Seminar

6

Ecosystem Services in Practice:

Management Decisions in the Public Sector—From Theory to Application

Speaker

Heather Wright · Dr. Carl Shapiro · Dr. Lydia Olander · Dr. Mary Ruckleshaus

GORDON AND BETTY MOORE FOUNDATION

Ecosystem Services and Public Sector Decision-Making

Introduction and Conclusion by Heather Wright, Gordon and Betty Moore Foundation

INTRODUCTION

Given the magnitude of the impact of global climate change and other human activities on our natural systems, there is a critical need for governments to support sustained and continued ecosystem benefits and to create incentives to maintain environmental capital. Traditionally, economic development goals have depended heavily on ecosystem services, but economic development activities tend to ignore the welfare of those ecosystems and thus jeopardize the well-being of people. This neglect of ecosystem services can increase ecological, social, and economic problems at local and global scales over the long term. As a result, long-term sustainability goals may be foregone for short-term economic wins. Linking policy and/or management objectives to ecosystem service objectives should and can be done in a way that aims to maximize economic, ecological, and social outcomes. To this end, decision-makers need to deliberately take into account the connections between development, ecosystems, and services provided.

This particular seminar is devoted to looking more closely at how ecosystem services are considered in public sector decision-making. The examples showcased explore current ecosystem service approaches that are being applied in the public sector, and examine the rationale and incentives shaping management decisions. They also elucidate the key successes and shortcomings of their implementation. As demonstrated in the following cases, a pure command-and-control approach to mitigation is evolving into policies with a market-like mechanism (e.g., water funds, mitigation banks). This makes an informed public sector even more important, as to date effective markets for ecosystem services are almost always associated with public policy or a regulatory framework.

For example, the active carbon trading market in Europe (European Union Emission Trading Scheme or EU ETS) is a result of the greenhouse gas limitations set in the Kyoto Protocol. And as seen in the North Carolina example in this seminar, wetland mitigation banking is a result of national U.S. policy and regulation under the Clean Water Act (CWA). However, as we have seen in practice, regulation or markets in isolation cannot solve the problem of global ecosystem degradation and the resulting loss of natural resources that we are currently experiencing. The involvement of the public sector is critical to affecting change at scale — from the micro and on-the-ground decision-making processes (e.g., in the coastal British Columbia case) to the meso, with subnational and national policy decisions (e.g., North Carolina's wetland mitigation program), and ultimately to macro policy scales that deal with transboundary and international policy issues (e.g., the Kyoto Protocol).

The case studies that follow underpin the notion that an ecosystem services approach is predicated on good governance, which is key to achieving an effective outcome. This is corroborated by researchers at the World Resource Institute (WRI), who agree that governance — regarding who is making the decision, the process by which the decision is made, and the information and data used to rationalize that decision — is core to an ecosystem approach. The United States Geological Survey (USGS) case study emphasizes this point as it lays out the needs and the framework required to implement an approach that considers ecosystem service science within an adaptive management construct. The cases in British Columbia and Colombia describe the governance and institutional structures that have operationalized their ecosystem services work and clearly linked it to relevant and timely policy questions — another key to successful implementation of an ecosystem services approach. Finally, the North Carolina wetland case study focuses on an ongoing ecosystem services approach to mitigating environmental damage that is being adapted real-time in parallel with an existing policy framework.

As evidenced by these examples and highlighted in other seminars, efforts like the Natural Capital Project on ecosystem services valuation, the work done by the United Nation's The Economics of Ecosystems and Biodiversity (TEEB) program to make natural capital visible, and WRI's strategy to mainstream ecosystem services in public and private sector decisions (among many others) all provide new methods that decision-makers can use to make clear links between ecosystems and development. As the ability to describe and value the benefits of ecosystem services improves, decision-makers can better balance the trade-offs inherent in public-sector decision-making, and ultimately design and implement policies that sustain these services.

ECOSYSTEM SERVICES IN PRACTICE: PERSPECTIVES FROM THE USGS SCIENCE AND DECISIONS CENTER

by Dr. Carl Shapiro, United States Geological Survey

Overview

The USGS Science and Decisions Center (SDC) was established in 2010 to advance the use of science in resource management decision-making. SDC's efforts focus on research and applications in three "sustainability science" areas: decision science (including adaptive management), ecosystem services, and resilience. Ecosystem services such as water, crop pollination, and carbon sequestration can have tremendous value, but are not always or adequately considered in resource management decisions. As a result, resource management, restoration, and development decisions are sometimes made with only partial information. An important question is what has to happen, scientifically, economically, spatially, and institutionally, to ensure that ecosystem services are more routinely incorporated into decisions? Understanding how to reduce these challenges is critical to SDC's goal of advancing the use of science in resource management decisions in market and non-market situations.

USGS science creates a foundation for the study of ecosystem services. The USGS Organic Act, enacted in 1879, establishes the USGS for the "classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." In today's terminology, the "products of the national domain" are services of value to humans produced in ecosystems, or ecosystem services.

The National Research Council in 2001 recommended that "USGS should shift from a more passive role of study and analysis to one that seeks to convey information actively in ways that are responsive to social, political, and economic needs," suggesting that USGS should actively use science to inform resource management decisions (Hutchinson et al. 2005).

To do this, three critical issues need to be addressed. First, a common analytical framework is needed to facilitate balanced decisions across natural, managed, and developed systems. Secondly, a structured decision process is needed that allows decision-making with uncertainty and incorporates new information as it becomes available. And third, methods are needed to incorporate resilience, risk, and vulnerability in resource management decisions.

Ecosystem services provide an integrated framework for assessing the consequences of land and resource management decisions on the environment and for evaluating tradeoffs among resource management, conservation, restoration, and development alternatives. This framework is especially important when assessing the impacts of dynamic systems caused by climate change, human settlement, and other drivers. Because ecosystem services can be expressed in terms of monetary or non-monetary values rather than only as ecological or physical values, they can be evaluated and compared in different spatial or temporal settings.

Adaptive management, or the use of learning-based management, provides a structured decision process for iterative decision-making when scientific uncertainty exists. Adaptive management facilitates near-term decision-making even when there is imperfect information about longer-term consequences. The integrated conceptual framework provided by ecosystem services can be important to an adaptive management decision process by contributing to the articulation of objectives, the assessment of potential management strategies, and the evaluation of management consequences.

Resilience, vulnerability, and risk provide measures of a natural, managed, or human system's ability to sustain and recover from disturbances. These elements can help frame the process of decision-making, and play an important role in assessing the potential consequences of management strategies. In this context, they are directly connected to both ecosystem services and adaptive management, and are used to describe and define sustainability.

Understanding the value of information is important to assessing the impact of additional information on decision-making. When making resource management decisions, it is critical that the benefits of additional information are understood so that scarce resources can be used effectively. The value of information provides a guide to prioritizing alternative investments in science so that uncertainty is reduced and relevant information is available to support informed decisions.

Moving Forward

Several outstanding questions need to be addressed to ensure that ecosystem services and their values are more routinely incorporated into sustainable resource management decisions. The answers to these questions will allow the impacts of decisions across natural, managed, and human systems to be more completely understood.

