Economic Value of the Services Provided by Florida Springs and Other Water Bodies: A Summary of Existing Studies[1]

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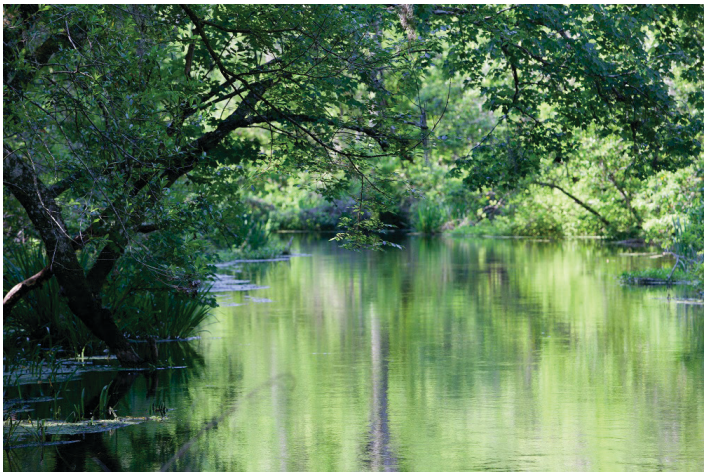

Ecosystem Services and Why Ecosystem Service Valuation Is Important

An *ecosystem* is an environment in which living things—plants, insects, fungi, birds, mammals and so on—live together, cooperate, and rely on one another for their survival. Ecosystems provide a variety of benefits to people. The services ecosystems provide people can be divided into four categories (MEA 2005):

- *Provisioning services*: Ecosystems provide food crops, water, timber, fiber, and other raw materials humans use.
- *Regulating services*: Ecosystems regulate the quality of the air, water, and soil; they sequester carbon, and regulate pests and diseases.
- *Cultural services*: Ecosystems provide for recreation, tourism, education, and spiritual and aesthetic appreciation.
- *Supporting services*: Ecosystems have a variety of other processes that may not directly benefit people but are necessary for all other ecosystem services (such as nutrient cycling) (MEA 2005).

The word "value" has many meanings. Economists measure the value of ecosystem services in dollar terms to assist management decisions concerning natural resources. For example, a monetary value can help an ecosystem manager compare management plans and choose a program that

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generates the highest value per dollar spent. The monetary value of ecosystem services can also help decision makers justify their environmental management decisions that may require significant investments by stakeholders and the public. However, ecosystem services are not bought and sold in markets, so their economic value can only be estimated using special valuation methods.

Assigning Values to Ecosystem Services

Ecosystem services can have many different types of value (Figure 1). *Use values* measure the worth of direct or indirect uses of the ecosystems by people. For example, for Florida springs, swimming and snorkeling, and bottling spring water for drinking purposes are direct uses. Use value can also include the worth of the opportunity to use the system in the future. *Non-use value* can be "existence value" (e.g., the value derived from simply knowing that Florida has more springs with plentiful flow than any other state in the nation) or "bequest value" (e.g., the value we place on knowing that future generations can enjoy and use the springs).

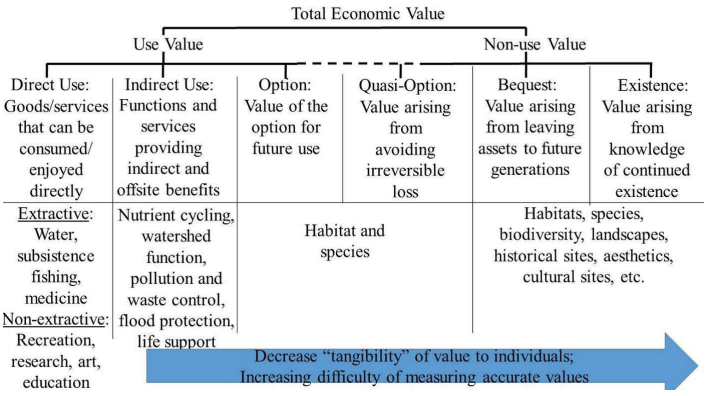

Figure 1. Examples of ecosystem services and their total economic value {Sources: Scottish Government (2004) and Boateng (2010)]

