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Framing local ecological knowledge to value marine ecosystem services for the customary sea tenure of aboriginal communities in southern Chile

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ABSTRACT

Fishing and shellfish activities of aboriginal communities in Southern Chile have been historically associated with a high subsistence value in the past. However, the decrease of abundance of fishery resources jointly with a higher dependency on the aquaculture development and canning industry led to a decrease of dependency on algae gathering with medicinal and fertilizing use. The objectives of the paper are three-fold: (a) to investigate the links between customary uses of aboriginal communities living in the coast with marine ecosystem services (ES), (b) to characterize benefits, values of marine ES used by these communities, (c) to use the ecological knowledge of them to examine their perceptions towards the co-management system of SSF.

Our results provide empirical evidence of a rich body of aboriginal knowledge, practices, beliefs and perspectives in both selected sites related to marine ES which is rooted in a ancient ecosystem perspective of the Mapuche–Williche's communities. However, authorities should recognize the existence and validity of the Mapuche-Williche's ecological knowledge to develop the management plans of the customary marine areas. It is demonstrated that aboriginal communities are suffering a selective erosion of ecological knowledge which is generation dependent, and which is mainly attributed to the development of aquaculture sector.

1. Introduction

Ecosystems services (ES) influence the types of knowledge systems developed by different cultures (Millennium Ecosystem Assessment (MEA), 2005). Local and traditional ecological knowledge (LEK and TEK) as well as indigenous or aboriginal ecological knowledge (IEK or AEK)[2] are subsystems of the same system root: knowledge systems (Berkes and Turner, 2005; Newell et al., 1999). Currently, society lacks a critical understanding regarding which type of programs, institutional arrangements and, more generally, "knowledge systems" can most effectively harness sustainability and environmental conservation (Cash et al., 2003; Drew, 2005).

Interest in investigating TEK and AEK has been growing in recent years, partially due to the recognition that such knowledge can contribute to biodiversity conservation (Berkes and Folke, 1998). Accordingly, Folke et al. (2010) suggest that the management and governance of complex adaptive systems may benefit from the combination of different knowledge systems. Although the magnitude and relevance of local knowledge marine social-ecological systems has been recognized for some time, a mismatch between that is known and which is used for any practical sense remains unresolved (Mackinson, 2001; Villasante, 2012).

A wide range of scientific evidence exists in the literature about aboriginal knowledge, practices and belief as contributors to conserve ES, and in some cases to the enhancement of locally present biological diversity (Gari, 2001). Considerable research efforts worldwide have been dedicated to study the use of traditional knowledge as adaptive management systems (Berkes et al., 2000) in building resilience as a way to sustainably manage marine social-ecological systems (Olsson

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[2] Hereafter, we will refer with AEK understood also as indigenous (IEK).

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and Folke, 2001; Cash et al., 2003; Magalhães et al., 2012; Villasante, 2012; Villasante et al., 2015). In addition, several authors have emphasized the importance of relying not only on science-driven and top-down conservation directives exclusively to manage ES but also on LEK and TEK (Gadgil et al., 1993; Berkes et al., 2000). For example, Aswani et al. (2007) pointed out how a marine protected area in Oceania was strongly conceived by using indigenous ecological knowledge and existing sea tenure governance (i.e., customary management practices) as part of a regional precautionary and adaptive community-based management plan.

Customary practices can also serve as hedge against social and biological uncertainty and can be resilient enough to adapt to socio-economic and ecological disturbances and changes (Cinner et al., 2006). In spite of customary management is not usually designed for conservation, it can provide useful information to better understand the institutional context of a given marine social-ecological system (Cinner and McClanahan, 2006).

The aboriginal communities of Latin American countries have been historically marginalized of environmental governmental decisions (Kronik and Verner, 2010). The vulnerability of these communities has been explained by the high dependency of natural resources uses, their relative isolation and the historical lack of recognition of territorial rights (Costello et al., 2009; Nakashima et al., 2012).

Under this context, the involvement of aboriginal communities in fisheries varies widely around the world, but invariably involves many complex social-ecological interactions (Berkes, 2009), in particular in the Bering Sea (Hungtington et al., 2013), Australia (Busilacchi et al., 2013), Canada (Charles et al., 2012), Chile (Coria and Calfucura, 2012), New Zealand (Kahui and Richards, 2004), Philippines, among others (Charles et al., 2012).