- What scientific information and what level of certainty is needed to provide a foundation for resource management decisions and for effective markets?
- How can we value ecosystem services, and what level of certainty is needed so that the calculated values are internalized in decisions?
- What institutional structures most effectively advance the routine consideration of ecosystem services?
- How can we address spatial issues related to ecosystem services flows so that they can be addressed in property rights?
- How can ecosystem services markets be structured so that price can be market-determined and provide a meaningful signal about the value of the service?
- How can metrics for resiliency be developed so that we understand the ability of natural and managed systems to recover from sudden and/or severe shocks, and so that the production of ecosystem services is sustainable?
- How can the value of scientific information be more effectively determined and used to prioritize the science needed to better understand ecosystem services and to inform sustainable resource management decisions?
- How can we more effectively communicate the concept of ecosystem services to technical and lay audiences?

References

Hutchinson, D., R. Sanders, and T. Faust. 2005. *Making U.S. Geological Survey information effective in the electronic age.* U.S. Geological Survey Open-File Report 03-240. http://pubs.usgs.gov/of/2003/of03-240.

Recommended Citation:

Shapiro, C. "Ecosystem Services in Practice: Perspectives from the USGS Science and Decisions Center." In Measuring Nature's Balance Sheet of 2011 Ecosystem Services Seminar Series. Edited by Coastal Quest and Gordon and Betty Moore Foundation, 412-414. Palo Alto: Gordon and Betty Moore Foundation, 2012. PDF e-book.

MITIGATION IN TRANSITION: NORTH CAROLINA'S ECOSYSTEM ENHANCEMENT PROGRAM

by Dr. Lydia Olander, Duke University
Incorporating ideas from Bill Holman, Duke University, Martin Doyle, Duke University, and Emily Bernhardt, Duke University

Public policy can have large-scale impacts on how ecosystem services are valued and managed. While environmental laws in the United States have traditionally used command-and-control approaches, revised regulations and state-level implementation are, in some cases, moving toward market-like mechanisms for ecosystem services. These approaches are expected to be a more efficient means of achieving environmental objectives as well as a more cost-effective and flexible means of compliance for those generating the pollution or impacting the environment.

The U.S. Clean Water Act (CWA) is designed to protect streams and wetlands and the services they provide. The implementation of the stream and wetland mitigation program under the CWA is one example where public policy has already shifted toward a market-like mechanism on a large scale. While there are definitely benefits to this transition, it is not achieving all the hoped-for environmental benefits. There are a number of lessons to be learned from the implementation challenges observed as the U.S. considers expanding market-like approaches in other realms of public policy.

Overview

This case study will focus on one example of implementation under the CWA: the wetland and stream mitigation program in the state of North Carolina, also called the Ecosystem Enhancement Program (EEP). This program went from a heralded example of good public policy to a program scrutinized by the press and forced to undergo significant review and revision. This discussion will cover the administrative problems faced, the transition to more market-like approaches, limitations to scientific foundations, and ideas for moving forward. Many of the issues affecting the North Carolina program can be found in mitigation programs across the United States.

Enabling Conditions

Wetland and stream mitigation programs in the United States developed under Section 404 of the CWA of 1977 require permits for placing dredge or fill materials into federal navigable waters, with exceptions for agriculture and other specified uses (33 U.S.C. § 1344). Most development activities that impact streams and wetlands fall under this rule and require a permit from the Army Corps of Engineers (Corps), which administers this program with oversight from the U.S. Environmental Protection Agency (EPA). Implementation involves rules that require the permittee to first avoid impacts, then minimize unavoidable impacts, and then finally to provide compensatory mitigation for unavoidable impacts (Hough and Robertson 2007; 33 U.S.C. § 1344).

In the mid-1990s, wetland mitigation programs in the United States began transitioning from a relationship between developers and regulators, often using onsite mitigation, which resulted in poor-quality mitigation, to one where third parties—state agencies, nonprofit organizations like land trusts, or private mitigation bankers—began developing off-site wetland and stream mitigation projects and banks to be used for compensatory programs.

Discussion of Outcomes

The North Carolina Department of Water Quality and the Corps began to regulate impacts to wetlands and streams in the 1990s. As enforcement strengthened, few private mitigation banks were available, causing costs and delays to highway construction and other development projects. The North Carolina EEP was developed in 2003,[1] bringing together the state Department of Transportation (DOT), the Department of Environment and Natural Resources (DENR), and the regional office of the Corps to share information, improve planning, and initiate an in-lieu fee program in which DOT could pay a fee to the EEP to provide mitigation for impacts. Private developers were later allowed to use this in-lieu fee program as well.

The EEP program covers state and federal compensatory mitigation for streams, wetlands, riparian buffers, and nutrients. It is one of the largest wetland and stream mitigation programs in the United States (Madsen et al. 2010). The program currently has over 560 projects covering more than 600 miles of streams, 30,000 acres of wetland, and 1,200 acres of buffers, and has resulted in zero delays to DOT projects (N.C. Department of Environmental and Natural Resources 2012). The program shifted liability for restoration projects from the transportation agency to an environmental agency, and earned recognition in 2005 and 2007 as one of the top 50 innovative new

[1] The EEP replaced the North Carolina Wetland Restoration Program (WRP), which was established by the state's General Assembly in 1996.

government programs in the nation by Harvard University's Kennedy School of Government.[2] While this suggests a regulatory and administrative success, such accolades preceded actual results from the program, and indeed the program has been beset by significant administrative issues and environmental limitations, most of which have commonalities with other compensatory mitigation programs across the United States and provide lessons for other ecosystem services programs.

The state faced problems commonly found in in-lieu fee programs (Wilkinson et al. 2006). Damages to wetlands and streams were occurring, and fees were being paid, but mitigation was delayed, leading to long lag times—sometimes more than a decade—between ecosystem services losses and replacement (Kane and Raynor 2011a). Fee prices were set politically and were based on least-cost projects—too low to develop high-quality projects, compensate for project risks, support long-term stewardship of restoration sites, or follow through with robust monitoring. In fact, prices were set below the price actually needed to cover the costs of projects. Fee prices should be set sufficiently high to be a disincentive for damaging streams and wetlands that have functions that are difficult or very costly to replace. The result of pushing for lowest-cost solutions may be that damages to highly productive systems are replaced by low-cost and lower-functioning systems. Low prices also undercut the potential for a private market of mitigation bankers that would have developed projects pre-impact.

Because North Carolina has small service areas (the areas adjacent to damages in which mitigation must take place) for compensatory mitigation, the land the state used for mitigation projects—low-cost land in rapidly growing urban areas—was often public lands such as parks. This meant that public funds for parks were subsidizing development projects and their damages to the environment. This has resulted in a pattern of small, scattered projects in suburbanizing areas. While not ideal for wildlife support, these wetlands may have local water-quality benefits.

In contrast, private banking tends to build large projects in outlying areas, where land is cheaper. This can be better for wildlife services but leads to a shift of wetland and stream services from urbanizing areas to rural edges (Womble and Doyle 2010). In terms of optimizing ecosystem service replacement, the program would probably benefit from a combination of project types, to provide a range of services comparable to the services damaged or lost.