Examples of the methods available to assign dollar values to different types of ecosystem uses include

- T*otal economic contributions method*: This method focuses on the *use values* of ecosystems, for instance, by examining the economic impacts of tourism activity near a spring (Figure 2). This method analyzes direct consumer spending by non-local visitors and relates the money they spend to the flow of goods and services in the local economy, from producers, through intermediaries, to final consumers. Based on this flow of goods and services, industry production, employment, taxes, and other indicators of regional economic activity are estimated (Mulkey and Hodges 2012).
- *Travel cost method*: This method focuses on *use values* of ecosystems specifically for recreation. It is based on the assumption that the time and costs incurred by users traveling to a recreational site are the price that people are willing to pay for nature-based recreation. The total value of visitors' recreation experience is reflected in their spending levels and how many trips they make to a particular site.
- *Contingent valuation method:* This method can be used to measure the *use and non-use values* of ecosystems. The method involves using surveys and asking people to make tradeoffs between consumption of various goods and services (including ecosystem services). For example, such surveys can ask how much people would be willing to pay for water quality improvement that can result in enhanced recreational opportunities. In this case, respondents would need to compare spending money for the water quality improvement project versus spending money on something else.
- *Hedonic valuation method*: This method involves analyzing property sales prices to infer the value of the property amenities, such as the proximity to a lake or river of good quality.
- *Benefits trasfer method:*This method applies information from previously completed studies on ecosystem services valuation in another location or context, adjusting for income levels, inflation, etc.

Additional information about the valuation methods for ecosystem services can be found on the Ecosystem Valuation website at http://www.ecosystemvaluation.org/1-03.htm and in Letson (2002).

Figure 2. Swimmers at Fanning Springs (Credit: UF/IFAS)

What the Literature Says about the Economic Value of Florida Springs

Existing studies applied a variety of methods to assign economic values to services provided by springs and other related ecosystems (Table 1). *Note that all estimates reported in this document were converted to 2014 US dollars using the*

Implicit Price Deflator for Gross Domestic Product (Federal Reserve Bank of St. Louis 2014).

Economic contributions of spring sites to regional economy

Bonn and Bell (2003), Bonn (2004), and Borisova et al. (2014) examined the economic contributions of different groups of Florida springs to the regional economy. Among the spring sites assessed in the three studies, the highest direct annual consumer spending was estimated for Silver Springs ($73.89 million), Ichetucknee Springs ($28.65 million), and Wakulla Springs ($28.02 million), and employment generated by economic activity at these three spring sites was estimated at 1060, 311, and 347 jobs, respectively (Bonn 2004; Bonn and Bell 2003). Note that the economic contributions can vary from year to year.

Consumer surplus value of water-based recreation

As stated above, the total value of recreational experiences generally exceeds visitors' total expenditures for recreational trips. Several studies used the contingent valuation method to examine consumer surplus (Huth and Morgan 2011; Morgan and Huth 2011; Shrestha et al. 2002). Note that, unlike most of the other studies listed in this document, these three studies were published in peer-reviewed journals, which increases the validity of the results. Shrestha et al. (2002) focused on water-based recreation at the Sweetwater Springs, Silver Glen Springs, Juniper Springs, and Salt Springs sites in the Ocala National Forest. The recreational experiences included boating, canoeing, swimming, fishing, and wildlife viewing activities. Estimated willingness to pay differed among day visitors and overnight (i.e., extended) visitors. Day visitors were willing to pay an average of $6.35 per visitor, per trip, given the current facilities at the spring sites. However, day visitors were willing to pay more, $11.39 per visitor trip, for moderately improved facilities (e.g., basic grocery, camping facilities, daytime tours), and $15.26 per visitor trip for greatly improved site facilities (e.g., children's play area, restaurant, rental cabins, weekend tours). In turn, for visitors who stayed overnight, willingness to pay (WTP) averages were $12.15, $16.86, and $22.72 per visitor, per trip, for different levels of improvements to spring site facilities, respectively. Based on overall visitor numbers, this amounted to a total annual WTP of about $1.30 million for current basic facilities, $2.47 million for moderately improved facilities, and $3.25 million for greatly improved facilities at the spring sites in the Ocala National Forest.

