EcoMetrix Method Development Overview

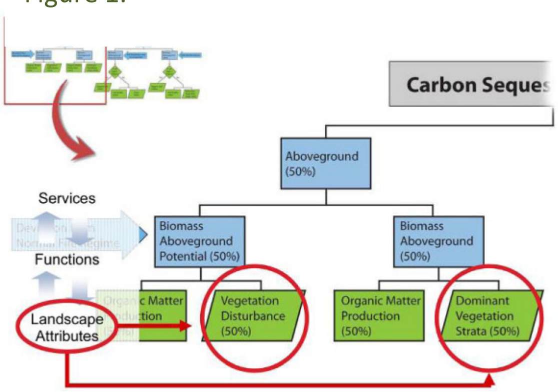
EcoMetrix is a tool used to quantify the impacts and benefits to ecosystem functions and ecosystem services that result from development or restoration activities. It does this by quantifying how well a particular ecosystem function is performed on the landscape. For each relevant function, whether physical (abiotic) or biological (biotic), EcoMetrix calculates an ecosystem functional performance score using algorithms developed for the EcoMetrix database. When functional performance is quantified in this way, the outputs represent a relative percent performance for the function. This percent performance can be calculated for a specific study area in functional hectares and/or in ecosystem services hectares. Outputs can be expressed in the context of multiple ecosystem services performed on a given site, such as the ability of the site to support food production (e.g., resident fish), or the extent to which a proposed action could impair climate regulation services (e.g., a reduction in soil carbon sequestration because of increased tillage).

The algorithms for calculating function scores that are contained in EcoMetrix are developed according to a standardized process that includes the following steps.

STEP 1

A conceptual model is developed for each function to describe how it is performed on the landscape. This conceptual model identifies the attributes that are relevant to the function being performed, how they contribute, and whether there are certain conditions that need to exist for the function to be performed, or that will alter how the function is performed (Figure 1). In other words, the conceptual model provides a systems-level framework for understanding how the physical attributes of the landscape (e.g., soil, vegetative structure, water regime, etc.) work together to perform a physical or chemical process or support a biological process. The conceptual model is developed by a team of scientists based on research, existing literature, peer review, and professional judgment. By identifying the individual parts of the system that are relevant to functional performance, the conceptual model helps ESG identify what data to collect and how that data can be used to understand the performance of the function. These conceptual models are relevant regardless of a project's location. However, attributes, scoring, and seasonal considerations are fine-tuned with input from local experts as needed when applied in a specific geographic location.

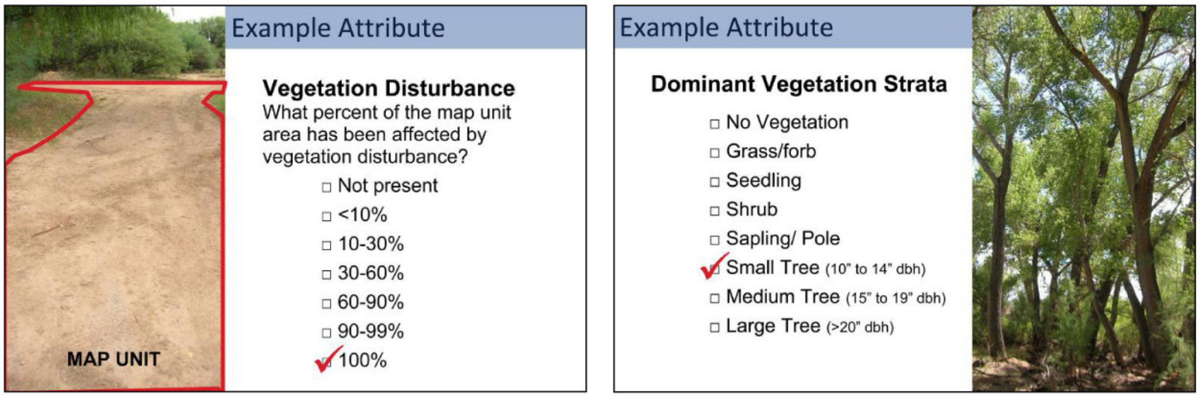
Figure 1.



