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RHODOLITH/MAERL BEDS AND ROCKY REEFS OF LAGUNA SAN IGNACIO, BAJA CALIFORNIA SUR: 2013 STATUS REPORT

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Objective

Report the status of Rhodolith/Maerl beds and rocky reefs critical to the conservation of biodiversity in coastal wetland Laguna San Ignacio, Baja California Sur.

Specific objectives

• Determine the area covering Rhodolith/Maerl beds in the lagoon and associated species as ecological monitoring baseline.

• Evaluate species composition on rocky reefs as critical habitats for conservation.

Introduction

In recent decades there has been more often the loss and degradation of biodiversity and landscape in many terrestrial and marine environments. Thus, there have been elements that currently favor the management and protection of ecosystems based on new concepts of land use and environmental policy. It is essential to know the biological dynamics of marine environments, allowing us to understand how ecosystems respond to natural and anthropogenic disturbance, and define what action should be taken based on this knowledge.

Laguna San Ignacio is part of the Biosphere Reserve El Vizcaíno, which was created by federal decree over 20 years ago (November 30, 1988), after which it was designated by UNESCO as a World Heritage Site in 1993 (whc. unesco.org). In 1998 Laguna San Ignacio was included in the list of Marine Priority Areas and the list of Priority Hydrological Regions of Mexico (Conabio, USAID, WWF, FMCN, Packard Foundation), owing to the high biodiversity that characterizes this unique coastal ecosystem, and the constant threat that exists for the conservation of its biodiversity (www.conabio.gob.mx). In that same year, the lagoon was listed as an Area of Concern for Bird Conservation (AICA) (Conabio, CIPAMEX, Bird Life International, CCA, FMCN), and on February 2, 2004, Laguna San Ignacio received its latest recognition by being included in the Ramsar List of Wetlands of International Importance (RAMSAR site # 1341) (www.ramsar.org). The Laguna is also the home of some rare and threatened species, and in 2002 was listed on Mexico's list of endangered species in NOM-059-ECOL-2001. Internationally, these species are also listed on the IUCN Red List (www.iucnredlist.org), which is the international list of threatened and endangered species, including: the Brant (*Branta bernicla*), gray whale (*Eschrichtius robustus*) and the black turtle (*Chelonia mydas*).

The main threats to biodiversity in Laguna San Ignacio are overfishing, the use of fishing gear and practices that damage the seabed, inadequate management of waste and the sale or lease of land to individuals interested in creating coastal developments that do not take into account the preservation of ecological balance (e.g., nautical ladder, solar salt productiion). There is still a chance to preserve biodiversity and ecosystem processes in Laguna San Ignacio, but this window will not remain open for long, since the potential for coastal development which tends to favor a few investors represents a potential threat to biodiversity and local economic activities (e.g., ecotourism, fishing and aquaculture). In fact, there are several non-governmental agencies (PRONATURA, TNC, SFS, WiLDCOAST) that are currently making efforts to protect the Laguna San Ignacio costal wetland complex by developing a management plan which has been in operation since 2000 (www.wildcoast.net). It is necessary to revise and extend this management plan and strengthen it with a better understanding of critical habitats that are part of Laguna San Ignacio, including Rhodolith/Maerl beds and rocky reefs, which are not currently included in the management plan.

In the lagoon there are different relevant habitats for conservation: Rhodolith/Maerl beds[1], rocky reefs, seaweed sheets, mangrove estuaries, and intertidal stands of marsh and

[1] Rhodolith/Maerl beds are free living forms of dense aggregations of non-geniculate coralline red algae (Corallinophycideae: Rhodophyta) that can cover kilometers of seabed.

seagrass beds. Developing appropriate conservation strategies requires the identification of critical areas that are sensitive to human and environmental disturbance. This is the case for Rhodolith/Maerl beds and rocky reefs within Laguna San Ignacio. This report provides an assessment of the presence of rocky reefs and Rhodolith/Maerl beds in Laguna San Ignacio. These findings will be provided to the Biosphere Reserve El Vizcaino to contribute to the improvement of its management plan. However, measures to ensure the conservation of seagrasses should also include an increased level of community awareness about the importance of these habitats, and the role they play not only for the economy and biodiversity at the regional level, but also their contribution to the reduction of greenhouse gases from the atmosphere, and the slowing of global warming and ocean acidification.

