



Exploring typologies of artisanal mussel seed producers in southern Chile

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ABSTRACT

Aquaculture is one of the most dynamic food production systems in the world, with a fast expansion, especially in developing countries. Among this sector, the Chilean mussel industry has experienced a substantial increase, turning Chile into one of the leading producers and global exporters of mussels. Among the different links in the mussel production chain, the natural seed collection conducted by artisanal fishers of southern Chile has been a fundamental pillar for the development of the industry. Often, this sub-sector has been thought of as a homogeneous group, with similar responses to different challenges and public policies. However, this is likely an unrealistic assumption, making it necessary to understand the complexity of the local context and the heterogeneity of producer groups within the territory. Using surveys and multivariate statistical analysis, we explore typologies of artisanal mussel seed producers in southern Chile. The results proposed four seed producer entrepreneur typologies associated mainly with socioeconomic features and their interactions with the environment. These variables explain heterogeneity in organizational structures and equipment. Spatial location and environmental conditions are important factors that directly or indirectly influence the fishers' investment in equipment and sales contracts. Our findings suggest that seed producer heterogeneity should be considered when designing, implementing, and providing policy incentives to support sustainable mussel aquaculture. Our results identified groups of fishers whose entrepreneurship capacity is vulnerable to environmental and market changes, informing future needs for technical assistance and support.

1. Introduction

Aquaculture is the fastest growing food production system in the world (FAO, 2014). The rapid expansion of aquaculture is taking place mostly in developing or middle-income countries, areas in which small-scale fisheries play important roles for livelihood security. Consequently, socially and economically sustainable aquaculture production needs to ensure local small-scale fisher communities and supply chains continue to function and provide socially and ethically acceptable working conditions. Indeed, aquaculture is still in its infancy regarding issues related to small-scale fisher participation in the aquaculture supply chain and the design and implementation of management and policy aimed at achieving successful engagement of small-scale fishers within aquaculture.

Some examples of small-scale fisheries participating in the

aquaculture supply chain can be found in India and northeast Brazil for the shrimp industry, or in Chile for the mussel industry. The latter is one of the most important Mytilidae production centers around the world (FAO, 2016a) experiencing a substantial increase from 30,000 tons to 283,307 tons during the past fifteen years (SERNAPESCA, 2014; SSPA, 2016). This increase in production has made the Chilean industry the world's number one exporter of mussels, with 59,300 tons shipped in the first nine months of 2015 (FAO, 2016a).

Mussel production is commonly divided into four stages of production, seed uptake, seed fattening, mussel processing and mussel marketing (Rivera et al., 2017). The seed uptake process is mainly carried out by artisanal fishers, who act as aquaculture entrepreneurs (Vik and McElwee, 2011). Seed uptake occurs mainly in rural areas during the spring and summer seasons of the year (October to March) and represents both an important source of income for fishers and other

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small-scale aquaculture entrepreneurs (Figuerola and Dresdner, 2016), and an alternative livelihood aimed at alleviating poverty. Seed uptake, is an essential pillar for mussel aquaculture as the seed represents the main raw material for the entire industry. Thus, any limitation in this input will affect the following stages of the production chain and therefore, the final supply. In Chile, 100% of the seed needed for the mussel aquaculture industry is obtained from the natural environment through seed uptake (Bagnara Vivanco, 2008; Carrasco et al., 2014; Saavedra Gallo and Macías Vázquez, 2016). These features have made seed uptake play a key role on both the entire production chain and the income of small-scale artisanal fishers, underscoring its vulnerability to environmental changes.

The seed is up-taken by collectors, which are artisanal gill nets that provide a surface for larvae settlement. Each collector is 20–25 cm in diameter and 4-meters-long and are installed in long-line systems which can be single or double. There are 3 legal mechanisms to carry out the activity: concessions, temporary permits (1 season), and Management and Exploitation Areas for Benthic Resources (MEABRs). The latter are legal concessions that assign exclusive user rights to extract benthic resources in specified areas of the seabed (Gelcich et al., 2010). These permissions are exclusive for artisanal fisher organizations that are legally constituted, who once authorized can install collectors in up to 40% of the assigned area. The members of the organization can organize in three different ways to carry out seed uptake activity in MEABRs: either collectively as organization, in smaller groups of members of the organization, or by individual members.

In recent years, seed producers have continuously faced several challenges related to environmental factors that influence seed production. For instance, during 2012, a significant decrease in mussel seed uptake was observed (Carrasco et al., 2014; SSPA, 2014). In addition, the Los Lagos Region is constantly hit by the “red tide” phenomenon, which severely affects industry productivity. Although this is a naturally recurrent phenomenon in southern Chile recorded during the past four decades (Buschmann et al., 2006; Cabello and Godfrey, 2016), the extent and the intensity of the latest phenomenon (in 2016) has been unprecedented (Cabello and Godfrey, 2016). On the other hand, seed producers also face changes in market conditions, where mussel prices have shown an important variability since 2005 (Figuerola and Dresdner, 2016; SERNAPESCA, 2014; Uriarte, 2008).