Another problem for the EEP was that contractors were not held liable for failure in the wetland or stream construction, which increased the burden on the state program (Kane and Raynor 2011a). Many of these issues have been partially addressed by a new law passed in 2011 (Kane 2011; General Assembly of North Carolina). Mitigation banks must now be used for private impacts where they exist (DOT can still use EEP even where banks exist), mitigation must be in the ground before impacts occur (seven years in advance), and EEP now has more flexibility in how fees are set.[3]

It also became apparent that the politics and incentive structure for the EEP were flawed, with DOT demands for timely, low-cost road construction the first priority and replacement of ecosystem damages secondary. There was little transparency and oversight in this system, which led to the only documented case of double-dipping, meaning that the same service was sold twice, in ecosystem services markets in the United States (Cooley and Olander 2012). In 2000, a company developed a project in eastern North Carolina to sell wetland and stream credits to DOT to offset impacts to wetlands and streams from road-building projects. In 2009, this company sold water-quality credits from the same project—without performing any additional management activities—to the EEP to offset nitrogen impacts to the Neuse River Basin (Kane 2009). According to local experts, if all other existing, already-sold mitigation sites in North Carolina were allowed to stack nitrogen credits, the market could be flooded with 1.1 million pounds of nitrogen credits, exceeding all credits generated since the program began in 2001 (Doyle and BenDor 2009).

The state proposed a rule that would completely disallow such trades (N.C. Division of Water Quality 2012b), but the rule has yet to be finalized. Many of these administrative problems may be fixable with a little political will. In North Carolina, new regulations are starting this process. It is not clear where this will lead, but other states have abandoned in-lieu fee models in favor of market-driven models.

Whether policy moves toward markets or maintains the fee structure, the scientific foundations for such programs still remains an issue. The fundamental question is whether the wetland and stream mitigation projects intended to replace ecosystem functions are working. The most simplistic assessment is whether the area of wetland lost and stream damaged equals the area restored and created. Given delays in construction, failures in projects, and limits to monitoring data, the answer may be no. State records show that more than 30 stream restoration projects totaling more than US $30 million have failed over the last decade (Kane and Raynor 2011a). This represents more than 30% of all stream restoration completed over this time.

---

[2] Innovations in American Government Awards committee, sponsored by the Ash Institute for Democratic Governance and Innovation at Harvard University's Kennedy School of Government, and the Council for Excellence in Government in Washington, D.C.

[3] Fees are still subject to review and revision by State legislature.

A more important question is whether lost ecosystem functions are being restored. It is clear that the metrics used to track success have been more structural (e.g., wetness of a wetland, shape and stability of stream banks, appropriate plant species growing) than functional (e.g., nutrient cycling, sediment storage, food web health). These functions have not been measured in the wetlands and streams lost, nor in those restored or created, but new methods and metrics, such as the North Carolina Wetland Assessment Method (NC WAM), which is designed to assess three wetland functions—hydrology, water quality, and habitat—are under development to try to better estimate functional equivalence (N.C. Division of Water Quality 2012a).

Even with improved methods there are limits and constraints on the functions restored systems can provide. Studies in North Carolina suggest little improvement from stream restoration, and in some cases declines in sensitive insect taxa (Penrose and Rozelle; Violin et al. 2011); similar results have been found elsewhere (Sundermann et al. 2011). A study by Sudduth et al. (2011) suggests that one of the problems with restoration, at least in the short term, is the clearing of stream-bank vegetation, which leads to significantly higher stream temperatures. One study of a large wetland restoration project that converted agricultural lands back to wetlands in the coastal plains of North Carolina found shifts in nutrient forms and types rather than reductions of nutrient flows (Ardón, Morse et al. 2010 and Ardón, Montanari et al. 2010). The ecological implications of this are not yet clear. One concern is that if ecosystem services and functions are not truly being restored by these programs, the political willingness to spend resources on them will wane.

Moving Forward

Moving forward will require an intentional strategy to build a sound scientific basis for mitigation and integrate this science into policy and market design. A fundamental issue that science is beginning to address is how piecemeal restoration on available or low-cost lands, which are often embedded in highly impacted environments (e.g., urban and agricultural lands), can replace the functions of a large-scale system of wetlands and streams (Sudduth et al. 2007; Bernhardt and Palmer 2011).

Ideally, mitigation programs would be embedded in broader watershed-scale strategies that connect the scale, location, and types of damages to the real costs of restoration, which would help limit impacts to those that are reasonable to replace. The scale, location, and types of restoration would be selected to ensure restoration of lost functions. Such a watershed-scale strategy would ideally connect the many programs and decision-making processes that impact watershed function and ecosystem services.

In addition to the CWA 404d mitigation program, this could include programs that require reductions in nutrient loading, stormwater management (including impervious surface restrictions), and flood control, all of which are managed through numerous federal agencies (Corps, EPA, U.S. Fish and Wildlife Service, Federal Emergency Management Agency), at multiple levels of governance (municipal, state, federal) and across a wide range of administrative programs (water quality, water quantity, risk management, zoning, parks). Under this new paradigm, all impacts to a watershed (e.g., wetland, stream, buffer, impervious surface) would be minimized, avoided, and if necessary, mitigated by an offset in the watershed that would replace lost services.

North Carolina may be a good place to test such a paradigm. Scientists in the region have studies under way to answer some of the fundamental questions about which types of wetlands in which locations provide which services, and whether and how to conduct stream restoration. State officials have expressed interest in more coordinated planning across programs. One example of such coordination would be to link the State Clean Water Management Trust Fund, Parks and Recreation Trust Fund, Natural Heritage Trust Fund, Farmland Preservation Trust Fund, floodplain buyout funds, EPA 319 funds, EEP, and local programs, such as the Upper Neuse Clean Water Initiative funded by Raleigh and Durham water customers. It is possible that such coordination could increase the efficiency of state programs, producing more value per dollar spent in terms of ecosystem services by creating synergies among priorities and avoiding significant tradeoffs.

In summary, while this case study explores the particular example of how national policy was implemented in North Carolina's wetland and stream mitigation program, most of the lessons learned are relevant for other mitigation or ecosystem services programs. A number of the lessons are those of basic good governance, such as the need for transparency and oversight, particularly where the government is tasked with multiple priorities, such as the need to support both economic development through new built infrastructure and the economic and social benefits of natural infrastructure. The shift toward market-like mechanisms and private banking in North Carolina can improve mitigation outcomes because the rules and oversight for private mitigation banks are more stringent, and free up private capital to generate pre-impact mitigation at the scale needed for development.

The shift toward private banks in North Carolina could reduce the use of public lands and hidden public subsidies, but also may move mitigation toward large-scale projects in more rural areas, reducing small-scale urban mitigation, which has pluses and minuses. The potential growth of market-like programs for a range of ecosystem services has raised concerns about stacking payments or double-dipping. It is a complex issue but can likely be managed through careful program design and coordination across programs (Cooley and Olander 2012).

Mitigation programs under the CWA establish a framework for maintaining ecosystem services that can achieve significant scale and bring private investment to bear, but weaknesses remain that need to be addressed. Watershed-scale approaches to improve ecological outcomes and efficiency of investments will require coordination across agencies, regulations, and jurisdictions, as well as advancements in restoration science. The evolving state of the science of stream and wetland restoration (Palmer and Filoso 2009), as well as of other ecosystem services, need not hinder development of ecosystem-based programs and markets, but rather, indicates the need for adaptive policy design that can incorporate new knowledge to improve outcomes over time in a transparent and consistent manner that will not increase risks for program participants and investors.

