Draft Marxan Frequently Asked Questions (FAQ)

What is Marxan and what does it do?

Marxan is a decision-support tool used in systematic conservation planning (SCP). Based on user input, available data and predefined planning goals and targets, it helps identify potential areas (referred to as "solutions") for protection that meet high-level biodiversity protection goals and quantitative conservation targets while minimizing social and economic costs.

To date, it has supported decisions on a wide range of conservation planning problems at global, regional and local scales, including:

- **Restoration activities** in the Atlantic Forest, Brazil, in the Yucatán Peninsula in the Mexican Caribbean, in the Murray–Darling Basin in South Australia, and southwestern Alberta, Canada.
- **Provision of ecosystem services** in Central Coast ecoregion of California, United States, Telemark in southern Norway, and Vermont, United States.
- **Understanding trade-offs between competing objectives** in the Andes of Bolivia, and Central Kalimantan, Indonesia.
- **Identifying management priorities** in the Danube River Basin, Europe, and South Africa's grassland biome.
- **Law enforcement activities** in the Greater Virunga Landscape, in Central Africa, and the Patos Lagoon estuary along the Brazilian coast.
- **Designing conservation networks to preserve environmental and cultural values** (e.g., Heiner et al. or Martinez-Harms et al. 2021)
- **Planning for conservation development objectives** (e.g., Heiner et al. 2019)
- **Reporting on the performance of existing reserve systems**
- **Developing multiple-use zoning plans for natural resource management**
- **Assessing the feasibility and set of options to meet global conservation targets**

Why use Marxan?

SCP is considered good practice because of its transparent and inclusive approach (Ardron et al. 2010); and Marxan is widely used in SCP because it provides potential solutions to complex conservation questions (e.g., "Where should a country site a marine protected area?") and aides decision-making based on user-defined conservation targets. Marxan is free, open-source, and has been used by over 6,700 planners in 4,700 organizations to inform marine, terrestrial, and freshwater projects worldwide.

Belize Sustainable Ocean Plan

What are the key data inputs into Marxan?

Marxan uses spatial (i.e. geographic) data as inputs. The main data inputs to Marxan are:

Features – These are sites or areas within the spatial planning area that the Marxan user wants to protect, manage, or represent in a spatial conservation plan (i.e. in protected area solutions). Features are typically habitat types (e.g., coral reefs, mangroves) or species (e.g., fish, turtles) that correspond with conservation objectives, but could also include other data on ocean uses or ecosystem services.

Conservation Targets - A conservation target is the amount or percentage of a feature we want to protect in the Marxan solution. Example: Protect 30% of coral reef habitat.

Costs - A cost reflects the trade-off for protecting an area. Costs can include:

- Economic values (e.g., fishing revenue, tourism)
- Human use intensity (e.g., aquaculture, shipping)
- Environmental risks (e.g., pollution, climate stress)
- Loss of cultural and traditional use spaces (e.g., artisanal fishing)

Marxan solutions will prioritize lower-cost areas—unless a higher-cost area is needed to meet conservation targets. Costs can be weighted such that a high weight makes Marxan more likely to avoid areas with that cost.

Lock out areas –Areas to be excluded from the Marxan solution. Common lock out areas include locations that are:

- Existing developments used for critical infrastructure (e.g., shipping lanes, submerged pipeline and cable corridors)
- Politically or culturally restricted zones (e.g., military exclusion zones, submerged archaeological sites)
- Other economically, culturally, or socially important areas

In Marxan, lock-out areas are treated as non-selectable (i.e. will not be considered in the conservation solution under any circumstance).

Lock in areas – An area that will automatically be included in the Marxan solution. Common lock-in areas are areas that are:

- Existing protected areas
- Areas with features desired for protection

Marxan must include these areas in its solutions.

Why do Conservation Targets Matter?

Ensuring the full range of biological and physical features in the planning area is represented in zoning scenarios designed for a biodiversity protection objective can distribute climate and disaster risk over larger spatial scales, promoting ecosystem resilience and protection over the long term. Marxan helps identify areas that efficiently represent key ocean features while minimizing overlap with human uses or areas where protection would be difficult.

Conservation targets generally reflect ecological processes (e.g., the minimum percentage of critical or complementary ecosystem components needed to sustain ecosystem functions) or policy goals/mandates requiring a percentage of areas to be conserved (e.g., Global Biodiversity Framework Target 3, aka. "30x30"). In a Marxan analysis, higher targets are typically set for rare, threatened, or irreplaceable features, while lower targets could be considered for widespread or common features that are not especially vulnerable.

Where official conservation targets haven't been set, assigning draft targets to features helps stakeholders explore different options and ask important questions like: *Are we protecting enough of the features that matter most?* Conservation targets provide a way to measure the ecological value of different zoning scenarios — so the final design is not just protecting a percentage of the planning area, but the right area(s).

What is a Planning Unit (PU)?

A planning unit is a small spatial area (usually a square or hexagon) that Marxan evaluates. The conservation planning area is divided into a grid of planning units. Each PU can include:

- Conservation features (like coral reefs, mangroves, fish spawning sites)
- Costs (like fishing pressure or development risk)

Marxan solutions are made up of combinations of planning units with desired features that meet conservation targets.

How do we know if a Marxan solution is "Good"?

A good solution:

- Meets or exceeds conservation targets
- Uses areas with the least total cost
- Is spatially connected and practical for monitoring and enforcement
- Aligns with stakeholder values and input

Because there is often more than one way to satisfy input parameters, Marxan produces multiple solutions and identifies a "best" solution. Multiple runs are used to explore different trade-offs and refine solutions.

What happens after Marxan runs?

Marxan doesn't provide a single right answer. It generates multiple solutions so that users and stakeholders can review and refine outputs to decide which areas are most suitable. The final planning decision will typically represent a compromise between what is most efficient (as defined by Marxan) and other stakeholder preferences. In other words, Marxan helps us move towards a solution, but Marxan results do not represent the final decision.

Outputs are reviewed with stakeholders to:

- Visualize and consider trade-offs
- Compare draft alternative zoning scenarios
- Refine zoning boundaries
- Facilitate achieving consensus on a final zoning plan

Marxan may be run multiple times, with multiple data inputs over the course of a planning process. This allows users to explore the trade-offs among multiple scenarios (e.g., including various combinations of costs, and/or varying conservation targets). Marxan outputs are typically refined through iterative stakeholder review before they are incorporated into the final zoning plan.

Can stakeholders influence Marxan solutions?

Absolutely. Stakeholders are integral to the process of running Marxan and reviewing outputs. Stakeholders can:

- Help select conservation features
- Set targets and weights
- Define lock-out and lock-in areas
- Review Marxan outputs and suggest adjustments

Stakeholder input ensures that the final outputs are both scientifically credible and socially acceptable.

How does Marxan interact with other tools that are used in Marine Spatial Planning?

Participatory mapping and planning tools like SeaSketch can be used to generate Marxan input data (i.e., through the Ocean Use Survey). SeaSketch tools can also be used to review draft Marxan results. Other tools like InVEST may produce spatial datasets that can be used as Marxan inputs (e.g., models of mangrove blue carbon).

For More Info:

- Visit https://marxansolutions.org
- Contact the BSOP Technical Team at bsop@coastalzonebelize.org
- Review the 2024 BSOP Multi-Stakeholder MSP Workshop Report available at https://bsop.coastalzonebelize.org/

V1 – April 7, 2025