From a policy perspective, the Chilean government is launching a large program promoting small-scale aquaculture. This as a way to develop alternative income and entrepreneur opportunities for coastal communities which depend heavily on overexploited fish stocks. However, knowledge about the best way to move forward in the implementation of this program is scarce. Specifically, there is little knowledge on drivers of coastal users' production and labour decision making processes. Moreover, there is no clarity about how to design and implement effective policy instruments to support small-scale aquaculture. A key stakeholder group to develop investment and support policies for small-scale aquaculture are artisanal fishers, despite their importance, there is little knowledge about their decision-making behaviour under different stressors or their reactions to past policy instruments supporting aquaculture related activities.

Researchers and policymakers have called for studies that help to understand producer groups' responses to both environmental and economic stressors (Carrasco et al., 2014) or their responses to support policies. An unrealistic expectation would be to think that these challenges affect all groups of artisanal fishers involved in seed uptake in a similar manner. Likewise, it is unexpected that public policies aimed at tackling these problems have homogenous responses from the various groups of producers. From agricultural economics, we know that the Identification of farm types through cluster analysis is commonly suggested as the first step to portray farm-system responses through different modelling approaches (Köbrich et al., 2003). In this context, identifying typologies of producer groups is an important step that can constitute the so-called recommendation domains which represent “for

whom we can make more or less the same recommendations” (Byerlee and Collinson, 1980; Köbrich et al., 2003).

Although cluster analysis is a common method used in agricultural economics literature to identify producer typologies (Bidogeza et al., 2009; Briggeman et al., 2007; Daloğlu et al., 2014; Köbrich et al., 2003), it is not a widespread approach in aquaculture. Examples can be found for the shrimp industry (Joffre and Bosma, 2009; Marques et al., 2016); brackish-water pond aquaculture systems in the Philippines (Stevenson et al., 2007); the French oyster industry (Le Grel and Le Bihan, 2009); the Asian carp farming systems (Michielsens et al., 2002); and Greek small-scale fishermen (Tzanatos et al., 2006). However, as far as we know, this approach has not been applied to the mussel industry or to the subsector of mussel seed production.

In order to achieve successful support and long-term engagement of small-scale fishers within the mussel industry, a typology of the mussel seed production subsector is critical. This, to 1) determine appropriate interventions per group of seed producers according to their specific characteristics; 2) understand how appropriate interventions can be scaled; 3) design a strategy for promoting artisanal fisher based entrepreneurship in aquaculture activities; and 4) improve the *ex-ante* impact assessments modelling (Stevenson et al., 2007).

In this study, we aim to build seed production group typologies for artisanal fishers, to strengthen the link of small-scale fisheries and the mussel industry. Due to the available information on environmental and productive conditions, this study focused on MEABRs managed by fishers. Thus, through multivariate statistics, we capture the diversity of artisanal fisher mussel seed production groups that operate within MEABRs in two districts within the Los Lagos region in Southern Chile. The results should help policymakers to understand the heterogeneity of agents involved. Therefore, findings can help determine and identify relevant policy actions targeted to specific needs of heterogeneous users.

2. Methodology

2.1. Study area and unit of analysis

Data collection was conducted in the Cochamó and Hualaihué districts located in the Los Lagos region of Chile (Fig. 1). These districts are the main zones where seed uptake takes place. Although there are three legal mechanism to carry out the activity, due to the information available on environmental and productive conditions this study focused on the small scale fishers as entrepreneurs that collected seeds in MEABRs. Further, the unit of analysis defined is the production group working in the MEABRs, independently of the way in which they organize the work.

The number of fishers working within the MEABR in mussel seed collection is not known because there is no official record in Chile of these producers. However, the total number of seed collector structures authorized to be installed in each MEABR is known. The survey considered 86 production groups operating in 32 MEABR who performed seed uptake between 2008 and 2013. Altogether the 86 groups installed 805,700 collectors that represented 45% of the total collectors authorized to be installed in the MEABRs in 2014, according to statistics provided by the National Fisheries and Aquaculture Service.

The questionnaire included three topics: 1) socioeconomic characteristics of the producers (experience, age, gender, production organization, funding for activity, training); 2) production statistics (number of collectors installed and harvested, collector yield, production losses, seed price, cost of seed); and 3) other occupations/livelihood alternatives of producers (main economic activity and income of complementary activities). The sample comprised 32 MEABRs, representing 58.2% of MEABRs that perform seed uptake within the Los Lagos region.

Surveys were performed in areas close to environmental monitoring stations located at seven localities within Cochamó and Hualaihué.

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