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Long term state of coastal lagoons in Veracruz, Mexico: Effects of land use changes in watersheds on seagrasses habitats

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ABSTRACT

An increase in population over the last 50 years along the central coast of Veracruz on the Gulf of Mexico has led to a corresponding intensification of agriculture, urbanization, and other economic activities. Most significantly, this has resulted in rapid changes of land use and an increase in the area dedicated to agriculture and livestock. Native coastal wetland vegetation has declined significantly, and coastal lagoons systems are altered as they receive excess nutrients and sediments from agricultural and economic activities. The aim of this study was to evaluate the influence of productive activities on four coastal lagoons and one estuary at the watershed level and to establish reference points or ecological indicators upon which future changes in coastal wetlands may be measured. For this purpose we analyzed the physico-chemical characteristics of the water column, assessed the abundance and biomass of seagrasses, and determined the historical and current trophic status of these coastal water bodies. Our results indicate that over time the lagoons have remained in a eutrophic state, and only one has become mesotrophic. The biomass of the seagrass *Halodule wrightii* decreased by 28% from 1991 to 2001 in La Mancha Lagoon. Our results provide a baseline to assess future changes in the water quality of the selected study sites and the seagrasses populations they contain.

1. Introduction

The coastal zone represents a unique domain of gradient-dependent ecosystems, climate, geomorphology, human habitation, and regimes of highly dynamic physical, chemical, and biological processes. The resource richness and diversity of coastal areas have led to an increase in human population along the coasts and estuaries throughout the world and a concomitant increase in productive activities (Crossland et al., 2005). Coastal degradation has occurred to a greater extent in developing countries due to rapid population growth and disorganized urbanization (Linden, 1990).

Human activities involving the physical removal or destruction of habitat are the most obvious forms of ecosystem alteration (Linden, 1990), and estuarine habitats, such as salt marshes, mangrove forests, and seagrass beds (Orth et al., 2006), are among the most affected. Coastal lagoons and estuaries can also be at the receiving end of urban and industrial wastewater discharge, agricultural runoff, and seepage into groundwater, all of which promote an increase in nutrients and lead to eutrophication (Aranda Cicerol et al., 2011). This outcome is associated with human settlements, industry, and the use of fertilizers around the lagoons. Seagrasses are considered valuable biological indicators because they have high light requirements and are highly responsive to environmental changes, especially those that alter water quality, including nutrient and sediment inputs (Koch, 2001). Eutrophication favors the rapid growth of macro- and microalgae, leading to competition for light and nutrients between algae and seagrasses, eventually causing the disappearance of seagrasses (Dunton, 1990). Short and Wyllie-Echeverria (1996) found that between 1970 and 1982, 50% of the seagrass loss worldwide could be attributed to natural disturbances like hurricanes, coastal erosion, grazing, and diseases, and the other 50% was caused by anthropogenic perturbations such as dredging, oil spills, and reductions in water quality. Between 1983 and 1994, about 90 000 ha of seagrass loss was documented mainly in the United States and Australia. Similarly, a reduction of seagrass cover by 58% in shallow beds along the Swedish coast took place between 1980 and 2000 (Baden et al., 2003).