Materials and methods

Assessments of the distribution of Rhodolith/Maerl beds for Laguna San Ignacio were made in 1998, and updated in 2011 and 2012. We use a methodology similar to that described by Riosmena-Rodriguez et. al. (2012) in which assessments are developed from GPS coordinates in relation to visual inspection and species confirmation by SCUBA divers within a bathymetric range of 0-10 m. This information provides a geographic profile of the distribution and, from collected specimens, species that form the Rhodolith/Maerl beds and associated flora according to the methodology proposed by Steller et al (2007).

Assessments of the presence and absence of rocky areas were developed in 2010-2012 by visiting mainly intertidal areas on the east coast of the lagoon (Fig. 1). These assessments are consistent and comparable with previous studies for the area (Nuñez-Lopez 1996, Nuñez-Lopez and Casas-Valdez, 1998a, 1998b; Riosmena-Rodríguez 1999). The findings of these previous studies were used to evaluate and compare the species richness in the lagoon, and included comparison with Herbarium collections that were deposited in the Herbarium of the UABCS phycological center since 1985. Species taxonomy was updated using the standards presented in AlgaeBase (www.algaebase.org). Comparisons of species diversity and richness were made with other information sources, including: Devinny (1978) and Aguilar-Rosas (1982) for Punta Banda; Aguilar-Rosas et al (2005) for San Quintin; Eagle-Ramirez et al (2000) for Lagua Ojo de Liebre (Scammon's lagoon); and Sánchez-Rodríguez et al. (1991) for Bahia Magdalena.

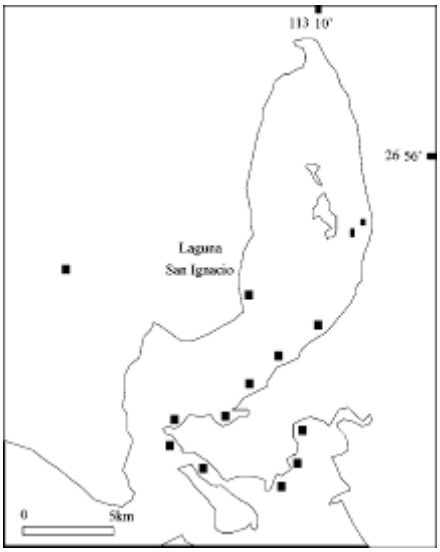

Fig.1 Localities historically visited (1993-2013) to assess species richness in rocky and sandy areas of Laguna San Ignacio.

Results

Field studies and surveys in October 2012 and March 2013 determined a total area of 378 hectares of Rhodolith/Maerl beds located in the northern portion of Laguna San Ignacio around the Islas Pelecaino and Garzas (Fig. 2). During this period we spoke with at least 30 fishermen who identified areas where Rhodoliths are commonly found. Local fishermen give these areas the name "Pope," and they are frequently associated with the presence of bay scallops and clams. These beds are comprised of a “fruticose” growth form (Fig. 3) which is associated with an algae species of the genus *Colpomenia* which had not previously reported from the lagoon, and other varied sessile organisms (Fig. 3).

