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A comparison of fishing activities between two coastal communities within a biosphere reserve in the Upper Gulf of California

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ABSTRACT

We engaged in collaborative research with two small-scale fishing communities inside the Upper Gulf of California Biosphere Reserve in Mexico, San Felipe (SF) and El Golfo de Santa Clara (GSC), to test how well the geographic heterogeneity of fishing activities within the reserve coincided with current regulations. We compared the two communities in terms of catch composition, fishing effort, ex-vessel prices and revenues, seasonal patterns in fishing activities in relation to the reproductive seasons of target species, and spatial patterns of fishing in relation to managed zones within the reserve. The top four species (*Cynoscion othonopterus*, *Micropogonias megalops*, *Scomberomorus concolor*, *Litopenaeus stylirostris*) in terms of relative effort, catch, and revenues were the same for both communities but overall fisheries production, effort, and revenues were higher in GSC than SF for these species. Fishing activities in GSC followed a predictable annual cycle that began with *L. stylirostris* and were followed sequentially by the harvesting of *C. othonopterus*, *M. megalops*, and *S. concolor* during their respective spawning seasons, which were associated with seasonal variations in ex-vessel prices. Conversely, catch and revenues in SF were more diversified, less dependent on those four species, less seasonal, and did not show seasonal variations in prices. Interactions between fisheries and managed zones also differed such that SF interacted mainly with the southwest portion of the vaquita (*Phocoena sinus*) refuge, whereas GSC fished over a larger area and interacted mainly with the northeast portion of the vaquita refuge and the no-take zone. Our results indicate the two communities differ markedly in their socio-economic dependence on fisheries, their spatio-temporal patterns of fishing, their use of and impacts on species, coastal ecosystems and managed areas, and how different regulations may affect livelihoods. Regional management and conservation efforts should account for these differences to ensure the protection of endangered species and to sustain ecosystem services that maintain livelihoods and healthy coastal ecosystems. This study provides further evidence of the ability of collaborative research between scientists and fishers to produce robust and fine-scale fisheries and biological information that improves the collective knowledge and management of small-scale fisheries within marine protected areas.

1. Introduction

Commercial fisheries are essential to the livelihood, welfare, and food security of coastal communities, and more than 90% of the world's fishers are employed in small-scale fisheries (Chuenpagdee et al., 2006; FAO, 2012; Teh and Sumaila, 2013). However, small-scale fisheries can be more difficult to manage than industrial (large-scale) fisheries, because they often lack sufficient or reliable data related to effort, catch, discard rates, the biology of target species, and other information necessary to assess stocks and set regulations (Johannes, 1998; Salas et al., 2007). Moreover, fisheries information is usually available only on coarse spatial and temporal scales that do not always correspond to the demographics or life history characteristics of fish stocks or the dynamics of small-scale fisheries that target them (Tzanatos et al., 2005; Erisman et al., 2011; Wilson et al., 2012). Understanding spatial and temporal

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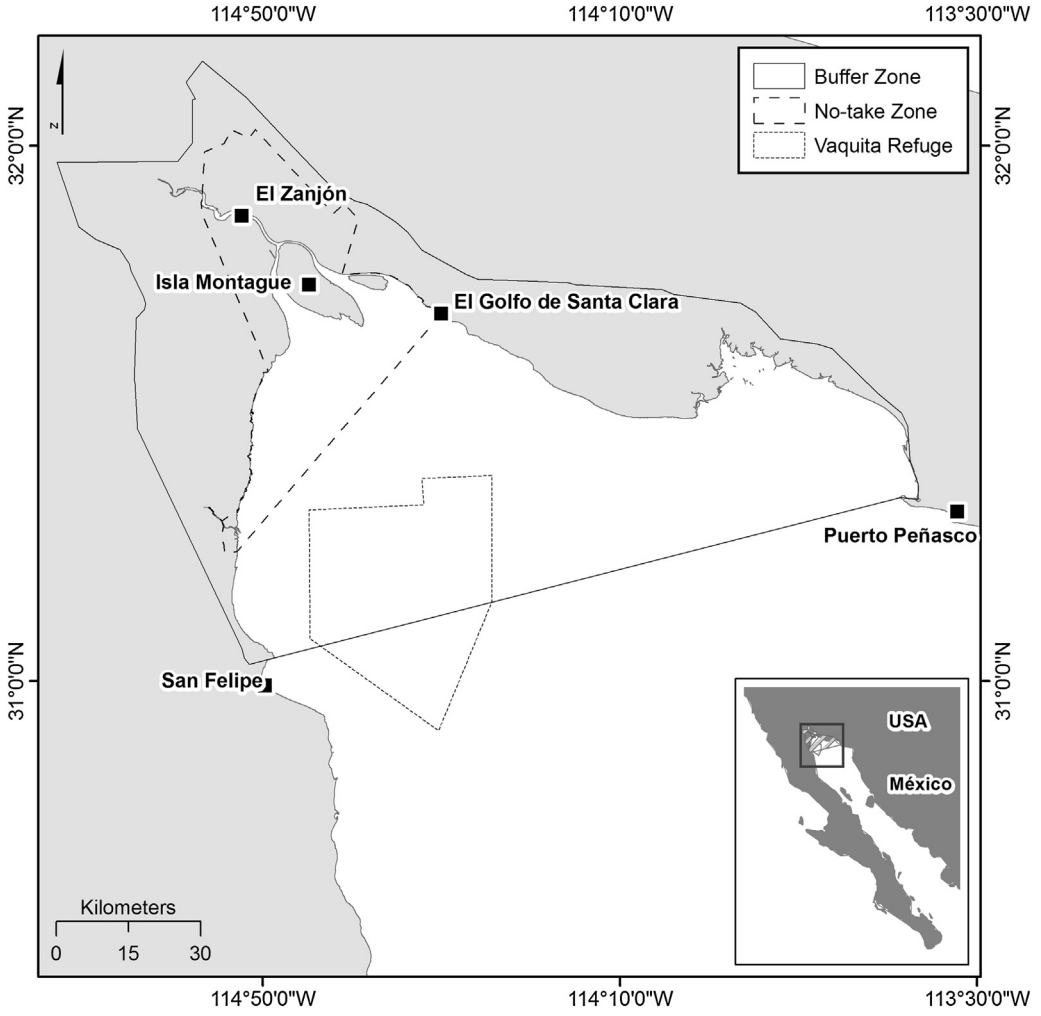

