

WP 2 – Activity 2.2.

DELIVERABLE 2.2.1

MARITIME SPATIAL PLANNING TOOLBOX

WP2	Joint development of the transnational strategy for long-term coexistence	
Activity 2.2	Organization of a mutual Learning Transnational event on Maritime Spatial Planning framework	
D.2.1.1	Maritime Spatial Planning toolbox	
Version	Date	20 th of February 2026
Description of the Deliverable	This document follows the implementation of the 3-day workshop on the use of MARXAN as a decision supporting tool in maritime spatial planning processes organized as Activity 2.2. It contains the materials developed and used at the workshop with the intention to facilitate future use and accessibility and capitalization.	
Deliverable responsible partner	PP2 - Blue World Institute of Marine Research and Conservation (BWI)	
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Introduction

According to the Intergovernmental Oceanographic Commission of UNESCO, Maritime Spatial Planning (MSP) is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives. It is a way governments plan how different parts of their territorial seas or oceans are used, so activities like fishing, shipping, tourism, offshore energy, and conservation do not conflict with each other.

In terms of the SAMESEA project, it is closely related to one of the main goals of the project, improved management of the human and sentinel species in the EUSAIR region. Therefore, this workshop was organized with the intention to enhance capacities of the project partners and their associated partners organizations for participation in MSP processes in their respective countries.

As appropriate learning method for this level of understanding and introduction to the MSP processes, we identify MARXAN as the decision-support tool that can be used at the workshop. Recognized international external expert, Jennifer McGowan, PhD, managing director at Marxan Conservation Solutions from USA, was engaged to lead the workshop.

This toolbox summarizes the Marxan Planning Platform (MaPP) Galápagos Tutorial*, developed by The Nature Conservancy (TNC) and used as an example in the exercise at the workshop. The purpose of this tutorial is to walk users through the development of several simple Marxan scenarios speaking to the foundations of spatial prioritization and Marxan concepts. It is targeted at users who are new to Marxan but may have some basic knowledge of core conservation spatial planning concepts. The narratives and scenarios used throughout this tutorial are fictional.

* TNC. 2024. The Marxan Planning Platform: Galapagos Tutorial. Global Science, The Nature Conservancy (TNC), Arlington, Virginia, USA. <https://marxanplanning.org>



Overview of the Marxan Planning Platform (MaPP)

MaPP is a cloud-based platform for systematic conservation planning. It allows users to:

- Upload spatial data (features, costs, protected areas)
- Create and duplicate projects
- Run Marxan scenarios
- Compare solutions
- Generate reports
- Share or publish projects

MaPP can be accessed at <https://marxanplanning.org>

At the same link the Galapagos Tutorial*, developed by The Nature Conservancy (TNC) can be found that guides users through this exercise that demonstrates advantages of using Marxan decision support tool in systematic conservation planning processes.



Objectives of the Marxan Tutorial

This toolbox presents a methodological overview of a systematic conservation planning exercise conducted using the Marxan Planning Platform (MaPP) in the Galápagos Islands region. The objective was to evaluate spatial prioritization scenarios for marine biodiversity conservation under varying ecological and economic constraints. Four progressively complex scenarios were developed to examine the effects of conservation targets, protected area locking, cost layers, and spatial configuration parameters on network design outcomes. The analysis demonstrates how boundary length calibration, species penalty factors, and economic opportunity costs influence spatial solutions. The study highlights the importance of integrating ecological representation and fisheries cost data when designing marine protected area (MPA) expansions.

The tutorial aims to:

1. Introduce foundational Marxan concepts
2. Demonstrate scenario development in MaPP
3. Explore conservation target setting and gap analysis
4. Understand cost minimization and trade-offs
5. Evaluate protected area performance
6. Practice stakeholder-informed spatial planning

The exercise demonstrates how spatial prioritization tools support transparent, data-driven marine conservation planning while balancing ecological and socioeconomic objectives.

The tutorial guides users through four progressive scenarios, users learn how to:

- Set conservation targets (30% representation)
- Calibrate spatial clustering using Boundary Length Modifier (BLM)
- Incorporate existing protected areas (Reserva Marina)
- Introduce economic cost layers (fishing pressure)
- Evaluate trade-offs between biodiversity conservation and fisheries impacts

The core workflow stages are grid setup, Marxan settings and solutions with evaluation.



