

Using Ecosystem Services to Increase Progress Toward, and Quantify the Benefits of Multiple CBP Outcomes



STAC Workshop Report

March 16, 2023

April 18, 2023

June 6, 2023



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About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. For additional information about STAC, please visit the STAC website at <http://www.chesapeake.org/stac>.

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Executive Summary

“Ecosystem services” are the benefits ecosystems provide to people. These benefits include providing food, clean air, clean water, recreation, and many other explicit or intrinsic values to people and communities. Investments in Chesapeake Bay restoration are typically designed to improve water quality, given the legal requirements of the Clean Water Act. The Chesapeake Bay Watershed Agreement sets goals that encompass a wide range of ecosystem services. A narrow focus on water quality can result in the implementation of practices and policies that maximize nutrient and sediment reductions at the expense of feasible alternatives that offer greater ecosystem services or multiple benefits to living resources and communities.

This workshop was designed to gather input from a diverse array of stakeholders to help shape a coherent framework to identify impactful and durable ways to embed ecosystem services considerations in decision-making. This framework is critical to drive change for both the Chesapeake Bay Total Maximum Daily Load (TMDL) and for multiple lagging outcomes in the 2014 Watershed Agreement that provide ecosystem service benefits beyond water quality. As jurisdictions are doubling down on their efforts to meet the TMDL 2025 target date and large investments are being made in environmental restoration and conservation, there is an opportunity to work strategically to achieve a broader set of goals for ecosystems and communities.

The workshop was organized as three 1-day sessions between March 2023 and June 2023: Day 1, Day 1.5, and Day 2. Day 1 convened a blend of ecosystem services practitioners and decision-makers and featured several presentations describing ecosystem service tools, information and applications. Day 1.5 was added to include a broader diversity of perspectives and dive deeper into opportunities and barriers to ecosystem service accounting, ideas and tools to incorporate ecosystem services into decision-making, and to identify the best audiences for ecosystem services benefits. On the final workshop day, Day 2, participants synthesized input from Day 1 and Day 1.5 into recommendations on how Bay Program partners and others can best achieve and incentivize multiple benefits as states and local decision-makers implement Watershed Implementation Plans (WIPs), or other action plans.

Findings and Recommendations:

The following six recommendations emerged from the discussions at the workshop. These are cross-cutting recommendations that address multiple levers of change for increasing the consideration of ecosystem services throughout the Chesapeake Bay Program.

Recommendation #1: Develop a tool that quantifies ecosystem services currently being provided across the Chesapeake Bay Watershed. Bay Program partners, with coordination by the Chesapeake Bay Program Office (CBPO), should adopt an accounting framework and develop an associated platform that quantifies a set of priority ecosystem services at appropriate spatial scales (e.g., parcel-scale, land-river segment, project-scale) across the Chesapeake Bay watershed, using science-based, standardized methods.

Recommendation #2: Build capacity to support the integration of ecosystem services throughout the Chesapeake Bay Program. CBPO should build internal capacity by adding personnel who are dedicated to providing technical support in the use and potential applications

of ecosystem service tools and supporting integration of ecosystem services throughout the partnership.

Recommendation #3: Develop a framework for quantifying the ecosystem service impacts of select best management practices (BMPs). CBPO should spearhead a partnership effort to complete quantification of ecosystem service impacts for a subset of BMPs and explore how best to model the ecosystem service impacts of those BMPs using an existing or new planning tool (e.g., CAST or the new tool developed in response to recommendation #1).

Recommendation #4: Improve consideration of ecosystem services in land use planning and decision-making. Bay Program partners (federal and state agencies) and local governments should identify opportunities to strengthen policies, incentives, and crediting to improve the consideration of ecosystem services in land use decision-making and planning, including restoration and conservation planning.

Recommendation #5: Improve consideration of ecosystem services in the funding and financing of Chesapeake Bay restoration activities. The Bay Program and funding/financing partners should embrace opportunities to improve internal funding decisions and to leverage funding from emerging ecosystem service markets to accelerate conservation and implementation of priority restoration practices

Recommendation #6: Identify and follow pathways to improve institutional structures and supporting policies to better integrate ecosystem services into the next phase of the Chesapeake Bay Program beyond 2025. Building on the identified opportunities and recommendations in this report, the Beyond 2025 Steering Committee should explore how to incorporate and prioritize ecosystem services and multiple-outcome efforts in the partnership's continued and renewed efforts toward Agreement goals and outcomes beyond 2025.

1. Introduction

1.1 Workshop Objectives and Purpose

The Chesapeake Bay Program (CBP) could benefit in multiple ways from a strategic plan to incorporate ecosystem services (ES) into its current decision framework, tools, and engagement with local partners. Multiple partners have expressed interest in guidance for applying ES information to enhance implementation of restoration and conservation activities and quantify diverse benefits. Such a plan will enable the CBP to take advantage of ongoing efforts and new datasets to better identify, assess, and communicate the multiple benefits of restoration and conservation activities in the Bay watershed. Several ongoing ES projects are advancing the recommendations of a 2017 Scientific and Technical Advisory Committee (STAC) workshop report (McGee et al. 2017) on quantifying ES benefits of management actions, including a soon-to-be-published STAC workshop report on crediting best management practices (BMPs) to inform wetland restoration.

This effort is a response to a clear next step to bring together ES researchers and CBP partners to interact with a broad set of CBP stakeholders on how best to apply recent findings/data on ES for decision-making. This discussion can be used to develop a strategic plan to accelerate progress toward multiple CBP outcomes of the Chesapeake Bay Watershed Agreement. The need for a strategic use of ES results is urgent:

- CBP workgroups are carrying out work plans for each of the 31 outcomes with very few approaches to collectively address two or more outcomes.
- Recent funding increases from various federal and state programs, including the Infrastructure Investment and Jobs Act (P.L. 117-58), aka The Bipartisan Infrastructure Law (BIL), provides opportunities to accelerate progress toward water quality implementation that can benefit multiple outcomes that need to be met by 2025.
- The development of the Phase 7 suite of models provides opportunities to expand beyond a water quality focus and address other CBP outcomes.

Within this context the workshop had two primary objectives: (1) engage investigators with stakeholders on effective application of new ES results into tools and decision-making at multiple levels, and (2) develop recommendations for an actionable work plan of how ecosystem services can be used to address multiple CBP outcomes. This plan allows for the steering committee to provide recommendations for both short-term applications of ecosystem services into tools (between 2023-2025), as well as longer-term improvements based on research needs identified at the workshop.

The purpose of the workshop was for experts to engage with stakeholders, gain insights into the specific ES and use cases that are of most importance and provide recommendations for a strategic plan to more effectively use ES to address multiple CBP outcomes through 2025 and beyond.

1.2 Management Relevance

The 2014 Chesapeake Bay Watershed Agreement (2014 Bay Agreement) has a total of 10 goals and 31 outcomes, with only two relating directly to water quality. Yet the regulatory nature of the Chesapeake Bay Total Maximum Daily Load ([TMDL](#)) puts the focus squarely on the reduction of nitrogen, phosphorus and sediment. The accountability framework and system used to track progress on these via the Chesapeake Assessment Scenario Tool ([CAST](#)) has a built-in incentive for cost-effective pollution reductions of nitrogen, phosphorus and sediment. Stakeholders implementing state Watershed Implementation Plans ([WIPs](#)) and local decision-makers at the local level often use CAST to select BMPs to meet their regulatory obligations.

Incorporating ecosystem service value is a way to rebalance the focus on achieving more holistic outcomes that attain multiple benefits for living resources and people, while also improving water quality. Local decision-makers want to understand their options. The CBP already develops a variety of decision-support tools and science synthesis products. Workshop discussions helped inform how to quantify and reflect the values of ecosystem services so that they may be embedded in CBP tools and match the needs of diverse stakeholders. The CBP can help drive the behavior change needed to support achieving multiple goals by making it easier to access and consider these additional values and structure decision-making in an integrated way by using our accounting and grant structures to incentivize and reward broader consideration of multiple benefits.

1.3 Urgency and Time Relevance

Ecosystem services have begun to be characterized in TMDL decision support tools, such as [CAST](#). However, much work remains to enable credible site-specific accounting of co-benefits of nutrient and sediment reduction projects or total benefits of restoration actions. Adding urgency to this task is recent guidance from the Biden Administration to “advance and strengthen” accounting for ecosystem services in government decision-making (see Revesz and Prabhakar 2023) ([Accounting for Ecosystem Services in Benefit-Cost Analysis](#)). The [federal guidance](#) is primarily intended to support regulatory analysis but will also inform other types of federal decisions and be used when assessing benefits of federal projects and programs. The guidance directs agencies to be thorough in accounting for the ecosystem service benefits and harms of proposed actions but also asks agencies to develop their own specific methods to monetize, quantify or describe benefits. Similar to other federal guidance, it suggests that valuing changes in monetary units is preferred but acknowledges that quantification and description will be needed to overcome data gaps.

This STAC workshop addressed stakeholder goals to quantify the benefits of ecosystem services that are currently being enhanced through the Chesapeake Bay restoration effort and to clarify opportunities to increase ecosystem service co-benefits through choice of project type and locations. As the CBP seeks to address lagging outcomes across all the Watershed Agreement Goals, decision tools can be useful for identifying cost-effective project options that address multiple goals simultaneously. Such tools might also help decision-makers find the most cost-effective locations to meet individual goals.

1.4 Workshop Format

The workshop was organized within three sessions between March 2023 and June 2023. Sessions were conducted as 1-day in-person events with an option for virtual participation. Detailed agendas for each day can be found in [Appendix A](#). The list of workshop participants can be found in [Appendix B](#).

On Day 1 (March 16, 2023), a blend of ecosystem services practitioners and decision-makers convened to present their relevant experiences with respect to ecosystem services information and how they have used it. A pre-workshop survey, [Appendix C](#), was used to better understand the affiliations and decision-making roles of participants, and their initial perspectives on ecosystem services. Mentimeter, an interactive online tool for meeting polling, was used as a workshop icebreaker to get participants to start thinking about their own favorite ways to interact with nature ([Appendix D1](#)). Invited speakers provided examples of i) approaches for quantifying, mapping, and visualizing ecosystem services as part of Chesapeake Bay environmental planning efforts, ii) case studies highlighting feasible approaches, and iii) stakeholder perspectives on incentives and partnerships. Breakout groups allowed participants to share their own thoughts about opportunities and barriers for using ecosystem services in their own organization ([Appendix E1](#)).

Day 1.5 (April 18, 2023) was added to extend what was learned from Day 1 and include a broader diversity of perspectives. Participants were debriefed on key takeaways from the first day. Facilitated discussion with virtual whiteboard (Jamboard) was used to brainstorm and dive deeper into opportunities and barriers to ecosystem service accounting, consider ideas and tools to incorporate ecosystem services into decision-making, and discuss the best audiences for communicating about ecosystem services benefits ([Appendix E2](#)).

Day 2 (June 6, 2023) was intended to synthesize input from Days 1 and 1.5 into recommendations on how best to achieve and incentivize multiple benefits as states and local decision-makers implement WIPs, with a particular emphasis on the role the Bay Program partnership can play. Participants used a virtual whiteboard (Jamboard) to prioritize ecosystem services levers, derived from Day 1 and Day 1.5 discussions, within an impact versus effort matrix ([Appendix E3](#)). The Mentimeter online polling tool, [Appendix D2](#), was used to survey participants about the degree to which they agreed with the top identified priority levers. Participants identified priority projects ([Appendix E4](#)) for the CBP that take best advantage of ongoing efforts and discussed new datasets to better identify, assess, and communicate the multiple benefits of restoration and conservation activities in the Bay watershed.

2. Presentation Summaries

On Day 1 of the workshop, ecosystem services practitioners and decision-makers were invited to present their relevant experiences. Presentations were used to provide a starting point for workshop participants to share their own thoughts and identify initial takeaways for further discussions on Days 1.5 and 2. Presentations are briefly summarized below.

Day 1, March 16, 2023.

Presentation slides from this session are available on the [session webpage](#).

Opening Plenary — *Anna Killius (Chesapeake Bay Commission)*

Anna Killius recently joined the Chesapeake Bay Commission as its new Executive Director, coming with the perspective of a local watershed advocate and legislative staffer. Killius discussed the interplay between science (STAC) and policy (the Commission) to highlight i) that policy decisions need to be grounded in science, ii) the importance of decision-making tools in pre-determining our values. One example mentioned were the concerns raised after 2010 when the CBP transitioned to a more regulatory focus on the TMDL that land conservation goals were at risk of being left behind in deference to quantifiable nutrient and sediment pollution reduction. STAC determined there was a scientific basis for adjusting nutrient and sediment rates assigned to natural landscapes, and the Commission identified potential policy changes that would allow measurable value of the contribution of land conservation to water quality goals. But there are many other values at play in communities and for decision-makers beyond pollution reduction and land conservation, including economic factors, resilience concerns, public health challenges, and historical or cultural assets. There are opportunities rising now to diversify the Bay portfolio and bring more ecosystem services into decision-making.

The Bay Program is already diversifying by spreading efforts across multiple outcomes but still needs to seek ways to improve on that diversification by making sure outcomes and the strategies to achieve them are more complementary, working together to maximize gains and limit losses when any one outcome falls short. Examples include linking forest buffer targets to cooler streams and expanded brook trout habitat, setting wetland goals to meet climate adaptation needs of at-risk communities, or measuring oyster reef restoration in terms of water filtration capacity. Ecosystem services can also help to diversify investors and attract more resources, grants, and funding opportunities, and get more people on board and excited about the work by speaking to their local needs and quality of life, especially in headwater localities. To head off conflicts, ecosystem services analysis needs to be easy to access, easy to use, and used as early in the development process as possible – to make lands with more marginal ecosystem services more attractive for developers and homeowners, so that conditions are not weighing so heavily toward development of prime farms and forests. Local organization and community leaders have highlighted impacts of housing policies on environmental justice communities, which often lack greenspace, lack of shade, and poor stormwater drainage. Communities must be brought into the conversation, as benefits of conservation projects will never be fully realized unless most immediate and acute needs are being met.

Setting the Stage and Facilitated Discussion: “How can ecosystem services information serve you?” — *Jeremy Hanson (CRC), Kristin Saunders (UMCES)*

This presentation set the stage for the workshop, starting with a definition of ecosystem services as “benefits from nature, restoration or conservation activities that yield explicit or intrinsic value to a community or an ecosystem, with an emphasis on benefits accrued to communities from anything beyond the narrowest water quality lens of nutrient or sediment reductions,” and noting that the workshop considers terms such as ‘co-benefits’ or ‘multiple benefits’ to be analogous with ecosystem services.

Steering committee members, Jeremy Hanson (CRC) and Kristin Saunders (UMCES), gave an overview of the pre-workshop survey results ([Appendix C](#)), noting that more than 50% of participants were from federal or state government, the majority of participants were either researchers (37%) or program managers (33%), and that more than 90% of participants agreed with the statement that “ecosystem services are important to communicate to communities to achieve restoration goals.” All participants (100%) identified that they already consider ecosystem services in their decision-making or projects, with 66% saying they always or often do. Ecosystem services information has been used by participants in a variety of ways, including communicating with stakeholders (29%), quantifying project benefits (20%), project siting (17%), practice selection (14%), and funding (14%). I-Tree, InVEST, CAST, EnviroAtlas, and Maryland Greenprint were the most cited tools commonly used by participants. Communities were considered the most important audience for ecosystem services information (25%), followed by local government and funders.

The presentation also reminded participants of recent reports on ecosystem services (TetraTech 2017, McGee et al. 2017, Rossi et al. 2023) noting there have been a lot of individual projects on ecosystem services, but it was time to tip the scales toward program-wide change.

