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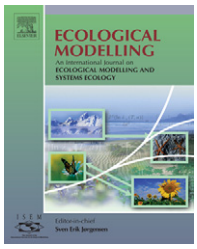

Multispecies perspective for small-scale fisheries management: A trophic analysis of La Paz Bay in the Gulf of California, Mexico

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ABSTRACT

Given the complexity of small-scale fisheries and the difficulties for applying classical assessment methods, the status of these fisheries has been poorly documented. In this study, we used a trophic mass-balance model as an analytical alternative to evaluate the trophic impacts of small-scale fisheries as a whole on the marine ecosystem and their implications for ecosystem-based management, taking as a case study the La Paz bay and adjacent fishing grounds (BALAP) located in the Gulf of California, Mexico.

Maturity indices, like ascendency and primary production to respiration ratio, indicate that the BALAP ecosystem is in a developing stage. This seems to be closely related to the reported two-season climatic regime that results in a nutrient supply characterized by an oscillating upwelling. The trophic model predicts a predominance of bottom-up control in the food web, which is congruent with the immaturity of the ecosystem. In this context, fisheries seem not to cause a significant impact to the ecosystem as a whole; however, target species show signals of being fully exploited by fisheries in the system. Red snapper and sharks showed the highest exploitation rates in the ecosystem. Based on these results, we discuss the current stock concept as a population-based management unit and the necessity for defining an ecosystem-based management unit.

1. Introduction

Artisanal or small-scale fisheries are important worldwide because they account for more than a quarter of the world marine catch, contribute about a half of the landings used as human food, and employ about 90% of the world's fishermen (McGoodwin, 1990; Mathew, 2001). In contrast, fish resources exploited by these fisheries are seldom studied and generally they are not taken into account for assessment and management programs. Biological, technological, and social complexity of these systems has been a hard subject to tackle and probably is the reason for the inat-

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tention they have received. Numerous, highly diverse sociocultural groups participate in small-scale fisheries, which exploit a great variety of species using multiple fishing gears. In this context, multispecies catches highlight the necessity for management plans to explicitly recognize the direct and indirect impacts these fisheries have on marine ecosystems.

Classical analysis methods are based on dynamic population models, which only allow for single-species assessment and management. Unfortunately, this approach is seriously limited for analyzing small-scale fisheries, since it generally uses a constant natural mortality value and masks the complexity of the fishery system function (Ralston and Polovina, 1982). The problem of the single-species analysis has long been discussed. More than three decades ago proposals to broaden this approach focused on evaluation of the effect of fisheries on whole biological communities (Reiger and Henderson, 1973; May et al., 1979; Sainsbury, 1982; Pimm and Hyman, 1987). In multispecies models three fundamental approaches can be recognized: (1) dynamic biomass models, which are an extension (or summation) of surplus models (May et al., 1979); (2) age-structured models of which Multispecies Virtual Population Analysis (MSVPA) is the most representative model (Magnusson, 1995; Rice and Gislason, 1996); and (3) trophic mass-balance models just such as *Ecopath* with *Ecosim* (*EwE*) (Christensen and Pauly, 1992; Walters et al., 1997). Most of these models, however, have been designed from well-documented fisheries (Hollingworth, 2000), which is an uncommon situation in small-scale fisheries since databases are usually limited. Recently, trophic mass-balance models have been used for analyzing ecosystems under different exploitative regimens and have proved to be easily parameterized with less intensive data requirements (Bundy and Pauly, 2001).

Until a few years ago, it was assumed that small-scale fisheries were not a major risk to marine ecosystems, since, compared with large-scale fisheries, each fishing unit has a lower and more selective fishing capacity. In the past two decades, small-scale fisheries have rapidly expanded in number and mobility, and their capacity for disturbing ecosystems can match large-scale fisheries (Bundy and Pauly, 2001; Mathew, 2001). Given the complexity of small-scale fisheries and the previous methodological difficulties, this situation has been poorly documented. Now trophic mass-balance models represent an analytical alternative to evaluate the effects of small-scale fishing on marine ecosystems. The purpose of this work is to contribute to the analysis of trophic impacts of small-scale fisheries, as a whole, and consider their implications for ecosystem-based management. We used as case study the La Paz bay and adjacent fishing grounds located in the Gulf of California, Mexico. In particular, we analyzed target species of the small-scale fisheries and discuss the current stock concept as a population-based management unit and the necessity for defining an ecosystem-based management unit.

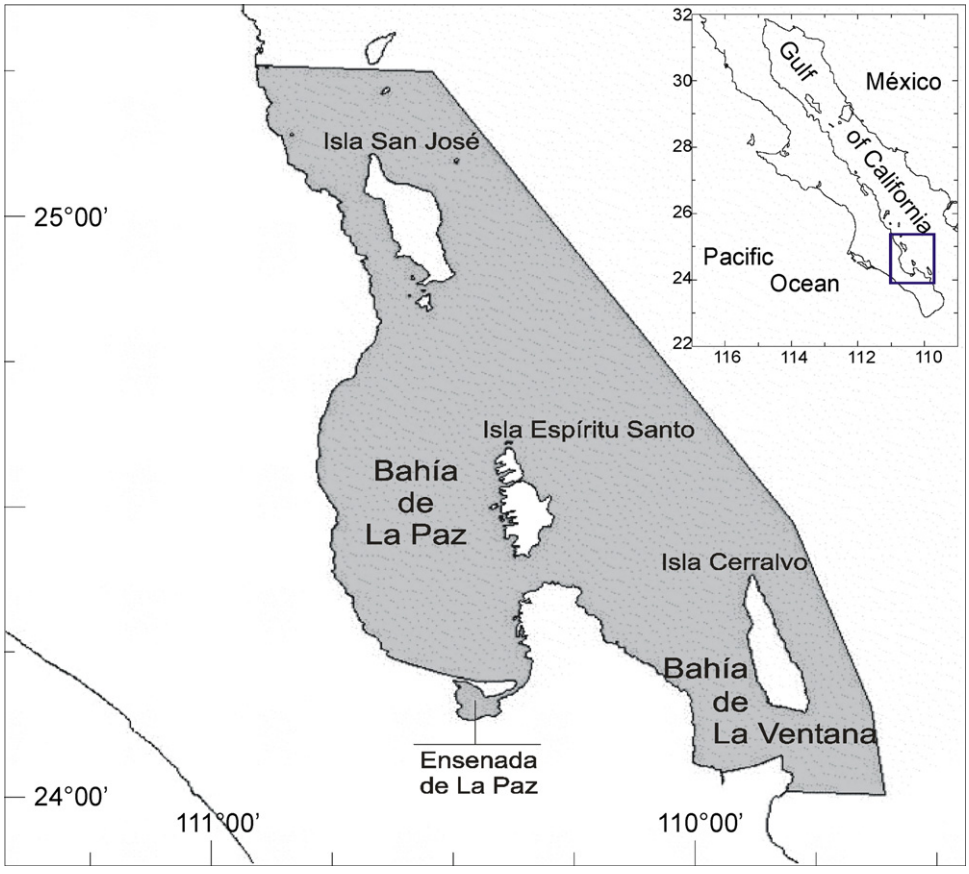

Fig. 1 – Study area showing the BALAP ecosystem limits. Surface area is about 7287 km^2.