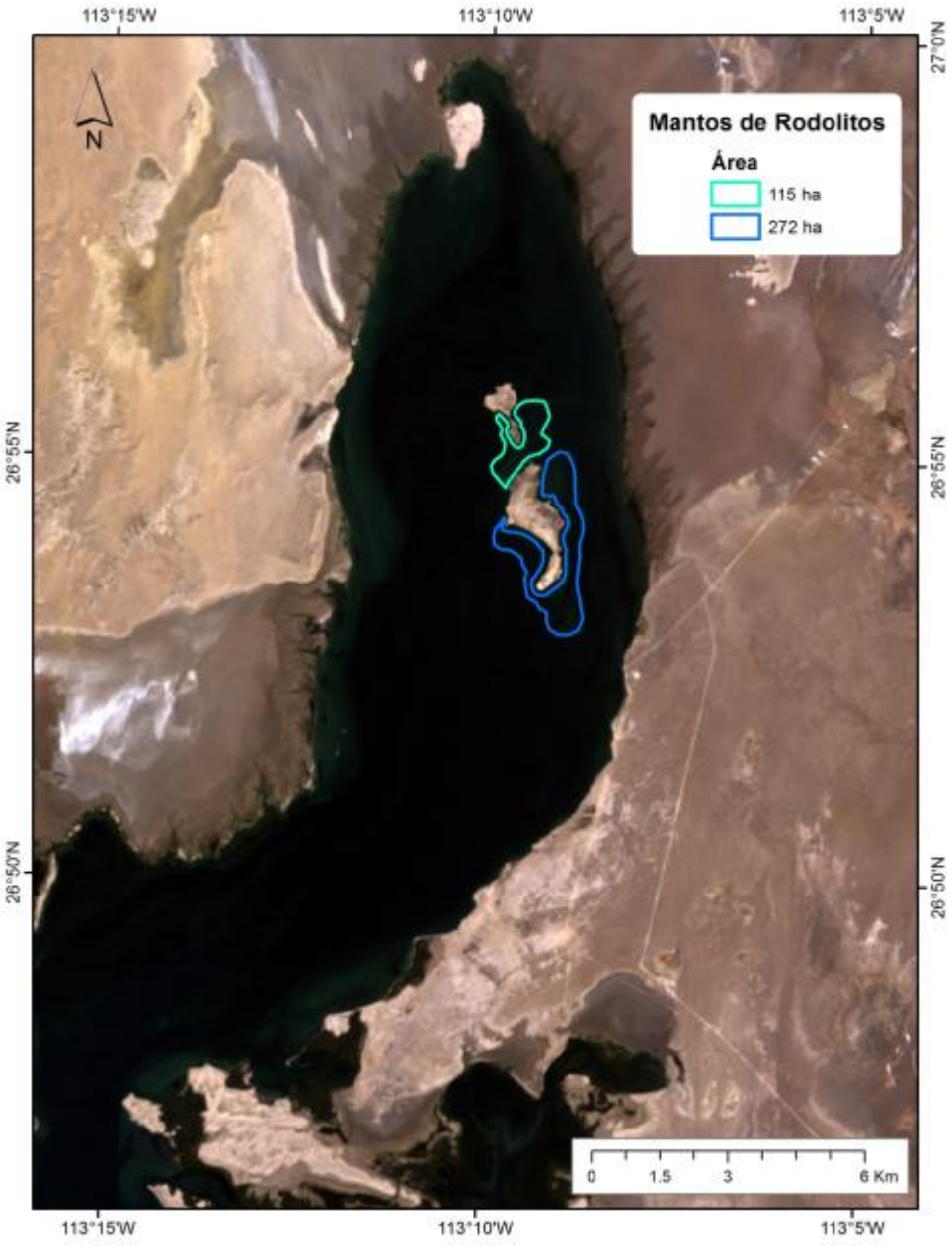

Fig. 2. Areas investigated to document the distribution and density of Rhodolith/Maerl beds in Laguna San Ignacio.

Fig. 3. Biodiversity associated with Rhodolith/Maerl banks where Rhodolith/Maerl forming fruticose plants (top right), species of the genus *Colpomenia* had not been determined before (left) and fauna (below right).