Quantifying Ecosystem Services Benefits of Restoration & Conservation Best Management Practices in the Chesapeake Bay Watershed — *Ryann Rossi (EPA ORISE), Susan Yee (EPA)*

Ryann Rossi (EPA ORISA) presented research conducted under EPA’s Regional Sustainability and Environmental Sciences (RESES) Program, a collaboration between EPA’s Office of Research and Development and EPA’s Region 3 Chesapeake Bay Program Office. One noted potential way to improve progress toward Chesapeake Bay Watershed Agreement goals is to demonstrate how Bay restoration and conservation related actions may align with the priorities of local headwater communities upstream of the Bay, in the watersheds where they would be implemented. The study extends assessment beyond water quality outcomes (i.e., nutrient, sediment loading to the bay) by identifying and quantifying additional ecosystem services benefits that may result from habitat restoration and conservation related BMPs, particularly to communities upstream of the Bay.

The study reviewed existing management documents and worked with Chesapeake Bay Program partners to generate a target list of BMPs based on the following criteria: i) related to Watershed Agreement goals that are lagging in implementation, ii) related to habitat restoration, creation, or conservation, and iii) likely relevant to upstream or headwater communities. A total of eleven

BMPs were selected: agricultural forest buffer, agricultural grass buffer, agriculture tree planting, cover crops, forest conservation, impervious surface reduction, urban forest buffers, urban forest planting, urban tree planting, wetland creation, and wetland restoration. Next, the study used the [National Ecosystem Services Classification System](#) and [Final Ecosystem Goods and Services Scoping Tool](#), in combination with a review of Chesapeake Bay planning documents and feedback from partners, to identify a comprehensive list of ecosystem services provided by each BMP, and narrow down a subset for further assessment based on those provided by multiple BMPs and that had broad relevance across many different stakeholder groups (Rossi et al. 2022). The priority list of ecosystem services included air quality, bird species for wildlife viewing, carbon sequestration, flood control, temperature reduction, open space, pathogen reduction, pollinator supply, soil quality, and water quantity (Figure 1). Finally, the study assumed each target BMP would result in new acres of landcover based on the Chesapeake Bay Conservancy 2013-2014 landcover types assigned in CAST (e.g., natural tree canopy, low vegetation, wetland), and reviewed literature to assemble data and models to translate landcover into ecosystem services supply (Rossi et al. 2023).

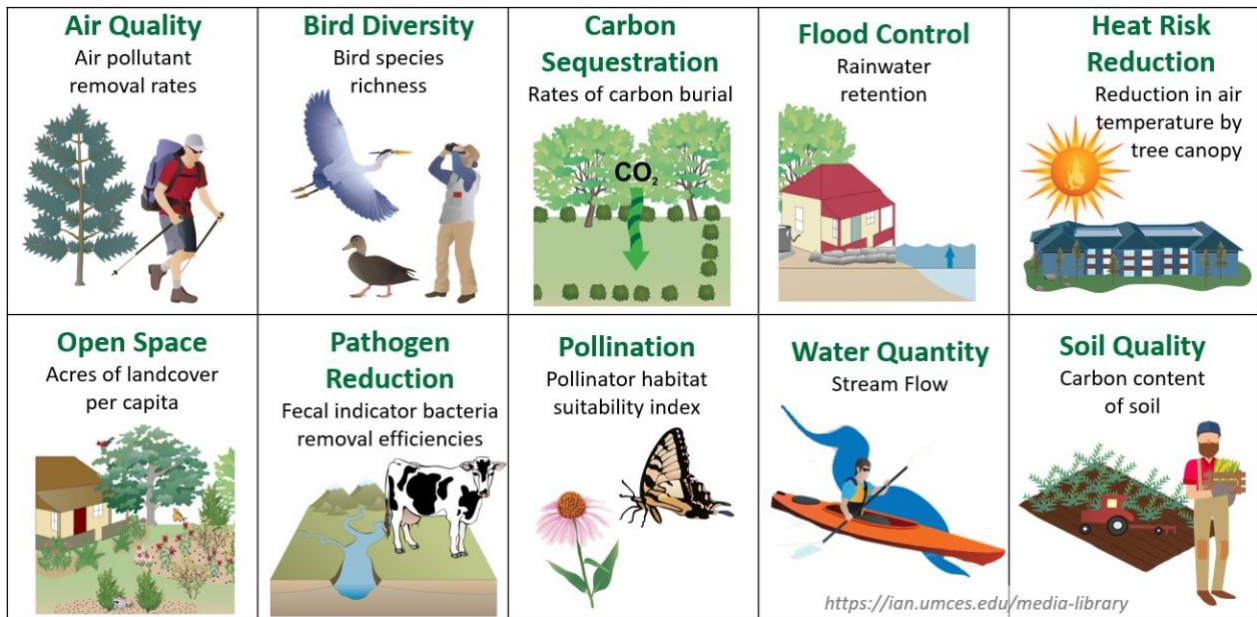


Figure 1. Ecosystem services considered in analysis of conservation/restoration-related BMPs.

The models and data are designed to work with existing tools, including CAST, a spatial modeling tool that lets users estimate nutrient reductions from BMPs, and the [Chesapeake Bay Watershed Data Dashboard](#), which allows users see information for each county in the watershed, to potentially target areas where ecosystem services could be improved. The project also recognizes how ecosystem services gained from BMP implementation could contribute, either indirectly or directly, to Watershed Agreement outcomes.

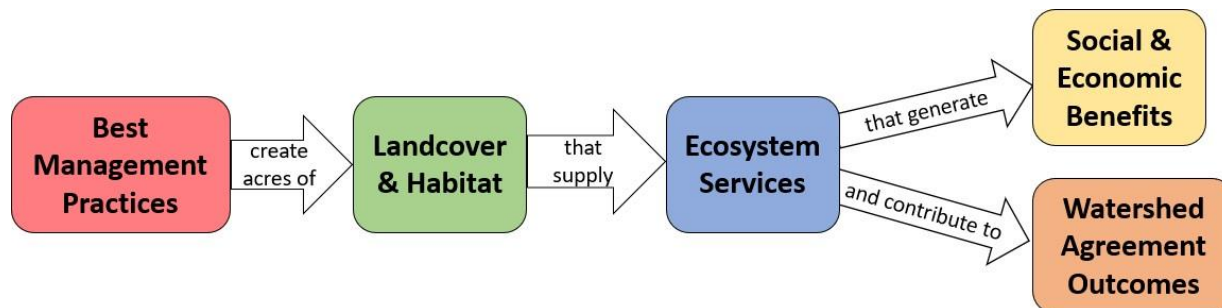


Figure 2. Connections between BMPs and benefits or watershed agreement outcomes via ecosystem services.

Quantifying ecosystem services for lagging implementation actions and connecting them with stakeholder interests can help communities understand co-benefits of different BMPs, empowering communities to participate in restoration efforts in ways that resonate with them and address their own local priorities. Figure 2 describes connections between BMPs and benefits or watershed agreement outcomes via ecosystem services.

Visualizing Ecosystem Benefits & Quantifying Carbon Sequestration for Environmental Plans — *Olivia Devereux (Devereux Consulting, Inc.)*

CAST is used for environmental planning for total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) reductions. There is a need to show the multiple benefits for environmental improvement practices and over the years, several efforts have been enacted to better visualize ES such as the [Ecosystem Benefits Browser](#) developed by the CBP on CAST. This interactive tool shows the relationship between goals, outcomes, and management practices associated with CAST BMPs. These relationships can help explain the interconnectedness of approaches to achieving multiple environmental goals. The presenter asked for feedback so that the tool could be further refined. Olivia Devereaux (Devereux Consulting, Inc.) reviewed the integration of a quantitative indicator of soil carbon sequestered for relevant water quality management practices. Devereaux discussed the status of integrating mapping functionality into CAST and noted the functionality is slated to be designed and integrated within 1-3 years.

Mapping Ecosystem Services — *John Wolf (USGS), Anne Neale (EPA)*

John Wolf (USGS) presented web mapping applications that can be used to connect ecosystem services more effectively to watershed agreement outcomes. The [Tools Targeting Portal](#), launched in Summer 2022, has a wide variety of different web mapping applications intended to help identify priority areas for implementation activities. Several examples were shown from different tools of how ecosystem services can be mapped to address various management questions at several different spatial scales, such as economic benefits of tree cover in counties, threats to natural stormwater infrastructure in catchments, and opportunities to view water resources in census blocks (Table 1). Anne Neale (EPA) provided an overview of geospatial data layers related to ecosystem services in the [EnviroAtlas](#), which includes both national data layers at the 30-meter land cover scale and community data layers for a growing subset of metropolitan areas, cities, and towns at the 1 meter land cover scale. A suite of metrics for all of EPA Region 3 based on 1 meter land cover data are currently being developed.

Table 1. Examples of applying mapping applications to address ecosystem services management questions.

Outcome	Management Question	Tool/Data	Spatial Scale	Metric
Tree Canopy	Where does tree canopy lead to the greatest reduction in temperature?	Final Ecosystem Goods and Service Mapper	County	Tree Canopy Cooling Impact
Tree Canopy	What are the economic benefits of tree cover?	Chesapeake Tree Canopy Network	County	Air Pollution removal; Reduced stormwater; Carbon sequestration
Protected Lands	Where are existing protected lands relative to a goal of 30% by 2030?	EnviroAtlas - National	HUC12	Percent protected Land (% with any IUCN status)
Public Access	Where are there opportunities to view water resources?	EnviroAtlas - Community	Census Block Group	Percent of residential population with views of the water
WIP/ Stormwater & Land Use Methods and Metrics	Where does the natural stormwater infrastructure provide protection from flooding? Where are impervious surfaces expected to increase? Where is natural stormwater infrastructure threatened by increases in impervious surface?	Maryland Healthy Watershed Assessment (derived from Maryland GreenPrint)	NHD Catchment	Economic value of flooding and stormwater; projected increase in impervious cover
Vital Habitats, Protected Lands	Are land conservation efforts protecting the best habitats?	GreenPrint Parcel Evaluation Tool	Parcel	Wildlife Habitat and Biodiversity Index Potential
Climate Resiliency, Wetlands, Black Duck	Where should we plan for future habitat migration?	InVEST Coastal Ecosystem Services for Mid-Atlantic States	Parcel/ Local	Projected coastal habitat changes

2.1 Examples of Feasible Approaches: Highlighting Case Studies

- **Accounting for Maryland’s Ecosystem Services Initiative & the Parcel Evaluation Tool** — *Elliot Campbell (Maryland DNR)*

Ecosystem services are broadly defined as “benefits gained by people from the environment” and can be categorized, evaluated, modeled, quantified, and valued in many ways. Different

applications of ecosystem services can call for certain methodological approaches, and the [Accounting for Maryland’s Ecosystem Services framework](#) prepared by the Maryland Department of Natural Resources (Maryland DNR), suggests that ecosystem services be defined as “benefits gained by people from the environment that are not already being paid for in a market and are contributing to a marginal increase in human well-being,” with the intention that the framework be used to help guide decision-making the state. The exclusion of marketed ecosystem services in the framework is not because they should not be considered, but because the framework is not necessary to establish a value; for goods like timber or agricultural products their economic value can be assessed in existing markets.

The Maryland DNR has developed [information on ecosystem services](#) in the state and displays this information on the online [GreenPrint web map](#) where a report with conservation scores and ecosystem service values can be generated for any land parcel in the state. The information is derived from peer reviewed science (Campbell 2018, Campbell et al. 2020) and is intended to inform decision-making, particularly for land conservation, in the Maryland DNR and our partners in local government, land trusts, and non-profits. The assessment reveals that ecosystem services in Maryland have a large non-market economic value, at over \$8 billion of benefits provided every year (Figure 3). New information in development at Maryland DNR in partnership with the Chesapeake Conservancy considers the potential ecosystem service benefits of ecological restoration like tree planting and wetland creation, along with vulnerability to climate change and social vulnerability. Taken together, these tools are intended to guide the state towards conservation and restoration investments that maximize ecosystem service benefits, build resilience to climate change, and are equitable, recognizing that there can be inherent trade-offs in these outcomes.

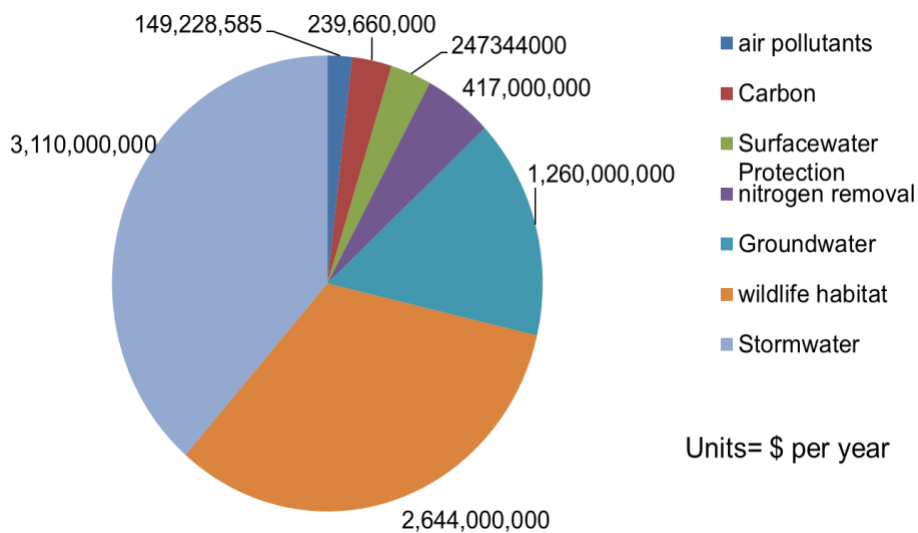


Figure 3. Total Ecosystem Service Value in Maryland in a Representative Year (Maryland DNR).

- **Mattawoman Watershed: Accounting for Ecosystem Services in Charles County, MD** — *Charles Rice (Charles County Government)*

Charles Rice, Planning Director for Charles County Maryland, provided participants with an in-

depth look at how Charles County consulted with the Maryland DNR and utilized the [Accounting for Ecosystem Services approach](#) demonstrated in the previous presentation by Elliott Campbell (MD DNR). Maryland DNR used the ecosystem service accounting method to identify and quantify ecosystem services being provided by the Mattawoman Creek Stream Valley and make the case to protect it in their [Charles County Comprehensive Plan](#). Rice noted a long and contentious history around the fast pace of development in Charles County and the management need to balance growth with protection of key natural resource areas. Stakeholders were very engaged from all perspectives to give voice to the need for growth in targeted areas balanced with preservation and conservation of the most important and precious natural resources. Providing a way to assign value and evaluate the ecosystem services of these key natural areas is an important science-based evaluation to determine the development of an area. The resulting comprehensive plan highlights the priority preservation and growth areas, with an intention to value carbon sequestration, wildlife habitat and biodiversity, air quality, stormwater mitigation, groundwater recharge, nutrient uptake and agriculture. The county was able to assign economic value to the natural resource areas and provide justification for protecting the Mattawoman Watershed.

- **Marsh Equilibrium Theory & Poplar Island: Implications for Carbon Sequestration**
— *James Morris (University of South Carolina)*

James Morris (University of South Carolina) summarized research efforts focused on evaluating the implications of marsh equilibrium theory for carbon sequestration on Poplar Island. Marsh equilibrium theory projects how marsh elevation will change in response to sea level rise. A marsh reaches equilibrium when the amount of vertical accretion (the deposition of sediments and expansion of soils in marshes) compensates for the amount of sea level rise, allowing vegetation to tolerate the mean sea level conditions. A marsh acts like a subterranean forest. Its rhizomes are like the branches in a tree canopy, its “stems and shoots” are leaves. Marshes grow biomass for at least a decade after first establishing, much like forest succession. The buildout of belowground biomass adds volume and results in higher vertical accretion rates. When the marsh matures, the accretion rate slows.