References

Ardón, M., S. Montanari, J. L. Morse, M. W. Doyle, and E. S. Bernhardt. 2010. Phosphorus export from a restored wetland ecosystem in response to natural and experimental hydrologic fluctuations. *Journal of Geophysical Research* 115.

Ardón, M., J. L. Morse, M. W. Doyle, and E. S. Bernhardt. 2010. The water quality consequences of restoring wetland hydrology to a large agricultural watershed in the southeastern coastal plain. *Ecosystems* 13(7):1060–1078.

Bernhardt, E. S., and M. A. Palmer. 2011. River restoration: The fuzzy logic of repairing reaches to reverse catchment scale degradation. *Ecological Applications* 21(6):1926–1931.

Cooley, D., and L. P. Olander. 2012. Stacking ecosystem services payments: Risks and solutions. *Environmental Law Reporter* 42:10150–10165.

Doyle, M., and T. BenDor. 2009 December 16. Stream restoration: Who really benefits? *News and Observer*.

Hough, P., and M. Robertson. 2007. Mitigation under Section 404 of the Clean Water Act: Where it comes from, what it means. *Wetlands Ecology and Management* 17(1):15–16.

Kane, D. 2009 December 8. EBX is paid twice for wetlands work. *News and Observer*.

Kane, D. 2011 June 19. Legislature OKs rule on streams. *News and Observer*.

Kane, D., and D. Raynor. 2011a April 17. State spends $140 million on faulty water projects. *News and Observer*.

———. 2011b April 20. For state streams, restoration just starts the costs. *News and Observer*.

Madsen, B., N. Carroll, and K. Moore Brands. 2010. *State of biodiversity markets report: Offset and compensation programs worldwide.* Ecosystem Marketplace. http://www.ecosystemmarketplace.com/documents/acrobat/sbdmr.pdf.

N.C. Department of Environment and Natural Resources. 2012. Website. http://portal.ncdenr.org./web/guest.

N.C. Division of Water Quality. 2012a. *N.C. wetland assessment method (NC WAM).* http://portal.ncdenr.org/web/wq/swp/ws/pdu/ncwam.

———. 2012b *Riparian buffer rules.* http://portal.ncdenr.org/web/wq/swp/ws/401/riparianbuffers/rules.

Palmer, M. A., and S. Filoso. 2009. Restoration of ecosystem services for environmental markets.” *Science* 325:575–576.

Penrose, D., and L. Rozelle. *Aquatic insect responses to stream restoration. How do we define success?* Poster.

Sudduth, E. B., B. A. Hassett, P. Cada, and E. S. Bernhardt. 2011. Testing the field of dreams hypothesis: Functional responses to urbanization and restoration in stream ecosystems. *Ecological Applications* 21:1972–1988.

Sudduth, E. B., J. L. Meyer, and E. S. Bernhardt. 2007. Stream restoration practices in the southeastern United States. *Restoration Ecology* 15(3): 573–583.

Sundermann, A., S. Stoll, and P. Haase. 2011. River restoration success depends on the species pool of the immediate surroundings. *Ecological Applications* 21:1962–1971.

Violin, C. R., P. Cada, E. B. Sudduth, B. A. Hassett, D. L. Penrose, and E. S. Bernhardt. 2011. Effects of urbanization and urban stream restoration on the physical and biological structure of stream ecosystems. *Ecological Applications* 21(6):1932–1949.

Wilkinson, J., R. Thomas, and J. Thompson. 2006. *The status and character of in-lieu fee mitigation in the United States.* Washington, DC: Environmental Law Institute.

Womble, P., and M. Doyle. 2010. Setting geographic service areas for compensatory mitigation banking” *National Wetlands Newsletter* 18:18–23.

Recommended Citation:

Olander, L. “Mitigation in Transition: North Carolina’s Ecosystem Enhancement Program.” In Measuring Nature's Balance Sheet of 2011 Ecosystem Services Seminar Series. Edited by Coastal Quest and Gordon and Betty Moore Foundation, 415-420. Palo Alto: Gordon and Betty Moore Foundation, 2012. PDF e-book.

IMPROVING CONSERVATION INVESTMENT RETURNS FOR PEOPLE AND NATURE IN THE EAST CAUCA VALLEY, COLOMBIA

by Dr. Mary Ruckelshaus, Natural Capital Project

Overview

Water is one of the scarcest resources on the planet, and pressures on this vital form of natural capital will only grow as the human population expands and climate changes. Latin America is making a major effort to address this issue by improving the management of watersheds, the green infrastructure that supplies, regulates, and cleans water. In June 2011, the Inter-American Development Bank, the Global Environment Facility, and FEMSA (a large beverage company) committed US $27 million to developing 32 new water funds across Latin America in the next 5 years. Figure 14 shows some of the planned water fund areas, which include water sources for many of the continent's largest cities and some of the most important remaining intact habitats.

The Natural Capital Project (NatCap) works with decision-makers to understand their policy or management objectives, and how information on ecosystem service values can help. We work with our partners in each decision context to scope the issues and identify how accounting for ecosystem service values will inform their specific policy or management interventions. The partners define the specific management questions, timelines over which scientific outputs are needed, and the most useful types of outputs (e.g., maps, tables, simple graphics.) The NatCap team works iteratively with the decision-making partners to refine analyses and ways of presenting results so that the science is clear and most relevant to their decision context.

Figure 14: Some of the 32 areas in Latin America where new water funds are planned. *Source: The Natural Capital Project.*

THE SCIENCE-POLICY PROCESS

While the idea of water funds is garnering international investment interest, there are still important scientific advances to be made in their design and implementation. For example, most existing water funds make investments on an ad hoc basis, offering incentives to anyone who will participate. In many cases, this approach is not likely to give the fund the best return on investment in terms of reaching project objectives for protecting biodiversity and improving or safeguarding ecosystem service flows.

NatCap has worked with the Water for Life and Sustainability water fund (red star in the map above) in the East Cauca Valley of Colombia to try to improve the fund's return on investment. Our approach brings ecological and social information to their investment process through a combination of methods, including ecological rankings, local knowledge, stakeholder preferences, return on investment, and ecosystem service modeling. The water fund secretariat identified the specific needs for ecosystem service value information: to help them prioritize *where* to target their investments, identify *which kinds* of restoration and protection activities were most likely to be cost-effective, and then to provide *accountability for testing* future observations against predicted changes in ecosystem service values. NatCap, in turn, provided the ecosystem-service valuation information to inform their prioritization decisions.

