Measuring and Monitoring the Economic Effects of Restoration:

Recommendations From a Blue Ribbon Panel

The recent oil spill disaster in the Gulf of Mexico has highlighted how important the region's coasts are to the economy. The National Oceanic and Atmospheric Administration has long been measuring the ecological successes of its marine and coastal restoration efforts, but a new panel offers ideas on how to also measure the economic impact of restoration.

By Linwood Pendleton and Suzanne Giles Simon

Restoring degraded marine and coastal habitat is critical if America's coasts and oceans are to reach their economic and ecological potential. The National Oceanic and Atmospheric Administration (NOAA) has a number of programs, including the Damage Assessment Remediation and Restoration Program (DARRP), the Restoration Center (RC), and the Assessment and Restoration Division (ARD) that are dedicated to restoring coastal, estuarine, and marine habitats. NOAA works in partnership with other federal agencies, nonprofit organizations, and state and local governments to identify and fund restoration projects around the country.

NOAA's restoration efforts focus on restoring the ecosystem functions of degraded and damaged habitats, and it uses biological and ecological metrics to measure the success of its activities—for example, the number of stream miles and acres restored. Applying additional emphasis to also documenting the economic benefits of habitat restoration will help in quantifying the additional values of restoration, above and beyond the ecological values.

Finding ways to determine the economic effects of restoration activities is a critical first step in showing how restoration can improve the economic and overall societal well-being of the nation.

A Blue Ribbon Panel for Estuary Economics

Unlike the commercial fisheries arm of the National Marine Fisheries Service, the Office of Science and Technology, restoration agencies have not historically collected systematic data on the economic outcomes associated with their activities. As a result, it is often difficult for NOAA's restoration programs to argue convincingly that their work has economic relevance.

Because there has never been a systematic effort to collect data to measure and monitor the effects of coastal habitat restoration on economic value, in December 2009, Restore America's Estuaries, in concert with NOAA, convened a blue ribbon panel (Table 1) of economists to consider approaches for collecting and analyzing data on the economic outcomes of selected restoration projects. The panel was asked to provide recommendations on what aspects of economic outcomes could be measured to best capture the economic value and impacts of restoration projects. The panel also was asked to provide recommendations on how these outcomes could be measured and analyzed and what types of restoration projects NOAA might first attempt to monitor for economic outcomes. While the recommendations within the report were developed

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at the request and under the auspices of the RC and the ARD, they were generally referred to as "NOAA" throughout the report and in this article. Moreover, though the report was funded by NOAA, it does not represent an official position, but rather captured the recommendations by a panel of experts. The panel did not and was not asked to seek consensus, and the report reflects a diversity of opinions.

The work of the panel was intended to be a starting point to help NOAA, its sister agencies, and its restoration partners consider systematic approaches for the collection of data to measure and monitor the economic outcomes of habitat restoration in the coastal zone. The panel suggested that the process of developing such a system of data collection should be an iterative one in which methods are applied, tested, and refined.

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Kenneth E. "Ted" McConnell	University of Maryland
Steve Newbold	U.S. Environmental Protection Agency
George Parsons	University of Delaware
Linwood Pendleton	Duke University
Steve Polasky	University of Minnesota
Randall S. Rosenberger	Oregon State University
Douglass Shaw	Texas A&M University
Kristy Wallmo	National Oceanic and Atmospheric Administration

Table 1. Blue Ribbon Panel on Estuary Economics, December 2009, Washington, D.C.

Metrics for Measuring and Monitoring the Economic Effects of Restoration Projects

Estuary and coastal ecosystems provide many goods and services that society values. These ecosystem services include providing habitat for finfish and shellfish that are harvested directly from these ecosystems by commercial fishers and recreational anglers, and recreational opportunities for birdwatchers, hikers, swimmers, and similar enthusiasts. Property values have been shown to reflect ecosystem and environmental quality in coastal and estuary ecosystems (see Kildow 2008 for a review of the literature). Finally, coastal ecosystems provide a variety of other services, including shoreline protection, flood control, and the ability to store carbon. All of these ecosystem services provide potential value to local, regional, national, and international economies.

Habitat restoration can create economic value if it produces new ecosystem services that did not exist prior to restoration or if it increases the value of existing ecosystem goods and services or the value of other economic activities that depend on ecosystem conditions. If the total increased value exceeds the costs of restoration, then it can be considered that the restoration had net economic benefits to society. The difference between the maximum amount that society would be willing to pay for a project's outcomes and its costs reveals its net economic value to society—a measure of the change in societal welfare.