Their research found that the vertical accretion rate and carbon sequestration are proportional to net ecosystem production (gross photosynthesis minus total respiration). The rate of carbon sequestration is sensitive to the trajectory of mean sea level. Higher rates of sea level rise lead to lower rates of sequestration and lower carbon inventories. Thin layer placement of sediment (TLP) is a strategy that can increase the resilience of a marsh and increase carbon sequestration. Simulations found that there is an optimum TLP sequence that depends on the trajectory of mean sea level. However, under the current or any higher rate of sea level rise, doing nothing (not using TLP) is not a sustainable trajectory for the marsh ecosystem. This suggests some amount of TLP will be needed to ensure that marshes can remain resilient to sea level rise and continue to provide carbon sequestration and other ecosystem services.

2.2 Stakeholder Panel Discussion

- **Incentives for ecosystem services in stormwater projects using Capacity, Opportunity, Payoff & Equity (COPE) Criteria** — *Lisa Wainger (UMCES)*

Lisa Wainger (UMCES-CBL) discussed incentives for ecosystem services in stormwater projects using Capacity, Opportunity, Payoff, and Equity (COPE) criteria. The goal of this project is to improve economic incentives for stormwater projects that deliver ecosystem services co-benefits, other than nutrient and sediment runoff reductions. Research is ongoing to develop a robust ecosystem service evaluation system to examine projects proposed under the Maryland Stormwater Program (MS4). If these co-benefit incentives were implemented by regulators, permit applicants could increase the equivalent impervious acres (EIAs) received for a project if it delivers ecosystem service co-benefits beyond nutrient and sediment reductions.

The proposed COPE system (Figure 4) evaluates the relative *Capacity* of a given stormwater project (by type) to create ecosystem service benefits. Location variables are used to assess whether the site has the *Opportunity* to produce the service because stressors are present (e.g., high density of impervious cover). Location also determines the *Payoff*, which is usually the population or likely users affected by the project. Finally, *Equity* concerns provide bonus points if the project will relieve stress on (or otherwise benefit) socially vulnerable populations (e.g., areas with older populations in poverty who are most at risk from heat stress).

By providing additional EIAs for ecosystem service co-benefits, the program intends to increase the cost-effectiveness of green infrastructure projects (those containing permanent vegetation) and projects placed in locations with high potential for benefit delivery. Data on existing MS4 permits suggest that permit seekers use project cost-effectiveness, in terms of EIAs per dollar spent, as a primary criterion for selecting project types. Therefore, altering the cost-effectiveness of projects by increasing co-benefit EIAs, has potential to change project selection behavior. However, incentives will need to be sufficient to overcome any increased costs and perceived challenges of changing project type or location or may need to be used in combination with other types of support to achieve sustainability goals.

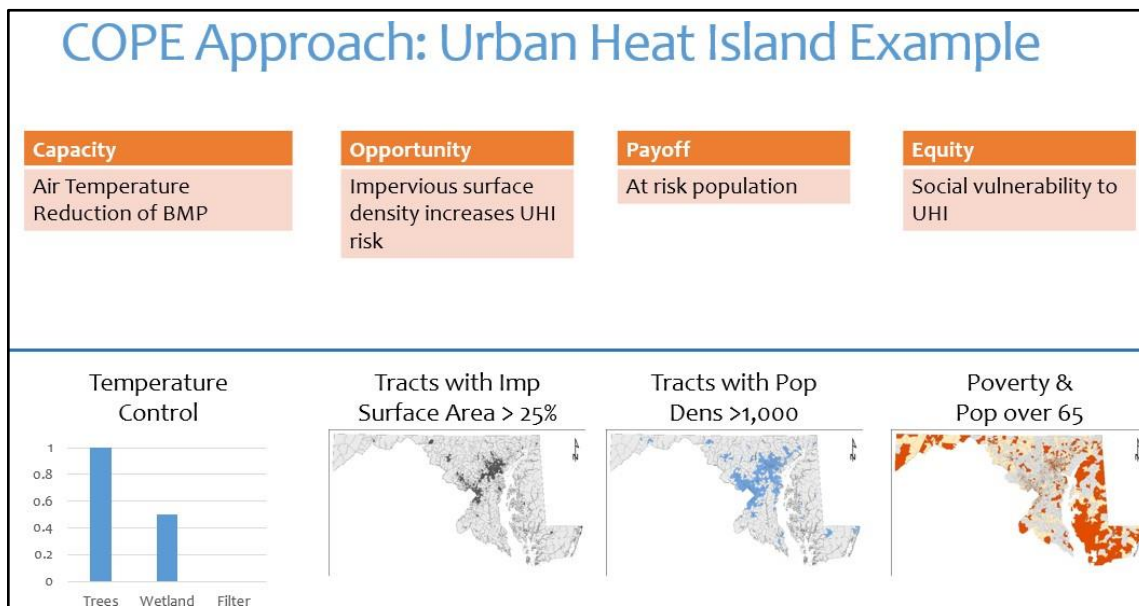


Figure 4. Example of using the COPE approach to score stormwater projects by practice type and location. An example ecosystem service of Urban Heat Island mitigation is shown. The same process is used for all relevant ecosystem services for a project.

- **Wetland Ecosystem Services: Stacking & Tracking** — *Pam Mason (VIMS)*

The [CBP Wetlands Outcome](#) is to “continually increase the capacity of wetlands to provide water quality and habitat benefits throughout the watershed. Create or reestablish 85,000 acres of tidal and non-tidal wetlands and enhance function of an additional 150,000 acres of degraded wetlands by 2025.” Pam Mason (VIMS) presented on this outcome, acknowledging specifically two of many ecosystem services provided by wetlands (tidal and nontidal). With the recent CBP accounting efforts focused on the Bay TMDL, efforts directed toward wetlands projects have diminished as these projects are often more complicated to implement due to the necessary land conversion and complex hydrological design, confounded by the need for a wetlands permit to create, restore or enhance wetlands. Accounting for the projects that are, or have, occurred is difficult as the existing CBP accounting system (tracking) is not structured to capture areal extent of the wetlands project, but rather the acreage of treatment area (watershed).

Nevertheless, practitioners and managers are looking to advance wetlands project implementation and using multiple crediting and incentives is one effective driver. This means moving away from consideration of only the potential BMP credits of wetlands toward an approach that also accounts for services such as erosion mitigation, aquatic and terrestrial habitat, rare, threatened, and endangered (RTE) species recovery, flood storage, blue carbon, cultural, recreational and aesthetics. An ecosystem services approach that can account for all potential services of a proposed wetland project (stacking) can be used to meet project proponents where they are from a mission or goal perspective and inform funding, bridge partners, and engage the public.

- **Supply-Chain Partnership for Climate-Smart Dairy BMPs** — *Mauricio Rosales (The Alliance for the Chesapeake Bay)*

The Alliance for the Chesapeake Bay partners with funders (e.g., NFWF and the Campbell Foundation) and corporations (e.g. The Hershey Company and Land O’Lakes Dairy Co-op) [to install BMPs that are beneficial to Pennsylvania dairy farms in those company’s supply chains](#) as part of [Sustainable Dairy PA](#). The efforts have focused on BMPs that benefit the producers, while reducing greenhouse gas emissions and manure nutrient loss to waterways. Mauricio Rosales (Alliance) presented on the efforts, discussing how the Alliance for the Chesapeake Bay built from previous experience in partnership with Turkey Hill Dairy and the Maryland and Virginia Milk Producers Cooperative, which established the [Clean Water Partnership](#). Under the partnership program, producers received conservation plans and were required reach compliance for Turkey Hill to purchase milk.

These efforts have continued to expand to additional partners, though funding and capacity may not always keep up with demand. Prospective partners include Organic Valley, the largest organic dairy co-op in the United States with many operations in the Chesapeake Bay watershed. Rosales mentioned that Organic Valley is keenly interested in reducing their greenhouse gas (GHG) emissions through their operations and supply chain and has a goal to reduce their carbon footprint incrementally and reach carbon neutrality by 2050.

Through these efforts to install BMPs on farms, the Alliance has worked to, when possible, cover costs that are otherwise out-of-pocket for the farmers. BMPs installed through these programs

include riparian forest buffers, streamside fencing, and animal waste storage structures. The corporate partnership model demonstrated by these efforts can produce larger scale results than may otherwise be achievable without the corporate partners. The programs' focus on practices that benefit farmers while they reduce either or both GHG emissions and nutrient loads, achieves multiple benefits for the Bay, the farmers, and corporate partners.

- **Advancing Agriculture Conservation Outcomes** — *Alex Echols (Campbell Foundation)*

Agricultural lands provide numerous ecosystem services, including collecting precipitation, habitat for endangered species, food, fiber, fuel, and scenic places to recharge. Conservation challenges in the past were more tangible for farmers to understand, such as restoration of eroded farmland. Conservation challenges today include downstream impacts at considerable distances from farmed lands, losses of farmland to other uses, and unprecedented demand for food with less land to do it on. Food production must become increasingly more efficient to adapt to declining inputs. Trust with farmers can be lost if data in Chesapeake Bay Program Office tools is antiquated or does not align with local knowledge, or if farmers feel they are being told what to do.

To address these challenges, a shift to performance-based conservation is needed that i) aligns incentives for conservation with benefits that align with individual farms or markets, ii) covers the real costs including operation and duration not just installation, and iii) advances our understanding of environmental return on investment. Technologies, such as saturated buffers, that provide very high environmental benefits to water quality, may have no on-the-farm benefits. If that water is captured and used for irrigation, then those nutrients can be returned to the soil and have direct tangible benefits on the farm. Farmers will invest in conservation practices that lead to on-the-farm benefits, but off-the-farm benefits like downstream water quality should be financed. Conservation programs must engage new funding sources, such as ecosystem services markets, lenders, insurance, or consumers. To successfully diversify funding, conservation programs must actively engage farmers and their advisors, better document environmental benefits, and align the incentives to the benefits. services markets, lenders, insurance, or consumers. To successfully diversify funding, conservation programs need to actively engage farmers and their advisors, better document environmental benefits, and align the incentives to the benefits.

3. Discussion Findings

Day 1, March 16, 2023.

The morning of Day 1 was reserved for invitation presentations and the afternoon, for participation in break out groups and plenary discussion. Participants were split into four groups, one being virtual. Breakout groups were charged with addressing the following questions:

1. Envisioning the opportunities: Share thought and vision about the opportunities ecosystem services may unlock within individual organizations and for Chesapeake Bay restoration generally.
2. Articulating the gaps and barriers: What is preventing us from using or considering ecosystem services in the work that we do?
3. What can the Bay Program do in this space? What can we do as a partnership to add value?

Key themes that emerged from breakout group discussions include the need to improve Bay Program crediting and incentives for the purpose of implementing practices that have the greatest benefits across multiple ecosystem services. Markets as well as policy and legislative tools could be used to improve crediting and incentives around practice selection. Participants identified ways to improve how stakeholders communicate about ecosystem services based on how each values various ecosystem services. Using translators and trusted sources can help ensure ecosystem services are being communicated to resonate with local audiences by focusing on ecosystem services that communities care about.

Finally, participants acknowledged that key stakeholders were missing from the Day 1 discussions, including stakeholders from the habitat, agriculture, source water protection, “in water” transition zone/living resource and private sectors. This observation informed the steering committee decision to host a planning session, Day 1.5, with a wider range of participants.

Day 1.5, April 18, 2023.

To gather broader perspectives from stakeholders missing from the first day, Day 1.5 was dedicated to discussion and collecting feedback using Jamboard. Participants were asked to address the following questions:

1. How do we improve our accounting of ecosystem service and benefits beyond nutrient and sediment load reductions?
2. How do we incorporate ecosystem services into decision-making and integrate ecosystem services into engagement?
3. What tools do we use to get ecosystem services fully considered in the work of decision support and decision-makers like WIP planners, local planners, funders, and nonprofit organizations?
4. Decision-makers: how do you best receive this information? How do you use it?
5. Who are the audiences for communicating about these ecosystem service benefits and how do we best communicate with these audiences?

Much of the discussion revolved around ways the Bay Program can “make it easier” to incorporate ecosystem services into communications and decision-making. Many expressed an interest and desire to include ecosystem service considerations but do not have the time or

bandwidth to search out information or learn to navigate multiple decision support tools. Participants again highlighted the need to provide better incentives for managers to implement practices that will provide more ecosystem service benefits. One workshop participant commented that “ecosystem services is the bridge between water quality and all the other outcomes we care about.” Developing standardized, partnership-approved approaches to quantify and account for the impacts of watershed restoration practices on key ecosystem services could provide a framework for incentivizing practices that provide greater ecosystem service benefits. As another workshop participant noted, “making the case for ecosystem services is the next big economic driver for us in agriculture.”

The Bay Program could assist local governments by providing customizable communications materials about ecosystem service benefits that could be used for community engagement and outreach. Finally, the Bay Program could improve existing tools or develop new tools to enhance access to information about the ecosystem services currently being provided by local ecosystems as well as the ecosystem service benefits provided by best management practices.

Based on these Day 1.5 discussions, the steering committee identified five primary “levers of change” that can be manipulated by various partnership actions:

- *Engagement*
- *Tools*
- *Crediting/Incentives*
- *Accounting*
- *Regulation/Planning*

Day 2, June 6, 2023.

Discussions on Day 2 were held in-person and using Jamboard. The conversation generally focused on prioritizing the five “levers of change” identified by the steering committee based on takeaways from Day 1.5. These levers were chosen for their potential for using ecosystem services information more strategically to improve the work of the Bay Program partnership. Participants were asked to rank and characterize actions for each of the levers of change by putting them in a quadrant based on their level of effort and impact (Figure 5).

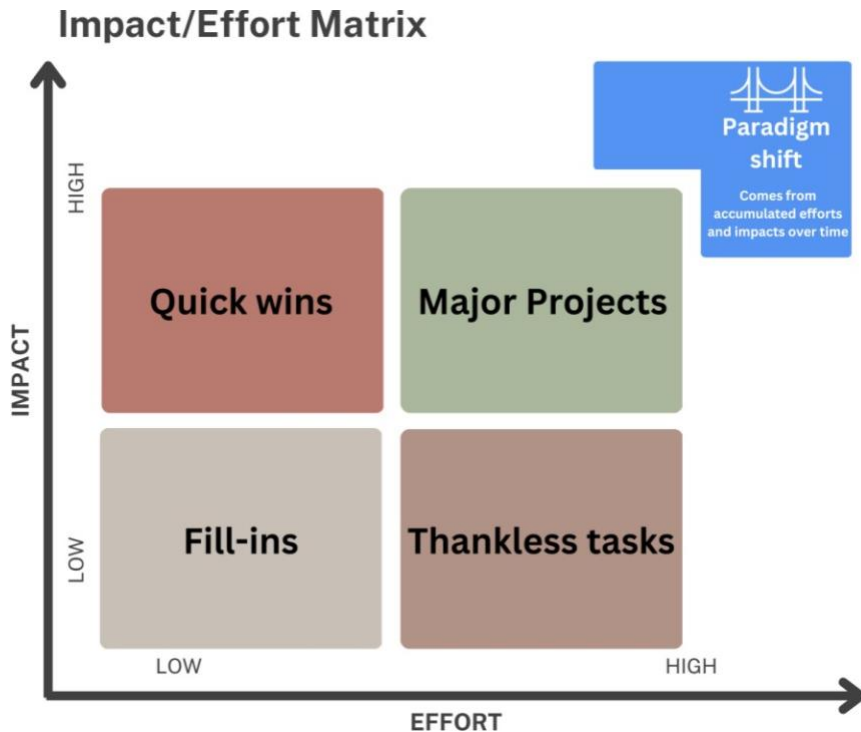


Figure 5. Impact/Effort Matrix designed by the steering committee to illustrate four generalized categories of low-high effort and impact for the ‘levers of change’ identified from Day 1.5: Engagement; Tools; Crediting/Incentives; Accounting; and Regulation/Planning.






After the prioritization exercise, participants provided more input on four high impact actions that were ranked the highest. Participant feedback is summarized below.

