UF IFAS Extension UNIVERSITY of FLORIDA

WEC340

Measuring the Economic Value of the Environment and Natural Resources[1]

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Figure 1. The Florida manatee
Credits: Eric Zamora, UF/IFAS

Conservation of natural resources requires investments of money, time, and effort by the government, businesses, landowners, conservation organizations, and the general public. Policies to conserve and manage natural resources should be based on a careful accounting of both the benefits and costs of conserving these resources. In a prior EDIS document ("The Use of Cost-Benefit Analysis in Environmental Policy"), cost-benefit analysis and the role it plays in natural resources management and policy was discussed. This document extends that previous discussion by presenting more detailed information about how economists categorize the benefits of natural resources.

When considering the benefits of natural resources conservation, economists focus on the *total economic value* that these resources provide to people. Total economic value is the dollar value of the total benefits that society derives from a resource. This dollar value can be decomposed into three different measures:

- use value;
- option value; and
- non-use value.

Use Value

Use value is the *direct* value that people derive from resources. Some examples of use values include:

- fish harvested from the ocean;
- timber or mushrooms harvested from forests;
- water extracted from rivers, lakes, or aquifers for agriculture, industrial production, and home consumption;
- oil used in transportation and the production of electricity;
- pollination of crops by bees;
- the capture of carbon dioxide by trees;
- nature-based recreational opportunities, e.g. hiking in forests, sailing on rivers and the ocean, skiing in the mountains, and hunting and fishing; and
- the scenic beauty of natural areas.

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The term, use value, is somewhat confusing because it implies that resources must be physically used or consumed for them to be valued by society, i.e. resources are destroyed or harvested to generate use value. If resources are used for agriculture, industry, fuel, or development, then this is accurate. But use value also includes values that people derive from activities that may not affect the amount or quality of the resource, for example, looking at a view or hiking on a trail. The key characteristic of use value is that people must directly benefit from the resource themselves.

For a person to derive use value from the Amazon basin, for instance, the person may either consume goods that are produced using materials from the Amazon (wood, soil, or other resources) or visit the Amazon for personal enjoyment. In Brazil, the Amazon is being cleared to plant soybeans, which are being used to produce food (tofu, meat substitutes, soy sauce), oil, and livestock and poultry feed (to provide meat, eggs, and dairy products). If a person consumes any products that are produced using soybeans grown in the Amazon basin or if the person visits the Amazon for a holiday, then that person derives use value from the Amazon. This means that people in the United States may be deriving use value from the Amazon because of the products and food they buy even though they may not be aware of this fact.

According to the World Wildlife Fund, the Amazon Rainforest also produces about 20% of the earth's oxygen. Protecting the rainforest provides use value to people by providing oxygen, which supports and sustains life. This raises an important point. Converting the rainforest to agricultural crops provides use value (food, oil, and livestock and poultry feed), but protecting the rainforest also provides use value (ecosystem services such as oxygen production and tourism). As is often the case with resource-use decisions, there is a tradeoff between the value generated by harvesting the resource and the value generated by protecting the resource. Finding the optimal level of the resource to harvest requires comprehensive cost-benefit analysis.

One method of calculating the use value of a resource is to measure revenues, income, and employment generated by harvesting that resource. This may be done by observing market transactions, for instance, profits generated by the fishing industry. However, care must be taken in determining exactly what share of revenues, income, or employment is linked to that resource. Careful analysis is required to make sure that use values are not overestimated because of double-counting. For example, the use value of a fish species would include revenues, income, and employment generated by that fishery, and a *percentage* of the revenues, income, and employment generated by industries that are *linked* to that fishery (the pet food industry, the restaurant and tourism industry, and so on).

Option Value

Option value is the value people place on their future ability to use the environment. In contrast to use value, which focuses on current use of a resource, option value focuses on potential future use of the resource. For example, a person may want the option to visit the Amazon in the future to view the forest and the wildlife. Or they may want the Amazon to be protected because it may contain important genetic material needed for future scientific or medical advances.

Option value is more difficult to estimate than use value. Environmental economists have developed a number of survey-based methods that may be used to estimate option value. These surveys must be carefully designed, pre-tested and implemented because they involve the presentation of counter-factual or hypothetical options from which survey respondents must choose. Economists then analyze this data, in order to estimate option value.

Non-use (Existence) Value

Non-use value is the value people place on conserving or improving the quality of resources that they will never use. This value is also called *existence value*. For example, if a person wants the Amazon rainforest to be protected even though they will never visit the forest or see any of the wildlife that lives in the forest then they place non-use (or existence) value on the Amazon. The value they place on the Amazon is not linked to current or potential future use of the resources in the Amazon. Rather, they value the existence of the Amazon.

As with option value, economists use survey methods to estimate non-use value. Although estimates of non-use value are often criticized because they are derived from hypothetical survey questions, the validity of these survey methods has been demonstrated. Following the *Exxon Valdez* oil spill, a blue-ribbon panel of high-ranking economists was commissioned by the National Oceanic and Atmospheric Administration (NOAA) to assess the use of hypothetical survey methods in measuring non-use value. The panel was commissioned because industry strongly objected to the use of hypothetical survey questions to measure the value the public placed on resources that were damaged by the oil spill. The blue-ribbon panel concluded

that surveys that are properly designed and implemented may provide estimates of non-use value that are sufficiently reliable for judicial and administrative use.

Total Economic Value

The calculation for total economic value is:

> Total Economic Value = Use Value + Option Value + Non-use (Existence) Value

The task of economists is to then estimate these various values, in order to calculate total economic value. These calculations are often complex, especially when estimating non-use (existence) value. Care must be taken not to double count values or to omit values because they are difficult to calculate. In particular, the omission of non-use (existence) value results in the value of a resource or environmental good being underestimated, which will result in inefficient resource-use decisions and policies. Below, I present a case study on the economic value of the Florida Manatee.

