



An Introduction to **EcoMetrix**[™]

Measuring change in ecosystem
performance at a site scale

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Parametrix

ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

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Introduction

This document provides an introduction to EcoMetrix, a system created by Parametrix to measure the anticipated change in ecosystem performance from proposed activities. The system is designed to operate primarily at a site scale, although it can be easily adapted for use in larger areas. The system is focused on measuring ecosystem performance in terms of the ability of the ecosystem to provide ecosystem services, including comprehensive biodiversity support. EcoMetrix has been developed by Parametrix over numerous years with the support of agency, private sector, and NGO partners and collaborators.

Why Ecosystem Services?

Ecosystem services are the societal benefits that result from nature's performance of functions. For example, a grassy meadow that filters stormwater runoff results in cleaner water. The same meadow can also store water to help attenuate flood events or aid in aquifer recharge, providing hazard mitigation and water supply protection. These services can be negatively affected by development, e.g., degradation of wildlife habitat as a result of wetland fill, and also positively affected through conservation-based resource management, e.g., wetland restoration resulting in improved water quality and floodplain restoration resulting in increased flood storage capacity and natural hazard mitigation, etc.

Ecosystem services are the societal benefits that result from nature's performance of functions.

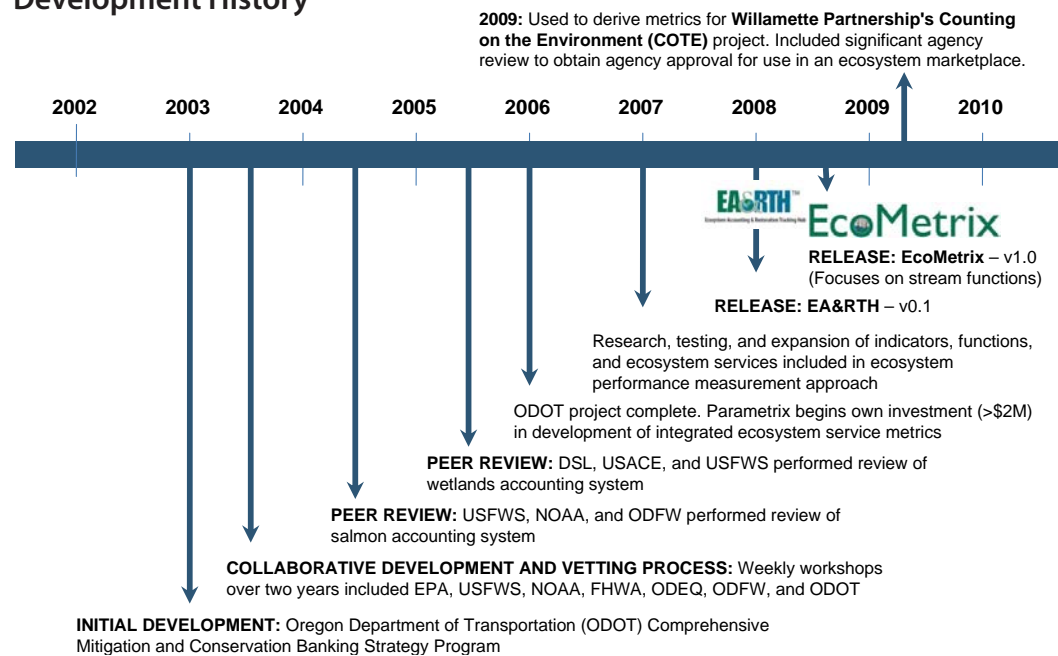
EcoMetrix is a comprehensive and evolving multiresource tool for quantifying ecosystem services. This quantification is based on how well abiotic (physical process) and biotic (biological process) ecosystem functions are performed. EcoMetrix allows the user to assess how well a site's ecological processes are being performed and to determine how the site's ecosystem functions will change upon the completion of a proposed project.

This change can be calculated for land restoration and conservation projects, and also for development projects that result in unavoidable negative impacts to the environment.

