

Valuing Ecosystem Services of Coastal Marshes and Wetlands

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Introduction

Coastal marshes and wetlands provide ecosystem services that are critical to coastal communities and economies worldwide. In general, the term ‘ecosystem services’ refers to the benefits people obtain from ecosystems. The natural functioning of coastal ecosystems is needed to produce and sustain the vital flow of various goods and services to humans. However, increasing threats from both human activities and environmental changes have been continually challenging the capacity of these natural systems to provide valuable benefits such as protection from flooding and storm events, filtering and detoxification, and providing nursery habitats.¹ Major human-induced causes include conversion to agriculture or commercial farming, increasing popularity of coastal tourism, and rising demand for urban development. Similarly, major environmental changes negatively affecting coastal marshes and wetlands include changes in precipitation patterns, temperature conditions, and sea-level rise. These causes mix to contribute not only to shrink the total area of ecosystems but also affect the quality of services they could provide.²

Increasing interest in and understanding of the importance of these coastal resources, at the global, national, and local levels, and the risks involved in not investing in appropriate coastal conservation or ecological restoration activities could result in irreparable damage. Economic valuation methods can quantify the value of benefits provided by these resources, and likewise, can identify the costs of failed or no conservation activities, or the incentives that might be necessary to encourage protection activities.¹ As a result, research related to the economic valuation of coastal resources has increased significantly in the last decade. Economists have considered different ecosystem components and used a myriad of valuation techniques to estimate the value of goods and services provided by coastal marshes and wetlands. We provide an overview of coastal ecosystem services and estimate economic values of various coastal marshes and wetlands benefits using the relevant literature. An additional focus will be on establishing the relevance of such studies to coastal marshes and wetlands in South Carolina.

Coastal Marshes and Wetlands in South Carolina

South Carolina’s coastal marshes and wetlands are incredibly diverse ecosystems comprised of numerous habitat types that are ecologically, economically, and culturally important to the local inhabitants. These coastal marshes and wetlands and the services that they provide have helped mold the people and culture that surrounds them throughout time and continue to do so today. Before the European settlement of South Carolina, coastal marshes and wetlands helped sustain Native American tribes as a source of raw materials and food. Reeds from coastal marshes were used to produce items like baskets, arrow shafts, and musical instruments.³ Native Americans found food staples in the marshes, using nets to pull fish and crabs from tidal creeks, gathering oysters, clams, and whelks, and hunting mammals that used the marsh edge. Oyster beds provided both food and shells to make tools.⁴ Deeply-rooted communities on South Carolina sea islands have a culture based on the coastal marshes and continue to use them as a source of food and products like sweetgrass baskets. Rice production was one of the first commercial uses of the coastal marshes, and scars still exist in old rice fields

(dikes and trunks to control water flow and extensive systems of canals). Some of these abandoned rice fields are still impounded and serve migrating waterfowl.⁵

South Carolina's coastal marshes and wetlands, located in the eight coastal counties, provide highly important goods and services, such as fisheries and oyster production, storm buffering, water quality improvement, and recreational opportunities to the local communities and tourists (figure 1). South Carolina has roughly five million acres of wetlands, accounting for nearly a quarter of the state's surface area, and in the eight coastal counties the marshes and wetlands are a major component of the landscape (table 1).⁶ Coastal marshes and wetlands occupy about 10% of the total wetland acres of the state, but their surrounding areas represent some of the most highly sought after and densely populated areas in the state.⁶

However, to ensure the sustainability of the coastal ecosystem and mitigate degradation of coastal marshes and wetlands due to anthropogenic and natural causes, we need a better understanding of the economic value of the goods and services provided by these coastal resources. It is obvious that coastal marshes and wetlands provide a significant contribution to South Carolina's economy and provide ecosystem services essential to people and the environment, but no one has yet estimated the dollar value of the goods and services provided by coastal marshes and wetlands. That information is critical for future coastal restoration or conservation planning decisions and lets the public know that such efforts are worth spending precious tax dollars.

