment efforts for benthic resources are based on the small-scale (TURF scale) estimates conducted by the fishers' unions in their management areas. For open access areas, the only sources of data are landing reports.

In this context, we analyzed the value of fishers' perception for providing reliable information about the abundance of exploited benthic artisanal resources in central Chile. In order to meet this goal, we compared fishers' perception with conventional direct abundance assessments at a local scale, using two benthic fisheries: the most valuable resource, the loco, and a second set of species, the keyhole limpets. Therefore, we can also discuss any bias in fishers' perception in relation to the social or economic importance of the resource. Taking advantage of the spatial mosaic of exploitation operating in central Chile (TURFs and OAs), we compared FP for these two access management regimes. We also assessed the value of FP to estimate present and past abundances of exploited benthic resources. Finally, and considering that official fisheries reports represent a relevant piece of information for conventional stock assessment, we compared fisheries reports with direct assessments in order to determine the reliability of the reports.

2. Material & methods

2.1. Background information

In Chile, the small-scale fisheries target approximately 60 benthic species, including invertebrates and algae. Exploited species are exclusively extracted by artisanal fishers either diving in the coastal zone or gathering along the intertidal zone (Castilla, 1994; Castilla and Fernández, 1998). Invertebrates, such as keyhole limpets (*Fissurella* spp.) and a whelk (*Concholepas concholepas*, hereafter ‘loco’), have historically been among the most important natural resources in Chile in terms of extractions and revenues (Leiva and Castilla, 2002). These gastropods, along with other benthic resources, such as the sea urchin *Loxechinus albus*, the surf-clam *Mesodesma donacium* and kelps such as *Lessonia*