- *Engagement: Technical assistance with ecosystem services tools.* The CBP could create a position or team dedicated to providing technical assistance to local governments and community organizations for using ecosystem service tools. These technical assistance providers could help communities quantify ecosystem services of interest and better understand the ecosystem service implications of land use change.
- *Crediting/Incentives: Standardize and centralize our ecosystem services quantification, modeling, incentives and crediting,* while recognizing that heterogeneity across the watershed will require methods to be adaptable. The CBP should leverage existing work from EPA-ORD and others to inform these efforts and use existing platforms to centralize this information.
- *Accounting: Complete quantification of ecosystem services and populate CAST.* This will require identifying a defined set of ecosystem services and additional data to quantify the impacts of BMPs on those ecosystem services. A consideration of how to account for spatial heterogeneity across the watershed will also be needed.
- *Regulation/planning: Move ecosystem services to front of decision-making,* including project siting/design/local planning processes/ permit review. This will likely be a long-term goal that starts at the local level, developing frameworks and tools for incorporating ecosystem services into decision-making.

4. Findings and Recommendations

The following six recommendations emerged from the discussions at the workshop. These are cross-cutting recommendations that address multiple levers of change for increasing the consideration of ecosystem services throughout the Chesapeake Bay Program.

These icons will be used to identify the levers of change relevant to each recommendation:

<i>Lever</i>	Engagement	Tools	Accounting	Crediting/Incentives	Regulation
<i>Icon</i>					

Recommendation #1: Develop a tool that quantifies ecosystem services currently being provided across the Chesapeake Bay Watershed. Bay Program partners, with coordination by the Chesapeake Bay Program Office (CBPO), should adopt an accounting framework and develop an associated platform that quantifies a set of priority ecosystem services at appropriate spatial scales (e.g., parcel-scale, land-river segment, project-scale) across the Chesapeake Bay watershed, using science-based, standardized methods.



- Engage with diverse stakeholders about decision support needs to identify preferred outputs to help define the appropriate accounting framework and structure for the associated platform.
- Include biophysical indicators in addition to values to serve different goals; summaries of monetary values of ES were seen as desirable by many workshop participants.
- Ensure the new tool aligns with existing protocols for quantifying and valuing ecosystem services.

Stakeholders indicated throughout the workshop sessions that they were more likely to consider ecosystem services in their decisions if there was a centralized place or set of tools that were easy to use and a common way to understand the ecosystem services and tradeoffs they needed to weigh. Some stakeholders who saw Maryland’s GreenPrint model expressed interest in seeing a similar tool built out across the watershed and indicated they would use it if it were to become available. Some stakeholders expressed interest in tools with clear methods and location-specific information. Tools that evaluate ES by evaluating details of site quality and landscape context can support decisions on site-by-site tradeoffs or inform BMP choices.

Recommendation #2: Build capacity to support the integration of ecosystem services throughout the Chesapeake Bay Program. CBPO should build internal capacity by adding personnel who are dedicated to providing technical support in the use and potential applications of ecosystem service tools and supporting integration of ecosystem services throughout the partnership.



- Develop a Chesapeake Bay ecosystem services communication toolbox. This could include compiling and disseminating use cases, developing customizable communications materials, and providing information about behavior change and social marketing campaigns.
- Provide additional support to train specific programmatic staff from Chesapeake Bay watershed states/jurisdictions on how to integrate ecosystem service tools into their work. For example, the Bay Program could help “train the trainers”, provide tool concierges to support tool users, and develop online resources to share information about ecosystem service tools across the partnership
- Identify opportunities to provide more targeted technical assistance for practices that generate the greatest ecosystem service benefits, including those benefits that are most relevant to local farmers and communities

As an integral member of the CBP partnership, the CBPO needs to have dedicated staff that champion the integration of ecosystem services throughout the CBP. Additionally, having available staff time to provide technical assistance for the use and development of potential applications of existing and future ecosystem service tools is essential for their use. Effective communication about how these ecosystem service tools work, both internally at the CPBO and across the partnership, will help to ensure that the right portfolio of ecosystem service tools get shared with the right user groups. Place-based use cases, communication materials, social marketing campaigns, and additional resources can support CBPO staff with outreach to Chesapeake Bay Program partners, workgroups, and organizations as they work with members of the general public to consider ecosystem services as a part of management actions and implementation activities. Additional CBPO staff technical support through staff training sessions will help inform local, on the ground decision-making through the use of these tools. Matching the right tool with the right audience who has direct connections to local, community decision-making and/or landowner decisions will be key to the success of this initiative.

Recommendation #3: Develop a framework for quantifying the ecosystem service impacts of select BMPs. CBPO should spearhead a partnership effort to complete quantification of ecosystem service impacts for a subset of BMPs and explore how best to model the ecosystem service impacts of those BMPs using an existing or new planning tool (e.g., CAST or the new tool developed in response to recommendation #1).



- Identify application ready (or near-ready) existing ecosystem services information (e.g.,

Rossi et al. 2023, COMET Planner, MD GreenPrint) that can be standardized across the Bay watershed, and integrated into a BMP planning tool (e.g., CAST). Ensure ecosystem services quantification is spatially compatible with spatial scales of BMP implementation (e.g., local, county, state) across a spatially heterogeneous watershed.

- Identify and develop approaches to model additional key regulated, market-relevant, or incentivized ecosystem services over the longer-term. Prioritize initial quantification for BMPs most likely to provide multiple benefits and expand to the full list of BMPs over the longer-term.
- Build out and improve related BMP planning products tailored to non-model users (e.g., fact sheets, communications products tailored to specific audiences, Ecosystem Benefits Browser).

The Chesapeake Bay Program has a partnership-approved tool (CAST) that partners are already using to model BMP outcomes on water quality. Although an Ecosystem Benefits Browser was recently added to this tool, which allows users to explore connections between various BMPs and ecosystem services there is still a need to quantify and account for the impacts of BMP implementation on key regulated or market-tiered ecosystem services. Integrating this ecosystem services accounting into CAST would empower Bay Program partners to prioritize the implementation of BMPs that generate multiple benefits for water quality and ecosystem services. It would also enable them to communicate about the broader ecosystem service benefits of BMP implementation to landowners, the public, and other organizations that could provide additional funding for restoration and conservation activities.

Recommendation #4: Improve consideration of ecosystem services in land use planning and decision-making. Bay Program partners (federal and state agencies) and local governments should identify opportunities to strengthen policies, incentives, and crediting to improve the consideration of ecosystem services in land use decision-making and planning, including restoration and conservation planning.



- Work with the Local Leadership Workgroup and the Local Government Advisory Committee to identify where ecosystem service values could be incorporated into local planning documents. For example, climate adaptation plans, hazard mitigation plans, local comprehensive plans, and MS4 accounting guidance could be modified to include ecosystem services. Agencies could provide model language or required sections that localities can then adopt or include.
- State and local decision-makers should identify mechanisms to discourage projects that will negatively impact lands with high ecosystem service values. For example, agencies could explore building effective incentives into permits for multi-benefit projects or develop incentives for siting development on lands with low ecosystem service value.
- The Chesapeake Bay Program should evaluate opportunities to develop an ecosystem

services crediting framework to complement the existing water quality crediting framework.

Multi-faceted incentives and crediting solutions will be needed to fully account for ecosystem services in land use decisions. The accounting framework and platform developed in response to Recommendations #1 and 3 would provide a consistent methodology for quantifying ecosystem services across the landscape and could provide the foundation for policies, incentives and crediting designed to improve consideration of ecosystem services (e.g., Wainger et al. COPE system, Day 1 stakeholder panel). With a growing population and increased pressure to convert high value lands to development, it is essential to use policies, incentives and crediting to focus development on lands with lower ecosystem service values.

Recommendation #5: Improve consideration of ecosystem services in the funding and financing of Chesapeake Bay restoration activities. *The Bay Program and funding/financing partners should embrace opportunities to improve internal funding decisions and to leverage funding from emerging ecosystem service markets to accelerate conservation and implementation of priority restoration practices.*



- States and federal agencies should identify grants and other incentives that could be modified to encourage multi-benefit projects. Federal and state grant guidance could ask grantees to demonstrate how projects or programs will impact ecosystem services (using tools like those we propose developing in Recommendations 1 and 3) and use scoring criteria rankings to incentivize projects with greater ecosystem service benefits. They could also increase cost-share for projects providing greater ecosystem service benefits.
- The CBP should convene program funders like foundations, NRCS, NFWF and CBT to identify mechanisms to prioritize BMPs that provide ecosystem services that are typically more expensive and difficult to implement. For example, they should explore how ecosystem service tools and markets can be incorporated into their grant guidance, decision criteria and cost-share amounts.
- Convene conversations between state revolving fund and finance experts to explore creative allocation of SRF investments and finance investment opportunities to draw on emerging ecosystem service markets and identify opportunities to develop new local and regional ecosystem service markets.

In the agricultural and urban sectors, cost share programs and technical assistance often focus implementation on low cost and high nutrient removal practices are often prioritized to meet the TMDL. During the workshop, stakeholders indicated that they were more likely to consider ecosystem services in their decisions if funding criteria or financial incentives were clearly driving toward a particular outcome or set of multiple benefits. In short, people were willing to invest if there was incentive to do so. Other stakeholders familiar with financial markets

indicated a true untapped potential source of funding in the ecosystem service markets that could bundle practices and existing funding sources to access and leverage financial market investment to amplify restoration and conservation. The ecosystem service tools developed in response to Recommendations 1 and 3 could provide a centralized, partnership-agreed upon framework to serve as a basis for improved funding criteria and for leveraging new sources of financing.

Recommendation #6: Identify and follow pathways to improve institutional structures and supporting policies to better integrate ecosystem services into the next phase of the Chesapeake Bay Program beyond 2025. Building on the identified opportunities and recommendations in this report, the Beyond 2025 Steering Committee should explore how to incorporate and prioritize ecosystem services and multiple-outcome efforts in the partnership's continued and renewed efforts toward Agreement goals and outcomes beyond 2025.



- *Workshop participants expressed concerns that restoration activities were concentrated on nutrient and sediment reductions rather than exploring opportunities to create multiple ecosystem service benefits.*
- The Beyond 2025 Steering Committee (B25SC) offers a transformational opportunity for the partnership to leverage ecosystem services as a conceptual bridge between gaps in the goals and outcomes of the 2014 Watershed Agreement that can support one another explicitly or implicitly.
- The longer-term recommendation is for partners to adapt the tools, information and frameworks shared and developed through partnership efforts. This would empower partners to re-envision current crediting frameworks to include more explicit consideration of ecosystem services in planning and decision-making.
- The B25 Steering Committee should consider what institutional and/or legal changes are needed to better incorporate consideration of ecosystem services into decision-making.

A key takeaway from discussions was that the Bay Program and its partners need to “make it easier” if ecosystem services are to achieve their desired potential impact as a link across all partnership goals and outcomes. Those discussions are consistent with results from a survey of the partnership that highlighted how insufficient capacity and inappropriate incentives were hindering progress on some Watershed Agreement goals (Wainger et al. 2023).

Recommendations #1 through #5 above include ideas and actions that can be molded into cross-partnership recommendations from the B25SC to the PSC, enabling a strategy to incorporate ecosystem services as a core, vanguard component of the Partnership’s evolution beyond 2025.

- In CBP’s current structure, legal requirements result in nutrients and sediments being prioritized for resource investments over other outcomes that deliver multiple benefits for ecosystems and communities. Many decisions get made based on CAST outputs for nutrients and sediments rather than evaluating broader impacts. Additional policies and incentives are needed to generate the institutional changes needed to ensure decision-makers consider ecosystem services beyond water quality.

5. Conclusions

Ecosystem services can provide an effective framework to link the restoration of ecosystems with local community priorities. This workshop demonstrated that academic, state, local and private partners are already using innovative approaches to apply ecosystem services concepts in their work.

The Bay Program has a unique opportunity to play an active role in supporting improved consideration of ecosystem services throughout the watershed restoration effort. Workshop participants verified multiple roles that the Bay Program and/or its partners could play in supporting enhanced engagement, tools, accounting, crediting and regulations/policy around ecosystem services. Improved ecosystem services integration would put the partnership on a path to leverage additional funding opportunities, achieve greater and more lasting progress toward multiple Chesapeake Bay Agreement Goals and Outcomes, and support healthy, vibrant and resilient watershed communities.

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Appendix A: Workshop Agendas



Chesapeake Bay Program's (CBP)
Scientific and Technical Advisory Committee (STAC)
**Using Ecosystem Services to Increase Progress Toward, and
Quantify the Benefits of Multiple CBP Outcomes**

Day 1: March 16, 2023

[Chesapeake Bay Beach Club](#) | Kent Island, MD

[Workshop Webpage](#)

****Exact Times Are Subject to Change****

For purposes of our workshop, “ecosystem services,” “multiple benefits,” or other similar terms, are mostly interchangeable for discussion. That said, “ecosystem services” is a more common and encompassing term that we apply throughout the agenda and our materials for convenience and consistency. For Day 1, we are applying this general definition to the term “ecosystem services:”

Benefits from nature, restoration or conservation activities that yield explicit or intrinsic value to a community or an ecosystem, with an emphasis on benefits accrued to communities from anything beyond the narrowest water quality lens of nutrient or sediment reductions.

Workshop Purpose (Days 1 and 2): To convene practitioners and decision-makers to create an action plan that can empower partners to accrue multiple, broader community benefits – beyond a focus on reducing excess nitrogen, phosphorus or sediment – through ecosystem services or similar information that can inform holistic implementation decisions in the Chesapeake Bay watershed.

- **Day 1 purpose:** To interface with a blend of stakeholders to gather their relevant experiences and needs with respect to the kind of ecosystem service information that has served them well to champion projects for broader, multiple benefits, or that would be helpful to strengthen efforts in the future.
- **Day 2 purpose [tentative]:** To synthesize input gathered through Day 1 into recommendations that can address key barriers and information gaps, with an emphasis in articulating a value-added role that the Bay Program partnership can play in relation to other actors.

9:00 am	Coffee & Light Breakfast (Provided)
9:15 am	Welcome & Introductions , <i>Sherry Witt (GDIT) and Meg Cole (CRC)</i>
9:30 am	Opening Plenary , <i>Anna Killius (Chesapeake Bay Commission)</i>
10:00 am	Setting the Stage and Facilitated Discussion: “How can ecosystem services information serve you?” , <i>Jeremy Hanson (CRC), Kristin Saunders (UMCES)</i>
10:30 am	15-minute Break
10:45 am	Quantifying Ecosystem Services Benefits of Restoration & Conservation Best Management Practices in the Chesapeake Bay Watershed , <i>Ryann Rossi (FSU), Susan Yee (EPA)</i>

11:15 am	Mapping Ecosystem Services, <i>John Wolf (USGS), Anne Neale (EPA)</i> Visualizing Ecosystem Benefits & Quantifying Carbon Sequestration for Environmental Plans, <i>Olivia Devereux (Devereux Consulting, Inc.)</i>
11:45 am	Lunch Break (Provided)
1:00 pm	<u>Examples of Feasible Approaches: Highlighting Case Studies</u> <ul style="list-style-type: none"> ● Accounting for Maryland's Ecosystem Services Initiative & the Parcel Evaluation Tool, <i>Elliot Campbell (MD DNR)</i> ● Mattawoman Watershed: Accounting for Ecosystem Services in Charles County, MD, <i>Charles Rice (Charles County Government)</i> ● Marsh Equilibrium Theory & Poplar Island: Implications for Carbon Sequestration, <i>James Morris (University of South Carolina)</i>
1:50 pm	10-minute Break
2:00 pm	<u>Stakeholder Panel Discussion</u> <ul style="list-style-type: none"> ● Incentives for ecosystem services in stormwater projects using Capacity, Opportunity, Payoff & Equity (COPE) Criteria, <i>Lisa Wainger (UMCES)</i> ● Wetland Ecosystem Services: Stacking & Tracking, <i>Pam Mason (VIMS)</i> ● Supply-Chain Partnership for Climate-Smart Dairy BMPs, <i>Mauricio Rosales (The Alliance for the Chesapeake Bay)</i> ● Advancing Agriculture Conservation Outcomes, <i>Alex Echols (Campbell Foundation)</i>
2:55 pm	Breakout Group Instruction
3:05 pm	Breakout Group Session
3:50 pm	Report Outs, <i>breakout facilitators/steering committee members</i>
4:30 pm	Summarize Day 1 & Next Steps for Day 2, <i>Jeremy Hanson (CRC)</i>
4:45 pm	Adjourn
4:45 pm	Steering Committee Meets

Note: Day 2 of the workshop is scheduled for April 18 at the Frederick Douglass-Isaac Myers Maritime Park in Baltimore, MD.