The value of cave diving to springs visitors

Huth and Morgan (2011) and Morgan and Huth (2011) examined visitors' WTP in addition to actual expenses incurred (i.e., consumer surplus) for spring cave diving (Figure 3). For Wakulla Springs, surveyed cave divers who had previously visited the area reported a WTP ranging from $56.02 to $61.41 *per dive*. For Jackson Blue Springs, under the existing conditions, diver WTP was $157.30 to $179.92 per person, *per trip* (may include several dives). Given the total number of visitors, this represents $619,498 in annual consumer surplus for divers visiting Jackson Blue Springs, a "first magnitude" spring, with flow exceeding 100 cubic feet per second.

Figure 3. Divers in a Florida springs (Credit: UF/IFAS)

The value of freshwater-based recreation in the southeastern United States

While only a few Florida-based studies examined the value of freshwater-based recreational opportunities, studies conducted in other states can also help measure the value of these ecosystem services. Loomis (2005) summarized past studies related to the value of forest-based and water-based recreation nationwide, examining consumer surplus for 30 recreational activities in five census regions of the United States. For the Southeast region, including Florida and 12 other states, the average consumer surplus values were $31.59 per person, per day for birdwatching; $94.56 for fishing; $152.16 for floatboating/rafting/canoeing; $72.72 for swimming; and $47.87 for wildlife viewing.

Willingness to pay for springs water quality improvement

The studies discussed above focused on one category of services provided by ecosystems—recreation and tourism. However, aquatic ecosystems provide a variety of services (Figure 1), and some studies attempt to estimate the total value of these services. Foster (2008) used contingent

valuation to examine Columbia County, Florida, residents' willingness to pay for water quality improvements in Ichetucknee Springs and the Ichetucknee River. Survey respondents were asked how much more they would be willing to pay in utility bills every month for the next ten years if the extra money were used to reduce nitrate pollution in the Ichetucknee River via a septic system replacement program. Reduced nitrate pollution was linked to expected ecological benefits, including improved water clarity, reduction in excessive algae growth, and protection of natural wildlife habitat. Although only 169 survey responses were collected, Foster attempted to relate the WTP to respondents' education levels, personal political beliefs, and past visitation of the Ichetucknee River. The study found a mean WTP of $18.55 per household, per month, or $221.74 per year. Combining all households in Columbia County, this amounts to $46.54 million over 10 years.

Kreyes et al. (2013) used a benefit transfer approach to estimate the value that people place on protecting water quality in unpolluted rivers and streams. The researchers conducted a review of 17 studies that examined 43 WTP measures for aquatic resource conservation in the United States. Using this data, the researchers examined the statistical relationship between the WTP estimates and the study characteristics, such as the survey method used, geographic region, water quality protection strategy, etc. The WTP estimates from these studies were applied to the state of Florida. The results demonstrate that WTP for water quality protection in Florida is high, and that WTP is very sensitive to how the water quality protection strategy is described to respondents. Florida residents' total annual WTP for programs using land acquisition or conservation easement to protect surface water was estimated at $17.93 million. For nonspecific programs or programs that do not use conservation easements or land acquisition, total WTP was $353.39 million. Specifically for the north Florida region, where many springs are located, total annual WTP for easement-type protection programs was $4.4 million, while WTP for nonspecific programs was $86.0 million.

