Marxan Inputs

The main inputs to Marxan and other site selection programs, including targets or features, goals, stratification and assessment units, and information on threats and human uses, are described earlier in the Regional Assessments section. This information is used to build inputs and set specific parameters for Marxan. There are three other inputs described below. One is a compilation of impacts, threats and human uses called the suitability index, while the other two are parameters used to calibrate and test the sensitivity of the Marxan algorithm. These are called boundary length modifier and the species penalty factor. Although these three inputs are not required for Marxan to run (defaults given in the Marxan manual can be used) they are highly influential and should be careful examined when using software program.

Suitability Index

In seeking spatially efficiency or the minimal number of places where goals can be met, the user can design and incorporate a suitability index as part of the selection process (referred to as a cost index in the Marxan manual and accompanying literature). This index is a compilation of conditions that impact, threaten and/or benefit the biological and physical targets. These conditions or factors usually include current impacts, future risks (threats), and human uses, but can also include information on managed areas.

Design Tip

The suitability index is a compilation of factors that generally includes impacts, threats and human uses that significantly influence where sites will be selected. The boundary length modifier determines the level of assessment unit clumping or adjacency. And the species penalty factor determines the priority in which each individual target or feature can accomplish its goal.

The purpose of the index is to balance the desired site selection of targeted species, habitats and ecosystems with known conditions. There are many different approaches and methods for constructing a suitability index. Places where the most direct impacts occur represent areas that are considered the least suitable for conservation. For example, places where high intensity coastal development and road density occur adjacent to a highly structured shoreline represents the least suitable places to put conservation efforts because the biological targets in those places are likely to be heavily impacted.

A suitability index may also include management designations that potentially help offset these degrading conditions depending on the protective status of the area. Often current protected areas are “locked in” to the selection process, meaning that the decision support tool is required to take those areas and count the targets within them towards their goals. By either including protected and other managed areas as benefits, or locked-in as requirements, both negative impacts and marine managed areas have a significant influence on the optimized site selection process. We recommend using protected areas as benefits in the index as opposed to locking them into the selection process as the spatial information itself is not an indication of management effectiveness. If these areas are considered required, then we advise that an appropriate management designation be assigned to each area before assuming that they all provide full protection (e.g. no-take designation versus a seasonal closure).

Boundary Length

A boundary length modifier (BLM) determines the relative importance placed on minimizing the perimeter relative to minimizing area. This is a weighting factor that can be used to control the spatial aggregation of selected assessment units. BLM is an important factor as it determines whether the output contains more, small sites (low BLM), or fewer, larger sites (high BLM). Spatial optimization is achieved by minimizing both area and length of perimeter between assessment units; therefore testing the influence of this parameter is essential.

There is never just one “optimal” solution, but it is possible to identify those areas that are consistently represented across multiple solutions. All solutions should undergo a thorough peer or expert review process prior to determining final priorities. Conducting sensitivity analyses with the BLM will help determine the appropriate setting specific to a region and the features within. Generally if BLM is set high the algorithm tends to over-represent assigned goals. Therefore examining the outputs of representation levels (i.e., goals under-represented, precisely met, and over-represented) for specific targets will help tune this parameter.

Species Penalty Factor

Another important parameter used in Marxan applications is the species penalty factor (SPF). This factor determines the priority with which the algorithm meets an individual target’s representation goal. These “species penalties” are costs imposed for failing to meet the goals. The SPF is a

multiplicative factor which can be unique to each conservation target. It is primarily based on the relative worth of that target but it includes a measure of how important it is to get it fully represented.

There are a few different schools of thought when setting this factor, although all agree that it is based on the importance of the target (i.e. keystone species, essential habitat types). For example, if a relatively high penalty factor is assigned to a target the algorithm will be forced to choose sites in heavily impacted areas if this is required in meeting its assigned goal. Considering data confidence can help determine the appropriate setting for this factor; generally higher penalty factors are assigned to targets that are represented by data of higher confidence.

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