The guiding principle of EcoMetrix is that a site's ecological condition, and the impacts and benefits to habitat functions from alterations to that site, can be calculated using a basic set of indicators (attributes). While it is common practice to use indicators to assess the performance of function, EcoMetrix is unique in that it includes a comprehensive data set of indicators used to evaluate over 50 physical process and species support functions. The measurement approach for all of these functions is to determine the percent of optimal performance the ecosystem provides in a specific geographic location.

The initial development of the methodology began in 2003 as part Parametrix's role in the Oregon Department of Transportation's (ODOT) Comprehensive Mitigation and Conservation Banking Strategy Program. This development effort evolved into a collaborative process involving state and federal regulatory agency personnel. As a result of this two-year process, a function-based accounting methodology for calculating salmon and wetland credits was developed. These methods were then submitted to the regulatory agencies responsible for each credit type for a final peer review and completed in 2006.

Development History



While this approach determining functional change in terms of salmon and wetland habitat were designed so that they could be based on the same data set, it was not possible to determine the extent of overlap between the two sets of functions, so multiresource functional assessments could not be conducted with the system as it existed. This, and the release of the findings of the 2005 Millennium Ecosystem Assessment (MEA), drove Parametrix to move away from determining “siloeed” functions, towards a more holistic, multifunctional, ecosystem services approach.



functional scoring for multiple land cover types in terms of an overall functional performance score and wetland functional credit score.

Development of this ecosystem services approach began in 2006, and through the research, testing, and expansion of indicators and functions, it culminated with the release of EA&RTH in early 2007. This desktop version of a functional assessment tool was focused towards wetland functions, but did produce

After the release of EA&RTH, Parametrix continued to add abiotic functions to the calculation matrix through the research, addition, and testing of field indicators. During this time, the equations used to determine the total functional score were also amended.

Up until then, the abiotic and biotic functions were all handled as equal contributors to the final score. Several new biotic habitat support groups were added to the functional performance matrix to strengthen the biodiversity aspect of the tool. However, to avoid the final scoring being overwhelmed by the potentially endless number of biotic support groups, the methodology was amended to derive the final total functional performance score from an equal contribution from both abiotic and biotic functions.

During this period, research was undertaken and a matrix was developed to associate ecosystem functions with ecosystem services. While a large portion was modeled after the findings of the MEA, other functional models and ongoing research, in both academia and the regulatory agencies, were reviewed to inform development of the ecosystem services calculations.

A web-based prototype of this tool was released as EcoMetrix v1.0 in 2008. This version was limited to selected stream functions, but it did calculate a total functional value and potential stream credit value for all land cover types. While the current version is not yet available online, it is now possible to use the system as a desktop application which incorporates Microsoft Excel spreadsheets and ArcGIS.



Currently, EcoMetrix can be used to score for a broad array of functions in a multitude of land cover and habitat types in terms of total functional performance, specific credit types, and a variety of ecosystem services such as water provisioning, water regulation, climate regulation and various cultural services. Parametrix continues to expand the functions that can be scored from its base set of indicators, and now applies an adaptive management process to the ongoing development and review of previously completed functions as knowledge is gained through the integration of new functions and coordination with technical stakeholders in the natural resource management community. We monitor the system development progress using tracking matrices and have attached a PDF of the current (as of October 2010) Land Cover Types by Function matrix as an example.

Recently, the EcoMetrix methodology, functions, and data set were used to create a metric for calculating a salmon credit for the Willamette Partnership's Counting on the Environment (COTE) project. The development of this metric provided the opportunity for significant agency review towards acceptance of using EcoMetrix in an Ecosystem Marketplace.

Applying the Methodology

Applying the EcoMetrix methodology to a site consists of the following three steps:

Step 1. Site Delineation

Applying the EcoMetrix method begins by delineating the site into substantially homogeneous map units based on land cover type (*listed below*). This delineation is the basis for collecting field data on the physical and biological indicators present within each map unit.