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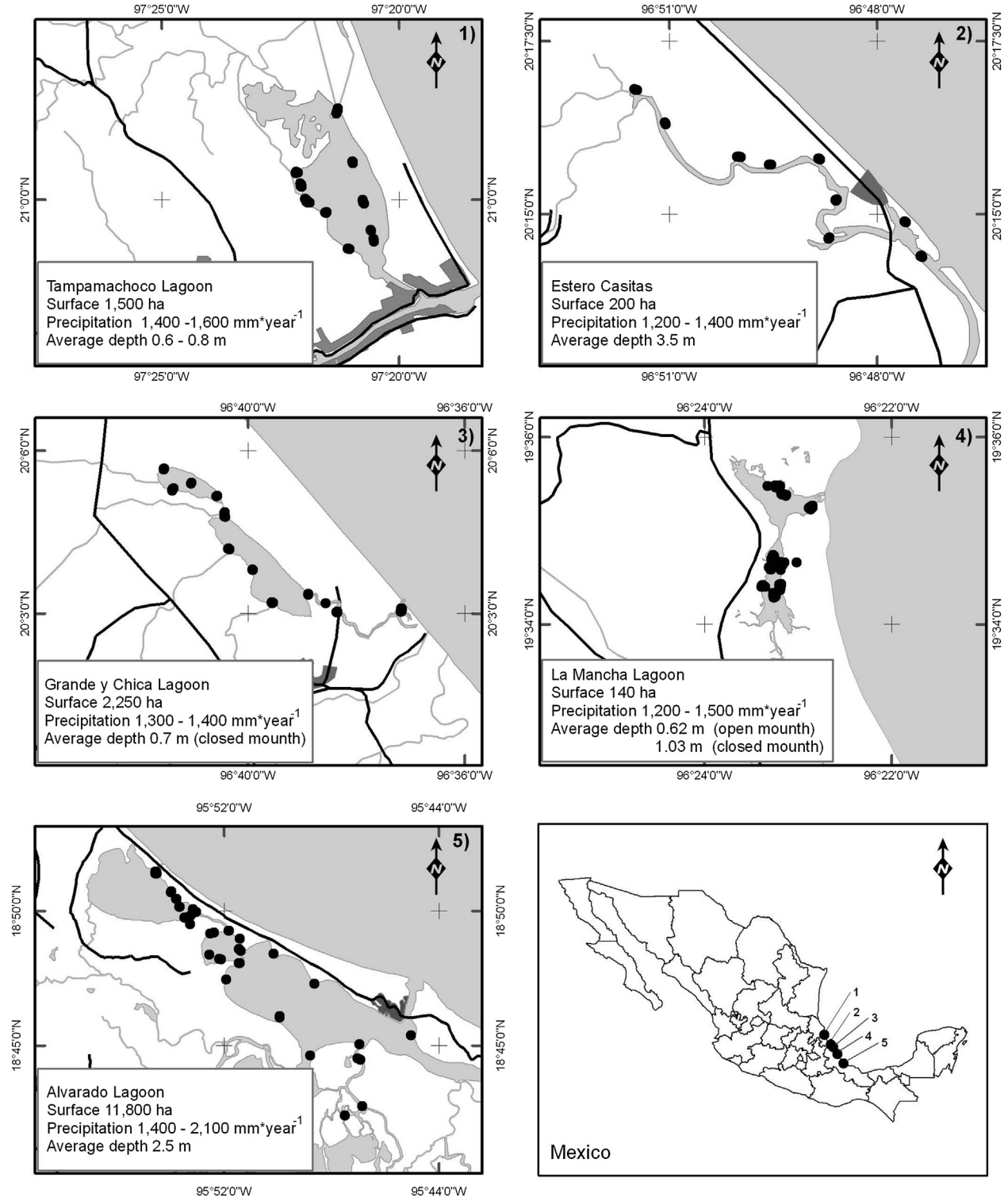

Fig. 1. Map of the Veracruz coast in the Gulf of Mexico showing study site locations. Dots indicate water column and seagrass sampling stations. Tampamachoco, Casitas Estuary, and Alvarado are considered deltaic depressions with a barrier, while Grande y Chica, and La Mancha are coastal plain depressions.

Unfortunately, in Mexico detailed information on seagrass loss along coastlines is unavailable. Therefore, the present study aims to catalogue information on seagrass loss, thereby establishing a reference point that would allow future changes in a select group of coastal water bodies along the Gulf of Mexico to be documented. The generated physico-chemical and biological information is mainly descriptive and is useful in determining the magnitude and speed of human alteration along the central Veracruz coast. Our hypothesis was that the increase in economic activities and human population along the coastal plain of Veracruz over the last 30 years has provoked the deterioration of water quality in the selected lagoons, which in turn has caused a reduction in seagrass species