STEP 2

The next step focuses on each of the specific landscape attributes identified within the conceptual model. For each of the attributes in the conceptual model, a unit of measurement is established. These units of measurement are broken down into quantitative, or where appropriate, qualitative ranges so that they can be measured for each map unit in the field. Determining the measurable units for the attributes is a key step, requiring a careful balance between the desire to capture small degrees of landscape change with the need to ensure that the data collection is repeatable.

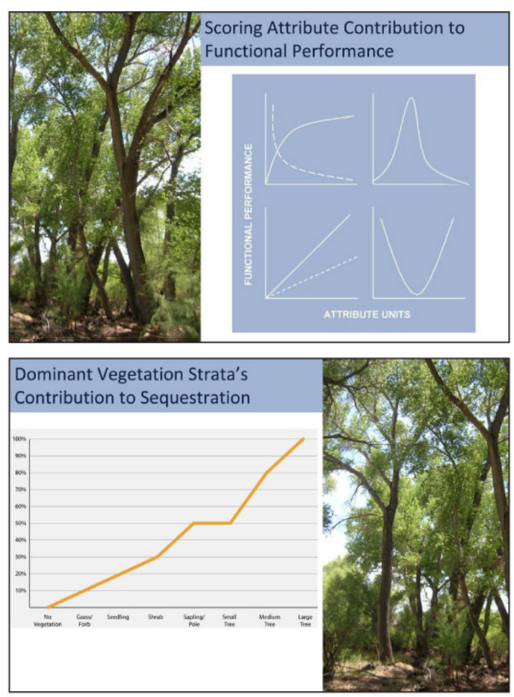
Figure 2.



For example, in the vegetation disturbance attribute shown in Figure 2, the ranges used for measuring the attribute could be narrowed to 5 percent increments. Doing so would allow EcoMetrix to be considerably more sensitive in its measurement of any function that incorporates this attribute. However, testing has shown that repeatability suffers significantly as ranges less than those shown are used. In addition, if EcoMetrix uses ranges that are too narrow, then the system will presume a level of sensitivity that is actually not achievable, given the current state of ecosystem science.

That said, the broader the ranges, the more generic system outputs become. For instance, if all data in the system are collected by a presence/absence measure, then EcoMetrix would not be able to measure any landscape changes that do not completely alter the site. The output would be so coarse as to be meaningless. EcoMetrix developers seek to keep the system well away from these extremes – optimizing the balance between repeatability and robustness.

Figure 3.



STEP 3

Scoring curves are developed for each of the quantitative and qualitative attribute ranges based on how increasing/decreasing or changing the attribute abundance and type will affect the performance of the relevant function (Figure 3). The goal is to represent how a site's ecosystem functional performance will change as site attributes or management strategies are changed through alternative development or conservation practices. The scoring curves are developed through use of existing literature, consultation with experts and best professional judgment. These curves, which are in the form of look-up tables, and the conceptual models they feed into, are the key to the functional performance scoring. Accordingly, the curves receive considerable internal and external peer review.[1] The curves are fine-tuned with the support of local experts as necessary to accommodate the unique characteristics of different geographies and are managed adaptively in response to on-the-ground monitoring results that create a feedback loop.

STEP 4

Functional performance scoring algorithms are then created by aggregating the individual attributes pursuant to the concept diagram developed in Step 1. The database is developed by tying the algorithm to the scoring tables developed for each attribute's contribution to each function. For example, the conceptual model for the infiltration function includes the rules and architecture described below, which leads to the algorithms.

The function-specific algorithms are generally universally applicable because landscape functions are landscape functions, regardless of the geography in which they occur. However the use of the algorithms in varied geographies does involve confirmation by local experts and, if appropriate, adjustments to attributes, modifiers, and/or weighting factors (see discussion below) are made to accommodate unique situations. For example, in the case of abiotic functions, such as infiltration, how water infiltrates into the ground is the same from location to location – the attributes (soil type, slope, etc.) are what vary. The contribution a given attribute makes to the performance of a function is confirmed with local experts so that scoring can be adjusted if needed.