SETTING THE STAGE

The Water for Life and Sustainability fund is overseen by the Cauca Valley's sugar cane producers association (ASOCANA), sugar cane growers association (PROCANA), each watershed's local environmental authority, a peace and justice organization, and The Nature Conservancy. The process developed by the water fund and NatCap for determining how investments would be made is shown in Figure 15. The stakeholder groups jointly agreed on the objective to "maintain consistent water flows necessary for drinking water, biodiversity, and agriculture through a coordinated strategy." In the 11 watersheds included in the water fund, investments are made in management changes that improve cattle ranching and small-scale farming practices, the major threats to biodiversity, water supply, and water quality (sediment) in the upper watershed. The activities supported by the fund include protection, fencing, silvopastoral systems, forest enrichment, and restoration. Past experience in the region has shown that these kinds of activities are feasible for landowners, given

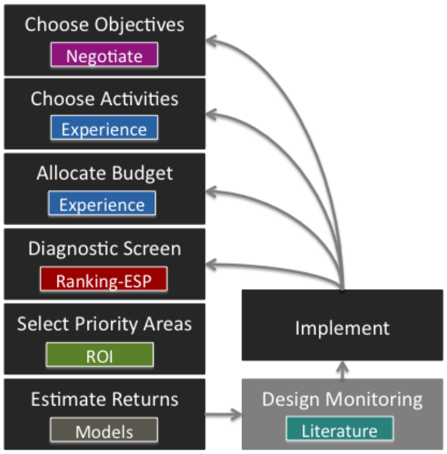

Figure 15: The process for determining investments made by the Water for Life and Sustainability fund. *Source: The Natural Capital Project.*

their likely opportunity costs. The fund committed to investing US $10 million over a five-year period, and this budget in the first few years has been allocated among watersheds proportional to watershed area, and among activities based on the kinds of land use in each watershed.

Discussion of Outcomes

WHERE SHOULD INVESTMENTS BE MADE?

To move beyond the standard approach to water fund investment, we focused in on four watersheds within the Cauca Valley water fund area. We started with a map of where each activity was feasible, based on past experience in the region, and then ranked the landscape to identify areas where each activity was likely to give the best returns in terms of terrestrial biodiversity, erosion control, annual water supply, and dry-season water supply. Rankings were based on literature reviews and, for annual water supply, on model estimates of likely change, using the free GIS-based InVEST model suite (Integrated Valuation of Environmental Services and Tradeoffs). We also asked stakeholders to identify areas in each watershed where they thought activities should be focused, and where water fund investments were not possible because of political instability.

We combined all of this information into one score that showed where each activity was likely to be most effective and socially acceptable in each watershed. Then, to identify which investments should be made first, we used a return on investment approach to select the areas that were likely to give the greatest returns for each activity. Using historic data on the cost of each activity, we selected areas until the budget level was reached. This gave us a final "investment portfolio" map that showed which activities the fund should invest in, and where, in each watershed (see Figure 16).

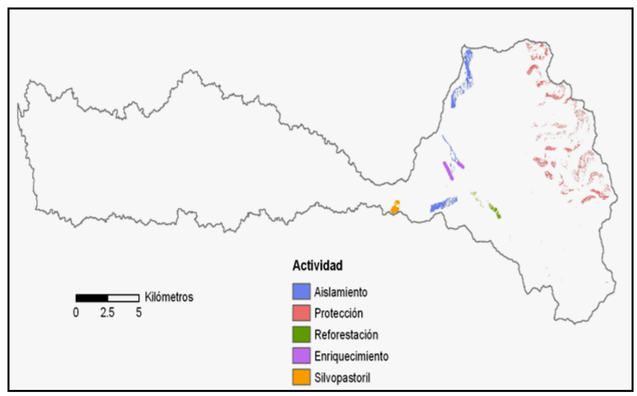

Figure 16: The Cauca Valley investment portfolio map*. Source: The Natural Capital Project.*

HOW MUCH ECOSYSTEM SERVICE CHANGE WILL THE FUND PROVIDE?

Investors want to know how much change they will get from each portfolio of activities. Ideally, we would have local studies that measured the response of biodiversity, erosion, and water supply to each of the activities supported by the fund. This kind of research has not been done in this region, so instead we estimated erosion and annual water yield response (just two of the water fund objectives) using InVEST. The InVEST tool can give fund managers a preliminary estimate of how much return to expect. The panels in Figure 17 how the estimated erosion control benefits for each watershed in the black lines.

There are no observed data on sediment loads in the region, so we cannot yet validate the model, but since we can estimate both current conditions and investment possibilities with the same modeling approach, we can get a relative sense of how much change to expect (percent change) as spending progresses over the next five years. For example, erosion control in the Fraile watershed will likely increase from a 1% benefit in year 1 to a 14% benefit by year 5.

Monitoring of actual changes on the ground is essential to the fund's success. In this case, the water fund is installing a monitoring program to track terrestrial and freshwater biodiversity, turbidity (sediments in the water), and water yield. These measures will show how much change the fund is really effecting, and will help inform adaptive management of where investments should be made. The monitoring can also be used to improve model estimates for further exploration of investment options.

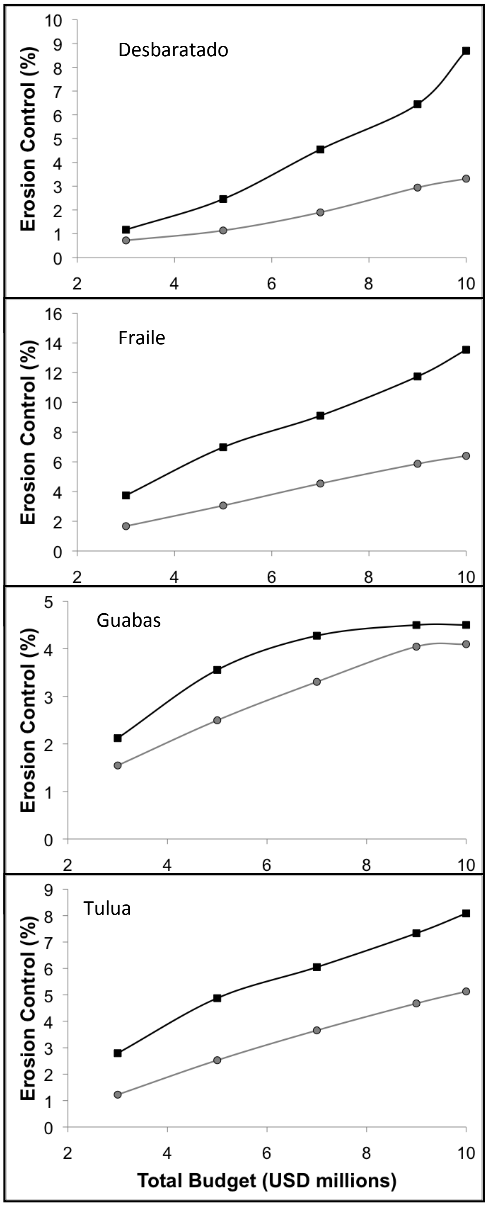

*Figure 17: **Estimated erosion control benefits by watershed.** Source: The Natural Capital Project.*

DOES THE SCIENCE HELP?

The Cauca Valley water fund secretariat invested extra time engaging with NatCap scientists, and the NatCap team committed significant time and resources to supporting the science-policy process. In short, scientifically targeting water fund investments takes a lot of work. In the end, is it really worth it? We asked this question for the Secretariat, using a metric that speaks to their bottom line: is the return on their investment improved by using a science-based approach to prioritization?