Chesapeake Bay Program's (CBP)
Scientific and Technical Advisory Committee (STAC)

Using Ecosystem Services to Increase Progress Toward, and Quantify the Benefits of Multiple CBP Outcomes

Day "1.5": April 18, 2023

Chesapeake Bay Program Office | Annapolis, MD

[Workshop Website](#)

****Exact Times Are Subject to Change****

For purposes of our workshop, "ecosystem services," "multiple benefits," or other similar terms, are mostly interchangeable for discussion. That said, "ecosystem services" is a more common and encompassing term that we apply throughout the agenda and our materials for convenience and consistency.

Benefits from nature, restoration or conservation activities that yield explicit or intrinsic value to a community or an ecosystem, with an emphasis on benefits accrued to communities from anything beyond the narrowest water quality lens of nutrient or sediment reductions.

Workshop Day 1.5 Purpose: To leverage what we learned from Day 1 and include broader perspectives to plan an effective – and new – "Day 2" that will dive deeper into diverse perspectives from stakeholders on the gaps, barriers, and opportunities to utilize ecosystem services information for their work within certain sectors of the Chesapeake Bay watershed restoration effort.

- 9:00 am** **Coffee & Light Breakfast (Provided)**
- 9:15 am** **Welcome & Setting the Stage**, Sherry Witt (GDIT) and Meg Cole (CRC)
Original Day 2 purpose and why we're pivoting (with your help)
- 9:30 am** **Ecosystem Services Overview, Key Takeaways and Debrief from Day 1.0, TBD**
- 10:00 am** **Stakeholder Perspectives on Ecosystem Services and Day 1 Key Takeaways – Part 1**
 - *Topic 1: Crediting and Incentives*
 - *Topic 2: Looking at other benefits aside from water quality*
 - *Topic 3: How to make a real change/ how to move the needle*
- 10:50 am** **10-minute Break**
- 11:00 am** **Stakeholder Perspectives on Ecosystem Services and Day 1 Key Takeaways – Part 2**
 - *Topic 4: How to make ecosystem services sustainable*
 - *Topic 5: Rebalancing priorities*
 - *Topic 6: Secondary benefits*
- 11:50 am** **Wrapping up and charting next steps**
- 12:15 pm** **Lunch Break (Provided)**
- 1:00 pm** **Steering Committee Work Session**
- 3:00 pm** **Adjourn**



Chesapeake Bay Program’s (CBP)
Scientific and Technical Advisory Committee (STAC)

Using Ecosystem Services to Increase Progress Toward, and Quantify the Benefits of Multiple CBP Outcomes

Day 2: June 6, 2023

Chesapeake Bay Program Office, Oyster Room | 1750 Forest Drive, Annapolis, MD

[Workshop Website](#)

Workshop MS Teams Link and call-in number

****Exact Times Are Subject to Change****

For purposes of our workshop, “ecosystem services” can generally be understood to mean: Benefits from nature, restoration or conservation activities that yield explicit or intrinsic value to a community or an ecosystem, with an emphasis on benefits accrued to communities from anything beyond the narrowest water quality lens of nutrient or sediment reductions.

Workshop Day 2 Purpose: To examine how to best achieve and incentivize broader ecosystem restoration (and multiple benefits/outcomes) as state and locals implement WIPs and other decisions that are traditionally focused on water quality and the TMDL. The workshop seeks to advise the CBP on how to take advantage of ongoing efforts and new datasets to better identify, assess, and communicate the multiple benefits of restoration and conservation activities in the Bay watershed.

12:30 pm	Lunch (Provided)
1:00 pm	Welcome & Setting the Stage , <i>Sherry Witt (General Dynamics Information Technology), Meg Cole (CRC)</i>
1:10 pm	Overview of Workshop Sessions Day 1 and 1.5: Where we have been, presentation of the Roadmap and Levers , <i>Kaylyn Gootman (EPA)</i>
1:30 pm	Prioritizing the Ecosystem Services Levers of Change , <i>Sherry Witt (General Dynamics Information Technology)</i> <ul style="list-style-type: none"> ● What are we missing? ● Prioritizing our list (impact matrix) ● Where do we focus?
2:30 pm	10-minute Break
2:40 pm	Chesapeake Bay Program Priority Projects Discussions , <i>Sherry Witt (General Dynamics Information Technology)</i> <ul style="list-style-type: none"> ● Who will lead this effort? ● Who should be a part of this effort? ● What are the key questions? ● What are key milestones?
3:45 pm	Where Do We Go From Here? , <i>Kristin Saunders (UMCES), Meg Cole (CRC)</i>
4:00 pm	Workshop Adjourns
4:10 pm	Steering Committee Debrief

Appendix B: Participants

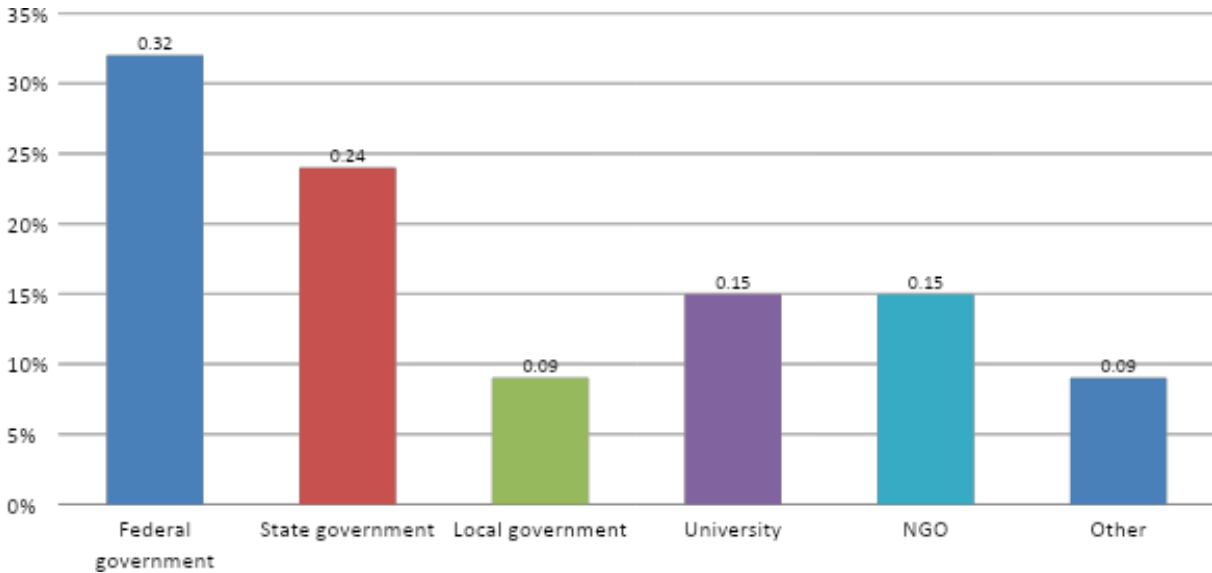
Alana Hartman	West Virginia Department of Environmental Protection
Alex Echols	Campbell Foundation
Andy Klinger	Pennsylvania Department of Environmental Protection
Anna Killius	Chesapeake Bay Commission
Anne Neale	US Environmental Protection Agency
Bill Jenkins	US Environmental Protection Agency
Bo Williams	US Environmental Protection Agency
Breck Sullivan	US Geological Survey
Bruce Vogt	NOAA Chesapeake Bay Office
Charles Rice	Charles County Government
Chris Brosch	Delaware Department of Agriculture
Chris Guy	US Fish and Wildlife Services
Dave Goshorn	Maryland Department of Natural Resources
Denice Wardrop	Chesapeake Research Consortium
Ed Dunne	US Environmental Protection Agency
Ellen Gilinsky	Gilinsky LLC.
Elliot Campbell	Maryland Department of Natural Resources
Emily Dekar	Upper Susquehanna Coalition
Emily Pindilli	US Environmental Protection Agency
Euginia Hart	TetraTech
Gary Shenk	US Geological Survey
George Onyullo	Department of Energy & Environment
Gina Hunt	Maryland Department of Natural Resources
Jackie Pickford	Chesapeake Research Consortium
Jake Kline	Virginia Department of Environmental Quality
James Morris	University of South Carolina
Jenn Starr	Alliance for the Bay
Jenna DeRario	Cornell Cooperative Extension
Jeremy Hanson	Chesapeake Research Consortium
Jill Whitcomb	Pennsylvania Department of Environmental Protection
Joe Wood	Chesapeake Bay Foundation
John Wolf	US Geological Survey
Katie Brownson	US Forest Service
Katie Walker	Chesapeake Conservancy
Kaylyn Gootman	US Environmental Protection Agency
KC Filippino	Hampton Roads Planning District Commission

Suzanne Trevena	US Environmental Protection Agency
Kevin MacLean	Virginia Department of Environmental Quality
Kristin Saunders	Alliance for the Bay
Kurt Stephenson	Virginia Tech
Larry Sanford	University of Maryland Center for Environmental Science
Laura Bachle	Eastern Research Group
Lee McDonnell	US Environmental Protection Agency
Leon Tillman	US Department of Agriculture
Lindsay Thompson	Maryland Grain Producers Association
Lisa Wainger	University of Maryland Center for Environmental Science
Lucinda Power	US Environmental Protection Agency
Matt Johnston	Arundel Rivers Federation
Meg Cole	Chesapeake Research Consortium
Mike LeSala	LandStudies
Olivia Devereaux	Devereux Consulting, Inc.
Pam Mason	Virginia Institute of Marine Science
Patricia Gleason	US Environmental Protection Agency
Rachel Felver	Alliance for the Bay
Robbie Coville	Keystone Tree Crops Cooperative
Ruth Cassily	University of Maryland
Ryann Rossi	EPA ORISE
Scott Heidel	Pennsylvania Department of Environmental Protection
Sean Corson	NOAA Chesapeake Bay Office
Sherry Witt	General Dynamics Information Technology
Susan Yee	US Environmental Protection Agency
Sushanth Gupta	Chesapeake Research Consortium
Suzanne Trevena	US Environmental Protection Agency
Tou Matthews	Chesapeake Research Consortium
Tyler Trostle	Pennsylvania Department of Environmental Protection
Zach Easton	Virginia Tech

Appendix C: Pre-workshop survey

Participants to the Day 1 workshop were asked to complete an online survey, to get a sense of the breadth of affiliation, decision-making roles, and initial ecosystem services perspectives prior to the workshop.

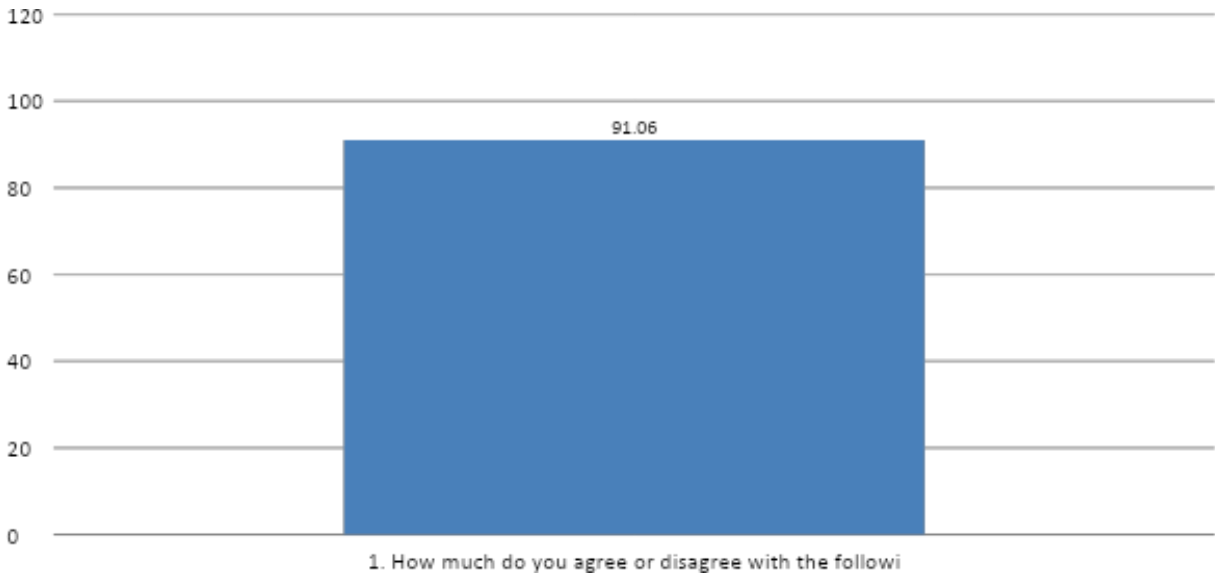
Question 1. What is your affiliation?



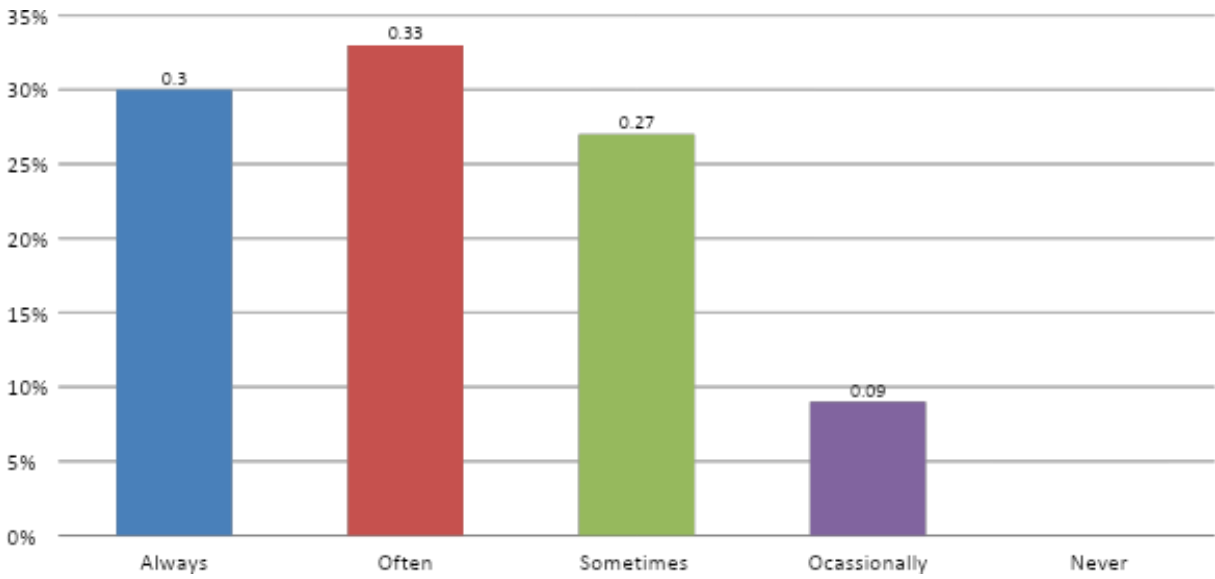
Question 2. How would you best describe your role?