Other Florida-based Studies of the Economic Value of Services Provided by Water Bodies

While this document focuses on economic studies related to springs, readers may be interested in other Florida-based studies of the economic value of various water bodies. Multiple studies focusing on the *economic contribution to local economy* of specific events and nature-based activities are available online. For example, an excellent collection of studies related to the economic contribution of trails and greenways, many of which are associated with the sites around lakes, streams, and other water bodies, is available at the website of the Office of Greenways and Trails, Florida Department of Environmental Protection (http://www.dep.state.fl.us/gwt/community/). The Florida Division of Recreation and Parks annually assesses the economic contributions of state parks (http://www.floridastateparks.org/resources/aboutus.cfm). An example assessment of the economic contribution of a specific event can be found in Larkin et al. (2012). The study examines the economic impact of the 2011 State Championship of the Florida BASS Federation Nation (a chapter of the Bass Anglers Sportsman Society) at Lake Tohopekaliga (Lake Toho) in Osceola County.

Given the significant investments that are required for restoration of the Florida Everglades (Figure 4), economic studies have investigated the economic benefits associated with these restoration efforts (Milon et al. 1999; Milon and Scrogin 2006; Mather Economics 2010; Richardson 2014). Specifically, Milon et al. (1999) and Milon and Scrogin (2006) described results of a public interview survey conducted in 1998 in Miami, Fort Myers, Orlando, Tampa, and West Palm Beach to examine the values assigned by the public to the Everglades restoration plan. Alternative restoration outcomes were associated with the degree of achieving either hydrologic functions (i.e., the management of the Lake Okeechobee levels, and the Everglades National Park and Water Conservation Areas management) or ecosystem attributes (such as increases in wildlife species populations). The potential effects of the restoration plan on agricultural acreage, residential water-use restrictions, and utility taxes were also presented. The authors estimated an average household WTP of $81 per year (all currencies in 2014 US dollars) for hydrologic restoration outcomes and $96 per year for ecosystem restoration outcomes. Extrapolation of these results to the Florida population shows that the WTP for the full hydrologic restoration was $468 million annually, or $4.7 billion over a ten-year period. Note that these are maximum WTP estimates reported in the study; WTP reduced significantly when the survey presented a scenario with annual costs of $50 per household coupled with agricultural farmland reduction or severe restrictions on municipal water use restrictions. Milon and Scrogin (2006) further discussed the differences in WTP depending on respondent demographics, restoration outcomes, and costs of the restoration plans for Floridians. Note that this study was published in a peer-reviewed journal.

Figure 4. Everglades, a view from a plane (Credit: Tatiana Borisova)

The value of water quality improvement for lakes in urban Orange County was assessed by Walsh (2009) and Walsh et al. (2010) using the hedonic valuation method to examine the relationships between the sale prices for single-family residential homes, homes' proximity to natural lakes, and the lakes' water quality (Figure 5). Specifically, sales of single-family residential properties located within 3,281 feet (1,000 meters) of one of 146 natural lakes were examined for the 1996–2004 period. Water quality in the lakes was measured using the annual mean value of Secchi Disk Measurement (SDM), an indicator of water transparency measured with a disk that is lowered into the water to a depth at which the observer can no longer see it. SDM can be linked to nutrient pollution, since nutrient load can lead to the bloom of microalgae that increases water turbidity. Walsh et al. (2010) estimated that an increase in Secchi depth (i.e., increased water clarity) by one foot results in an increase in average home sale price of about 1.2 percent ($6,900) and 0.3 percent ($880) for lakefront and non-lakefront properties, respectively.

Figure 5. A residential subdivision in Florida (Credit: Tatiana Borisova)

Adams and Lee (2007) examined the services provided by lakes for fishing as related to the control of invasive aquatic plants in 13 of Florida's public lakes. The study used a coupled economic-hydrologic model to analyze the costs of invasive plant control and its effect on the spread of aquatic plants and on visitation to the lakes. They found that the annual net benefit of invasive plant control in the 13 lakes is $75 million.

Interested readers can also find other reports developed by federal and state agencies and other organizations related to proposed water quality regulations (e.g., USEPA 2010; National Research Council 2012). Finally, for the analysis of the value of water in agricultural production, see studies by de Bodisco (2007), Moss and Schmitz (2013), and Schmitz et al. (2012).