The challenge with understanding, measuring, and monitoring the economic value of habitat restoration lies in the fact that economic values of estuary and coastal ecosystems, and thus the economic outcomes associated with restoration, often are not reflected in market transactions and thus are not always easy to quantify. Economic outcomes from habitat restoration include: direct market effects, e.g., people might be willing to pay to visit a restored area; indirect market effects, e.g., restoration could increase commercial fishing harvest by providing more or better nursery habitat; non-market effects, e.g., the recreational value of fishing in a restored estuary, enjoying the view offered by a restored area, or knowing that an endangered species exists because of habitat restoration; and offsite effects, e.g., restoration can result in reduced sedimentation in downstream areas of estuaries or increased property values.

To carefully measure the economic outcomes of restoration projects and programs, economists need to characterize the basic components of economic value associated with the ecosystem that is restored. These include:

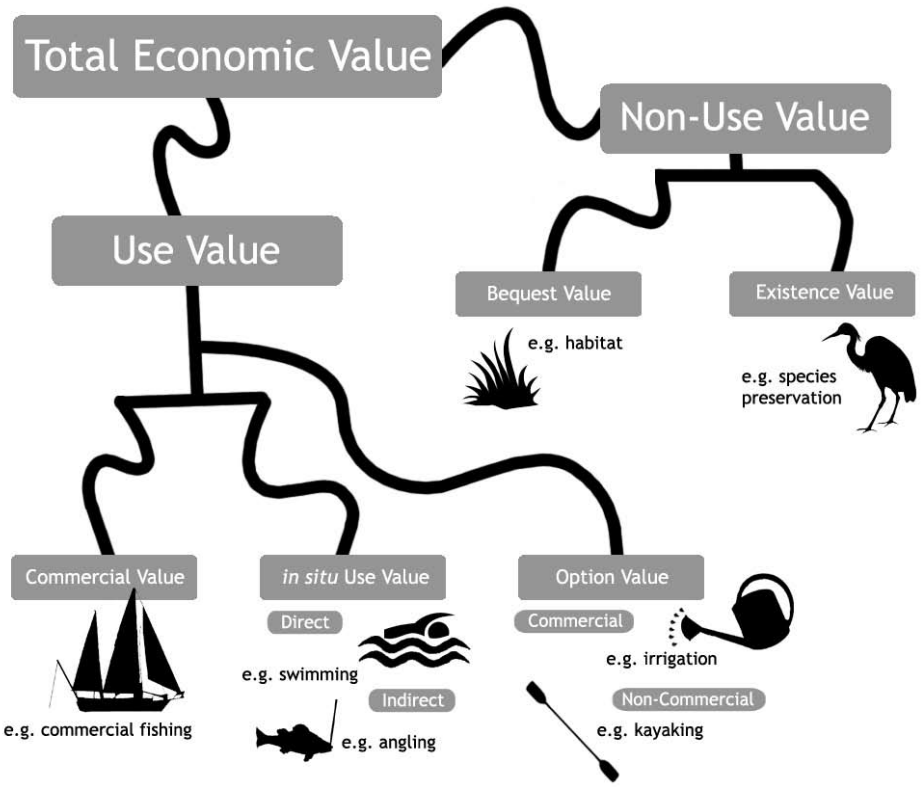
(1) Use value—the maximum willingness of society to pay for the direct or indirect use of a coastal ecosystem.
(2) Non-use (passive) value—the maximum willingness of society to pay for the existence of or improvement in an ecosystem, now or in the future.

Together, use and non-use values represent the Total Economic Value of an ecosystem good or service. (Go to www.csc.noaa.gov/coastal/economics/envvaluation.htm, for more information on total economic value.)

The value of restoration is limited to the change in ecosystem value that can be attributed to the restoration project or program. The net economic value of habitat restoration is this change in value minus the costs of restoration, including any in-kind costs, such as the value of donated land. Because most of the costs of restoration are accounted for directly by restoration managers, the panel was asked to focus specifically on providing recommendations about methods and approaches for measuring the values (benefits) of restoration.

Data and Analysis for Determining the Influence of Restoration on Economic Value

To understand the effects of a restoration project on economic value, we need to know exactly how value differs as a result of the restoration, compared to what that value would have been without the restoration. Ideally, the panel suggested that we ought to have two kinds of data:



To learn more about total economic value and its components please go to www.noaa.gov/coastal/economics/envvaluation.htm. Graphic by Sandeep Prassana.

(1) Ecological performance data—how much did the restoration improve the ecosystem goods and services valued by humans; and
(2) Economic outcome data—how much did the willingness to pay for these goods and services change due to restoration.

Historically, NOAA has used "miles of stream restored" and "acres of wetland restored" as the basic measures of ecological outcome. The value of a stream mile or wetland acre restored depends on certain attributes of those stream miles and restored acres. Data on stream miles and acres restored alone are insufficient to estimate the economic value of a restoration project or program. The specific ecological outcome measures of restoration that would be needed to estimate the economic value of restoration will depend on the habitat restored, how people will use that habitat or indirectly benefit from the ecosystem services it provides, and what attributes of that habitat might generate non-use value.