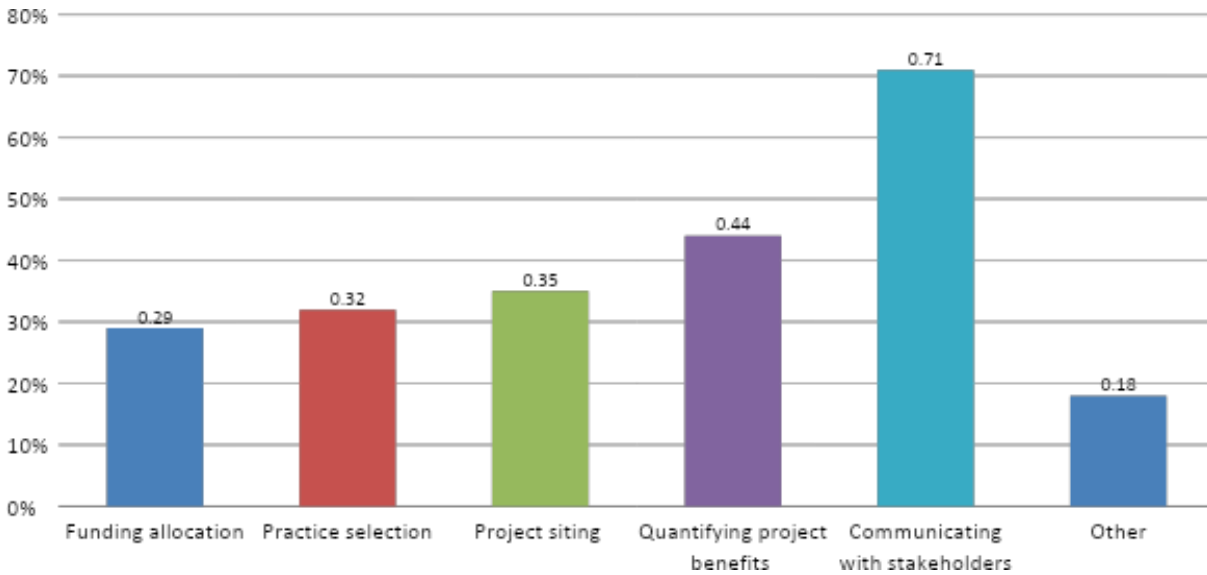
Question 3. How much do you agree or disagree with the following statement? "Ecosystem services are important to communicate to communities to achieve restoration goals"



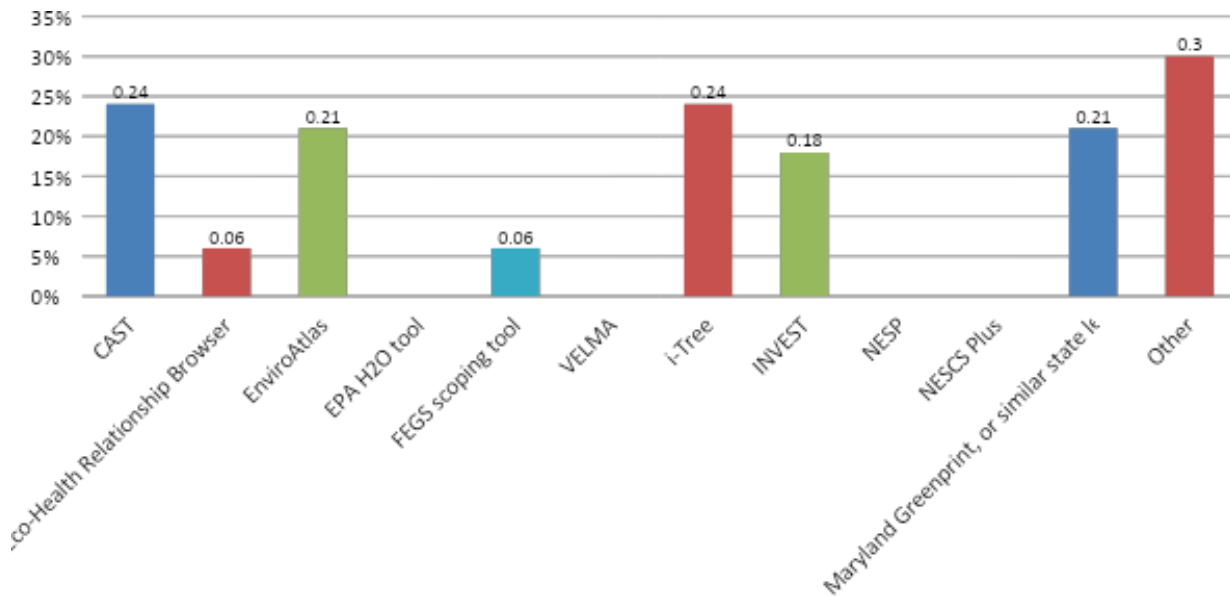
Question 4. How often do you consider ecosystem services in your decision-making/projects now?



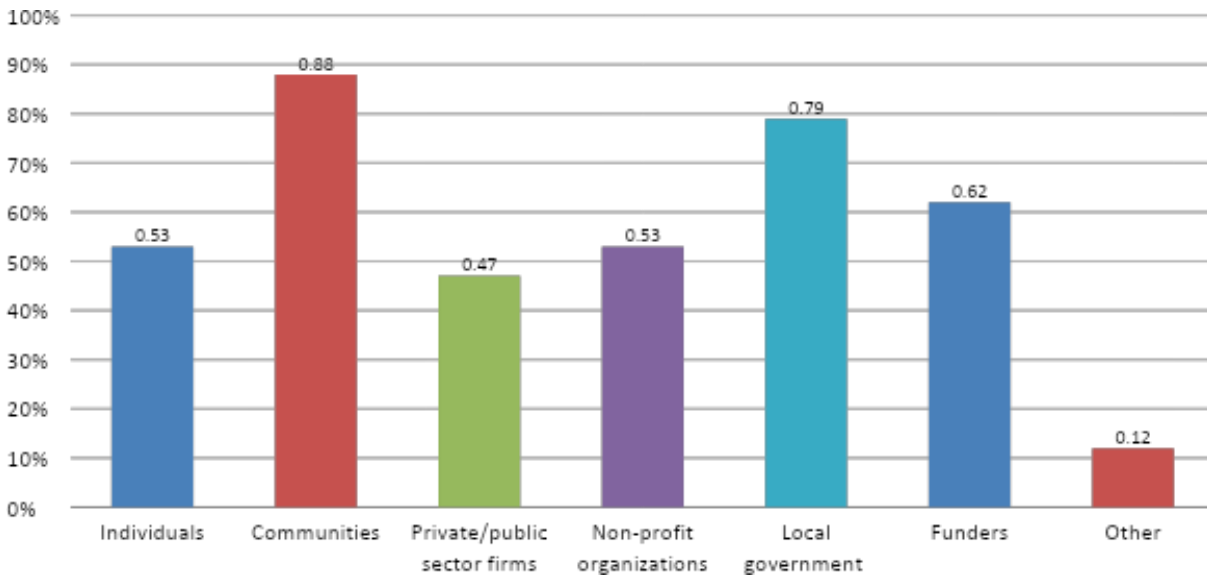
Question 5. If you have considered ecosystem services in your decision-making/projects over the last year, how have you used this information?



Question 6. What tools do you and your staff use to measure ecosystem services? Please select all that apply.



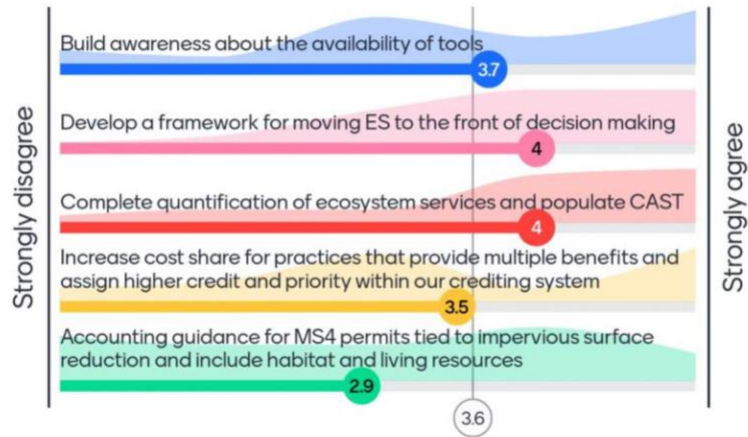
Question 7. Who do you believe is your audience for ecosystem values?



Question 8. What additional questions or comments do you have for the steering committee?

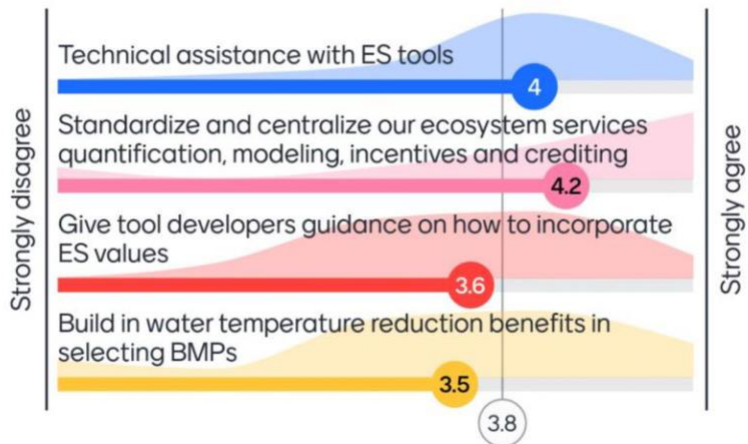
Response
Ecosystem services are important to communicate to the community only if the community has a role to play in conservation. That role is not clearly defined or accessible for many communities. Developing markets/buyers for ecosystem services at the local level and regional level is key to their success because it creates and reinforces community resiliency
The area of ecosystem services in which I work is the value of restored ecosystem components for enhancing the physical environment, including improved water clarity, reduced shoreline erosion, growing natural reef structures, etc.
How is this workshop different from others I have participated in in past years? E.g., STAC workshop to brainstorm quantifying/displaying co-benefits from CAST data, STAC workshop where we had breakout groups to monetize/valuate various co-benefits of urban stormwater BMPs
I'm looking for ways to integrate Ecosystem services into an RFP for my grants and wanted to get a better sense of the tools I can use to help include these benefits in our project review and selection.
As a researcher, I think ecosystem services are an important component. But, from experience, they are not widely valued or understood in the broader community of decision-makers, so they often are more of an "add on" after other benefits are calculated. They are still valuable, but they do not drive the discussion unless directly tied with things people understand (e.g., fishing revenue and jobs).

Prioritize Levers



22

Prioritize Levers



22

Day 2 Mentimeter Responses on degree of support for levers chosen through the impact/effort matrix exercises ([Appendix E3](#)). Top scoring levers were selected for further discussion about opportunities and barriers to implementation ([Appendix E4](#)).

Appendix E: Jamboard Responses

E1. Day 1 Example Breakout Group Responses.

Gaps & Barriers

What is keeping you from using or considering ecosystem service in the work that you do?

- Miss-targeting ES desired with ES stakeholder cares about...
- Not having a common framework across boundaries
- We're currently just attempting to implement the WIP and a lot of these tools weren't available when we planned it.-Alana
- Not measuring in a consistent way
- Our understanding of ES(s) has shifted over time (and will likely continue to do so)
- the difficulty of "monetizing" something like "increased ability to fish in these streams" - Alana
- Although they can be good for targeting in some cases, if opportunity is the limiting factor, as it often is, it doesn't help us to use metrics like this in funding decisions.
- We can build any kind of tool. Tools don't replace communications. (Olivia)
- I have participated in some Stewardship workgroup meetings - they would probably like to weigh in on use of the tools.

Day 1. Example of breakout group responses to question “What is keeping you from using or considering ecosystem services in the work that you do?”

Preview Day 2

How do we bait the hook according to the fish we are trying to catch?

What can the Bay program do in this space?

- Define consistent set of ES to consider/leverage over the next Bay Agreement

Day 1. Example of breakout group responses to what the Bay Program can do.

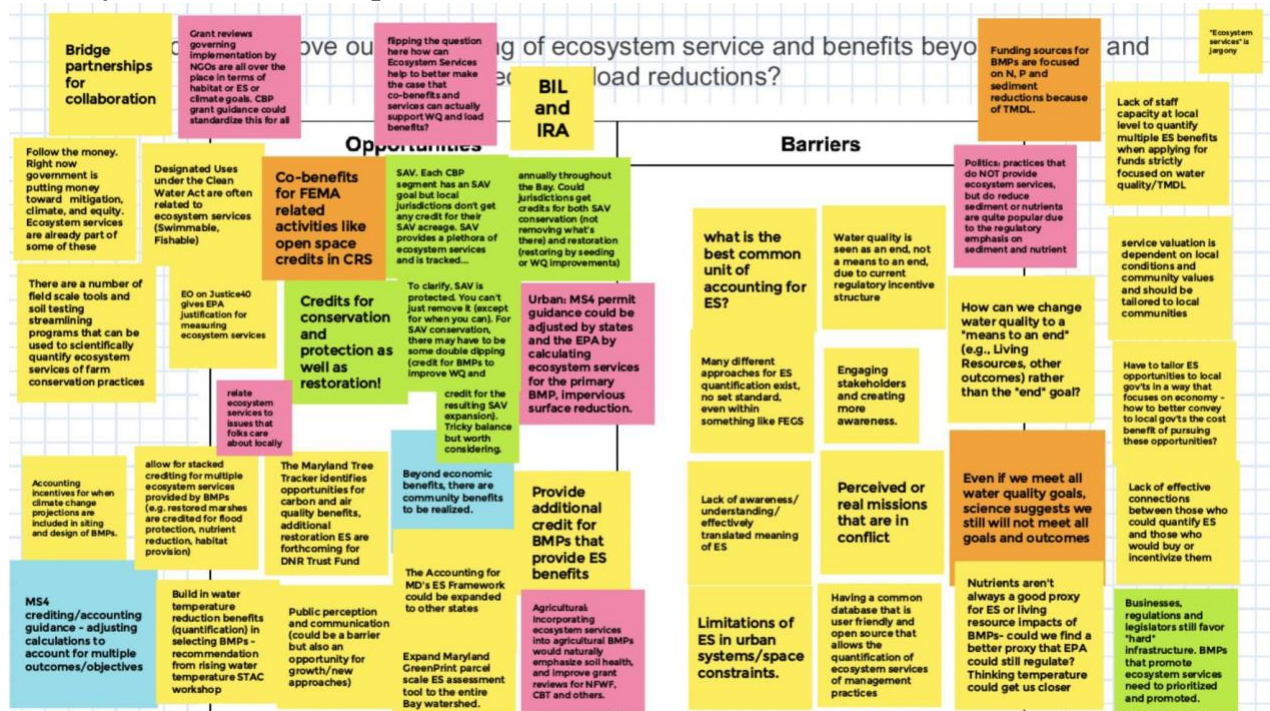
Opportunities

Share your own thoughts and vision about the opportunities that you think ecosystem services may unlock in your own work/organization, or for the Chesapeake Bay restoration generally.