Land Cover Types

- River/stream
 - Perennial
 - Intermittent
 - Ephemeral
 - Lake
 - Oxbow/oxbow lake
 - Playa lake
 - Pond
 - Permanent
 - Seasonal
 - Canal
 - Perennial
 - Intermittent
 - Ephemeral
 - Culvert
 - Perennial
 - Intermittent
 - Ephemeral
 - Ditch
 - Perennial
 - Intermittent
 - Ephemeral
 - Still water
 - Abandoned open pit
 - Bioswale
 - Lake
 - Pond
 - Constructed
 - Municipal
 - Treatment
 - Reservoir
-
- Open coastal inlet
 - Barrier estuaries
 - Barrier lagoons
 - Eelgrass bed
 - Kelp forest
 - Photic zone
 - Neritic marine habitat types
-
- Dam
 - Beaver
 - Natural
 - Flats
 - Mud
 - Sand
 - Tidal
 - Rocky shores
 - Platform/ramp
 - Plunging shore
 - Pocket beaches
-
- Shorelines/beaches
 - Bar
 - Modified shoreline
 - Bio-engineered
 - Rip rap
 - Bulkhead/seawall
 - Beach
 - Low tide terrace
 - Spit
 - Causeways
 - Docks/slips/dolphins
 - Fish passage
 - Flow control
 - Berm
 - Dam
 - Flood gate
 - Groins/jetties
 - Levee/dike
 - Lock
 - Log booms
 - Piling/abutment
 - Wingwall/apron
 - Tide gate
-
- Arid areas
 - Dry salt flat
 - Sandy area
 - Barren areas
 - Bare ground
 - Bare exposed rock
 - Channeled scabland
 - Dunes
 - Herbaceous/grassland
 - Mixed grass/shrub
 - Savanna
 - Deciduous stand
 - Mixed stand
 - Coniferous stand
 - Slash/clear cut
 - Transitional area
-
- Alkali wetland
 - Emergent wetland
 - Forested wetland
 - Freshwater marsh
 - Peatlands (bogs & fens)
 - Scrub-shrub wetland
 - Tidal wetlands
-
- Brackishwater
 - Freshwater
 - Saltwater
 - Vernal pool
 - Wet meadow
 - Wet prairie
-
- Construction site
 - Extractive
 - Open pit
 - Underground/mine
 - Well
 - Junk/salvage yard
 - Multi-use area
 - <30% impervious surface
 - 30-60% impervious surface
 - ≥60% impervious surface
 - Open space
 - Landscaped
 - Non-landscaped
 - Boatramp
 - Building/structure
 - Industrial park
 - Marina
 - Outdoor recreation/cultural
 - Parking lot/sidewalk
 - Pier
-
- Transportation
 - Bridge
 - Railroad track
 - Roadway
 - Tunway/helipad
 - Trail
 - Utilities
 - Bush fruits/vineyards
 - Fruit/nut trees
 - Industrial forest
 - Row crops
 - Pasture
 - Improved
 - Unimproved
 - Modified grassland
 - Ornamental horticulture
 - Farmstead
 - Confined feeding operation

Step 2. Measuring the Site Attributes

During the field data collection process, information is collected on the indicators present within each map unit using datasheets with preset, defined quantitative and/or qualitative ranges (checkboxes). These indicators are basic site attributes easily recognizable to most people with fieldwork experience: total ground cover, total canopy cover, down wood, litter/duff, water depth, substrate composition, etc. These collected data are the building blocks upon which EcoMetrix’s functional and ecosystem service scoring is constructed.

Each attribute within the base data set is evaluated or scored according to how it contributes to the performance of one or more functions. As discussed earlier, scoring may be quantitative (i.e., quantity of an attribute) or qualitative (relative quality of an attribute).