During surveys conducted in March 2013 intertidal stands of *Spartina foliosa* were observed. Additionally, massive proliferations of *Hincksia sp.* were found covering virtually all shallow zones (1-5 m), and were also present in intertidal areas with *Sargassum muticum*, *Gracilariopsis sp.*, and *Halymenia sp*. (Fig. 4). We also observed a strong reduction of seagrass in the southern portion of the lagoon nearest the entrance, along the east coast of the lagoon, and the areas around the islands in the northern portion of the lagoon.

The rocky areas examined during the period 2010-2012 revealed a decrease not only in the presence but also a decrease of the biomass of marine plants and macroalgae (Fig. 5). We also observed patches of the invasive algae *Sargassum muticum*, and large dense areas of this species in the shallow areas (Fig. 5). Comparison with the list of marine plant species observed in 1998, it was evident that there has been a significant reduction of 50% of the species of flora, from 84 species in 1998 to 42 species in 2010-2012 (Table 1). These observations suggest that some process is occurring within Laguna San Ignacio which has promoted a drastic reduction in the diversity and density of the native flora, and an increase in some invasive species (e.g., *Sargassum muticum*) in some areas.

Fig. 4. Marine algae and plants in the sandy banks of Laguna San Ignacio: top left banks of *Spartina foliosa*, top right: dead *Hincksia* sp.and *Ulva intestinalis*, Bottom left: subtidal *Sargassum muticum* with *Halymenia sp*., Bottom right: *Gracilariopsis sp*. on subtidal banks.

Fig. 5. Detail of the rocky area on the east coast of the lagoon (above) which shows the absence of common species in the area, bottom left the invasive algae *Sargassum muticum* which is now a common element in the area along with *Hincksia sp.* (right).

Table I. Comparison of the marine flora of Laguna San Ignacio BCS between sampling events in 1998 and in the period 2010-2012.

Especies	1998	2010-2012
Acetabularia calyculus	1	0
Acrosorium venulosum	1	1
Amphiroa beauvoisii	1	1
Centroceras clavulatum	1	1
Ceramium caudatum	1	0
Ceramium flaccidum	1	1
Ceramium serpens	1	0
Ceramium sp	1	0
Chaetomorpha californica	1	0
Chaetomorpha linum	1	1
Chondracanthus canaliculatus	1	0
Chondria dasyphylla	1	1
Chroodactylon ornatum	1	0
Cladophora albida	1	1
Cladophora graminea	1	1
Cladophora microcladioides	1	1
Cladophora sericea	1	0
Codium simulans	1	1
Codium amplivesiculatum	1	1
Colpomenia sinuosa	1	1
Colpomenia tuberculata	1	1
Corallina frondensis	1	0
Cryptopleura sp	1	0
Dasya baillouviana	1	0
Dictyota flabellata	1	1
Ectocarpus commensalis	1	1
Gelidium pusillum	1	1
Gracilaria marcialana	1	0
Gracilaria pacifica	1	1
Gracilaria sp		1
Gracilaria subsecundata	1	0
Gracilaria textorii var. cunninghamii	1	0
Gracilariopsis lemaneiformis	1	1
Grateloupia versicolor	1	0
Herposiphonia secunda f. tenella	1	0
Herposiphonia sp	1	0
Spongites decipiens	1	0
Hypnea valentiae	1	1
Hypoglossum attenuatum var. abyssicola	1	1
Jania adhaerens	1	1
Jania sp	1	1
Kornmannia leptoderma	1	0

