Tools for Valuing Marine Ecosystem Services

This inventory summarizes the functionality of marine ecosystem services valuation tools and examples of their application.

A variety of modeling tools provide resource managers and stakeholders with the capabilities to assign, analyze, and compare the value of marine ecosystem services (MES). Several of these valuation tools exist, each with its own unique parameters, scale, and applications.

Building upon previous work by other practitioners, including the Center for Ocean Solutions,[1] SeaPlan compiled an inventory of 15 marine ecosystem services valuation tools to highlight the range in technical capabilities and applications. This inventory includes tools that have been used for several years in many applications, and others that have only been more recently developed. We present each tool along with hyperlinks to the host website and example study publication, a brief description, and other supplementary information.

Tool	Tool Description	Tool Developer	Example Study	Study Scale	Study Publication	Additional Study Notes
ARIES	ARtificial Intelligence for Ecosystem Services (ARIES) is an open-source modeling platform for mapping potential provision of ecosystem services and valuation through ecological process and ad hoc probabilistic Bayesian models.	ARIES Consortium	Madagascar	Local	Wendland et al. 2010	Developed and tested flow models for marine ecosystem services constructed for subsistence fisheries and coastal storm regulation in order to target incentivized basis of biodiversity preservation and ecosystem service conservation.
Atlantis	Atlantis is a deterministic whole-ecosystem model, with sub-models for biophysical ecological processes, exploitation, sampling/assessment, and rules/management actions to fully cover adaptive management cycle.	Commonwealth Scientific and Industrial Research Organization (CSIRO)	California Current	Ecosystem	Kaplan et al. 2012	Strategic exploration of broad fishery management options for both groundfish and ecosystem services in the California Current. Status quo management was examined along with 20-year projections of several gear switching and spatial management scenarios.
BVMtool	Tool for Marine Biological Valuation Mapping (BVMtool) is a set of R scripts that automate marine biological valuation calculations based on species density observations data displayed as raster grid cells or habitat classification polygons.	Flanders Marine Institute	Belgian North Sea Coast	Coastal Zone	Vanden Eede et al. 2014	Integrated study on nature's intrinsic value in intertidal and subtidal coastal subzones, relative to each other, using R scripts. Script outputs are biological valuation maps for use as management tools and allow for integration of these values early in policy implementation.

---

[1] The Center for Ocean Solutions, 2011*, Decision Guide: Selecting Decision Support Tools for Marine Spatial Planning*, The Woods Institute for the Environment, Stanford University, CA.

Tool	Tool Description	Tool Developer	Example Study	Study Scale	Study Publication	Additional Study Notes
Coastal Capital Valuation Tool	Coastal Capital Valuation Tool was developed for Caribbean communities to measure valuation for tourism, recreation, and fisheries, and the economic impact of Marine Protected Areas (MPAs).	World Resources Institute	Caribbean Sea	Regional	Waite et al. 2014	Excel Macros that, when given data on fisheries, coral reefs, mangroves, tourism & recreation, and MPAs, use set equations to produce monetary valuations of these services specific to the Caribbean region.
Envision	Envision is an open-source GIS-based tool for scenario-based integrated planning assessments. The platform integrates a variety of spatially explicit models of landscape change processes and production for alternative futures analyses.	Oregon State University	Bainbridge Island, Washington, USA	Local	PNNL Marine Science Lab 2006	Calculated metrics for aquatic ecosystem function, including fish spawning areas, habitat types, and shellfish presence per drift cell or management zone, to guide appropriate restoration action.
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) is a suite of open-source spatially-explicit software models that use maps and other information to value ecosystem services in resulting biophysical or economic terms.	Natural Capital Project	Belize	Coastal Zone	Clarke et al. 2013	Integrated coastal zone management plan for Belize designed with seven scenarios to depict ecosystems services outcomes under planning options at the local level. InVEST models on habitat risk assessment, coastal protection, recreation, and spiny lobster used to assess change in ecosystem services.
InVitro	InVitro is an agent-based ecosystem-level management strategy evaluation modeling framework used to consider multiple use management questions for the marine environment.	CSIRO	Northwest Shelf Australia	Sub-Regional	NWSJEMS 2010	Single-sector biophysical and resource exploitation sub-models combined with models of management operations to capture whole system dynamics. Simulates the effects of human activity in an economically and ecologically important region of Australia.
Madrona	Madrona is a flexible set of hierarchical data layers, spatial features, and software for decision support and area-based planning with various levels of models and analysis.	Ecotrust	Mid-Atlantic Region, USA	Regional	MARCO Mid-Atlantic Ocean Data Portal	Integrates a number of data layers published by ESRI, NOAA, and The Nature Conservancy. In addition to the ArcGIS, Arc2Earth, and OpenLayers data publishing workflow, this project takes advantage of tools and technologies including Tilemill, Tilestache, Knockout JS, and UTF-grids.