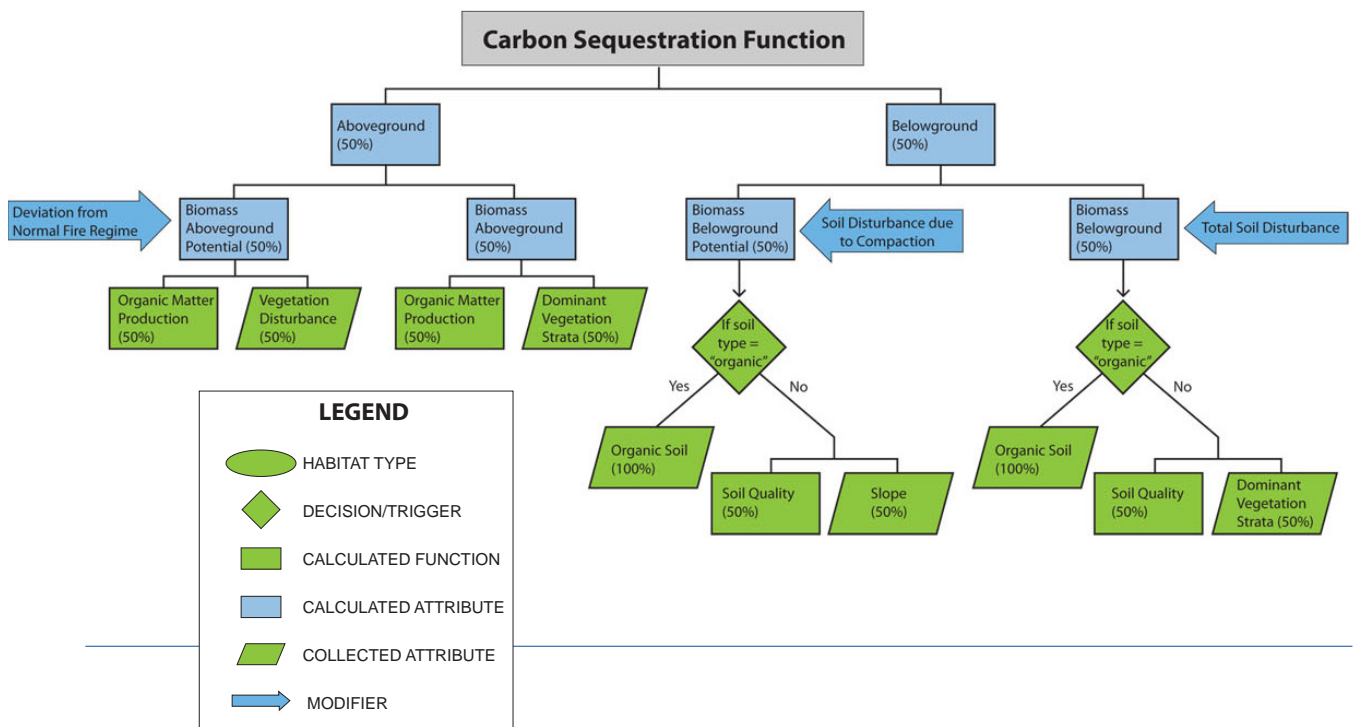
Step 3. Scoring the Ecosystem Performance

Scoring a site’s ecosystem performance simply involves entering the site data into the database. The database contains algorithms for each of the functions currently in the system. Each algorithm is developed through a standard process that includes the following steps:

1. A conceptual model (*carbon sequestration example below*) is developed to describe how the function 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.

Conceptual Model: Measuring Function Performance

Function performance is measured by gathering data on the attributes that contribute to function performance. The scores for the attributes are combined based on the conceptual model that was developed for the function.



- The identified attributes (*examples below*) are broken into quantitative, or where appropriate, qualitative ranges so that they can be measured in the field with greater sensitivity than mere presence/absence. Care is taken to not create ranges that cannot be easily repeated by subsequent data collection efforts. These attribute ranges are the data collected in the Measuring the Site Attributes section above.