Even without a complete accounting of ecological and environmental change, it may be possible to show that a restoration event has had an impact on a target economic use or value. An ecosystem or environmental change does not necessarily translate to a discernable change in value. For instance, increasing fish abundance if fish are already highly abundant may have only an incremental and small effect on economic value (Dunford et al. 2004). A change in economic value alone also does not conclusively demonstrate that the restoration project or program is responsible for the change in value. Other, unexplained factors could have occurred at roughly the same time and place as a restoration event, and these factors, not restoration, may account for all or part of the change in value, such as changes in human populations, awareness of ecosystems, or the economy.

To empirically show that restoration has created value, we need to be able to accurately isolate the effects of restoration from other factors and provide convincing evidence, e.g., a survey in which people indicate that the ecological attributes restored matter to them, that the ecological and environmental outcomes of restoration are indeed the causes of these changes in value (see, for instance, Barbier 2007 and Fisher et al. 2008).

As part of the effort to explicitly show the effects of restoration, the panel outlined a series of steps to do so. First, the analyst should choose sites that:

(1) Are as similar as possible in their basic ecosystem types; and
(2) Have similar uses or are valued for similar reasons across all sites.

In addition, statistical analysis requires variation in the variables analyzed. To ensure sufficient variation in ecological condition over time and sites, the analyst should focus on sites that are likely to be restored over a certain course of time, e.g., next 5-20 years. This means there will be enough observations with and without, before and after, in the data.

The panel also noted that it is critical to identify those sites where clear ecological and behavioral relationships exist between the restoration undertaken and the effects on the surrounding area. Some examples of such projects include: restoration of passage for recreationally important fish; restoration of salt marsh in areas frequented by birdwatchers; restoration of coral reefs that are used for recreational diving; restoration of essential fish habitats that are demonstrably important for commercial harvest; and improvement of bacterial water quality for swimming areas. All of these types of restoration projects have an effect that should be more easily identified and, therefore, more accurately quantified.

Regardless of the economic outcomes, restoration outcomes, or explanatory variables chosen, it is critically important that the data for the analysis are consistent across time and across the sites examined. Without this consistency, measurement errors can be so large that it becomes difficult to accurately estimate the statistical relationship between the economic outcome and the restoration event. As a result, consistency is absolutely vital when undertaking any type of project intended to measure pre- and post-project changes.

Proposals for Moving Forward

During its meeting in December 2009, the panel provided suggestions that we summarized as a seven-step approach to commencing a program for the systematic collection of data on: (1) economic and ecological outcomes associated with coastal and estuary habitat restoration; and (2) explanatory factors needed to analyze these data. The approach is general, and the details will depend ultimately on which of many types of habitat restoration the agency decides to monitor. A pilot or several demonstration projects could provide technical insight and guidance for future efforts that will be needed for the agency, if systematic and long-term data will be collected. The basic elements of the plan are:

(1) Start collecting systematic, long-term data on ecological and economic outcomes now.
(2) Begin by selecting one or more restoration themes that have clear and demonstrable links to economic outcomes.
(3) For each restoration theme selected, focus on a region for which this restoration theme is common.
(4) Select sites for data collection where restoration is likely to occur and start collecting data as soon as possible.
(5) Use on-site surveys and other site-specific data collection to identify economic and ecological data to be collected and to collect data that will supplement the longer term, systematic data.
(6) Once the approach and analysis are well established, extend data collection to other regions and restoration themes.
(7) Make good examples of economic metrics and measures of economic outcomes available to restoration partners through a website.

Because systematic, long-term data collection has not been initiated for coastal and estuarine habitat restoration, the panel envisioned this process as one in which the agency learns by doing. It is an approach similar to that followed historically in the attempt to constantly improve the collection and analysis of fisheries data. NOAA and its federal partners can be leaders in developing an understanding of the economic outcomes of coastal ecosystem change—an understanding that will benefit all aspects of coastal ecosystem management.

Restoration has the potential to be a valuable policy tool to achieve ecological and economic goals. While NOAA continues in its mission to restore ecologically critical habitat, it could benefit from working with the larger restoration community to also think about how to explicitly incorporate economic goals in the design and choice of restoration efforts. If the restoration community considers the explicit economic ramifications of its work and incorporates these concepts in its restoration framework, it will become increasingly easier to detect the economic effects of future restoration projects and demonstrate their economic outcomes.

A full copy of the report may be downloaded at www.estuaries.org/images/stories/NOAA_RAE_BRP_Estuary_Economics.pdf. ■

Resources

The blue ribbon panel's report can be read at www.estuaries.org/images/stories/NOAA_RAE_BRP_Estuary_Economics.pdf.

For more information on Total Economic Value, go to www.csc.noaa.gov/coastal/economics/envvaluation.htm.

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