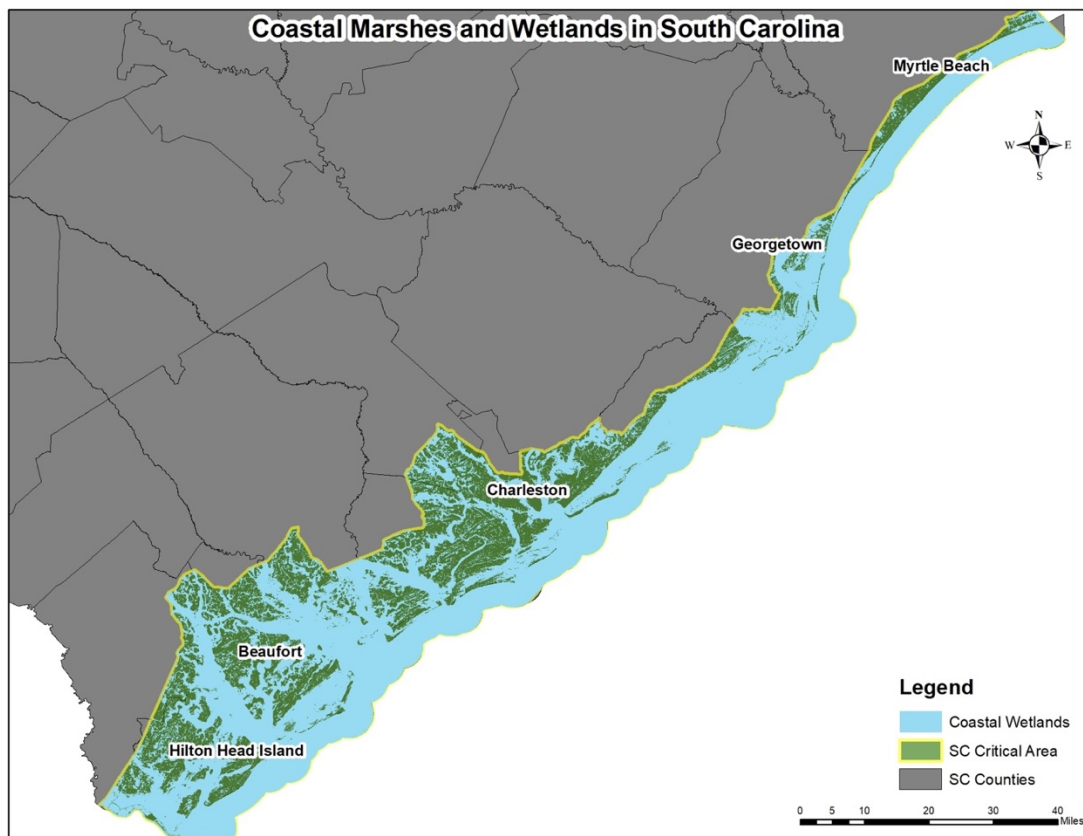


Figure 1. South Carolina's coastal marshes and wetlands (2019). Image credit: Andrew Purcell, Clemson University.

Table 1. Acreage and percentage of coastal marsh and wetland areas in South Carolina’s coastal counties (2018).

SC County	Total Acreage	Coastal Marsh and Wetland Area (Acres)	Percent Coastal Marsh and Wetland Area
Jasper	419,840	55,190	13%
Beaufort	375,680	179,330	48%
Colleton	675,840	55,465	8%
Charleston	588,160	193,816	33%
Dorchester	368,000	16,121	4%
Berkeley	702,720	11,870	2%
Georgetown	521,600	55,891	11%
Horry	725,760	7,525	1%

Ecosystem Services Categories

Ecosystem services are the benefits that humans derive from different aspects of ecosystem structure and function. Coastal marshes and wetlands provide benefits and services that are valued in the billions of dollars. Salt marshes are an extremely valuable component of South Carolina's economy. Animals harvested as seafood in South Carolina, even offshore species such as some groupers, spend all or part of their lives in estuarine waters within salt marshes. This makes for a unique habitat critical to the coastal environment. When coastal ecosystems are damaged, the resulting losses in function and value can be substantial and the ecosystems can be difficult to restore. Activities in the coastal economy, which depend on the health of the underlying natural capital asset base, also have the potential to deplete it, putting jobs and economic growth at risk.