Tool	Tool Description	Tool Developer	Example Study	Study Scale	Study Publication	Additional Study Notes
Marxan	Marxan is a conservation planning software that provides decision support in new reserve design, reserve performance, and developing multiple-use zoning plans for natural resource allocation management.	University of Queensland	British Columbia, CAN	Sub-Regional	British Columbia sub-regional marine plans	Ecosystem-based framework to designate a hierarchy of zones into three management levels (general, special, and protected) according to extensive stakeholder input, biophysical, and economic data. Siting of each zone was based on tradeoff analyses for least conflict and optimal effect among uses.
MIMES	Multi-scale Integrated Models of Ecosystem Services (MIMES) is a set of models that assess the value of ecosystem services in addressing ecosystem dynamics, human well-being from services, and how various management scenarios affect valuation.	University of Vermont Gund Institute for Ecological Economics	Massachusetts Bay, USA	Regional	Altman et al. 2012	Ecosystem service tradeoffs (wind energy development, forage fish fishery, and bottom habitat disturbance) were outlined in detail through a narrative document to organize necessary information. Development relied heavily on these narratives to provide a detailed outline of ecological and economic flows and to translate these into modeled equations.
RIOS	Resource Investment Optimization System (RIOS) is a watershed management tool that combines biophysical, social, and economic data to help users identify the best locations for protection and restoration activities to maximize ecological return on investment (ROI).	Natural Capital Project	Upper Tana Basin, KEN	Watershed	The Nature Conservancy 2015	Analysis focused on the benefits that would arise from a $10 million investment over a 10 year period focusing on sediment retention and the maintenance of base flows in three priority sub-watersheds. Results projected a 50% reduction in sediment concentration, a 15% increase in annual water yields, and an expected ROI of $21.5 million over 30 years.
SERVES	Simple and Effective Resource for Valuing Ecosystem Services (SERVES) is an internal tool for calculating the economic value of natural capital, intended to realign economic incentives with ecological and financial sustainability.	Earth Economics	Long Island Sound Basin, USA	Coastal Zone	Kocian et al. 2015	Study valued 14 (of 21) ecosystem services present in the Basin, and a benefit transfer methodology was applied using over 40 primary ecological economic valuation studies from the US East Coast. Studies made use of multiple valuation methodologies, including market pricing, cost avoidance, replacement cost, travel cost, hedonic values, and contingent valuation.
SolVES	Social Values for Ecosystem Services (SolVES) uses a quantitative 'value-index' from spatial and non-spatial information to calculate underlying metrics of the environment and assess, map, and quantify social values of ecosystem services.	Rocky Mountain Geographic Science Center, Colorado State University	Hinchinbrook Island National Park, AUS	Local	Van Riper et al. 2012	Examined statistically significant spatial clustering across two subgroups of the survey population for three value types that reflect recreation, biological diversity, and aesthetic qualities. The relationship between the relative importance of social values for ecosystem services and spatially-defined ecological data is explored to guide management decision making.

Tool	Tool Description	Tool Developer	Example Study	Study Scale	Study Publication	Additional Study Notes
Vista	Vista is an ArcGIS extension for advanced spatial analysis to integrate conservation with planning, ecosystem-based management, ecosystem-based adaptation, and scenario-based planning.	NatureServe	Eastern Shore, VA, USA	Regional	Crist et al. 2012	Current baseline and three future scenarios for the years 2025, 2050, and 2100 were evaluated by intersecting priority resource distributions with each of the spatially defined scenarios to predict effects of stressors on resources. Habitat- and species-based priority resources were examined, as well as the potential impacts of sea level rise on critical infrastructure.
Zonation	Zonation produces a hierarchical landscape prioritization based on occurrence level of biodiversity features and iteratively removing least valuable remaining cell while accounting for connectivity and complementarity.	Conservation Biology Informatics Group - University of Helsinki	New Zealand	National	Leathwick et al. 2008	Analyzed distributions of 96 demersal fish species through statistical learning and conservation prioritization to produce MPA scenarios with varying costs and benefits for New Zealand's Exclusive Economic Zone, conservation, and fisheries.