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Exercise: Marine Spatial Prioritization in the Galápagos Using the Marxan Planning Platform

Background

The marine ecosystems surrounding the Galápagos Islands are globally significant for their biodiversity, endemism, and ecological connectivity. The establishment of the Galápagos Marine Reserve in 1998 marked a major conservation milestone, protecting approximately 138,000 km² of ocean.

However, increasing fishing pressure, expanding distant-water fleets, and the highly migratory nature of many marine species have raised concerns about whether the current reserve configuration sufficiently protects biodiversity and ecosystem functions. In response, spatial planning tools are increasingly being used to evaluate reserve effectiveness and identify priority areas for expansion.

This raises an important policy question - is the current reserve network enough to protect biodiversity while sustaining fisheries and local livelihoods?

To help answer this, this exercise applied the Marxan Planning Platform (MaPP), developed by The Nature Conservancy (TNC), to explore conservation planning scenarios for the Galápagos region.

The tutorial simulates a conservation planning exercise to evaluate whether current protected areas meet biodiversity targets and to explore options for expansion.

Purpose of the Analysis

The objective was to evaluate how different conservation planning configurations influence spatial priorities for marine protection. Specifically, the analysis aimed to:

- Assess whether 30% biodiversity representation targets could be achieved
- Evaluate how the existing marine reserve contributes to target fulfillment
- Examine trade-offs between conservation objectives and fisheries impacts
- Understand how spatial configuration parameters affect network design

The analysis used Marxan, a decision-support tool that identifies spatially efficient conservation networks by minimizing costs while achieving biodiversity targets. For that purpose, four scenarios were developed.



Methodological Overview

Key Planning Concepts:

Conservation Targets - percentage of each feature that must be represented in selected planning units.

Boundary Length Modifier (BLM)

Spatial compactness was controlled using the Boundary Length Modifier (BLM), calibrated to balance clustering and total cost. Outputs included best solutions, selection frequency maps, and target achievement metrics. Where low BLM implicates fragmented solutions, and high BLM aggregated/clumped networks. The optimal value was found using calibration curve (“elbow method”).

Species Penalty Factor (SPF)

Increases importance of meeting targets where higher SPF represents stronger penalty for missed targets. It forces inclusion of high-cost areas if necessary.

Cost Surfaces

May include area-based cost (default), economic opportunity cost (e.g., fisheries) and/or social or management cost layers.

The platform supports evidence-based planning by making ecological-economic trade-offs explicit and reproducible. The benefits of such planning approach are evidence-based decision-making, transparent trade-offs, reduced stakeholder conflict, adaptable scenarios and improved long-term sustainability.

This approach does not dictate a single outcome. Instead, it supports informed choices grounded in science and socioeconomic realities.



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Scenario Analysis Summary

The planning exercise explored how different conservation strategies would affect marine protection outcomes. Instead of proposing one fixed solution, the analysis tested several scenarios to compare trade-offs.

Four main scenarios were examined:

1. Baseline - Conservation Only

The objective was to identify areas needed to protect 30% of key habitats and species, without considering fishing costs or existing protected areas:

- 30% target for each habitat and species
- Equal-area cost surface
- No protected areas locked in

Key Findings were that without locked-in protected areas, targets initially unmet, solutions prioritize smallest spatial footprint, selection frequency identifies high-priority planning units and trade-offs emerge between cost minimization and target achievement.

2. Features with existing Marine Reserve

The objective was to assess how much the current reserve already contributes to conservation targets:

- Current reserve locked into the solution (50% threshold)
- 30% targets maintained

Key steps were to lock-in planning units overlapping >50% with reserve boundary and re-run Marxan with same BLM calibration. Findings were that with this scenario existing marine reserve contributes toward target achievement, but some features remain underrepresented. Costs and spatial configuration differ from Scenario 1.

3. With fishing costs included

In this scenario main objective was to add information on the economic value of fishing areas to understand how protection could affect the fishing sector and minimize economic impacts.

- Economic cost layer representing fishing pressure (artisanal longline + industrial tuna fleets)
- No reserve locked in



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Key observations were that Marxan avoids high-value fishing areas and low-cost areas inside reserve were prioritized. Spatial configuration shifts to reduce economic conflict and trade-offs between biodiversity and fisheries become explicit.

