

# Marxan as a Key Conservation Tool to Support the Management Plan of the New Puerto Rico Marine Corridor of the Northeast

## Marxan como Herramienta Clave Para Apoyar el Plan de Manejo del Nuevo Corredor Marino del Noreste en Puerto Rico

### Marxan: Un Outil Clé pour Porter le Plan de Gestion du Nouveau Corridor Marin du Nordest au Puerto Rico

DANIEL MATEOS-MOLINA<sup>1,2,\*</sup>, DAN DORFMAN<sup>3,4</sup>, CHRISTOPHER F.G. JEFFREY<sup>3,4</sup>, CHARLES MENZA<sup>3</sup>, SIMÓN J. PITTMAN<sup>3</sup>, ANTARES RAMOS-ALVAREZ<sup>3,6</sup>, ANGELA ORTHMEYER<sup>3</sup>, and GUSTAV KAGESTEN<sup>3</sup>  
<sup>1,\*</sup> *Departamento de Ecología e Hidrología, Universidad de Murcia, Campus de Espinardo, 30100 Murcia, Spain.*

*\*dmateos5@gmail.com.*

<sup>2</sup> *UBICA s.r.l., Via S. Siro 6/1, I-16124 Genova, Italy.*

<sup>3</sup> *NOAA, National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment, Biogeography Branch, 1305 East-West Highway, Silver Spring, Maryland 20910 USA.*

<sup>4</sup> *CSS-Dynamac, 10301 Democracy Lane, Suite 300 Fairfax, Virginia 22030 USA.*

<sup>5</sup> *NOAA Coral Reef Conservation Program, 654 Muñoz Rivera. Ave Suite 604, San Juan, Puerto Rico 00918.*

<sup>6</sup> *Department of Zoology, University of Oxford, England*

#### ABSTRACT

Marxan is the most widely used software in conservation planning around the world providing spatially explicit decision support for a range of conservation planning problems. This systematic conservation approach provides objective, transparent and repeatable results that allow spatial visualizations of areas being considered conservation and facilitates the negotiation process with stakeholders. This case study describes the process followed to identify major ecological important areas and define a network of marine priorities areas in order to minimize the main threats affecting the new Puerto Rico Marine Corridor of the Northeast. Our conservation objectives included the representation of endangered and vulnerable species and habitats. Data collected in the area from different regional and federal agencies and academic institutions was incorporated and analyzed following expert-defined criteria. In order to achieve feasible and efficient conservation outcomes, a detailed analysis of multiple threats and stressors was also incorporated. Scenarios were mapped showing networks of priority areas and biodiversity hotspots based on a range of different conservation targets. These scenarios will guide resource managers tasked with developing an integrated management plan for the Marine Corridor of The Northeast.

KEY WORDS: Marxan, conservation planning, stressors, Puerto Rico

#### INTRODUCTION

Marxan is a conservation planning software created by researchers at the University of Queensland (Ball and Possingham, 2000; Possingham et al., 2000). This software has been widely used around the world thanks to its flexibility and efficiency. Marxan provides decision support to a range of conservation planning problems, including: design of efficient protected areas for the conservation of marine resources and the identification of ecological important areas. This systematic conservation approach is considered as the “best practice” because of the transparency, inclusive, defensible and repetitive results allowing spatial visualizations of areas considered for conservation on a clearly defined problem that facilitates the negotiation process with stakeholders.

Marxan uses site selection algorithms to achieve conservation target goals in a spatially efficient manner with minimum costs (ie., area, threats,...). However, the use of site selection algorithms to identify priority conservation sites must not replace the need to engage local ecological knowledge from local experts and resource users.

This study explored the potential scenarios for a network of marine priorities areas minimizing the main threats affecting the new Puerto Rico Marine Corridor of the Northeast, and additionally, identified ecological important areas in the region.

#### MATERIAL AND METHODS

##### Study Area

The new Puerto Rico Marine Corridor of the Northeast (PRMCN) includes five natural reserves due to the high value of its natural resources. This area has recently been recognized as part of a Habitat Blueprint focus area for NOAA which will promote conservation projects to protect and restore coastal habitats, and management by motoring, research, and educational programs. The area includes important natural resources such as a bioluminescent bay, species of corals identified as threatened or endangered under the Endangered Species Act (ESA), and sea turtle nesting areas.

##### Planning Units

The planning area was divided into 0.2 km<sup>2</sup> hexagonal planning units resulting in a total of 22,400 units. The 0.2 km<sup>2</sup> planning unit size was selected to provide fine enough detail to resolve habitat within coastal features (especially within bays and estuaries) but not exceeding the resolution of the habitat data.