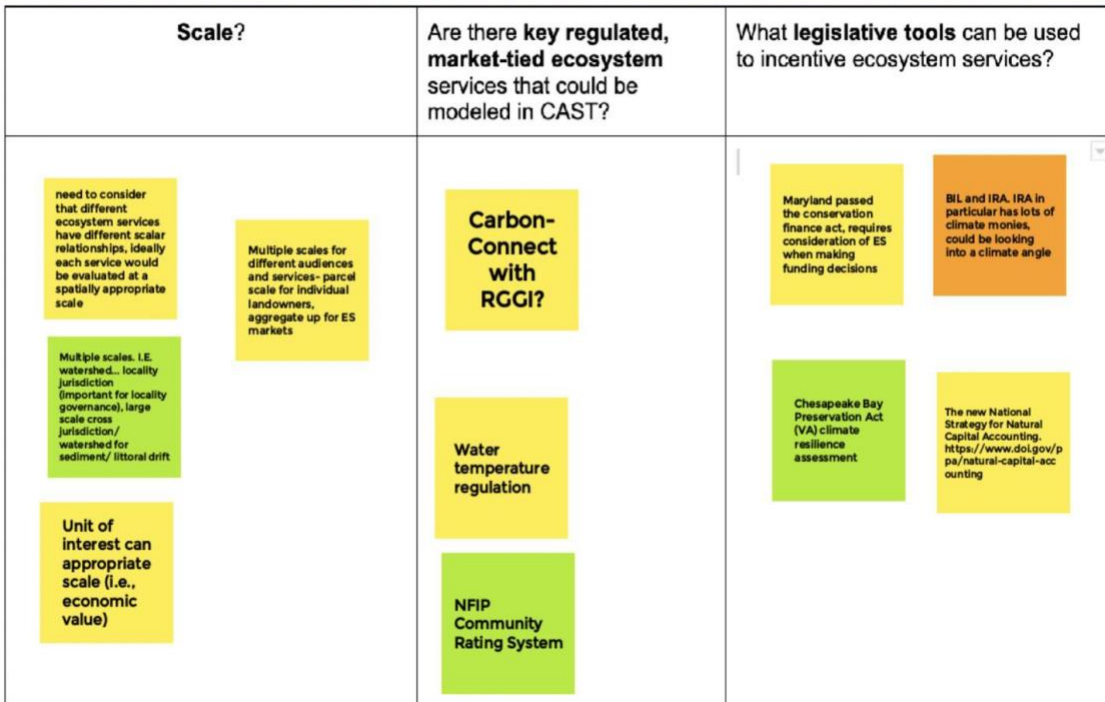
Day 1 Example of breakout group responses to opportunities that you think ecosystem services may unlock in your own work/organization or for Chesapeake Bay restoration generally.

E2. Day 1.5 Jamboard Responses



Day 1.5. Jamboard responses to identify opportunities and barriers to "improve our accounting of ecosystem service and benefits beyond nutrient and sediment load reductions?"

How do we improve our accounting of ecosystem service and benefits beyond nutrient and sediment load reductions?



Day 1.5 Jamboard responses to identify scale issues, key regulated, market-tied ecosystem services that could be modeled, and legislative tools to incentivize ecosystem services.

How do we incorporate ecosystem services into decision making and integrate ecosystem services into engagement?



Day 1.5 Responses to incorporate ecosystem services into decision-making and engagement.

What tools do we use to get ecosystem services fully considered in the work of decision support and decision makers like WIP planners, local planners, funders, and nonprofit organizations?

EPA is working on an Ecosystem Services Tools Portal that uses Decision Tree approach to navigate & identify different tools for different contexts like contam. sites

Virginia isn't nearly as far along/ ready as MD.

Know who to contact, and give input when requested

Definition of ecosystem services from MD Conservation Finance Act: climate resilience; carbon sequestration; provision of wildlife habitat; forest health and wetlands

There is more opportunity for the CCP Atlas and the Chesapeake Healthy Watersheds Assessment to help communicate and be a resource for WIP planners.

Integration of ES information into CAST is a great option, could pull from existing tools like COMET but also may require development of additional models

Web-based apps. Perhaps a shared framework with plugins for different sectors and jurisdictions (as needed)

A curated tool like this could be good. - <https://cmap2.vims.edu/LivingShoreline/DecisionSupportTool/> Explanation, definitions and examples

ready-made comm materials or modules, like the LLWG modules, about ES in general or specific benefits of interest (drinking water, urban heat island mitigation)

Parcel scale ES metrics (a la GreenPrint)

Beyond Environmental Benefits Case Study Database

more use cases and examples (like Julie suggested), improved training

Quick Start Information

Submerged Aquatic Vegetation (SAV) Sheets

Instructions: Click on a segment in the map to access that segment's fact sheet. Use the widget icons to access additional features. Use the Quick Guide below for more detailed instructions.

Quick Guide: Access more detailed background information on the development of the SAV fact sheets and how to use this tool: [Click here.](https://gis.chesapeakebay.net/wip/dashboard/quickguide/sav.pdf) (<https://gis.chesapeakebay.net/wip/dashboard/quickguide/sav.pdf>)

Background: The Chesapeake Bay Submerged Aquatic Vegetation (SAV) Synthesis Project brought together experts from the Chesapeake Bay Program (CBP) partnership specializing in water quality, and land-use research and management. The goal of the project was to conduct a synthesis of multiple long-term datasets to determine what role the growing human population in the Chesapeake Bay watershed has played in influencing SAV distribution and abundance and if the sustained...

<https://vims-sav.shinyapps.io/testshinyrmd/#section-segments>

Quick start guide on Data Dashboard...

Day 1.5 Jamboard responses to what tools can be used to get ecosystem services fully considered in the work of decision support and decision-makers.

Decision makers: how do you best receive this information? How do you use it?

A tool like this could be great. Each step with an explanation, and examples for choices.
<https://cmap2.vims.edu/LivingShoreline/DecisionSupportTool/>

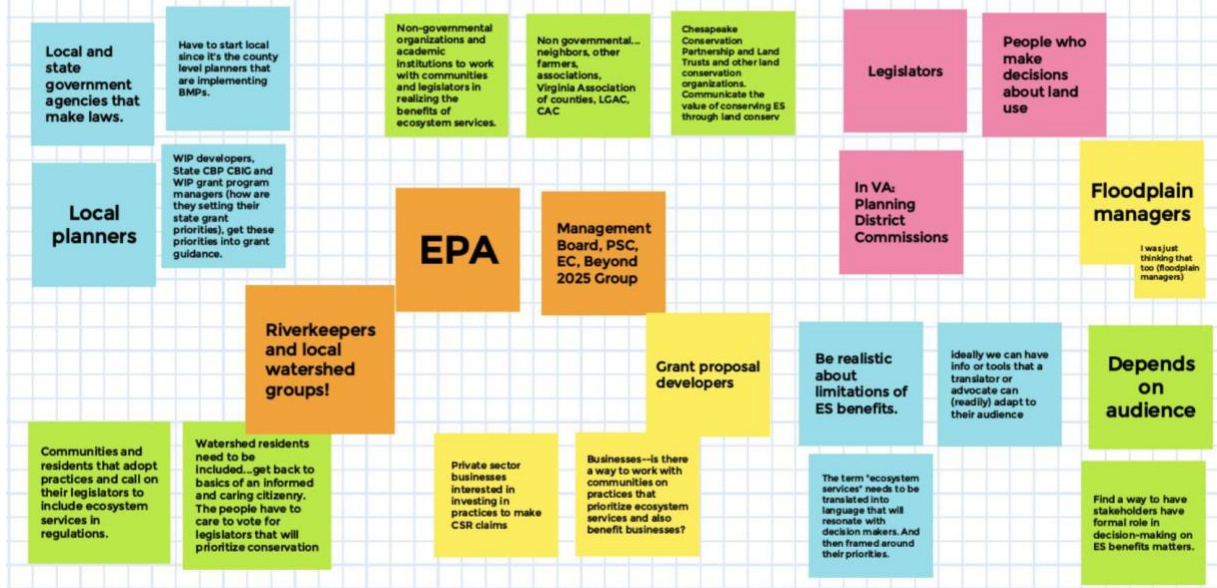
https://www.vims.edu/ccrm/research/climate_change/adaptation/nbf/index.php
Another example for public information on ecosystem services for coastal NNB

Status of Portlands

- 1. Search & locate** - Search for a portland by name, location, or other criteria.
- 2. Search Results** - Display a list of search results with details for each portland.
- 3. Search & Details** - Search for a portland and view details for that portland.
- 4. Search & Details** - Search for a portland and view details for that portland.
- 5. Search & Details** - Search for a portland and view details for that portland.
- 6. Search & Details** - Search for a portland and view details for that portland.
- 7. Search & Details** - Search for a portland and view details for that portland.
- 8. Search & Details** - Search for a portland and view details for that portland.
- 9. Search & Details** - Search for a portland and view details for that portland.
- 10. Search & Details** - Search for a portland and view details for that portland.

Day 1.5 Responses to how decision-makers best receive this information or how they use it.

Who are the audiences for communicating about these ecosystem service benefits and how do we best communicate with these audiences?



Day 1.5 Jamboard responses to who are the audiences for communicating ecosystem services benefits and how do we best communicate with these audiences.

Post Day 1.5 (Jamboard will stay open after today)

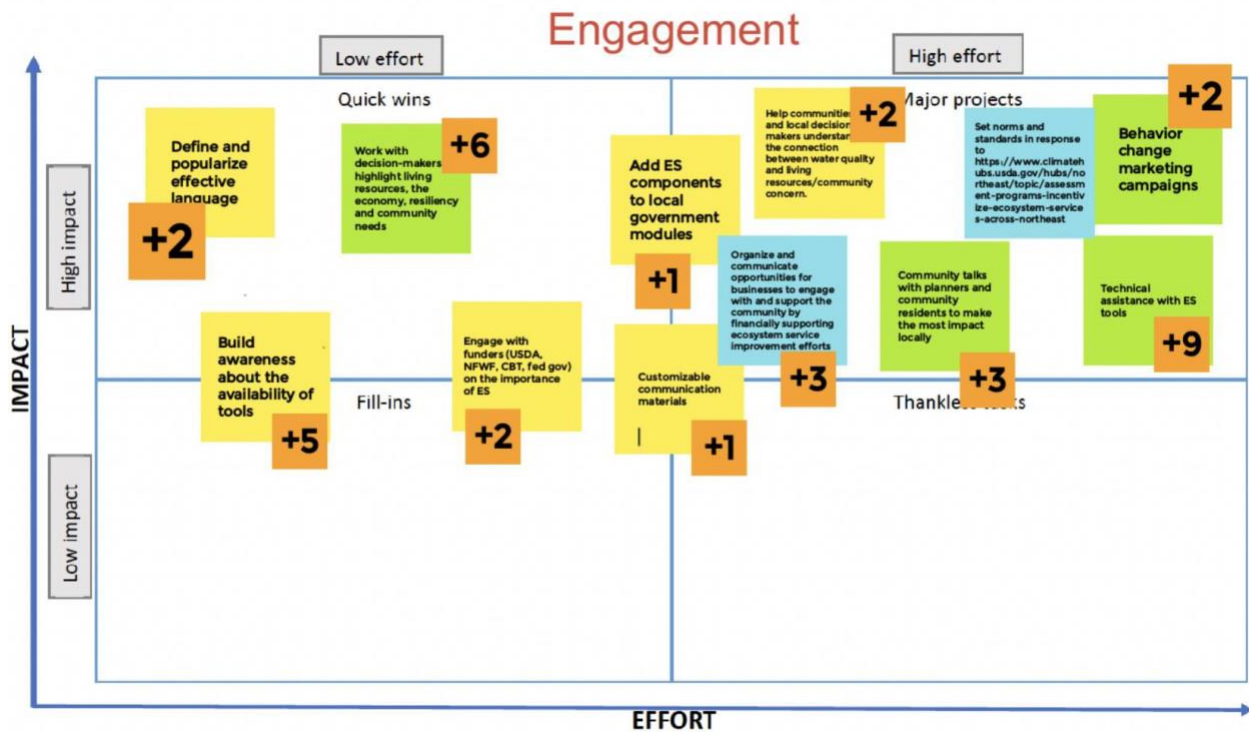


Day 1.5 Jamboard responses to i) what the Bay Program can do to advance ecosystem services, ii) who are the people missing from the discussion today, and iii) what should the purpose of the final workshop day be, or what questions should it ask.



Day 1.5 Parking lot or wish list of items not captured in other Jamboard questions.

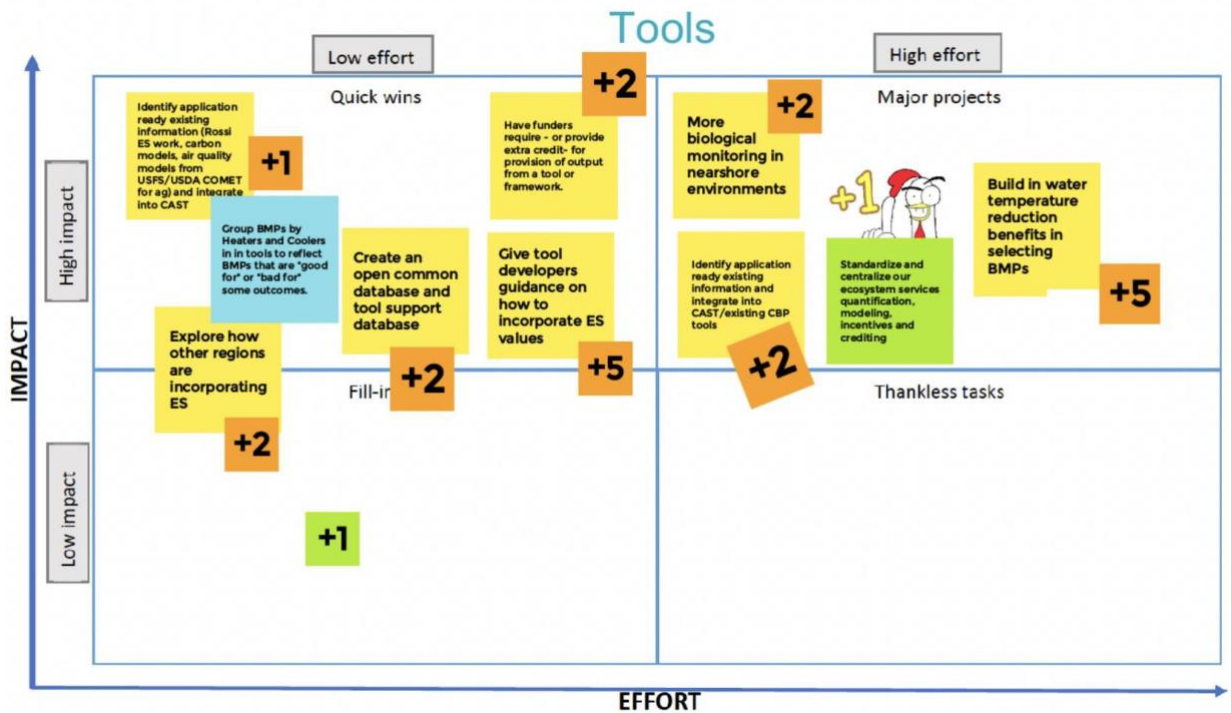
E3. Day 2 Impact By Effort Matrices for 5 Categories of Levers



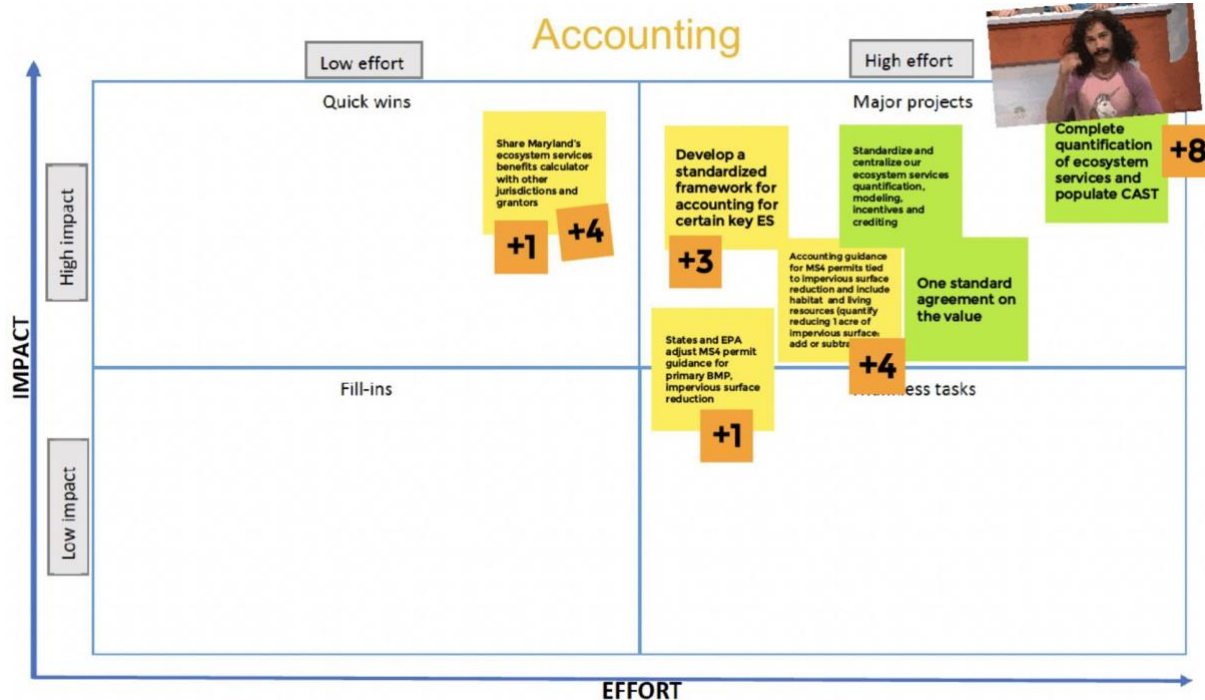
Day 2 Responses to identify actions to improve engagement within an impact/effort matrix.