Indicators

Basic attributes are broken into measurable units.

SUBSTRATE TEXTURE:

Organic Silt Sand Gravel Clay



NUMBER OF PIECES OF DOWN WOOD:

1-3 4-7 8-12 13-20 >20



TOTAL CANOPY COVER:

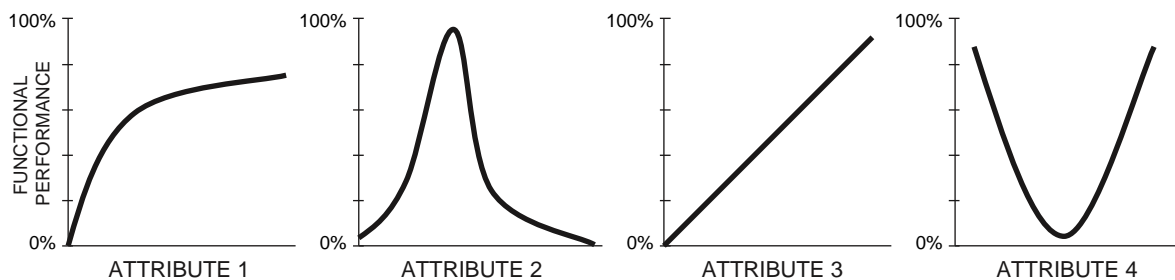
<10% 10-30% 30-60% 60-90% >90%



- Scoring curves (*examples below*) are developed for each of the quantitative and qualitative attribute ranges based on how increasing/decreasing or changing the attribute type will affect the performance of the relevant function. The scoring curves are then used to generate lookup tables that are tied to the relevant data entered from the field datasheets.

Examples of Functional Performance Scoring Curves

Scored on a 0 to 100% scale



For each function a scoring curve is developed for each of the identified attributes. Attributes have unique scoring curves developed for each of the functions to which they contribute. The scoring curves are based on available literature, expert opinion, agency guidance, monitoring feedback and best professional judgment. Above are some examples.