Fig. 1. Map of the Upper Gulf of California and Colorado River Delta Biosphere Reserve, managed areas within the reserve, the locations of the coastal fishing communities of El Golfo de Santa Clara and San Felipe, and the location of the Biosphere Reserve within the Gulf of California (inset).

patterns of small-scale fisheries and how they align with fisheries and conservation regulations is particularly important for the management of marine protected areas. Such information is crucial to assess possible impacts of fishing on endangered or protected species, coastal ecosystems, and managed areas as well as to identify and mitigate socio-economic impacts of regulations on fishing communities (Gunderson et al., 2008; Abbott and Haynie, 2012; Erisman et al., 2012; Horta e Costa et al., 2013). Likewise, incorporating spatio-temporal interactions within and among ecosystem components and human activities into management decisions is an essential component of ecosystem-based fisheries management (Leslie and McLeod, 2007), which aims to simultaneously protect the structure and function of marine ecosystems and the services they provide to mankind (FAO, 2005).

The Gulf of California is the most important fishing region in Mexico, as it contributes more than half of the country's total annual fisheries production, and small-scale fisheries generate the majority of this production (Cisneros-Mata, 2010; Erisman et al., 2011). The Upper Gulf of California (Fig. 1) is arguably the most important region in Mexico in terms of small-scale fisheries production, where nearly 1000 small boats use gill nets to harvest blue shrimp (*Litopenaeus stylirostris*), Gulf corvina (*Cynoscion othonopterus*), bigeye croaker (*Micropogonias megalops*), Spanish mackerel (*Scomberomorus concolor*), and small volumes of other groups such as sharks, rays, crustaceans, and bivalves (Cudney and Turk, 1998; Rodríguez-Quiroz et al., 2010). Fishing activities in this region have long interacted with the conservation of two endangered species of national and international concern: the vaquita porpoise (*Phocoena sinus*) and the totoaba (*Totoaba macdonaldi*) (Aragón-Noriega et al., 2010; Bobadilla et al., 2011; Ávila-Forcada et al., 2012). Consequently, the region has a storied history of management and conservation efforts that are now most visible through the implementation of the Upper Gulf of California and Colorado River Delta Biosphere Reserve, which includes a no-take zone in the estuary of the Colorado River to protect the spawning grounds of totoaba and Gulf corvina and another no-take zone that serves as a refuge for vaquita (Fig. 1).

Successful management of small-scale fisheries in the Biosphere Reserve is hindered by a paucity of fisheries information and ongoing conflicts between fishing communities that operate inside the reserve and the region's conservation agenda (Bobadilla et al., 2011). The coastal fishing communities of San Felipe, Baja California, and El Golfo de Santa Clara, Sonora, (henceforth referred to as "Santa Clara" and "San Felipe") lie within the boundaries of the reserve, utilize the buffer zones within the reserve as their principal fishing grounds, and thus are effected greatly by strict regulations implemented within the reserve for conservation purposes (Bobadilla et al., 2011; Pérez Valencia et al., 2011; Ávila-Forcada et al., 2012). Small-scale fisheries are central socioeconomic components in both communities. However, they differ in terms of capacity and fisheries production. There are 457 boats in Santa Clara that collectively operate a total of 925 fishing permits for 20