Changes in Mangrove Habitat in Baja California Sur from 1986 to 2001

Executive Summary

NatureServe
A Network Connecting Science With Conservation

pro natura
noroeste, a.c.

NatureServe is a non-profit organization dedicated to providing the scientific knowledge that forms the basis for effective conservation.

Pronatura Noroeste is the leading conservation organization in Northwest Mexico.

Executive summary was derived from:

Hak, Jon, Xavier Lopez Medellin, Jose M. Beltran, Carmen Josse, Bruce Stein, Rickie White. 2008. Mapping and Analysis of Mangrove Habitat Extent Change in Baja California Sur from 1986 to 2001. In draft.

Front cover photo: White mangrove stand in Magdalena Bay, Baja California Sur, Mexico (photographer credit: Jon Hak)

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

Pronatura Noroeste
A.C. Calle Décima #60 (esquina Ryerson)
Zona Centro
Ensenada, Baja California CP 22800 MEXICO
646-175-3461
www.pronatura-noroeste.org

Introduction

The Gulf of California, with its 3,000-kilometer coastline, is famed as a world center for marine biodiversity. The gulf's rich waters and coastal wetlands support large concentrations of fish, birds, and marine mammals. Giant manta rays, diminutive harbor porpoises, and several species of sea turtles thrive here. Gray whales congregate each winter to calve and nurture their young in the region's sheltered lagoons, some of the planet's last unspoiled refuges. The wetlands along the gulf's coastline are particularly important environmentally and economically because mangrove wetlands are significant nurseries for prawn and other species vital to commercial fisheries. Wetlands provide a vast array of ecological services ranging from coastline stabilization to pollution filtration. Coastal wetlands also provide critical oases for resident and migratory birds of all types in this extremely arid region.

Unfortunately, mangrove-dominated habitats are facing a number of threats including coastal development (Whitmore et al. 2004), shrimp farming (Páez-Osuna et al. 1998), and unregulated municipal pollution. In May 2004, the Mexican government repealed existing mangrove protection regulations, opening the way for plans for extensive coastal development. From May 2004 until the passage of a new mangrove protection law by President Felipe Calderón in February 2007, the agency charged with regulating wetland development could "exempt" previously prohibited uses in mangrove-dominated habitats if the entity applying for exemption "establish(ed) compensation measures that benefit(ed) the wetlands" and obtained the necessary authorization to change the land use. This change opened the door to large-scale plans for development along many previously untouched coastal areas. Losses in mangrove-dominated habitats in Baja California Sur have historically been lower than the 65% loss recorded in other states in Mexico (Whitmore et al. 2004), but the repeal of the mangrove protection regulations threatened to accelerate the loss. Development plans for marinas and other tourism facilities as well as expanded aquaculture (shrimp farming) facilities have already begun to impact wetland areas in the Gulf of California and degrade surrounding habitats.

Figure 1. Study Area

Despite the reinstatement of mangrove protection regulations in Mexico, efforts to protect the remaining mangrove habitat along the Sea of Cortez from further degradation are still urgently needed. The fact that there is little baseline information out there about the historic and current extent of these mangroves makes assessment of the scale of the problem challenging. To meet this critical need, NatureServe worked in partnership with Pronatura Noroeste to document changes over a 15 year period (1986-2001) in the extent

of mangrove-dominated habitats along the Gulf of California and Pacific Ocean in the state of Baja California Sur. These maps provide a means to:

- detect change in mangrove habitat due to conversion to other uses from 1986 to 2001;
- serve as a baseline for assessing change in the extent of mangrove-dominated habitats in response to the 2004 law change;
- facilitate detection of future mangrove conversion as imagery becomes available and new regional mapping exercises are completed.

Methods

Our team identified the extent of mangrove-dominated habitats in 1986 and 2001 using Landsat imagery from those two years. A team consisting of staff from Pronatura Noroeste and NatureServe collected on-the-ground data on areas dominated by mangrove via field surveys conducted over a 15 day period from March 12 to March 27, 2007.

Based on the imagery and field data, we attempted to distinguish signatures for communities dominated by black mangrove (*Avicennia germinans*), red mangrove (*Rhizophora mangle*), white mangrove (*Laguncularia racemosa*), or a combination of these species. We focused on image spectral qualities such as redness and adjacency to water to create a spatial representation of mangrove-dominated habitat.

Our analysis involved using the CART (Classification and Regression Tree) tool to model and map the mangrove-dominated community types. This modeling approach is well documented as an accurate and reliable approach for utilizing both imagery and ancillary data sets and has demonstrated a greater degree of accuracy than the use of traditional classifiers (Hansen et al. 1996, Pal and Mather 2003).