Laurencia gardnerii	1	0
Laurencia hancockii	1	0
Laurencia lajolla	1	0
Laurencia masonii	1	0
Laurencia pacifica	1	0
Osmundea sinicola	1	0
Laurencia snyderie	1	0
Laurencia sp	1	0
Leptofauchea pacifica	1	0
Neogoniolithon setchellii	1	1
Neogoniolithon sp	1	1
Dictyota coriacea	1	1
Padina crispata	1	1
Padina durvillei	1	1
Peyssonnellia rubra var. orientalis	1	0
Plocamium sp	1	0
Polysiphonia flaccidissima	1	0
Polysiphonia johnstonii var. johnstonii	1	1
Polysiphonia mollis	1	0
Polysiphonia pacifica	1	1
Neosiphonia simplex	1	0
Polysiphonia sp	1	0
Pterocladiella caloglossoides	1	1
Pterosiphonia dendroidea	1	0
Ralfsia confusa	1	1
Rhizoclonium riparium	1	1
Rosenvingea intricata	1	1
Sargassum agardhianum	1	0
Sargassum sinicola	1	0
Sphacelaria californica	1	1
Spyridia filamentosa	1	1
Tiffaniella saccorhiza	1	0
Ulva californica	1	0
Ulva dactylifera	1	0
Ulva lactuca	1	1
Ulva lobata	1	1
Ulva clathrata	1	1
Ulva compressa	1	0
Ulva flexuosa	1	0
Ulva intestinalis	1	1
Ulva prolifera	1	0
Ulva clathrata	1	1
Ulva rigida	1	1
Total de especies	84	42

Discussion

Our observations indicate that Rhodolith/Maerl banks are present in Laguna San Ignacioits and their size is considerably greater than that observed in Bahia Magdalena (Avila et. al. 2010), but with fewer morphological variants and a need to determine the number Rhodolith/Maerl-forming species that actually occur in Laguna San Ignacio. Clearly the Pacific coast of Baja California supports significant Rhodolith/Maerl banks (Robinson and Riosmena unpublished data), but in much lower densities than are found in the Gulf of California (Riosmena et. al. 2012; Hinojosa-Arango et. al. *in press*). The assessment of the associated flora in this study is the first step in developing a comprehensive evaluation of the marine flora in Laguna San Ignacio, and a complete evaluation will require additional sampling effort. The observations of *Spartina foliosa* blooms have been documented in other areas (Echevarria-Heras et. al., 2007), but the presence of *Hincksia sp.* requires further evaluation.

The significant decrease in the flora in rocky areas observed in Laguna San Ignacio requires a more detailed evaluation (Table 2). Coastal lagoons that have been examined present different physiographic and sedimentary characteristics, and the floristic composition varies between the more northern and southern areas. This is contradictory to what could be considered with respect to San Ignacio, owing to the position of its entrance to the Pacific. The composition of marine flora within these systems is not consistent, with the distribution of the species and their biomass varying among locations and depths, and depending on physical conditions species distributions will vary (Nuñez-Lopez, 1996; Aguila-Ramirez, 1998). Research has demonstrated that banks of sub-tidal algal and seagrass pastures are very changeable (Vergara2006, Lopez-Calderon 2012), and these may have influence on marine food webs involving many species (López-Calderón et al 2010). Due to the important ecological function of these marine plants to coastal areas, monitoring of dynamic changes in the abundance and distribution of marine plant communities may be good indicators of changing conditions within Laguna San Ignacio. In particular, the preponderance of the invasive species *Sargassum muticum* which is widely present in areas within north of Laguna San Ignacio, and within Laguna San Ignacio, appears to be evidence of disturbance of the seabeds of these areas. It will require more effort to evaluate and to understand whether there are, and to what extent, increases of this invasive species impact the native flora and fauna of Laguna San Ignacio.

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Table II. Comparative analysis of species richness of macroalgae and seagrasses for larger coastal lagoons of the Pacific Coast of Baja California. ND = No data.

Lagoon/year	Before 2000	After 2000
Punta Banda[1]	26	ND
San Quintin[2]	36	46
Ojo de Liebre[3]	73	ND
San Ignacio[4]	84	42
Bahía Magdalena [5]	98	ND

[1]Aguilar-Rosas et al (2005); 2Aquilar-Rosas (1982); 3Aguila-Ramírez et al (2000); 4 Este estudio; 5 Sánchez-Rodríguez et al (1999).

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