Marxan Outputs and Results

Marxan has been employed extensively to generate potential solutions for representing the biodiversity of an ecoregion. This approach is based on a representation analysis which assumes that the objectives for conservation are to protect viable examples of species and ecosystems within managed areas. Based on this assumption, “efficient” solutions are sought that meet representation goals at the least total cost in terms of total area and other associated factors.

Running Scenarios

At the core of the optimized selection process is the overall objective of minimizing the area encompassed with the network of selected sites. Marxan uses a simulated annealing algorithm to evaluate alternative site selection scenarios, comparing a very large number of alternatives to identify a good solution. A scenario in Marxan is a user-defined set of parameters including the desired number of solutions or runs and the amount of aggregation or clumping of assessment units. The procedure begins with a random set of units, and then at each iteration swaps assessment units in and out of that set and measures the change in “cost.” Cost here means the amount of area selected in the alternative. The algorithm’s function is a nonlinear combination of the total area and the boundary length of perimeter of the site selection output.

Interpreting Results

There is never just one “optimal” solution (e.g. the definitive set of conservation areas), but it is possible to identify those areas that are both essential and representative across multiple scenarios. Output from Marxan should undergo a thorough peer or expert review process prior to determining final priorities.

Summed Solutions

There are two most widely used solution provided by Marxan. One is called “sum solution” that reports out on all of the runs or solutions from a given scenario. This keeps track of how often each unit was involved in any solution. So if the user chooses the program to run one hundred times in a particular scenario, then the output reports on how many times any specific assessment unit is selected out of a hundred. This information is a useful way to explore the irreplaceability of units. A “sum of sum solution,” or multiple scenarios added together, has also been referred to as an irreplaceability analysis. These solutions are considered by marine planning teams to be the most appropriate output when conducting an expert review or stakeholder decision process. The relative value of each unit is assessed rather than whether the unit was in or out of the solution. High irreplaceable units across scenarios provide insight into which areas are most critical in terms of conservation effort; low irreplaceable units are often considered negotiable or flexible in decision making formats. In some cases conservation targets are only found in limited sites and therefore these areas are always chosen in any representative portfolio. Additionally, areas of high irreplaceabiity also include assessment units whose exclusion would require a proportionally larger conservation area to achieve the same level of representation, resulting in a loss of spatial efficiency.

Best Solutions

The other output is called “best solution” which is the most optimal run in the scenario that best meets the defined parameters. The objective function states that the best or most efficient solution will be the selected sites at the lowest total cost. While useful, planning teams have generally chosen to run Marxan by varying parameters and comparing best solutions. This increases the flexible nature of the site selection process and can trace patterns of representation across scenarios. This is extremely helpful for highlighting areas that have previously been overlooked, where goals for many targets can be met in a spatially cohesive manner that increases the likelihood of strategy effectiveness.

These solutions can also be used as a measure against protected area designations. Selected sites that fall within currently protected or other marine managed areas can be used to verify their importance at both regional and local scales. In the Pacific Northwest Coast ecoregion (pdf, 11MB), for example, although marine managed area data were not considered in the suitability index Marxan chose areas along the Olympic coast of Washington state that are currently under a variety of protective designations (i.e. National Park Service, National Wildlife Refuge, National Marine Sanctuary). These areas were selected across a range of Marxan parameters, examined in a controlled sensitivity analysis. The selection of these areas in Marxan highlight their biodiversity value when compared to other areas along the Washington and Oregon coasts. They may also be an indication of management effectiveness in protecting target species, habitats and ecosystems

while abating current impacts. Further, selected sites that do not fall within designated areas can be used to “fill in the gaps” of an established protected area network.

Expert Review

Output from this decision support tool provides a “strawman” set of sites that must have expert review. This review may indicate ways to redo analyses or make direct changes to the sites that are selected. Changes to the sites should be clearly documented and clear rationales identified in order to ensure the transparency of the whole process.

Site delineation of priority areas at the regional scale does not have to be highly detailed. There is a tendency towards designing the assessment units at finer scales in order to facilitate the convenience of converting these units to management units on the ground. Nonetheless at regional scales, then it is probably best to identify areas at a coarser scale and expect boundaries to be modified somewhat at the next stage of in depth planning (Conservation Action Planning).

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