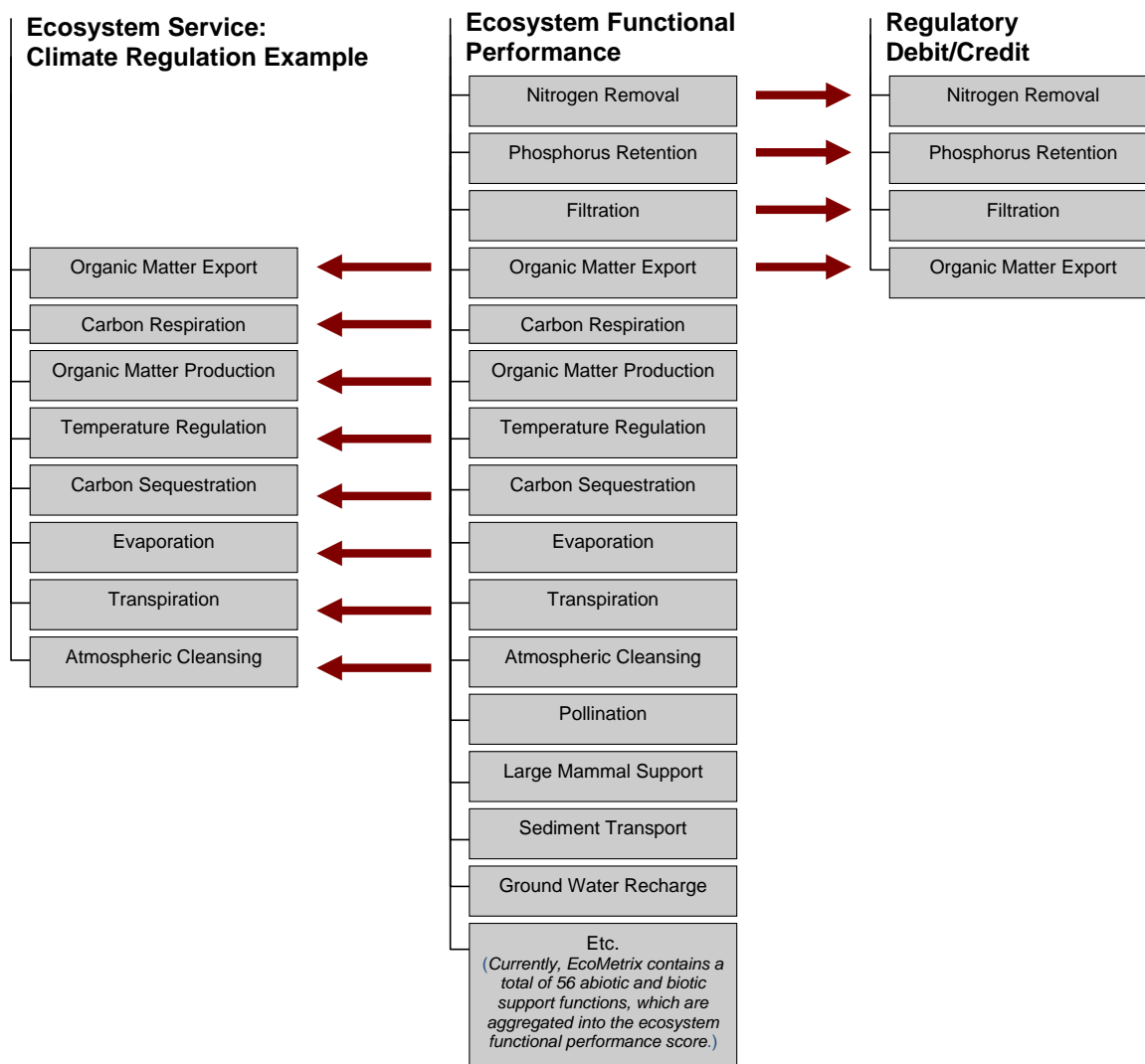
- The algorithm is then created by aggregating the attributes pursuant to the conceptual model that was developed in the first step. The database is developed by tying the algorithm to the scoring tables developed for each attribute's contribution to each function.

A Building Block Approach

EcoMetrix currently provides function scores for over 50 biotic support and abiotic (physical process) functions. Each of these functions is scored the same way—an area’s ability to perform the function is scored as a percent of optimum performance. Because all of the functions in EcoMetrix are measured in the same units, the functions can be used as building blocks to answer specific questions or measure specific resource concerns. For instance, the entire set of functions can be aggregated to provide an overall ecosystem performance score, or a subset of functions can be combined to focus on a specific regulatory issue (e.g., the functions necessary to support salmon recovery).

This building block approach makes EcoMetrix well suited to serve as a decision-support tool and Parametrix has used it in this fashion to combine functions to measure ecosystem services (e.g., climate regulation, water provisioning, water regulation, etc.). There is more information on how EcoMetrix relates to measuring ecosystem services below. The figure below shows how the function scores provided by EcoMetrix can be aggregated to serve different purposes.

Aggregating Functions



Stacking and Double-Dipping in a Debit and Credit Context

Ecosystem functions and services have interconnected relationships that can be complementary, conflicting, or magnified based on their interactions. The ability to measure multiple resources and services at once is a critical function in EcoMetrix, particularly when used to generate credits that will be bought or sold in a mitigation or ecosystem marketplace context. By working at the most basic level of environmental measurements, EcoMetrix provides a system that can “stack” or combine multiple credit types or resources and, at the same time, assures that credits are used only as approved and allowed. This stacking function allows for the interactions of the natural elements to be more fully measured.

