GALAPAGOS REPORT 2011-2012

MARINE MANAGEMENT

SPECIES, COMMUNITIES AND ECOSYSTEMS: THE ROLE OF SCIENCE IN THE CONSERVATION AND MANAGEMENT OF THE GALAPAGOS MARINE RESERVE

SOLEDAD LUNA, STUART BANKS, VOLKER KOCH, DIEGO RUIZ, NATALIA TIRADO, MARIANA VERA, ANNA SCHUHBAUER, INTI KEITH, DAVID ACUÑA, JENNIFER SUÁREZ, MACARENA PARRA, GUSTAVO JIMÉNEZ, CAROLINA GARCÍA, JORGE BAQUE AND JULIO DELGADO

How to cite this document
GNPS, GCREG, CDF, and GC. 2013. Galapagos Report 2011-2012. Puerto Ayora, Galapagos, Ecuador.

How to cite this article
Luna S, S Banks, V Koch, D Ruiz, N Tirado, M Vera, A Schuhbauer, I Keith, D Acuña, J Suárez, M Parra, G Jiménez, C García, J Baque and J Delgado. 2013. Species, communities and ecosystems: The role of science in the conservation and management of the Galapagos Marine Reserve. Pp. 131-135. In: Galapagos Report 2011-2012. GNPS, GCREG, CDF and GC. Puerto Ayora, Galapagos, Ecuador.

*The **Galapagos National Park Service** has its headquarters in Puerto Ayora, Santa Cruz Island, Galapagos and is the Ecuadorian governmental institution responsible for the administration and management of the protected areas of Galapagos.*

*The **Governing Council of Galapagos** has its headquarters in Puerto Baquerizo Moreno, San Cristóbal Island, and is the Ecuadorian governmental institution responsible for planning and the administration of the province.*

*The **Charles Darwin Foundation**, an international non-profit organization registered in Belgium, operates the Charles Darwin Research Station in Puerto Ayora, Santa Cruz Island, Galapagos.*

***Galapagos Conservancy**, based in Fairfax, Virginia USA, is the only US non-profit organization focused exclusively on the long-term protection of the Galapagos Archipelago.*

Photograph: Janet Laing

Species, communities and ecosystems: The role of science in the conservation and management of the Galapagos Marine Reserve

Soledad Luna, Stuart Banks, Volker Koch, Diego Ruiz, Natalia Tirado, Mariana Vera, Anna Schuhbauer, Inti Keith, David Acuña, Jennifer Suárez, Macarena Parra, Gustavo Jiménez, Carolina García, Jorge Baque and Julio Delgado

Charles Darwin Foundation

The Galapagos Marine Reserve: its nature and management

The complex climatic and oceanographic conditions of Galapagos allow for the presence of a mixture of tropical and temperate species, ecosystems and communities. The Islands are primarily influenced by their volcanic origin, the confluence of the tropical Panama Current from the northeast, the temperate Peru Current from the southeast, and the upwelling of the subsurface Equatorial Counter Current from the west. The multi-use, participatory and adaptive management model used in Galapagos has generated globally significant contributions on how to integrate scientific research and local social dynamics with effective conservation management activities in ways that benefit the human population. In this sense, the Galapagos Marine Reserve (GMR) is an invaluable resource for knowledge, education and understanding of how to live sustainably in our natural environment (SENPLADES, 2009).

An initial characterization: the baseline

The first step in understanding the natural dynamics of marine ecosystems and the effects of their use is to create a baseline that encompasses: 1) the heterogeneity of the marine communities depending on the biogeographic region of the archipelago (Harris, 1969; Jennings *et al.*, 1994; Edgar *et al.*, 2004), and 2) changes within and outside extraction and protected zones, both before and after their establishment (Banks *et al.*, 2012). The first consideration is useful for identifying sites that are representative of the large-scale dynamics of the GMR. The second measures the effects of El Niño Southern Oscillation (ENSO) events, climate change and the intensity of human use of marine environments under different uses.

Between 1994 and 1999 a standardized monitoring methodology for mobile macroinvertebrates, benthic organisms, algae and demersal fish was tested and then implemented. Since 1999, when it was agreed to zone the coastal area of the GMR, a series of studies in subtidal zones near the coast were carried out as part of the establishment of the systematization of the Biodiversity Baseline, a benchmark for subsequent biological studies (Danulat & Edgar, 2002). Between 2004 and 2007, the Galapagos National Park Service (GNPS) and the Charles Darwin Foundation (CDF) collected baseline oceanographic information and built a model for Galapagos that helps to better understand the influence of the upwelling of the subsurface Equatorial Counter Current and can be used to compare and extrapolate global climate change models.