The Economic Value of the Florida Manatee: A Case Study

The Florida manatee (*Trichechus manatus latirostirs*) is a sub-species of the West Indian manatee. The Florida manatee is listed as an endangered species. Although the population of the manatee has increased, the long-term survival of the manatee is highly uncertain, in part owing to injuries and deaths from collisions with motorboats and mortality related to red tide or extreme low water temperatures. To determine the benefits of manatee protection to residents of one county in Florida (Citrus County), Solomon et al. (2004) estimated the economic value of the manatee in that county.[1]

In Citrus County, Florida manatees provide use value by:

- eating aquatic vegetation that impedes the movement of water traffic, thereby reducing the cost to local governments of clearing vegetation from waterways;
- generating employment; and
- generating tourism income from people snorkeling or swimming with manatees in the wild or visiting the Homosassa Springs State Wildlife Park to view the manatees.

The Florida manatee also generates option and non-use values.

Solomon et al. (2004) estimated these values for Citrus County and demonstrated that the manatee generates between $8.7 million and $9.4 million in economic value to Citrus County each year (Table 1). An explanation of how this value was estimated is provided below.

The use value of the manatee was estimated at between $8,252,900 and $9,013,600 per year. This use value was calculated as follows:

- Between 1994 and 1999 the Citrus County Department of Public Works-Aquatic Services Division spent $1,730,000 on mechanical and herbicidal treatment of aquatic vegetation in waterways for six months of each year (Solomon et al. 2004). If manatees did not provide the ecological service of eating aquatic vegetation for the remainder of the year, these costs would be approximately doubled.
- Between 1994 and 1999 the Homosassa Springs State Wildlife Park generated $12,312,000 in total revenues (approximately $2,052,000 per year) (Solomon et al. 2004).
- Manatee-related employment at the Citrus County's State Wildlife Park and the National Wildlife Refuge generated $576,000 in total salaries each year (Solomon et al. 2004).
- Between 40,000 and 80,000 people visit the Citrus County area every year to dive with the Florida manatee. Additional manatee tourism-related expenditures by visitors to Citrus County were composed of estimated transportation, lodging, dining and retail purchases of $5,324,900 to $6,085,600 per year. These expenditures included $25 to $27.50 per person for guided manatee snorkeling tours, and an average of $18.50 per person for rental of dive masks, snorkels, fins and wet suits (Solomon et al. 2004).

Solomon et al. (2004) also used a survey to estimate the non-use value of the manatee to residents of Citrus County. They found that, on average, people in Citrus County are willing to donate $10.25 each year to protection of the manatee. Based on their survey results, they estimated that the population of Citrus County would be willing to donate $194,220/year to manatee protection.

Solomon et al. (2004) augmented this data by gathering information from the United States Fish and Wildlife Service (USFWS) and the State Law Enforcement Division of the Florida Fish and Wildlife Conservation Commission (FWC). Solomon et al. (2004) estimated that the FWC spent $176,000 per year on manatee protection in Citrus County, and the USFWS spent $44,000 per year. These costs

of manatee protection provide an additional estimate of the value of manatee protection.

Solomon et al. (2004) used market, employment, and survey data to estimate the economic value of the manatee. Based on their findings, they argued that a policy should be implemented that maintains the manatee population at its current population or a higher population.

Although Solomon et al. (2004) only focused on the value of the Florida manatee in one county, their results suggest that conserving the Florida manatee provides millions of dollars of benefits to residents of Florida. A full cost-benefit analysis would require the costs of Florida manatee protection to be weighed against the benefits of conserving the manatee. Solomon et al.'s (2004) numbers do not provide information on the optimal level of protection for the Florida manatee, but these numbers do provide part of the necessary information required to conduct that analysis.

[1]Note, this study specifically focused only on residents of Citrus County. It would be possible to estimate the value of the Florida manatee to residents of the state of Florida or the entire United States, but this would require additional analysis.

Concluding Comments

Attempts to calculate the economic value of entire ecosystems, such as the Amazon basin, are extremely difficult, but even estimating the value of a single species, as the example of the Florida manatee shows, can be more complicated than it might at first appear. Estimating the total economic value of ecosystems, natural resources, or individual plant or animal species requires careful calculation of applicable use, option, and non-use values. Understanding and accounting for these components of total economic value is necessary to ensure that resources, species, and the environment are neither over- nor undervalued.

Table 1. Estimated Total Economic Value of the Florida Manatee in Citrus County, Florida

Value	$/Year
Use Value:	
Ecological services (clearing of vegetation from waterways)	300,000
Tourism value:	
Homosassa Springs State Wildlife Park revenues	2,052,000
Manatee-related employment	576,000
Other tourism expenditures (transportation, lodging, dining, retail)	5,324,900[a]
Subtotal	8,252,900
Nonuse Value:	
Willingness to donate to manatee protection	194,220
Additional Value of Manatee Protection:	
Manatee protection by the FWC	176,000
Manatee protection by the USFWS	44,000
Subtotal	220,000
Total Economic Value	**8,667,120**

[a]This is the lower bound estimate of other tourism expenditures. If the upper bound estimate of $6,085,600 were used, then the estimated use value of the manatee would be $9,013,600/year. The total economic value of the manatee would be $9,427,820/year. In general, economists prefer to be conservative in their estimates of economic value. If a conservation policy or program is cost-benefit justified even with the most conservative estimates of economic value (or benefits), then the argument in favor of that policy or program is strengthened.

Further Reading

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