



Ecology, conservation and human history of marine mammals in the Gulf of California and Pacific coast of Baja California, Mexico



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ABSTRACT

In total, 43 marine mammal species, eight of which are threatened, inhabit the Gulf of California and Pacific coast of Baja California. The unique attributes of marine mammal fauna such as species richness, risk condition, energy consumption and calving in this region are historically and geographically important. Marine mammals in the Baja California seas have been hunted for the past 10,000 years and they are also currently subject to severe anthropogenic impacts. Commercial hunting started in the late 18th century and some populations declined until the 1970s. Anthropogenic impacts on marine mammals diversified during the 20th century, with fisheries and pollution now being their greatest threats. Currently, the coasts surrounding Baja California seas are home to 3.06% of Mexican people and 1.77% live in relation with maritime activities. This is a relatively small population that has been growing since the Spanish conquest in the 16th century together with decimation of the regional indigenous populations. The scarce people around Baja California seas have important contributions to Mexican economy and marine disturbance, mostly because the arid environments of northwestern Mexico have historically encouraged marine fisheries as the major intake of natural living resources in the region. Therefore, the region's environmental problems do not stem from an overpopulation requiring ecosystem services, with the exception that exhaustion of the underground aquifers is of great concern, but from historical problems related with social and economic development. Conservation of marine mammals in the Baja California seas may be helpful to geographically and socially integrate human development and ecosystem protection, to address current problems of illegality, sectorial conflicts and partiality in conservation actions as well as to monitor the modifications and functionality of the marine ecosystem.

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1. Introduction

Many marine mammal species have been historically overkilled by different human activities, mainly commercial hunting and fisheries. Some populations recovered after protection actions since the 20th century and some did not. Nowadays, marine mammals are mostly threatened by the destruction of their habitats and the introduction of exotic species among which pathogens are of great concern. Anthropogenic disturbances and climate change often synergize in a current staggering regime of environmental degradation that favors the emergence of unprecedented phenomena of

disease interplayed between humans and biodiversity (Acevedo-Whitehouse and Duffus, 2009; Aguirre and Tabor, 2004; Anderson, 2001; Harwood, 2001; Ross, 2000; Smith et al., 2009). Infectious diseases are currently a considerable contribution for the extinction risk in marine and terrestrial mammals (Gulland and Hall, 2005; Pedersen et al., 2007).

Besides the global public attention for the protection of marine mammals, these animals are indeed important for marine ecology and conservation due to several aspects of their biology. The high metabolic budgets of marine mammals largely contribute to the flow of energy and materials in the oceans and also cause an overlap of food items with humans with many detrimental consequences for both. Anthropogenic food depletion for example, constitute a major factor for marine mammal mortality in the Mediterranean and Black Seas (IUCN [International Union for

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Conservation of Nature], 2012). Marine mammals have a mid to high trophic level that makes them accumulate high amounts of pollutants, mostly in fat tissues, that cause several physiological failures. Most marine mammals distribute in large geographic ranges within which they travel long distances. For this reason, marine mammals are affected by many human activities with complex effects on their feeding, reproduction and/or traveling. Therefore, marine mammals and large marine vertebrates in general, appear as highly vulnerable to the ongoing processes of environmental deterioration (Acedo-Whitehouse and Duffus, 2009; Aguirre and Tabor, 2004; Harwood, 2001; Moore, 2008; Ross, 2000; Smith et al., 2009). For these reasons, research on marine mammals and other large vertebrates is currently largely focused to infer from them, ecosystem modifications and functionality under the concept of sentinel species (Aguirre and Tabor, 2004; Moore, 2008; Ross, 2000).

During the last century in Mexico, several issues of marine mammal conservation became important for national and international affairs of marine resources management, economy, politics and social welfare (Aurioles, 1993). The Gulf of California and Pacific coast of Baja California, hereinafter “the Baja California seas” (Fig. 1A), are among the most biologically-rich and productive seas in the world. These seas are home to 43 marine mammal species including the critically endangered vaquita, *Phocoena sinus*, which is endemic in the upper Gulf of California (CIRVA [Comité Internacional para la Recuperación de la Vaquita], 2014). Another seven species of the Baja California seas are classified in other threat categories and their occurrence in this region is higher as compared with the neighboring North Pacific Ocean (Arellano Peralta and Medrano González, 2013; Rosales-Nanduca et al., 2011). The Baja California seas and adjacent coastal regions between California and Tehuantepec, exhibit values for marine mammal-species richness and phylogenetic diversity among the largest world-wide (Schipper et al., 2008). Nevertheless, the Baja California seas are affected by a great diversity of human activities many of which are unsustainable (Brusca, 2010; Carvajal et al., 2010; Cudney-Bueno et al., 2009; Ezcurra, 1998; Ortiz-Lozano et al., 2005). In a global context, anthropogenic impacts on the Baja California seas range from low in most of the Pacific coast of Baja California to mid-high in the coasts of the Gulf of California according to the scale of Halpern et al. (2008).