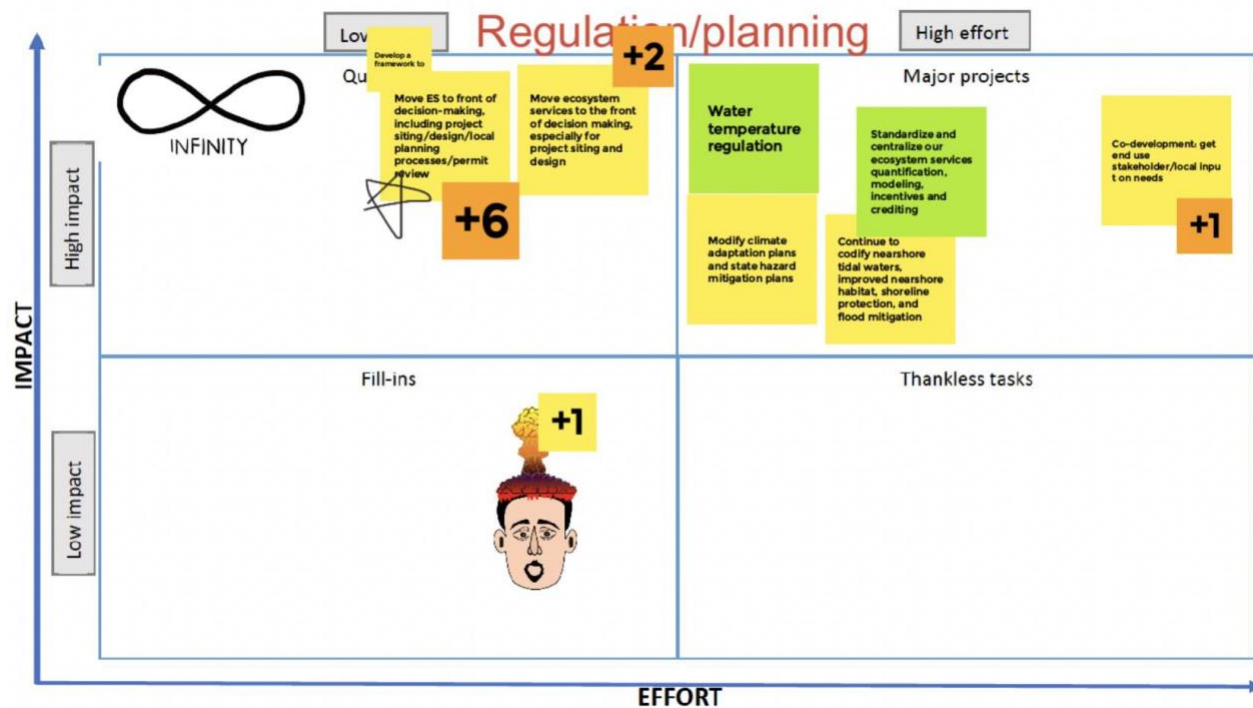
Day 2 Responses to identify actions toward crediting/incentives within an impact/effort matrix.



Day 2 Responses to identify actions to improve tools within an impact/effort matrix.



Day 2 Responses to identify actions to improve accounting within an impact/effort matrix.



Day 2 Responses to identify actions to improve regulation/planning within an impact/effort matrix.

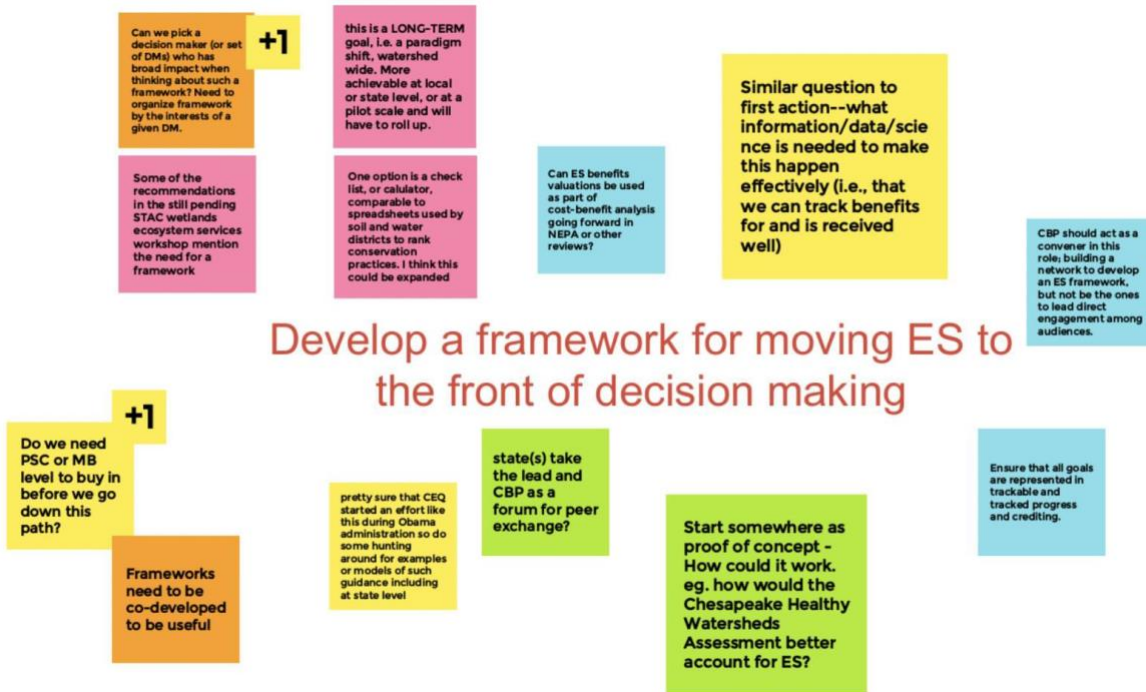
E4. Day 2 Opportunities for Top Identified Priority Levels



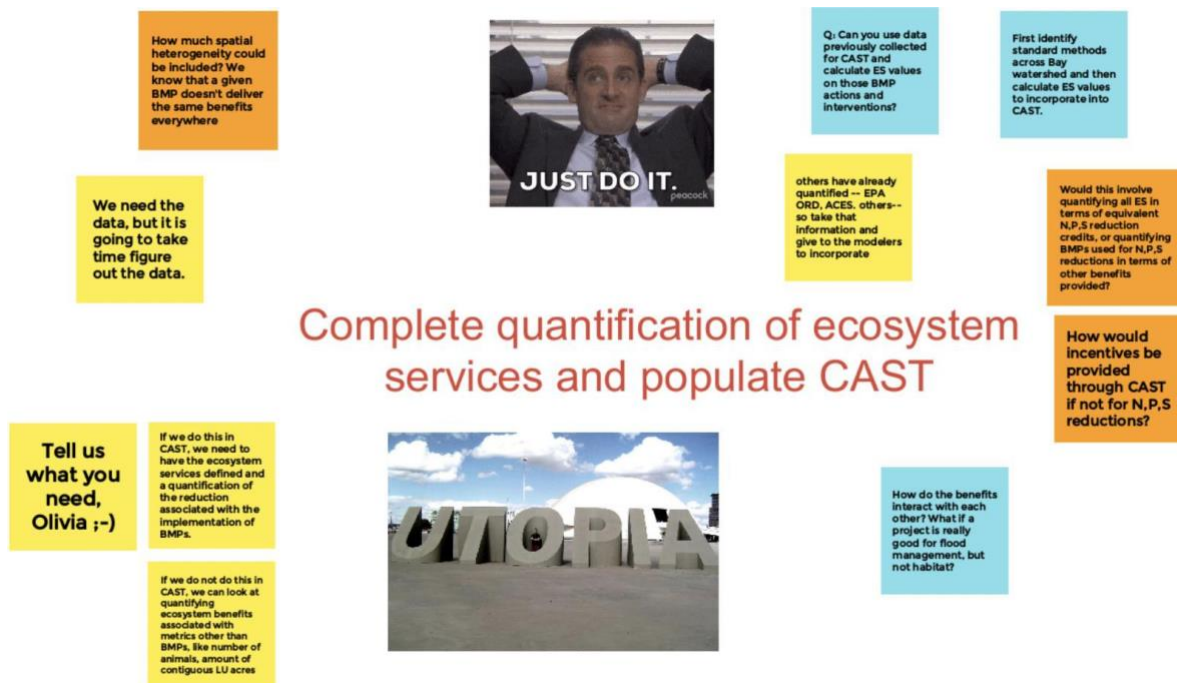
Day 2 Opportunities and barriers to standardize and centralize our ecosystem services quantification, modeling, incentives, and crediting.



Day 2 Opportunities and barriers to improve technical assistance with ES tools.



Day 2 Opportunities and barriers to a framework for moving ES to the front of decision-making.



Day 2 Opportunities and barriers to complete quantification of ecosystem services into CAST.

Parking lot

Questions?
Comments?

Invest in dedicated, centralized technical service for translating authoritative data into action plans, not just producing data or communication products, but assistance w/ plannin

Some of the stickies related to regulations don't seem appropriate since regs are different in each jurisdiction. Are there examples of how ES are incorporated into regs currently?

Good point. Most Envir law cites reasons for provisions-like wetlands provide....

Other conversations discuss moving away from crediting, slide 2 & 5 are directly tied to crediting. How are these different trajectories going to be addressed?

There is not much quantification of the environmental effects of BMPS. This will be a major hurdle in quantifying some of the ecosystem effects when translated to other goals.

To prioritize engagement actions, we need to know the communicator. Engagement to local governments (not LGAC) could be high effort, but thankless without buy-in.

<https://virginia.planning.org/conferences-and-meetings/mid-atlantic-planning/>

Breck, Kaylyn, and Ruth presented on tools to planners and the webinar provides the planners continuing education credits they need. Can do others in the future.

← THIS

Day 2 Parking lot of additional issues to consider.

Appendix F: List of Shared Resources

Recent CBP Efforts Addressing Multiple Outcomes

- [Additional Beneficial Outcomes of Implementing the Chesapeake Bay TMDL: Quantification and Description of Ecosystem Services Not Monetized](#). Wainger et al. 2015.
- [EnviroAtlas High Resolution Metrics of Ecosystem Services for the Mid-Atlantic](#), USEPA.
- [Estimation of BMP Impact on Chesapeake Bay Program Management Strategies](#). Tetra Tech, 2017.
- [Evaluating an Improved Systems Approach to Crediting: Consideration of Wetland Ecosystem Services](#), CBP STAC 2022
- [GIT-funded Ecosystem Services Project: Quantification of the Value of Green Infrastructure Hazard Mitigation Related to Flooding](#), RTI 2020.
- [Identifying and Defining Levels of Meaningful Change in Ecosystem Services of the Chesapeake Bay and its Watershed](#). Rossi et al. 2022.
- [Quantifying Ecosystem Services Benefits of Restoration and Conservation Best Management Practices in the Chesapeake Bay Watershed](#). Rossi et al. 2023.
- [Wetland Evaluation Taskgroup](#), CBP

Chesapeake Bay Area Mapping and Evaluation Tools

- [Chesapeake Assessment Scenario Tool: CAST](#) (CBP)
- [CAST: Ecosystem Benefits](#) (CBP)
- [Chesapeake Bay Environmental Justice and Equity Dashboard](#) (CBP)
- [Chesapeake Bay Ecosystem Benefits Relationship Browser](#) (CBP)
- [Chesapeake Bay Final Ecosystem Goods and Service Mapper](#) (CBP)
- [Chesapeake Bay Tools Targeting Portal](#) (CBP)
- [Chesapeake Bay Watershed Data Dashboard](#) (CBP)
- [Chesapeake Bay Watershed Model Map Viewer](#) (CBP)
- [Chesapeake Tree Canopy Network](#) (CBP)
- [Ecosystems Services of Floodplains in Chesapeake and Delaware Basins](#) (USGS)
- [InVEST Coastal Ecosystem Services for Mid-Atlantic States](#) (Nicholas Institute)
- [Maryland Biodiversity Conservation Network – BioNet](#) (Maryland DNR)
- [Maryland GreenPrint Parcel Evaluation Tool](#) (Maryland DNR)
- [Predict Submerged Aquatic Vegetation](#) (VIMS)
- [Shoreline Decision Support Tool](#) (VIMS)

Measuring and Modeling Ecosystem Services

- [What are Ecosystem Services?](#) (Maryland DNR)
- [Metrics for National and Regional Assessment of Aquatic, Marine, and Terrestrial Final Ecosystem Goods and Services](#) (EPA)

- [Coastal Wetland Equilibrium Model](#) (Morris et al. 1986)

Ecosystem Services Tools

- [Analytical Tools Interface for Landscape Assessments ATiLA](#) (EPA)
- [COMET-Planner](#) (US Department of Agriculture)
- [Ecosystem Services Models Library](#) (EPA)
- [EnviroAtlas](#) (EPA)
- [EPA H2O](#) (EPA)
- [Final Ecosystem Goods and Services Scoping Tool](#) (EPA)
- [InVEST](#) (Natural Capital Project, Stanford University)
- [I-Tree](#) (USDA Forest Service)
- [National Ecosystem Goods and Services Classification System](#) (EPA)

Conservation Practice Effectiveness and Cost

- [Beyond the nutrient strategies: Common ground to accelerate agricultural water quality improvement in the upper Midwest](#). Christianson et al. 2018.
- [Saturated Buffers: What Is Their Potential Impact across the US Midwest?](#) Chandrasoma et al. 2019.
- [Cost Analysis of Stormwater and Agricultural Practices for Reducing Nitrogen and Phosphorus Runoff in Maryland](#). Price et al. 2021.

Case Study, Management, and Planning Examples

- [Accounting for Ecosystem Services in Charles County, Maryland](#) (Maryland DNR)
- [Case for Protection of the Watershed Resources of Mattawoman Creek](#) (Charles County Department of Planning and Growth Management)
- [Charles County Comprehensive Plan](#): Chapter 5 Natural Resources (Charles County Board of Commissioners)
- [Interagency Nonstructural Flood Risk Management Efforts](#) (US Army Engineer Institute for Water Resources)
- [Mapping Ecosystem Services in Maryland to Inform decision-making](#) (Maryland DNR)
- [Maryland's Green Infrastructure Assessment](#) (Maryland DNR)
- [Mid-Atlantic Planning Collaboration](#) (American Planning Association Virginia Chapter)
- [Tree planting in Richmond high-poverty neighborhoods](#) (Richmond Times-Dispatch)

Policy and Strategy Initiatives

- [Crediting Conservation: Accounting for the Water Quality Value of Conserved Lands Under the Chesapeake Bay TMDL](#). Chesapeake Bay Commission 2013.
- [Conserving Chesapeake Landscapes: Protecting our Investments, Securing Future Progress](#). Chesapeake Bay Commission 2010.
- [Natural Capital Accounting](#) (DOI)

- [National Strategy to Develop Statistics for Environmental-Economic Decisions](#) (US Office of Science and Technology Policy 2023)
- [30X30](#) Advancing Women in Policing: 30% Women Recruits by 2030. Policing Project at NYU School of Law.

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