We used a random investment approach that represents well the way most water fund investments are made, and then we asked how the erosion control returns from that approach compared to our targeted approach described above. We used InVEST again to estimate returns, and found overall lower returns in all watersheds (gray lines in the panels in Figure 17). When we used these estimated returns to calculate an estimated return on investment (change in erosion control per dollar spent), we found that using science is likely to double returns. The ratio of return on investment between the two approaches varies by watershed, meaning science is more worth the effort in some watersheds, like Desbaratado (the red bars in Figure 18), than in others, like Guabas (the blue bars in Figure 18).
The four watersheds we analyzed account for about 40% of the budget, so at the total fund level of US $10 million, these watersheds would spend US $4.2 million. Using the targeted investment strategy saves US $3 million in these watersheds at that level of investment. Further exploration of these methods, and the actual measurement of water fund outcomes, will allow us to continue to improve the efficiency of this promising conservation finance strategy.

IMPLEMENTING THE NEW SCIENCE GUIDANCE IN FUND PRIORITIZATION

The modeled ecosystem service maps provided by NatCap and its partners in Colombia are now included in the regular requests for proposals for projects to be funded as part of the fund investments. The priority areas for service provision and restoration that are highlighted on the maps provide information for project proponents and reviewers of proposals, to help guide investments in protection and restoration activities and monitor returns. Families in the watershed comprising the water fund voluntarily opt in to the fund, receiving materials and labor for activities designed to improve water quality downstream (e.g., fencing, riparian planting, different silvicultural practices). For each round of fund investments, the secretariat mails out the NatCap-generated prioritization maps so that families in the watershed can see the priority areas and activities.

The InVEST tool is made up of a number of simple ecosystem service models, and the upside of this simplicity is that data requirements generally are not a limitation of using the tool. The downside is a lack of specificity in predicted impacts of different protection or restoration activities. A primary challenge for the water fund is thus to learn from its experience, testing empirically whether the activities implemented through their program do in fact provide the water quality and other ecosystem service benefits projected in the InVEST model.

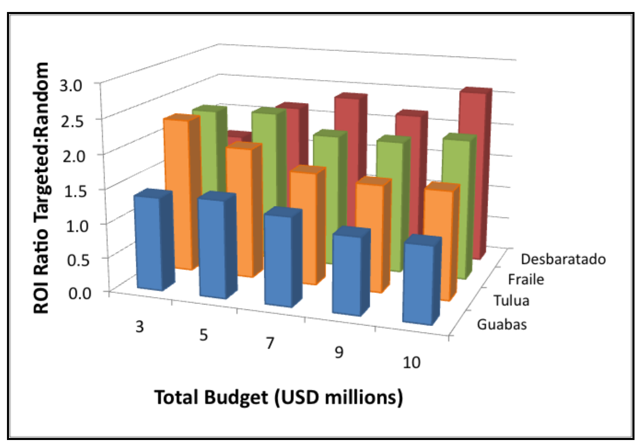

*Figure 18: **The ratio of return on investment, by watershed.** Source: The Natural Capital Project.*

Enabling Conditions

The Nature Conservancy (TNC) and its local partners in Latin America have been key drivers of the policy processes leading development, implementation, and testing of the water funds. Early successes in the 1990s of the water fund project in Quito, Ecuador, provided momentum for TNC and partners to build upon; this momentum culminated in the spring 2011 announcement of an ambitious policy and decision support platform to establish 32 new water funds in Latin America by 2016. The close partnership between NatCap and TNC provided the needed policy support for an iterative science-policy process through which NatCap trained partners in the use of the InVEST tool, provided scientific guidance and input, and adapted the models and outputs as needed.

The broad and committed leadership by government, private industry, and non-governmental organization (NGO) sectors on the governing board of the water fund ensure that its deliberations and decisions are coherent and consistent with the objectives established by the fund. TNC has been a constant leader and supporter of the water fund process throughout its evolution, and its long-standing presence in Latin America lends it credibility and legitimacy within the region.

Moving Forward

Monitoring and adapting the protection and restoration strategies implemented under the water fund will be key to providing accountability to the investors that the water quality and other ecosystem service returns are efficient and effective. The next exciting opportunity and challenge is to scale up lessons learned from a few existing water funds to develop a standardized approach to implement 32 water funds over the next 5 years. TNC and NatCap will work with government, business and NGO practitioners to design the standard approach so that it addresses the prioritization and accountability needs and concerns of the entities who will be implementing the funds.

The challenges for replicating the science-policy process are twofold: 1) to provide an ecosystem services modeling and decision support tool for prioritizing locations and types of investments that is rigorous and yet simple to use with widely available data, and 2) to design monitoring protocols and analytical approaches for testing the ecosystem service outcomes that allow the funds to be accountable to their investors and beneficiaries, and to adapt their strategies as needed. On the policy front, the challenges are to find a generalizable approach to testing and refining the investments so that ecosystem and human well-being returns continue to be maximized over time.

For more information, contact Heather Tallis (htallis@stanford.edu) or Alejandro Calvache (acalvache@tnc.org).

References

Natural Capital Project. InVEST: Integrated Valuation of Environmental Services and Tradeoffs. http://www.naturalcapitalproject.org/InVEST.html.

Recommended Citation:

Ruckelshaus, M. "Improving Conservation Investment Returns for People and Nature in the East Cauca Valley, Colombia." In Measuring Nature's Balance Sheet of 2011 Ecosystem Services Seminar Series. Edited by Coastal Quest and Gordon and Betty Moore Foundation, 421-425. Palo Alto: Gordon and Betty Moore Foundation, 2012. PDF e-book.

DEVELOPING A MARINE SPATIAL PLAN WITH PARTNERS ALONG THE WEST COAST OF VANCOUVER ISLAND, BRITISH COLUMBIA, CANADA

by Dr. Mary Ruckelshaus, The Natural Capital Project

Overview

Along the west coast of Canada's Vancouver Island, multiple, often competing interest groups have come together to envision the future character of the region and how myriad human uses can co-occur without undermining each other and the marine ecosystem on which they depend. The West Coast Aquatic Management Board (WCA) is helping to achieve this by creating a marine spatial plan for the region. WCA has been cultivating stakeholders in the region for several years, and has developed a positive, personal working relationship with First Nations, local governments, and citizens in the region. They were interested in enlisting help from NatCap to provide independent scientific guidance to inform their process. Marine spatial planning involves using scientific and geospatial information to address conflicts and organize human activities in the ocean, while maintaining ecosystem health, function, and services. In a marine spatial plan, a wide range of allowable uses of the marine environment are incorporated on one map, as depicted in Figure 19 below.