Results/Conclusion

Despite heavy development pressure and other human-caused disturbance, the acreage in Baja California Sur with mangrove appears to have increased from 1986 to 2001. The overall **extent** of mangrove-dominated habitat has increased 32% (7,575 Ha) during the 15 year period from 1986 to 2001.

	Overall Total	**Red mangrove**	**White mangrove**	**Black mangrove**	**Mixed mangrove**
1986 Area by Class*	23952	7111	7819	5740	3281
2001 Area by Class*	31527	8539	9653	11797	1538
Change in Area	7575	1428	1834	6057	-1743
Percent Change +/-	32%	20%	23%	106%	-53%

*Note: area is expressed in hectares.

Since we attempted to map mangrove by dominant species (red, white, black, or mixed stands), we can also report out on percent change by type of mangrove. It appears that the most significant increase in mangrove occurred with the black mangrove-dominated stands which increased by 6056 hectares (105% increase) from 1986 to 2001. Much of this increase appeared to occur in the Magdalena Bay region.

Although these results indicate that the **extent** of mangrove habitat in Baja California Sur has increased, they do not provide any information on the overall **condition** of mangrove ecosystems. Mangrove extent was measured by isolating remotely sensed "signatures" that appear to contain mangrove based on the imagery, high levels of field work, and commonly used extrapolation techniques. Our analysis does not provide information on mangrove height or density, factors which indicate the overall condition of a stand.

Summary

The maps developed in this study indicate the "maximum extent" that mangroves occupied at two points in time. These maps display areas of potential mangrove habitat and provide a baseline from which to evaluate future mangrove changes.

We are unsure at this time why the extent of mangrove-dominated habitat has increased in the face of increased development and agricultural pressure on the peninsula from 1986 to 2001. Based on consultations with other researchers in the area, we suspect that climatic and hydrological changes in the region may be the primary reasons of the increase in the extent of mangrove-dominated habitat. The dramatic increases in black mangrove may have been caused by short term climatic shifts favoring the expansion of these plants into new areas. In the Magdalena Bay area, local hydrological changes such as fresh water diversion may have resulted in changes in availability of fresh water, leading to black mangroves outcompeting salt marsh plants. However, we do not have enough information at this time to isolate the exact cause of this change in extent.

Field workers working for this project in 2007 documented through photography several areas on the east coast of the peninsula where large vacation resorts, including golf courses and marinas, are being built on or near mangrove-dominated habitat. Since our latest imagery was from 2001, any recent development was not captured in our analysis.

Figure 2. Road building through mangrove habitat near La Paz (credit: Jon Hak)

These future resorts represent serious threats for these important wetland communities. Even when not placed directly on mangrove habitat, developments such as these can consume and divert key fresh water sources from the mangrove communities, pollute water streams running into mangrove habitats through construction siltation and waste water effluent, and lead to direct mangrove deforestation from support facilities such as boat ramps and trails constructed as part of the resort.

Key Findings

- Mangrove **extent** increased from 23,952 hectares to 31,527 hectares between 1986 to 2001 based on an analysis of existing imagery and ground truthing.
- The 2001 map of mangrove should be considered the "maximum extent" baseline from which to evaluate future changes in extent and condition of mangroves.
- Since 2001, heavy development has occurred in portions of the study area. As a consequence, mangrove condition and extent should be measured by 2010 to ensure that mangroves ecosystems continue to function for the sake of local fisheries and biodiversity.

References

Hansen, M., R. Dubayah and R. DeFries. 1996. Classification trees: an alternative to traditional land cover classifiers. International Journal of Remote Sensing 17(5):1075-81.

Páez-Osuna, Federico, Saúl R. Guerrero-Galván and Ana C. Ruiz-Fernández. 1998**.** The environmental impact of shrimp aquaculture and the coastal pollution in Mexico. Marine Pollution Bulletin. Vol. 36, Issue 1. 65-75

Pal & Mather, 2003 M. Pal and P.M. Mather, An assessment of the effectiveness of decision tree methods for land cover classification, Remote Sensing of Environment 86 (2003), pp. 554–565.

UNEP-WCMC (2006) In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs. UNEP-WCMC, Cambridge, UK 33 pp. EarthSatellite Corp. 2003.

Whitmore, R., R. C. Brusca**,** P. González-Zamoran, R. Mendoza-Salgado, E. S. Amador-Silva, G. Holguin, C. C. McIvor, F. Galván-Magaña, J. A. Seminoff and J. León de la Luz . The Ecological Importance of Mangroves in Baja California Sur: Conservation Implications for an Endangered Ecosystem. In J.-L. E. Cartron and G. Ceballos (eds.) Biodiversity, Ecosystems, and Conservation in Northern Mexico. Oxford University Press. (Summer 2004)