



Emerging fisheries in subtropical coastal lagoons: *Sphoeroides annulatus* in Magdalena-Almejas Bay, BCS, Mexico (1998–2008)



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ABSTRACT

Fishing is an important economic activity in Baja California Sur that creates thousands of jobs and provides high-quality food. Magdalena-Almejas Bay is a highly productive region that contributes an annual average close to 50% of state catches. It is the center of various small-scale fisheries that include the marine species commonly known as “finfish”, for which information is scarce. To understand the operation of this multi-species fishery and its recent changes, operations of the coastal fleet were analyzed using a historical series of official capture landing reports for the period 1998–2008. Surveys were administered to fishers in order to record their local knowledge on aspects such as target species, associated species and bycatch, fishing gear currently used, and fishing seasons and areas. Primary (on-beach) buyers were surveyed to document the market. The information obtained revealed the existence of emerging fisheries, highlighting *Sphoeroides annulatus* (locally known as “botete diana”) that ranks fifth in relative importance based on volume captured, production value, and number of capture landing reports. Fishing operations were documented on fishing trips with producers who use specific fishing gear locally called “*chinchorro botetero*” (puffer seine net). Due to the lack of published information about this particular fishery, this work attempts to set a foundation for the systematic documentation of this fishery, recording biological aspects of the species, fishing gear used, catch techniques, initial preservation, the prices of fish sold on the beach, the marketing channel, the target market, seasonality, and spatial distribution of the fishery.

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1. Introduction

Fishing is a global productive activity that significantly impacts the economy and development of countries, especially in coastal areas, creating millions of direct and indirect jobs, both in industrial activities as well as in the so-called small-scale, artisanal, or coastal fishery (FAO, 2005; FAO, 2014).

According to a recent report on the global state of fisheries, Mexico ranks 16th among the most important nations in terms of fisheries production, showing a 1% increase between 2011 and 2012, with a 16.7% cumulative growth in catch during 2003–2012 (FAO, 2014). The country's northwestern region, which encompasses the states of Sonora, Sinaloa, Baja California and Baja

California Sur (BCS), contributes 70% to national production (CONAPESCA, 2014).

In BCS, the region encompassed by the Magdalena-Almejas lagoon complex (BMA) has become the main fishing center. This is due to its high productivity associated with geographic, oceanographic, and environmental factors, all of which allow coastal fisheries and the industrial fishing of sardines. Together these contribute annually between 55% and 60% of state catches and over 40% of production value (Ojeda, 2012).

While fisheries of species of high commercial value such as abalone and lobster supported social development in this subtropical coastal lagoon (Cárdenas, 2014), the decline in catches, the reduction of natural banks, and the growth of the fishing sector jointly led to the diversification toward alternative resources. The relative importance of other fisheries consequently increased, raising the fishing pressure on a larger number of species.

A study coordinated by the FAO entitled “*El Potencial Pesquero y*

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Acuicola de Baja California Sur” includes reports on the major fisheries in the state based on records from the 1980s and early 1990s. The document defines the potential for development as appropriate. It includes traditional coastal fisheries, such as lobster, abalone, pacific calico, estuarine shrimp, shark, crab, snail, and finfish, among others. In the case of marine finfish fisheries, the study was divided into 3 resources for analysis: flounder, hake and finfish (the latter comprises other marine finfish captured, including *Sphoeroides annulatus* (“*botete diana*”). This structure was proposed in consideration to the potential of the flounder and hake fisheries identified at that time (Casas and Ponce, 1996).

According to Ramírez (1996), the finfish fishery contributes between 5% and 7% of the BCS volume, with variations in the composition of annual catches. It has been the driving force of the growth of fishing activity in the latest years analyzed, associated with the decline in the production of resources of higher commercial value (including the catarina scallop) and the incorporation of workers displaced from other local economic activities (specifically from the agricultural sector).

An analysis of the statistics of finfish catches from 1984 to 1994 from both BCS littorals identified marked differences in the composition of catches. *Caulolatilus* spp (“*pierna*”), *Paralabrax nebulifer* (“*verdillo*”) and *Paralichthys* spp and *Pleuronichthys* spp (“*lenguado*”) catches stand out on the northern Pacific coast – the most productive area; *verdillo*, *pierna* and *Mugil* spp (“*lisa*”), in the southern Pacific; and *Lutjanus peru* (“*huachinango*”), in the Gulf (Ramírez, 1996). *Verdillo* and *pierna* were considered emerging fishing resources at that time.

As regards applicable legislation, the finfish fishery management approach includes several measures such as licenses, fishing gear, and no-fishing zones. However, the only marine fish species with specific regulation is *Mugil* spp, “Norma Oficial Mexicana”/DOF, NOM-016-SAG/PESC-2014 (DOF, 2015). In addition, there was no basis for estimating the potential exploitation of finfish and this diverse and multi-species fishery. In Ramírez (1996) the first reports of *botete diana* catches appear, with important volumes in the southern Pacific – nearly 100 tons per year –, as bycatch from other fisheries (Ramírez, 1996).