**Conservation Features**

Data was collected from different regional and federal agencies and academic institutions. Expert review workshops were held throughout the data analysis process and helped to set the targets and priorities. A set of conservation targets was used in the analysis (Table 1).

**Table 1:** List of conservation features used in the study.

Benthic habitats and species	Species
Coral cover > 50%	Spawning aggregation of commercial fishes (31 species)
Coral cover > 10%	Manatee hotspots
Hardbottom habitat	Conch areas
High topographic complexity	Sea Turtle hotspots (3 species)
Seagrass	Sea Turtle nesting areas (3 species)
Shelf edge	Mangrove areas
Shelf edge reef	Bird breeding
Submarine canyon	Bird hotspots
Mangrove	<i>Acropora palmate</i> <i>Acropora cervicornis</i> <i>Agaricia lamarky</i> <i>Dendrogyra cylindrus</i> <i>Dichocoenia stokes</i> <i>Mycetophyllia ferox</i> <i>Montastrea annularis</i> <i>Montastrea faveolata</i> <i>Montastrea franksy</i> <i>Montastrea cavernosa</i>

In order to achieve feasible and efficient conservation outcomes, a detailed analysis of multiple threats and stressors was also incorporated as the cost of planning units selected. The analyzed threats were vessel damage, coastal infrastructure, light pollution, coral bleaching, marine-based pollution, agricultural pollution, urban pollution and coastal population.

**RESULTS AND DISCUSSION**

Preliminary scenarios were mapped showing a network of priority areas and ecologically important areas based on a range of different conservation targets. Scenario 1 (Figure 1) shows a network of priority areas selected by Marxan setting the software with 4four “lock in” conservation features:

- i) nesting sea turtle areas,
- ii) bioluminescent bay area,
- iii) endangered and threatened species of corals, and
- iv) fish spawning aggregation areas.

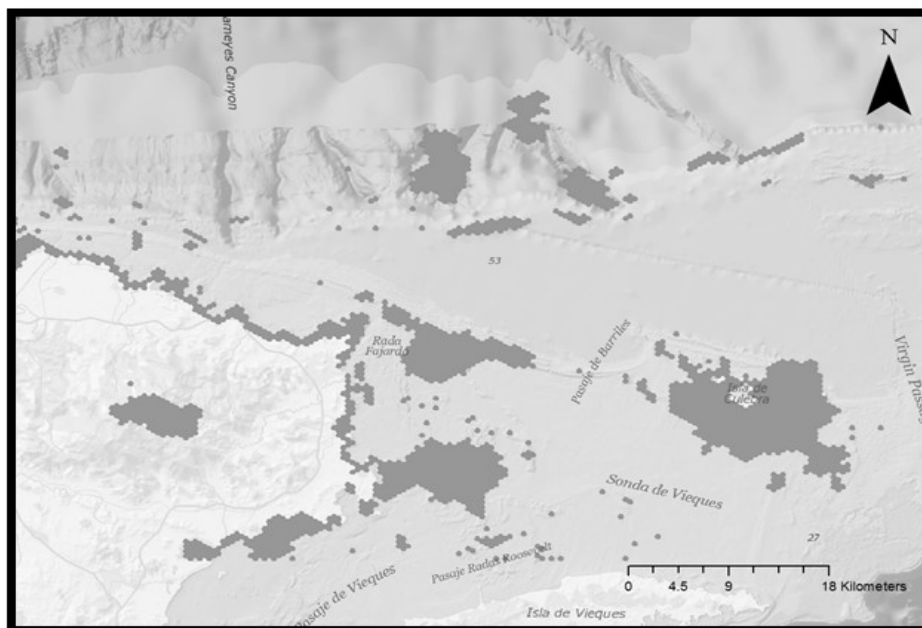
These scenarios will guide resource managers tasked with developing an integrated management plan for the Marine Corridor of the Northeast.

**ACKNOWLEDGEMENTS**

The present study was supported by NOAA Coral Reef Conservation program. We would like to thank the collaboration of the Puerto Rico Department of Natural Resources and MMMPA - Training Network for Monitoring Mediterranean Marine Protected Areas, which has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no. 290056.

**LITERATURE CITED**

Ball I, Possingham H. 2000. MARXAN (V1.8.2): *Marine Reserve Design Using Spatially Explicit Annealing, A Manual*. The Ecology Centre, University of Queensland: Brisbane, Australia.  
 Possingham H.P., I.R. Ball, and S. Andelman. 2000. Mathematical methods for identifying representative reserve networks. Pages 291 - 305 in: S. Ferson and M. Burgman (eds.) *Quantitative Methods for Conservation Biology*. Springer-Verlag, New York, New York USA.



**Figure 1.** Scenario 1 provides a preliminary result of a potential network of priority areas.