In the field of fisheries management tools, Castro and Nielsen (2001) found that indigenous people, state agencies, and other stakeholders offer windows of opportunities as a way of dealing with natural resource conflicts in a participatory and equitable manner. While Carter and Hill (2007) assessed the role of indigenous communities in the habitat mapping in Australia to evaluate the potential expansion of their fishing operations, Busilacchi et al. (2013) studied the shift in the nature of the traditional subsistence activities to include the relatively recent practice of sending fish from the islands to family members in other locations.

Our research hypothesis is based on the fact that those communities closed to the aquaculture development during the last two decades had shifted in their relationships with the ecosystem and dependencies of marine ES values and benefits. Moreover, fishing and shellfish harvesting had a strong subsistence value in the past, but today the decrease of abundance of fishery resources jointly with a higher dependency on the aquaculture and transformation industry led to a decrease of dependency on algae gathering with medicinal and fertilizing use. The marine ecological knowledge still kept by elders is not passing to the new generations as they are moving towards to the development of aquaculture activities.

Under this context, the objectives of the paper are three-fold: (a) to investigate the links between customary uses of aboriginal communities living in the coast with marine ES, (b) to characterize benefits, values (commercial, subsistence and existence) of marine ES used by these communities, (c) to use the ecological knowledge of aboriginal communities to examine their perceptions towards the co-management system of SSF. The final aim of the study is to provide evidence of the existence (presence or absence) of ecological knowledge from the coastal aboriginal communities of Southern Chile, and how this knowledge might be used as an official self-management of ES in the context of their rights to apply for the customary sea tenure regime.

2. Aboriginal customary rights, the *Lafkenche law* and the marine and coastal areas of aboriginal nations

Chile has been navigating during the last thirty years from abrupt social-political changes which were inherited from the dictatorship regime towards a new development paradigm which led to influence changes in many areas of knowledge, perspectives and local economies (Zelada Muñoz and Park Key, 2013). Top-down approaches have been traditionally used to manage marine ecosystems overriding the values, traditional knowledge and social needs of coastal communities (Armesto et al., 2001).

During the first democratic government after the dictatorship, the Fisheries and Aquaculture Law (1991) created different management tools for benthic resources which were mainly based on scientific knowledge which they have been proven to help to successfully navigate into sustainable trajectories of benthic fisheries (Gelcich et al., 2010). With the development of the fisheries sector, the objectives of the government were primarily focused on the "acculturation and education" of the fishermen from a scientific perspective to achieve sustainable exploitation of fishery resources. Combined to this, the promotion of the rational mentality and the view of a better society was also incentived, building trust between national institutions and linking successful practices with the scientifically management of fishery resources (Bacigalupo Falcon, 2000; Schumann, 2010).

The Mapuche's community has the largest population among the eight aboriginal communities present in Chile (Atacameño, Aymara, Colla, Kawashkar, Mapuche, Quechua, Rapanui and Yagan). Mapuche's communities have traditionally occupied a territory in the South-center of Chile, from the Limarí river to the Chiloé Island. *Williche* ("*willi*" means South and "*che*" means people) is the meaning of the territorial identity of the people settled South of the Toltén River and the *Lafkenche* means the marine and coastal identity of people ("*lafken*" means sea and "*che*" means people in aboriginal language). *Lafkenche*'s communities are mainly settled along the administrative regions known as Aysen, Los Lagos and Los, today occupying small isolated patches of the coast.

Mapuche's culture is embedded in the ecosystem perspective with an economic, spiritual and cultural relationship with natural resources. However, the existing rules and norms about the use of coastal areas were not specific enough to recognize the right of aboriginal communities on spaces who had used ancestrally and customarily in recent times. As a result, aboriginal people mainly represented by the *Lafkenche*'s communities jointly developed with the government the Law No. 20.249 (also known as "*Lafkenche* Law") in order to promote the legal framework with a specific tool to recognize the special relationship between aboriginal people and the coastal fringe.

The *Lafkenche* Law provides the possibility to aboriginal communities to apply for the customary management of the areas in a concession basis which is known as MCAAN ("*Marine and Coastal Areas of Aboriginal Nations*", in Spanish "*Espacios Costero-Marinos de Pueblos Originarios*").

3. Material and methods

3.1. The study area

This study was developed within the administrative region of Los Lagos (Southern Chile), which concentrates a high number of aboriginal communities claiming MCAAN for customary sea tenure. The National Institute of Statistics reported a total of 5305 aboriginal fishermen in the area, which represents 21.4% of the total fishermen in the region of Los Lagos (INE, 2009) (Fig. 1).

We have investigated the importance of ES for Mapuche-Williche communities applying for the customary sea tenure regime of the MCAAN. We have also analyzed the importance of

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