Conclusions

Overall, the existing studies illustrate the high value Florida residents and visitors place on aquatic natural resources. And as the nine studies reviewed here demonstrate, Florida's springs have a very large economic value, both for recreation and resource conservation. Willingness to pay studies show that people who benefit from Florida springs place a high value on them. Economic contribution studies show that Florida springs play a significant role in local and state economic health and job creation.

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Table 1. Summary of past studies to assess the economic values of Florida springs protection*

Study author(s), year, and publication type	Study Goal	Study Area	Data Collection	Valuation Method	Findings/Conclusions
Bonn and Bell 2003 (Project Report)	To assess economic contribution of four Florida spring sites on local economies	Ichetucknee, Homosassa, Wakulla, and Volusia Blue Springs	Onsite interviews (over 400 surveys at each spring site)	Total economic contributions	In 2002, total spending of visitors from outside the local area was $68.5 million*; 1,038 jobs generated
Bonn, 2004 (Project Report)	To assess economic contribution of eight spring sights in the SJRWM	Silver Glen, Silver, Bugg, Alexander, Apopka, Ponce de Leon, Gemini, and Green Springs	Onsite interviews (2,298 usable surveys collected)	Total economic contributions	Total annual direct spending by visitors outside local area was $65 million*; 1,124 jobs generated
Borisova, Hodges, and Stevens 2014 (Project Report)	To assess the economic contribution of 15 spring sites in north-central Florida	Fanning, Hart, Ichetucknee, Poe, Lafayette Little River, Blue, Manatee, Tory, Rum Island, Wes Skiles Peacock, Blue Grotto, Blue Springs, Devil's Den, Ginnie, and Hornsby Springs	Interviews with business owners and data from published reports	Total economic contributions	Total annual direct spending by visitors outside local area was $45 million dollars; 1,106 jobs generated
Foster 2008 (Master's Thesis)	To estimate public WTP for water quality improvement in Ichetucknee Spring and River	Ichetucknee springshed	Survey of Columbia County residents (169 survey responses collected)	Contingent valuation	Columbia County total WTP over 10 years was estimated to be $42.4 million*
Huth and Morgan 2011 (peer-reviewed journal)	To provide a statistical estimate of divers' WTP for cave diving	Wakulla Springs	146 surveys from divers known to have visited the area	Contingent valuation	Divers' mean WTP was $52 to $57 per dive; the aggregate annual WTP in region was $500,000*
Morgan and Huth 2011 (peer-reviewed journal)	To estimate demand for freshwater cave diving, and to examine whether diver preferences are impacted by dive-site attributes	Jackson Blue Spring in Jackson County	186 surveys from visitors who had previously dived at Jackson Blue Springs collected	Travel cost and contingent valuation	Estimated average per-person, per-trip use values were $155. Aggregate annual consumer surplus for site was $575,000*
Shrestha et al. 2002 (peer-reviewed journal)	To estimate visitors' WTP for water-based recreational activities in the Ocala National Forest (ONF)	Ocala National Forest	Mail survey conducted with ONF visitors. About 445 responses collected	Contingent valuation	Visitors' total annual WTP for basic, moderately improved, and improved facilities was estimated to be $1M, $1.9M, and $2.5M
Loomis 2005 (project report)	Summarize the literature on economic value of outdoor recreation on public lands	USA	Literature review (research conducted from 1967 to 2003)		Report provides the average daily net WTP for 30 recreation activities at the national and regional levels
Kreye et al 2013 (University of Florida EDIS document)	To estimate Floridians' WTP for water quality protection through forest conservation	Florida	Literature review of studies that examined WTP for maintenance of benefits associated with unpolluted aquatic resources (17 studies)	Benefit transfer	WTP was lower for programs that use land acquisition to protect surface water (all-Florida total of $17 M) than programs that are non-specific in their methods ($335 M)

** Note that all estimates reported in this paper were converted to 2014 US dollars using the Implicit Price Deflator for Gross Domestic Product* (Federal Reserve Bank of St. Louis, 2014).