Natural processes have been studied at various temporal and spatial scales to support and inform GNPS management and conservation activities. For example, studies of marine communities at specific sites have increased understanding of the dynamics of seasonal and annual ecological processes and have resulted in an adjustment of management methodologies. Moreover, long-term monitoring of marine communities around the archipelago provides useful information for planning and evaluating effectiveness of management measures, and reviewing zoning at the archipelago level as well as for biogeographic regions, individual islands, and fishing, tourism or study sites (Figure 1).

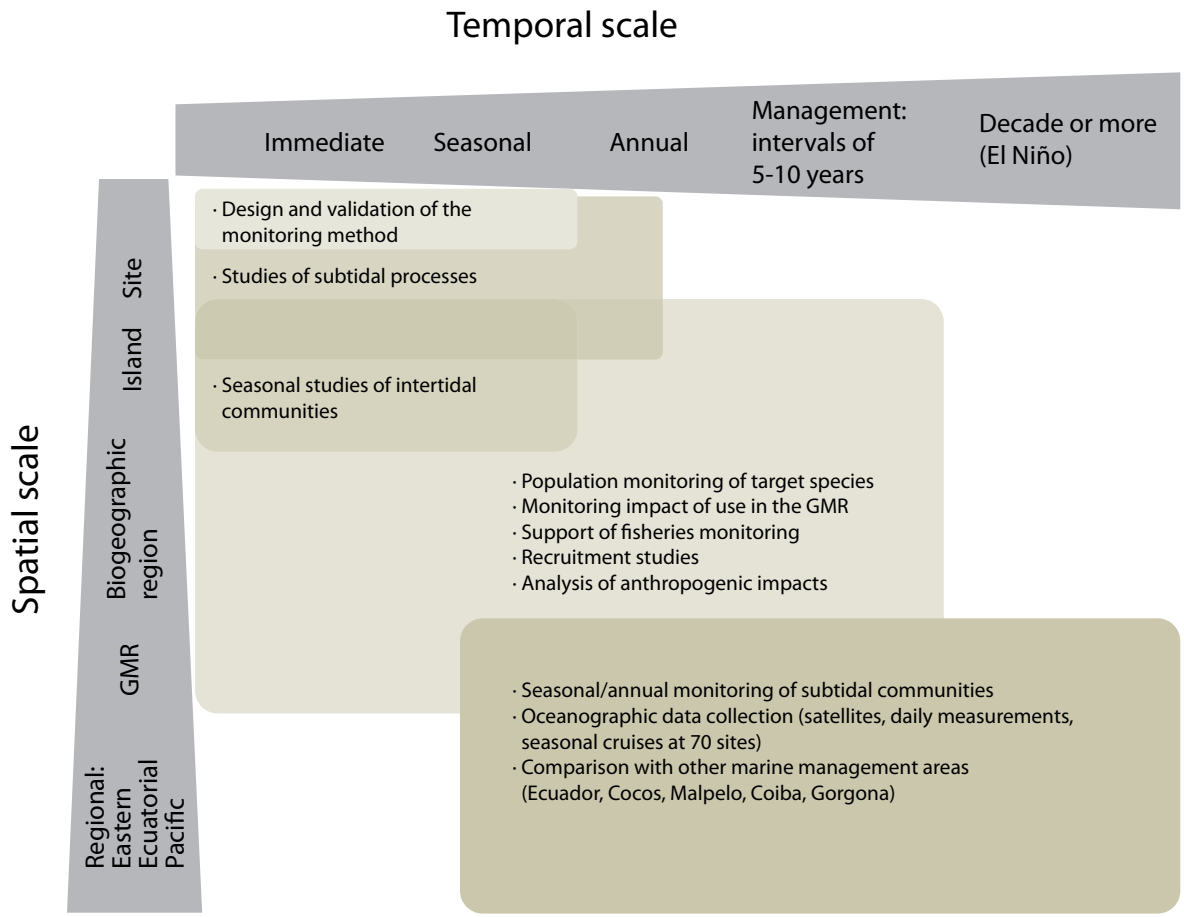

Figure 1. Spatial and temporal scale of the contribution of science conducted in the GMR (Banks *et al.*, 2012).

Monitoring to detect changes

Monitoring data show the status of marine communities and the effect that management measures, zoning and climate events such as El Niño have on these communities. In the case of Galapagos cod (*Mycteroperca olfax*), monitoring has shown that in the central and southern regions of the archipelago cod are found in higher quantities in protected zones compared to fishing zones (Banks *et al.*, 2012). In all the sites monitored, the top trophic groups, such as sharks, have higher biomass in areas where only non-extractive activities are allowed.