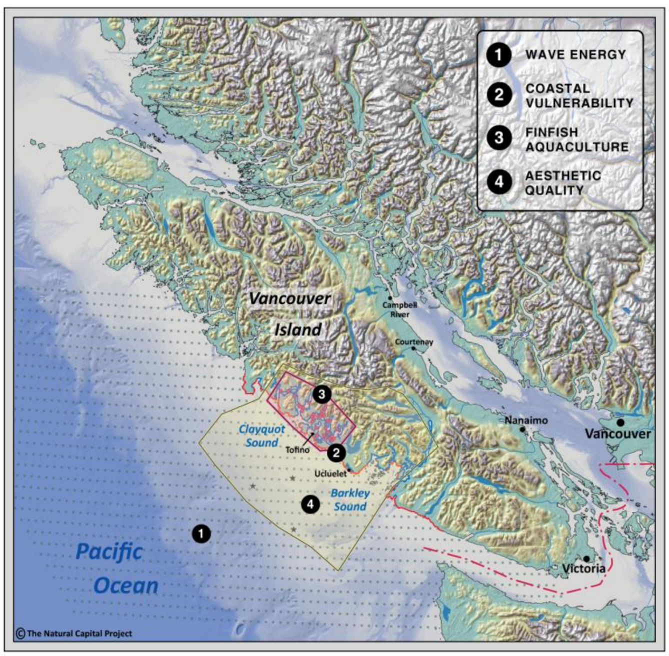

Figure 19: Map of west coast Vancouver Island, British Columbia, marine spatial planning area. *Some of the many ecosystem services we modeled and their general locations are denoted by numbers 1-4 in the map at left. Planning scenarios are being developed and analyzed both at the scale of individual sounds (e.g., Clayoquot and Barkley sounds) and on the broader scale of the entire west coast, where wave energy projects, commercial and recreational fisheries, and wildlife viewing activities occur. Source: The Natural Capital Project****.***

WCA is a public-private partnership with participation from four levels of government (federal, provincial, local, and First Nations) and diverse stakeholders. Ultimately, WCA's vision is to manage resources for the benefit of current and future generations of both people and non-human species and their communities. Some key considerations for WCA and its stakeholders include balancing important industrial and commercial activities (such as shipping, mining, logging, aquaculture, and fisheries), increased development of tourism and recreation, renewable energy generation, access to healthy and local seafood, and a strong cultural desire for sustaining the remote, wild feeling of the place. Aesthetic, spiritual, and cultural values — benefits that are not readily quantified — are universally important across the diverse communities.

NatCap works with decision-makers to understand their policy or management objectives, and how information on ecosystem service values can help. We work with our partners in each decision context to scope the issues and identify how accounting for ecosystem service values will inform their policy or management interventions. The partners define the specific management questions, timelines over which scientific outputs are needed, and the most useful types of outputs (e.g., maps, tables, simple graphics.) The NatCap team works iteratively with the decision-making partners to refine analyses and ways of presenting results so that the science is clear and most relevant to their decision context.

What Policy Questions Did the Analysis Set Out to Address?

WCA is working with the NatCap to apply InVEST as part of a four-year marine spatial planning process. WCA is using intensive outreach to engage communities spread throughout Vancouver Island's sparsely populated west coast. It hosted a series of meetings to clarify visions and values of local First Nations and non-tribal communities, and are iteratively developing and getting feedback from communities to the interim results produced by the WCA-NatCap collaboration. The goal of the collaboration is to: 1) assess the suitability of regions for different activities, 2) assess how alternative spatial plans might affect a range of ecosystem services, and 3) identify the marine use conflicts likely to arise from alternative spatial plans, and how they could be avoided or minimized.

Together WCA and NatCap created a large number of spatially explicit scenarios with extensive stakeholder engagement, each representing alternative configurations and intensities of activities on the coast and in the ocean. Since marine spatial planning involves a diversity of decisions made by different industries and government agencies, the team developed scenarios at two spatial scales, local and regional, each with a different mix of stakeholders and uses.

Discussion of Outcomes

TRADE-OFFS IN MARINE USES AT THE LOCAL SCALE

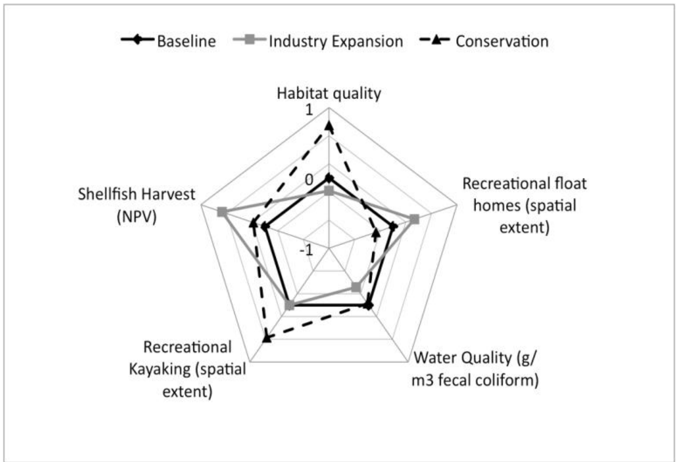

Figure 20: Percent changes relative to current conditions (baseline) in habitat risk, recreational float homes, water quality, kayaking, and shellfish harvest under three alternative management scenarios in Lemmens Inlet, B.C*. In the Conservation scenario, habitat risk is lower due to the relocation and removal of some float homes, while water quality, kayaking, and shellfish harvest all increase to varying degrees. In the Industry Expansion scenario, shellfish harvest and float homes increase, there are no effects on kayaking, and negative impacts on water and habitat quality increase substantially. Note that the axis for water quality is reversed (i.e., points further from the origin have lower concentrations of fecal coliform bacteria and indicate higher water quality). Source: The Natural Capital Project.*

The local-scale scenarios reflected the visions and values of each First Nation and consisted of alternative arrangements of zones for a range of human uses and activities. For example, zones were identified to accommodate important income-generating activities (e.g., finfish farms) as well as cultural and spiritual activities (e.g., culturally managed areas). We used the InVEST tool to model changes in ecosystem services from several local areas. As an example of the kinds of results our process is providing, trade-offs from one such area, Lemmens Inlet, are shown in Figure 20, under three alternative scenarios of human uses and activities.

The traditional territories of nine First Nations bands together constitute all of WCA's planning area; thus, individual First Nation-scale planning is critical to WCA's strategy for marine spatial planning for the region. The Nations have jurisdiction over many activities (e.g., development of tourist facilities, shellfish aquaculture tenures) in their territories, significantly simplifying the planning process. However, other activities (e.g., shipping, renewable energy generation, commercial fisheries) occur at larger scales and require agreement from other levels of government. Layering these activities into the mix necessitates a larger-scale perspective and is more representative of the multi-stakeholder marine spatial planning processes occurring in other regions.

Where Can Commercial and Recreational Activities Avoid Use Conflicts?

The larger-scale scenarios reflect the interests of a much broader range of stakeholders, including industries such as commercial fisheries, aquaculture, and shipping operators. Coastal towns on the island are being approached by wave-energy interests who seek high-energy sites near existing electrical grid points on land. We used InVEST to analyze how the potential siting of wave energy facilities would intersect with commercial and recreational fishing areas along the coast so that spatial conflicts could be minimized. Our analyses highlighted areas of potentially high net present value for wave energy generating facilities that are outside of most commercial and recreational fishing activities, as shown in Figure 21 below. This information will be used in the next phase of marine spatial planning at the larger scales along the coast.

Enabling Conditions

Our primary partner on Vancouver Island, West Coast Aquatic, is a public-private entity with good representation from many government, First Nation, private, and NGO stakeholders in the region. Its leadership of the political process and engagement with different sector groups in the area is critical to the collaboration. Because of the distinct and unassailable property rights and authorities in the region, the science-policy process conducted through our collaboration is essential for illuminating options that minimize conflicts among interests. External funding for science capacity from NatCap to help in designing and evaluating alternative scenarios brings additional technical support to the process.