Biotic function models (e.g. species support) are constructed similarly to the abiotic models. In order to make EcoMetrix broadly applicable, species support function models are developed around species groups, rather than individual species. These species-group models capture the fact that often, within a given species group, consistent sub-functions are need for lifecycle support. For example, in the case of raptors, nesting, foraging, cover/refugia, and connectivity sub-functions are critical for most raptor species. Basic habitat attributes needed to ensure the provision of these sub-functions have been pre-identified within the EcoMetrix framework. ESG works with local biologists to modify attributes and scoring curves as appropriate to address the specific species of concern in a given location.

Weighting

The output that EcoMetrix provides is the ability of a given area of landscape to perform functions. That output is expressed as a functional acre. The algorithms within the system calculate the ability of a map unit to perform functions—they do not prioritize or "value" whether any particular function or underlying habitat type is more important. However, it is important that the functional acre score be understood in a landscape/regional context.

[1] ESG is fortunate in that much of the early system development occurred in the context of multi-agency workgroups where external peer review was provided for all aspects of development on a weekly basis. However, as development has continued beyond the original contexts that provided the workgroups, ESG has developed an external peer review process for function development. Monitoring feedback loops that can be used to refine conceptual models and scoring curves over time are also in development.

Ecological priorities differ from region to region, change over time within a given region, and are generally driven by policy determinations. Accordingly, EcoMetrix treats application of these priorities as a separate step in the process by providing placeholders within the database for "weighting factors" to be applied. Weighting factors are integrated at the function level and can vary across services as needed to meet policy objectives. Weighting factors allow for the core of the EcoMetrix measurement system to be driven by science and research; it is only at the value stage that policy inputs can affect outcomes. Using this approach provides the following important benefits:

- Functional scores can be based solely on the scientific research and data for that particular function.
- Policy or implementation concerns can be simply and easily adjusted independent of the function calculation.
- If new science emerges, the function can be updated in a transparent manner.
- Policy goals can be changed and tracked simply by modifying weighting factors, thereby keeping the scientific basis of the functional score removed from the policy discussion.

How weighting factors are set will depend on the context in which EcoMetrix is being applied. The most appropriate sources for establishing weighting factors will vary from region to region depending on what is available and accepted in a given location. In some instances, it will make sense to have stakeholders identify priorities in advance. In other cases, the weighting factors will be based on existing policy documents. Which approach is appropriate will depend on the context in which EcoMetrix is being applied.

Following are some example approaches for setting weighting factors:

- If EcoMetrix is being used in a regulatory context, then agency objectives as stated in policy documents would be an appropriate source for weighting factors. For example, limiting factors identified by NMFS in Recovery Plans for the relevant Evolutionarily Significant Unit (ESU) would provide a good basis of setting weighting factors.
- Where a watershed assessment (e.g., a WRIA Habitat Limiting Factors Report) or an ecoregional planning document (e.g., a state wildlife agency's Wildlife Action Plan) provide a much relied upon prioritization tool or definitive policy statement, this would be the most obvious source for setting weighting factors.

STEP 5

The individual function measurements act as building blocks for the final step in the EcoMetrix calculation, which is to determine the gain or loss in ecosystem services benefits from the landscape. This is not a value calculation, but rather a performance calculation. The ecosystem services measure that is provided can be fed into a number of different economic or non-economic valuing calculations.

To construct the final step in the process, a conceptual model of the respective service is developed. The conceptual model ensures clear definition of the ecosystem service benefit(s) being measured and ensures full consideration of the relationships between the individual functions that contribute to providing the benefit. As an example, for the water regulation service, the conceptual model breaks the service into three discreet benefits that must be understood in order to quantify the service:

- How the ecosystem helps avoid excess loss of surface and soil moisture from the landscape,
- How the ecosystem helps moderate stormwater flow to ensure sustained water availability, and
- How the ecosystem provides surface and sub-surface storage opportunities to ensure both short-term and long-term access to water.

Since a conceptual model exists within EcoMetrix for each of these service benefits, conceptual models also exist to identify the way in which functions interacting on the landscape actually provide the benefit. The conceptual models are used to develop system rules and algorithms. As attribute conditions are entered into the database, the function scores are automatically calculated and then a subsequent ecosystem service score is also generated.