Monitoring has identified coastal marine "refuges" that have a narrower range of temperature changes due to the distribution patterns of ocean currents. Populations and communities living in these areas are less affected and recover more quickly after events such as El Niño (Banks *et al.*, 2012). One of these sites is Playa Tortuga Negra on Isabela, where the only healthy populations of Wellington coral (*Rhizopsammia wellingtoni*) and the endemic coral *Tubastrea taguensis*, both of which were previously widely distributed in the archipelago, are found (Figure 2). Galapagos kelp (*Eisenia galapagensis*), a recently discovered deep-water macroalgae that is listed as threatened by the International Union for Conservation of Nature (IUCN), is only found to the west of Isabela and Fernandina. The populations that are surviving in these refuges can help to repopulate surrounding areas or affected species.

Relevance of science: contributions to management

Basic research provides practical, cultural, educational and economic benefits to the general population and helps in understanding natural phenomena and their impacts in an objective manner. In the GMR, both the creation of the baseline and the subsequent monitoring have helped in the establishment of management measures to ensure

Figure 2. Galapagos focal species cataloged in the IUCN Red List (left to right): Galapagos Penguin (*Spheniscus mendiculus*) is listed as endangered, while the endemic coral *Tubastrea taguensis* and endemic kelp (*Eisenia galapagensis*) are both listed as critically endangered.

that resources are maintained and that we can continue to enjoy their benefits. Recent examples include:

- Installation of low impact mooring sites in fragmented coral communities that are at high risk.
- Contributions to the national Biological Diversity Agreement and to the list of island biodiversity through the generation and dissemination of relevant information.
- Predictions of the impact of fisheries and management measures through trophic models of rocky reefs and upwelling zones.
- Inclusion in the IUCN Red List of sensitive species of algae and corals that create habitat, which is a milestone for their protection.
- Risk and resilience analyses of populations, communities and habitats confronted with overfishing or climate change.
- Distribution models for fragile species to help reduce the impact and adjust the itineraries of tour boats.
- Support for the evaluation of the effectiveness of zoning and planning through annual monitoring.

A key to achieving conservation at the local level is to promote and maintain joint management actions that are coordinated among a broad network of marine areas that influence and are influenced by Galapagos. For example, several species have long life cycles, use various types of habitat, and some, such as plankton, are even able to travel several hundred kilometers. Because of this, and in order to be able to compare the characterization and quantification of changes in the marine protected areas of the Tropical Eastern Pacific (Figure 3), protocols for subtidal monitoring have been implemented in Malpelo (Colombia), Cocos Island (Costa Rica), Coiba (Panama) and Machalilla (continental Ecuador). The data and lessons learned have also served for an overall evaluation of the effectiveness of management in several protected marine areas worldwide: United States, Panama, Belize, Brazil, Fiji and the Solomon Islands.

Current and future challenges

The main challenge for marine research in Galapagos involves promoting, strengthening and maintaining inter-institutional projects that include all stakeholders of the GMR. Specifically, it requires improving links between experts and the network of decision-makers, creating a coalition of organizations that carry out long-term monitoring, and establishing systems for collaboration with students and national and international universities. Lastly, we wish to highlight the key role that government agencies play in coordinating information and knowledge management and ensuring its accessibility to decision-makers and the general public.

Recommendations

The species, communities and ecosystems of the GMR require continuous monitoring and study. Only through monitoring is it possible to measure the impact of climatic variations, evaluate the effectiveness of management measures, improve the food supply, and avoid human activities that negatively impact the resilience of ecosystems. We need coordination, communication and continuity to build on the foundations that have been laid. Specifically, we recommend continuing and strengthening the following areas of research:

- **Baseline and inventory of species.** These studies are required to fill information gaps and to assess the impact of climate change and management adjustments over time. The subtidal ecological monitoring, ongoing since 2004 in more than 60 sites around the islands, should be continued. The installation of a long-term monitoring system (oceanographic, population dynamics, type and intensity of use, etc.) with multiple players should be supported.

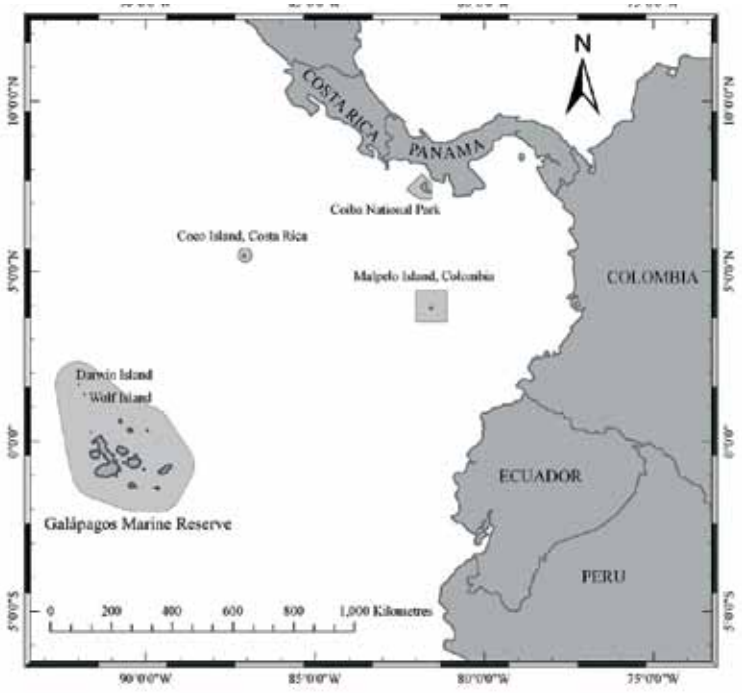

Figure 3. Protected marine areas of the Tropical Eastern Pacific region (shaded areas). Source: Banks *et al.*, 2009.