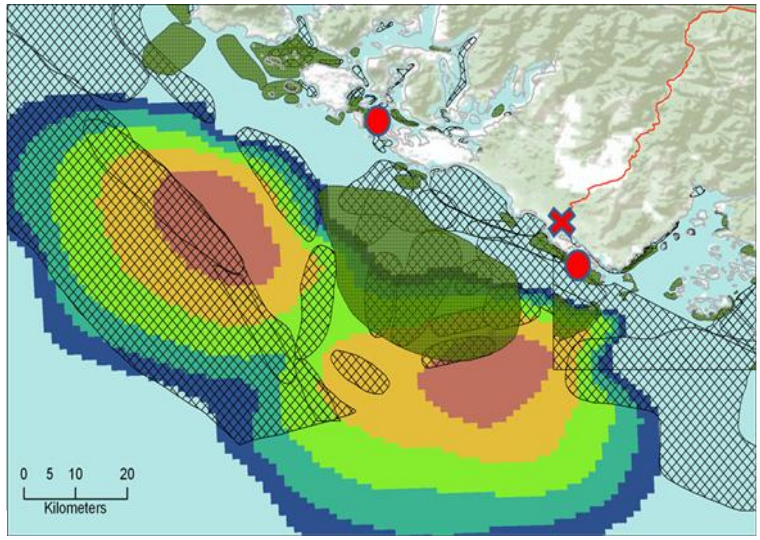

***Figure 21: Potentially high net present value (NPV) areas for wave energy facilities**. Colored contours show NPV estimates of potential wave energy facilities based on captured wave energy, operating costs, and distance to electrical grid (warmer colors have higher NPV). The red line on land shows grid location; red dots show assumed landing points for electricity from facilities. Distribution of commercial crab, salmon, and shrimp fishing grounds (stippled areas) and recreational salmon and groundfish areas (green areas) are overlaid on contours of the NPV of wave energy. Source: The Natural Capital Project.*

Moving Forward

Marine spatial planning processes are a relatively new phenomenon, and have a strong appeal in that they allow stakeholders to incorporate multiple human values and uses into creating a plan for how to allocate space and ecosystem benefits in ways that maximize value and minimize conflicts. Nevertheless, such multi-sector processes are challenging to implement — they require time, a dedication to iterative communications, and the refinement of scientific analyses to support the process.

In this collaboration thus far, we are finding that when tradeoffs are communicated clearly in metrics that resonate with stakeholders (e.g., net present value of the shellfish harvest or bacterial content in water), people are equipped to make their own decisions about which tradeoffs are acceptable and which are not. By using process-based models linked through impacts to habitat and water quality, InVEST allows users to identify unexpected consequences and compatibilities among human uses that could not be gleaned from simple maps alone.

Marine environments are complicated because authority and property rights are often unclear; thus, no single marine planner knows where everything happens on the seascape. The development and implementation of a marine spatial plan requires coordination among many government agencies, First Nations, and private interests. Taking a community-based, bottom-up approach to planning and scenario development takes extensive time and resources, so factoring in realistic timeframes is important for setting expectations of progress.

Aesthetic, spiritual, and cultural values — benefits that are not readily monetized or even quantified — are universally important across the diverse communities in the region. These cultural services are included in the marine spatial planning process in two primary ways: through articulation of acceptable future activities in scenarios (e.g., by excluding or encouraging some activities in areas of spiritual or cultural significance), and through the selection of models to run (e.g., aesthetic values, provision of culturally valuable shellfish landings). Value is not always easily characterized or fully captured in monetary terms, so it is important to characterize value in multiple dimensions, including health, livelihood support, cultural significance, and so forth. This will help ensure that valuation and broader decision-making approaches are inclusive of the range of benefits and people concerned. Interdisciplinary efforts are presently underway to create a conceptual framework that is useful both in theory and in practice for a broad suite of cultural ecosystem services.

For more information, contact Anne Guerry (anne.guerry@stanford.edu).

Recommended Citation:

Ruckelshaus, M. "Developing a Marine Spatial Plan with Partners along the West of Vancouver Island, British Columbia, Canada." In Measuring Nature's Balance Sheet of 2011 Ecosystem Services Seminar Series. Edited by Coastal Quest and Gordon and Betty Moore Foundation, 426-428. Palo Alto: Gordon and Betty Moore Foundation, 2012. PDF e-book.

CONCLUSION

The suite of concepts gleaned from the public sector and presented in this chapter highlights several key issues and helps to further reveal the underlying technical and political complexity inherent to an ecosystem services approach. First, as previously noted, concrete governance and robust oversight are fundamental to implementing an ecosystem services approach. However, these experiences highlight the need for a robust decision-making framework to be coupled with rigorous science, a clear articulation of policy linkages, economic analyses, benefit-sharing schemes, monitoring and reporting regimes, coordination across agencies, and participation among key stakeholder groups, as well as a comprehensive understanding of any trade-offs involved, in order to deliver effective, efficient, and equitable results on the ground.

In addition, by working within the public sector, this type of framework can be strengthened by decision-makers' abilities to design policy measures that create incentives for large multinational corporations, small businesses, civil society, communities, and individuals to maintain and sustainably manage ecosystem services, as well as disincentives that deter actions that promote widespread ecosystem degradation. Finally, credible and transparent governance structures that support consistent monitoring of biophysical, social, and economic returns can serve to attract investment from the private sector to complement public funds and scale the approach beyond what limited public resources can support (as demonstrated by the development of additional investment in the Colombia water fund's fund structure and in North Carolina's engagement of private banks).

From these case studies, it appears that building a framework to track and manage ecosystem services offers public-sector benefits in terms of management cost savings and public support. For example, Wunder (2009) has identified the following attributes in large-scale, government-led payment for ecosystem services (PES) programs that are relevant to the public sector ecosystem services–focused case studies presented here: lower transaction costs, better links with existing policies, ability to secure greater targeted impacts and multiple benefits, and easier-to-control issues of leakage (leakage occurs when the provision of ecosystem services in one location increases pressures for conversion in another[4]).

Wunder's work highlights key characteristics of public sector ecosystem services efforts that support the case for this approach from an economic, social, and environmental perspective, though it is important to note the need for strong frameworks with clear indicators from which to assess and verify performance and compliance, which in the past have been notably lacking. Ultimately, an ecosystem services approach can help facilitate a global sustainability paradigm shift that depends on investing in ecosystems for long-term social well-being and economic development; however, this effort requires continued improvement and integration from all levels of decision-making to realize the ambitious goal of sustainability.

[4] For example, in the case of deforestation, leakage is the shifting of deforestation activities from one area to another.

References

Wunder, S. 2009. Can payments for environmental services reduce deforestation and forest degradation? In *Realising REDD+: National strategy and policy options,* Angelsen, A., M. Brockhaus, M. Kanninen, E. Sills, W. D. Sunderlin, and S. Wertz-Kanounnikoff, eds. Pp. 213-224. Bogor, Indonesia: CIFOR.

This document is a product of the Gordon and Betty Moore Foundation's Ecosystem Services Seminar Series that took place between March and November 2011. For more information please visit www.moore.org or request "ES Course Info" from Heather Wright at info@moore.org.

Recommended Citation:

Wright, H. Introduction & Conclusion. "Ecosystem Services and Public Sector Decision-Making." In Measuring Nature's Balance Sheet of 2011 Ecosystem Services Seminar Series. Edited by Coastal Quest and Gordon and Betty Moore Foundation, 410-411,429-430. Palo Alto: Gordon and Betty Moore Foundation, 2012. PDF e-book.