1.1. Finfish fishery in Magdalena-Almejas Bay

An analysis of Official Catch Landing Reports (OCLRs) from 1998 to 2008 for BMA identified 14 small-scale fisheries. Considering the contribution of each in landed weight (kg), production value, and the number of OCLR reported, the relative importance was estimated with the index (RII) proposed by Ojeda and Ramírez (2012). As a result, the pacific calico, finfish, and shrimp were classified as the most relevant small-scale fisheries in the region (Ojeda and Ramírez, 2012).

In BMA, the marine fish potential comprises more than 22 families and over 100 species potentially suitable for fishing. The fishing activities take place mainly with small boats, using a wide range of fishing gear that includes nets, traps, longlines, and hand lines (De la Cruz et al., 1994; Ramírez, 2011).

The representatives of the Tetraodontidae family are fish of ecological, economic, and fishing importance. They are distributed mainly in marine and brackish waters (Walker and Bussing, 1996). This group comprises 193 species, some of which are exploited for local and regional consumption (Eschmeyer, 2014). In northwestern Mexico, and specifically in Magdalena Bay, there are 3 species belonging to the genus *Sphoeroides* (*S. annulatus*, *S. lipus* and *S. lobatus*) which are exploited commercially (Walker and Bussing, 1996; Aguirre et al., 2006). *S. annulatus* is by far the dominant species, accounting for nearly 95% (CONAPESCA, 2014) and with the potential to reach a high commercial value (Froese and Pauly, 2014).

As regards finfish fisheries, the DOF 2010 (“*Carta Nacional Pesquera*”) includes only a minimum number of target species from this group, some living in the Pacific and others in the Gulf of Mexico. It does not contemplate specific management measures for each of the species that currently support the finfish fisheries in BMA, such as *Caulolatilus* spp and *P. nebulifer*, nor does it list *S. annulatus*. There are only general measures like a non-fishing zone, fishing gear, and licenses.

No publications were found regarding the operation of the bullseye puffer fishery (*botete diana*). However, a number of authors point to its importance in the northwest of Mexico, particularly in Sinaloa. Research work has been done on some reproductive parameters and on population dynamics that provide a deeper insight into this resource and set the basis for management strategies and actions (Sánchez et al., 2011; Díaz et al., 2013; Valdez et al., 2014).

When new species are incorporated into the catch series or the specific catch composition varies, this can lead to changes in the fishery regime, depletion of conventional resources, social changes, or market pressures (Maullil et al., 2013). Apparently, this is currently happening in BMA. Several species of serranid or sea bass (*Mycteroperca* spp, *Epinephelus* spp and *Hyporthodus acantisthius*) are less frequent on OCLR and exert a low impact on production volumes, while the contribution of other species such as *Caulolatilus* spp and *P. nebulifer* are on the rise. Species such as *S. annulatus*, listed in catches of recent years, are recognized as target resources for small scale fleets.

It is important to document the results and changes in the country’s fishing activities with the aim of including new fisheries at the right time in public policy instruments such as the national fishing chart or regional management committees. Thus, the objective of this study is to set the foundation for the systematic documentation of the puffer fishery (*S. annulatus*) emerging in BMA. This can be achieved through holistic approach that investigates about the resource, fishing gear, fishing operations, on-board handling, marketing channels, and prices on the beach.

2. Materials and methods

2.1. Study area

Magdalena-Almejas Bay is a subtropical lagoon complex located on the Pacific coast of Baja California Sur, between the municipalities of La Paz and Comondú. Physiographically it consists of three major water bodies: estuaries to the north, Magdalena Bay in the central area, and Almejas Bay to the south (Fig 1). The climate and oceanographic conditions in BMA create conditions of high primary productivity. The influence of the California current together with prolonged upwelling effects sustain abundant populations that support intense fishing activity in the area, considered the center of several coastal and even some industrial fisheries (Ojeda, 2012).

From the environmental standpoint, the region is highly valued for the diversity and richness of its ecosystems. Mangrove forests are notable, since these include abundant areas of seagrass, macroalgae, and rhodolite, which serve as a source of energy and shelter for species of commercial importance. This has given rise to conservation interests in the area and led to the promotion of sustainable development (Funes et al., 2007).

Official censuses estimate a population of around 8942 inhabitants in the region, with the communities of Puerto San Carlos, Puerto Adolfo Lopez Mateos, and Puerto Chale as the main population centers (CONAPO, 2010). The local population is dedicated mostly to fishing activities, tourism and trade, or work in the Federal Electricity Commission power plant located near Puerto San Carlos, BCS (Ojeda, 2012).

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