- **Population dynamics.** Monitoring and research related to population dynamics, life history and ecology of resource species, as well as socioeconomic factors important for commercial and recreational fisheries provide stakeholders with the scientific data needed for managing marine resources. Special emphasis should be placed on sea cucumbers (*Stichopus fuscus*), lobster (*Panulirus penicillatus* and *P. gracilis*), slipper lobster (*Scyllarides astori*) and Galapagos cod (*Mycteroperca olfax*), which is an endemic species considered vulnerable by IUCN. The evaluation of population and life cycles of migratory species with high commercial value such as wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*) should be continued to provide input to the design of open water zoning and fishing regulations. Additionally, an analysis of the ecological and socioeconomic impacts of recreational fishing as an alternative income for the fishing community should be conducted.

- **Priority marine species.** There are a number of Galapagos marine species that are of higher priority in terms of research. We recommend:

  1. Continued research on the ecology of priority conservation species, such as those found on the IUCN Red List, endemic species, ecologically important species, those with high tourism value and those that comprise the World Heritage of "biodiversity," such as sharks, the sunfish or mola mola, penguins, cormorants, albatross, lava gulls, petrels, marine iguanas and sea turtles.

  2. Continued studies that provide greater understanding of the inter-connectivity and identification of species and populations at risk due to their low genetic diversity.

  3. Establishment of a surveillance and monitoring program of the health status and threats to vulnerable marine species such as sea lions, fur seals, sea turtles, seabirds, marine iguanas and cetaceans, to assess risks, develop rapid response protocols, design and implement sampling methodologies, and implement strategies that will contribute to the conservation and management of the GMR.

- **Invasive marine species.** Research on invasive marine species seeks to minimize the negative impacts of these species on the marine biodiversity, ecosystem services and health of the GMR. The first step is to collect and produce basic information, followed by the implementation of monitoring and early warning systems primarily in the ports of the islands. We recommend supporting studies on the distribution, abundance and interactions of introduced species, and analysis of the risks based on the dispersal capabilities and habitat requirements of potential invasive species as determined by ocean circulation models. Special emphasis should be placed on training for GMR users, the general public and authorities, as well as the dissemination of information about threats, impacts and preventative measures.

- **Interpretation of science.** The interpretation of scientific information and its effective communication

to decision-makers and stakeholders in the GMR represent a major challenge. This effort requires a constant exchange of knowledge between the different user groups and authorities of the GMR. It is recommended that each sector designate a person or group to maintain communication, interpretation, understanding and use of science related to the reserve, as well as work to stimulate interest within their sector. The goal is to generate more knowledge, awareness and acceptance of science as critical information that is useful in solving conservation problems and clarifying misconceptions.

References

Banks S, R Bustamante, D Ruiz, N Tirado, M Vera & F Smith. 2012. The power of long-term monitoring to understand mechanisms of ecosystem change. *In*: The role of Science for Conservation (M Wolff & M Gardner, eds.). Pp. 143-164. Routledge, Oxon, UK.

Banks S, M Vera & A Chiriboga. 2009. Establishing reference points to assess long-term change in Zooxanthellate coral communities of the northern Galapagos coral reefs. Galapagos Research 66:43-66.

Danulat E & GJ Edgar (eds). 2002. Reserva Marina de Galápagos: Línea Base de la Biodiversidad. Pp 10-21. Charles Darwin Foundation & Galapagos National Park Service, Galapagos, Ecuador.

Edgar GJ, RH Bustamante, JM Fariña, M Calvopiña, C Martínez & MV Toral-Granda. 2004. Bias in evaluating the effects of marine protected areas: The importance of baseline data for the Galapagos Marine Reserve. Environmental Conservation 31(3):212-218.

Harris MP. 1969. Breeding seasons of sea-birds in the Galápagos Islands. Journal of Zoology (London) 159:145-165.

Jennings S, AS Brierley & JW Walker. 1994. The inshore fish assemblages of the Galapagos Archipelago. Biological Conservation 70:49-57.

SENPLADES. 2009. Plan Nacional para el Buen Vivir 2009-2013: Construyendo un Estado Plurinacional e Intercultural. Republic of Ecuador.