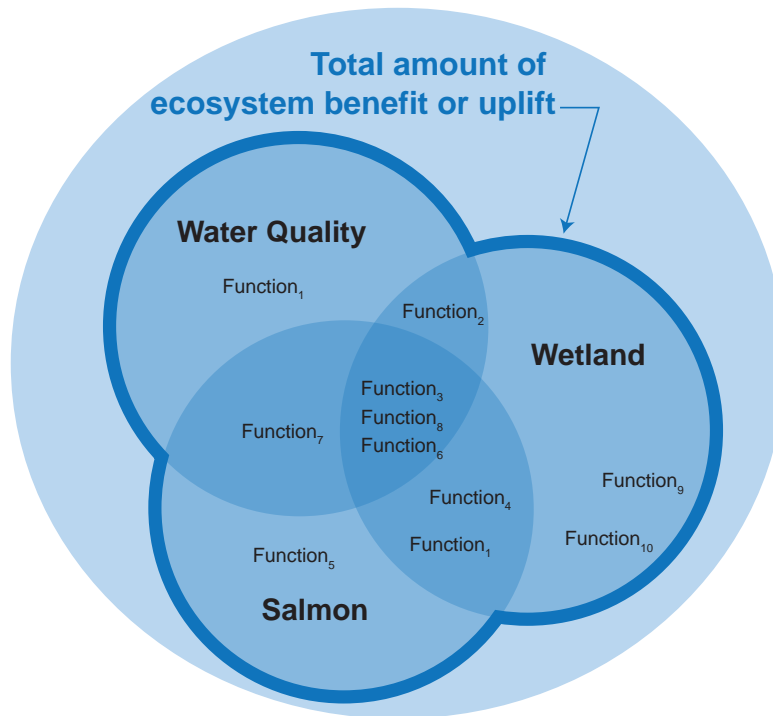
Incentives for investing in conservation and restoration actions that generate a wide variety of ecosystem benefits are currently missing in regulation-driven, acreage-based credit systems. Generally, once a site meets the minimum regulatory requirements for mitigation of a given resource, all potential additional benefits provided by the site are ignored or forgotten. But with a “stacking” credit system, the proper incentives for conservation can be introduced, as the benefits of an action to all resources become clear. Similarly, in an impact context, stacking allows the effects on resources to be better understood.

Stacking requires strict accounting to prevent the use of credits to offset impacts of multiple projects. In a regulatory context, this is critically important. Through the function-based nature of EcoMetrix credits, individual functions are assigned to the credit type that must be audited. This ties the constituent components of the credit together, ensuring that credits are not used repeatedly in different transactions (double-dipping).

The diagram at right shows several overlapping circles, each of which represents an amount of restoration benefit (uplift) expected to result from restoration actions on a hypothetical mitigation site. Each type of uplift reflects improvements to resources (water quality, wetlands, salmon) regulated within a specific regulatory context. For each one, ecosystem markets exist, thus enabling the buying and selling of credits generated from the uplift activities.

In order to allow for multiple types of credits to be generated from the same site, controls need to be in place to keep a given credit from being sold more than one time (as has happened in the carbon market). EcoMetrix’s ability to provide these controls is based on the way uplift is calculated—by using functional performance measurements. If we look at all of the circles of this diagram together, the outside edge (traced without moving into any circle) defines the total amount of ecosystem benefit or uplift that has been provided by these services. However, this may not be equal to the actual total amount of ecosystem benefit provided by the site, because there are overlaps that may provide even greater

EcoMetrix Prevents a Given Credit from Being Sold More Than One Times



benefit as a sum than do any of the parts. Within the wetland circle, for example, a subset of functions also contributes to water quality. However, in current regulatory schemes, these benefits are recognized in only one context: water quality or wetlands, but not both. In order to allow for this recognition, while preventing a given credit to be sold for two different projects, EcoMetrix is designed to structure accounting for the debit-credit sales such that, for every transaction, it tracks both the total ecosystem debit and credit and the specific regulatory debits and credits.