4. Integrated Approach (Features + Fishing Cost + Marine Reserve)

The objective was to integrate planning, combining biodiversity goals, fishing costs, and the existing reserve to identify balanced solutions.

- Integrated scenario combining biodiversity targets (30 %), economic costs (fishing cost layer), and existing marine reserve locked in
- Additional element was hermandad migration corridor considered in bonus scenario

Key insights were that integrated scenario reflects realistic conservation planning, cost constraints significantly influence solutions and existing MPAs reduce additional conservation burden. This approach allows policymakers to see how decisions change depending on priorities and constraints.



Major Findings from the Tutorial Exercise

1. The existing marine reserve is significant but not sufficient

The current reserve covers a significant portion of important habitats. However, some species, especially migratory sharks and turtles, spend time outside protected boundaries and certain offshore areas remain underrepresented. Scientific evidence suggests that protecting 30% of key features may require additional areas, especially for wide-ranging species. Protection may need to extend beyond current borders to meet biodiversity goals.

This implies that the reserve remains essential, but strategic expansion or complementary measures may be needed.

2. Including fishing data strongly influences spatial priorities

When fishing activity was included in the analysis proposed conservation areas shifted away from high-value fishing grounds, areas with lower economic impact were prioritized and trade-offs between conservation and fisheries became clearer.

This shows that spatial planning can reduce conflict by identifying areas where conservation gains are high but economic disruption is lower. Integrating fisheries information early in planning reduces unintended economic impacts and supports more durable solutions. This demonstrates the importance of incorporating socioeconomic data into conservation planning.

3. Smarter design reduces fragmentation

Mobile species require protection strategies that go beyond static boundaries, potentially including corridors or cooperative regional management. The analysis tested how to avoid scattered, hard-to-enforce protected areas. BLM calibration significantly influenced network design - low BLM values produced fragmented networks, moderate BLM values generated more enforceable, compact solutions. Proper calibration is essential for producing realistic conservation networks. More compact and connected protection networks were possible without dramatically increasing costs.

This shows how strategic design improves enforcement feasibility and ecological effectiveness.

4. Transparent trade-offs support better governance

Use scenario-based planning to build consensus - rather than debating a single map, stakeholders can compare options and understand trade-offs in a structured way.



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By comparing multiple scenarios, decision-makers can see how much additional area is needed to meet biodiversity targets, the economic implications of different expansion options, which areas are consistently important across scenarios and where conflicts are most likely to occur. This transparency strengthens stakeholder dialogue and evidence-based policy.

Implications for Marine Spatial Planning

This analysis highlights several important considerations for marine spatial planning in the Galápagos region:

- Expanding protection beyond current reserve boundaries may be necessary to meet representation targets.
- Migratory species require larger or corridor-based planning approaches.
- Incorporating fisheries cost data allows for more balanced and socially acceptable conservation strategies.
- Scenario comparison tools improve transparency and stakeholder engagement.

The current Galápagos Marine Reserve is a strong foundation. However, as pressures on marine ecosystems increase, proactive planning becomes essential. The Galápagos region has long been a global conservation leader. Continuing that leadership requires tools that integrate biodiversity science, economic realities, enforcement feasibility and community livelihoods.

The choice is not between conservation and livelihoods. With careful planning, both can be advanced together. Spatial planning platforms such as Marxan provide a practical way to design marine protection that is both ecologically effective and socially responsible



Conclusion

The Marxan Planning Platform provides a practical introduction to for systematic marine conservation planning in the Galápagos. By integrating biodiversity targets, economic costs, and existing protected areas, it enables decision-makers to design spatially efficient and economically informed conservation networks.

This scenario-based approach strengthens strategic planning for marine protected area expansion and supports adaptive, data-driven governance in one of the world's most important marine ecosystems. The exercise underscores that marine conservation planning must balance ecological representation, economic sustainability, and enforceability to produce durable and socially acceptable outcomes.

This exercise and toolbox demonstrate that effective marine spatial planning:

- Requires integration of ecological and socioeconomic data
- Benefits from transparent, scenario-based modeling
- Supports stakeholder discussions through visual outputs
- Helps identify priority expansion areas
- Makes trade-offs explicit and quantifiable
- Supports evidence-based policy decisions



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