Besides the vaquita, marine mammals of historical and ecological relevance in the region are the gray whale (*Eschrichtius robustus*; Berdegué, 1956), the blue whale (*Balaenoptera musculus*; Gendron, 2002), the fin whale (*Balaenoptera physalus*; Rojas Bracho, 1984), the humpback whale (*Megaptera novaeangliae*; Medrano González and Urbán Ramírez, 2002), the common dolphins (*Delphinus delphis* and *Delphinus capensis*; Perrin et al., 1985), the California sea lion (*Zalophus californianus*; Aurioles-Gamboa, 1988), the Guadalupe fur seal (*Arctocephalus townsendi*; Berdegué, 1956), the elephant seal (*Mirounga angustirostris*; Berdegué, 1956) and the sea otter (*Enhydra lutris*; Schramm et al., 2014; Table 1). Marine mammals in the Baja California seas have been closely linked to human history as far back as 10,000 years ago, having been profaned and worshipped in various ways (Jones et al., 2011). Even though the threats currently faced by marine mammals in the Baja California seas are well known (e.g. Arellano Peralta and Medrano González, 2013; Guerrero Ruiz et al., 2006), an integrated account of the history of those threats in relation to the current social determinants for the interactions of humans with marine mammals is lacking and is needed to solve the problems these animals now face. Here, we analyze the distribution of species richness, risk condition, energy consumption and calving of marine mammals in the Mexican Pacific Ocean looking to highlight the importance of the Baja California seas for these animals. We also examine the historical demography around Baja California seas, review the history of interactions between marine mammals and humans, and examine the current abundance and distribution of people in relation to fishing activities and interactions with these animals as one of the most important environmental problems in the region (Ezcurra, 1998; Guzmán Zatarain, 2006). We look for traits of marine mammal ecology as well as human history and demography that may improve extant conservation policies.

2. Methods

2.1. Distribution of marine mammal faunal attributes

In order to visualize the importance of Baja California seas for marine mammals, we analyzed the distribution of species richness, risk condition, energy consumption and calving in the whole Mexican Pacific Ocean defined operatively between 92° (or the

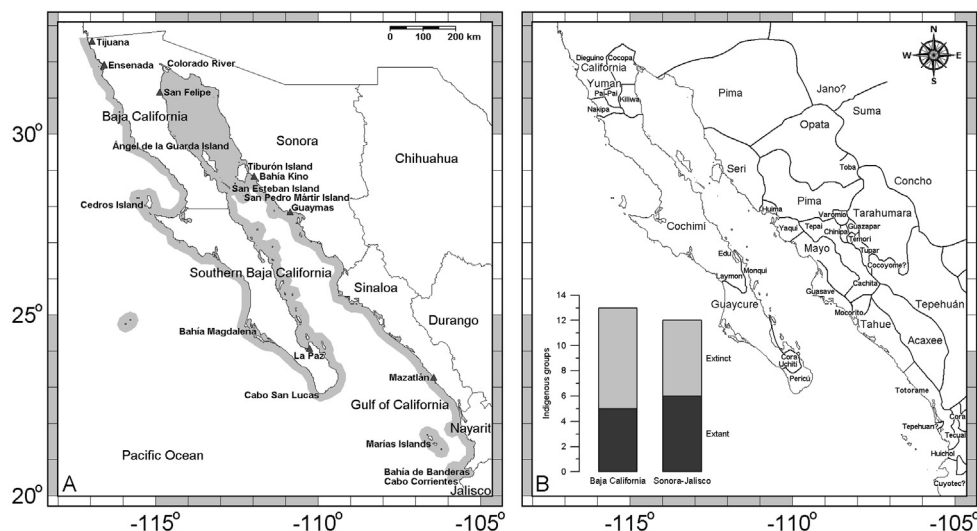


Fig. 1. General geography of northwestern Mexico. A) Regions and sites mentioned in the text. The gray area is the territorial belt of 12 nautical miles. B) Territories and numbers of indigenous groups in the 16th century (Gerhard, 1982).

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