Functionally, EcoMetrix makes this tracking simple because, since one set of attribute data is collected and used to calculate the performance of those functions, it is easy to obtain from the database a subset of function scores and the total score. Based on this quantification, the total ecosystem uplift score can be calculated for the site, and this number represents the limit of credits available for sale at a site level. Credits can then be sold from within each circle (service). Within the wetland context, for example, a landowner cannot sell more than the circle of wetland benefit that was calculated. As long as these restrictions are put in place for each of the markets and we track overall ecosystem uplift, we know when credits can no longer be sold.

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.

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.



Loss of water quality function on a property can be compared to the cost of treating that same water with engineered solutions.

Ecosystem Services

The concept of ecosystem services is that if we understand how ecosystem performance has been affected, then we can also identify social and economic consequences as well. Accordingly, we see the measurement of ecosystem services requiring a sequence of steps. These steps include the following activities:

- Measuring attributes to understand how functions are performed at a given location.
- Using our understanding of how the functions are being performed to determine the potential social and economic benefits being provided.
- Incorporating relevant landscape context information to determine a value for the services being provided (the value can be described in either monetary or non-economic terms).

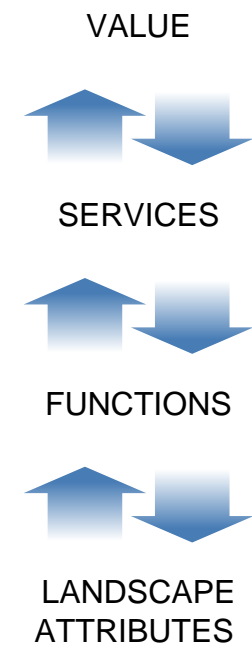
EcoMetrix provides outputs for the first two steps, which are then used to provide a robust basis for calculating the value.

While not every user will want to calculate the actual ecosystem service loss, for those that do, EcoMetrix provides a clean and simple way to understand the value and cost of decisions made about the environment. Measuring a site's level of functional performance allows us to compare that performance with the performance of engineered or replacement scenarios. Loss of water quality function on a property can be compared to the cost of treating that same water with engineered solutions. This feature allows managers to understand the true costs and benefits of decisions.

Additionally, it is a cost that is real, demonstrable, and trusted. Unlike economic valuation models that rely on complex secondary data analyses, EcoMetrix provides a simple functional score that can be compared to engineered solutions on a cost basis.

Thus, EcoMetrix allows the cost-effectiveness question to be asked and answered. Which is the best choice: the services nature provides, a lifelong commitment to an engineered solution, or both?

Elements of Ecosystem Services Analysis



Potential Applications

Application of this ecosystem services assessment and crediting approach can be used in many contexts and provides new opportunities for innovative decision making at all levels.

Measuring Impacts and Benefits using EcoMetrix allows for the following:

Strategic Planning

- Organizational sustainability planning/program development
- Design of regulatory compliance strategies
- Capital project budgeting
- Natural asset management opportunities
- Participation in ecosystem markets

Improved Decision Making

- Facility/project design siting locations
- Facility/project operational practices
- Conservation investment decisions can be assessed for ecological ROI

Regulatory Streamlining/ Risk Reduction

- Quantitative, repeatable alternatives analysis
- Documenting avoidance and minimization
- Quantifying mitigation
- Regulatory compliance
- Applications: NPDES, Section 404 CWA, ESA, MBTA, FWCA, NEPA, etc.

Monitoring and Reporting

- Permit compliance
- Mitigation tracking
- Corporate sustainability reporting

Adaptive Management

- Project-level controls
- Program-level controls
- Organization-level controls

Stewardship

- Documented results used to realize recognition for avoidance and minimization efforts
- Measure and get “credit” for co-benefits provided
- Ability to weight decisions to reflect societal values
- Tangible documentation of where investment dollars are spent and whether or not adequate ROI is attained
- Documenting the good things done that typically go unnoticed

Conclusion

A variety of supporting documentation has been developed to document, explain, and aid in the implementation of EcoMetrix. Please contact Parametrix for additional detail on the system and its applications. To request information, please contact:

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