One of the most commonly cited documents for defining ecosystem services is the Millennium Ecosystem Assessment.⁷ It describes what ecosystem services are and how they arise from ecological processes and functions. To determine the value of ecosystem services, the first step is to identify ecosystem services that coastal marshes and wetlands provide. These goods and services could include activities (like bird watching and kayaking), raw materials (like wood or fish), erosion prevention, water filtration, and habitats/nurseries for fisheries and oysters. Table 2 provides ecosystem services categories (as in the Millennium Ecosystem Assessment) and their associated ecosystem structure and function. Then, the next step is to estimate the monetary value (total vs marginal values) of these goods and services in the area. For provisioning services, goods that are traded in the open market and that have a price available, their value is calculated using the quantity available multiplied by the market price. It is a pretty simple and straightforward approach to estimate dollar values for these benefits. It is more challenging and requires additional efforts to estimate the value of the benefits that are not marketed, as no such price is available. To estimate the value of these non-market benefits, economists use various non-market valuation approaches such as travel cost, hedonic pricing, and contingent valuation.

Table 2. Examples of coastal marsh and wetland structure, function, goods, and services for the four ecosystem services categories.

Ecosystem service categories	Ecosystem structure and function	Ecosystem goods and services
Provisioning	Supplies food and raw materials.	Food (e.g., fish, oysters, and waterfowl), raw materials, and other natural resources.
Regulating	Attenuates and/or dissipates waves, water flow and regulation, sediment stabilization, provides nutrient and pollution uptake.	Coastal protection from storms, flood protection, erosion control, water purification and supply, carbon sequestration.

Cultural	Provides unique and aesthetic landscape of cultural, historical, or spiritual significance.	Tourism, recreation, education, and research.
Supporting	Provides suitable reproductive habitat and nursery for fish and game and sheltered living space for diverse flora and fauna and generates biogeochemical activity.	Supports fishing, gaming, foraging, and carbon sequestration.

Provisioning Ecosystem Services

Provisioning services are the ecosystem services that generate material or energy outputs such as food, water, and other natural resources. In South Carolina, the main provisioning service provided by coastal marshes and wetlands is commercial fishing, which serves as both a food source and employment to the state. South Carolina’s commercial fisheries include shrimp, crabs, shellfish, and offshore finfish. Various species of shrimp and offshore finfish are harvested off the coast but spend their juvenile life developing in the tidal creeks and marshes, which serve as nursery habitat to these important commercial species. Species such as blue crab and oysters are grown and regularly harvested in South Carolina’s coastal marshes. The shrimp fishery is the most commercially important fishery in South Carolina, followed by fisheries for blue crab and oysters.⁸ The state’s commercial fisheries industry generates \$42 million annually in total economic contribution to the state economy and provides 840 jobs.⁸ Without the provisioning services provided by South Carolina’s coastal marshes and wetlands, the commercial fishing industry, a staple to the state’s economy, would not be possible.

Regulating Ecosystem Services

Regulating services are ecosystem services or benefits that aid in the regulation of that ecosystem and its surrounding areas. Regulating services provided by South Carolina’s coastal marshes and wetlands include shoreline stabilization, wave attenuation, flood protection and prevention, water quality enhancement, and carbon sequestration. South Carolina is subject to frequent hurricanes, in which high winds and floodwaters can cause significant damages to the coastal areas. The storm and flood protection provided by coastal marshes and wetlands has a substantial economic impact on South Carolina, protecting coastal peoples and their property. While few estimates exist for regulating ecosystem services in South Carolina, some of these services’ economic estimates from comparable sites can be found in the literature. Studies from Delaware, the northern Gulf of Mexico, Maryland, Florida, and Virginia have estimated the value of shoreline stabilization from coastal wetland habitats to be anywhere from \$50 to \$232 per linear foot of shoreline.⁹

As development increases on the coast, shoreline stability provided by these natural systems is much more economically efficient than building man-made seawalls and bulkheads. Much of the quality of life in coastal South Carolina can be related to pristine water quality. From outdoor recreation and coastal tourism to clean drinking water and commercial fisheries, enhanced water quality provided by coastal marshes and wetlands is essential to the state. Without these vital wetlands, water quality treatment can be extremely expensive, highlighting the importance of clean water for coastal marshes and wetlands. For example, water quality enhancement provided by coastal marshes and wetlands was estimated in Louisiana to range from \$99 to \$5,551 per acre based on the type of treatment.¹⁰

Another service that coastal marshes and wetlands provide is the sequestration of carbon. While this is not a new revelation, carbon trading markets are relatively new and offer a means to value coastal resources. In South Carolina, carbon trading is already occurring. Over 5,500 acres of the Francis Beidler Forest Audubon Center and Sanctuary is registered in California’s cap-and-trade program, where 450,000 metric tons of Carbon credits have brought in \$3.4 million.¹¹ A California study estimated that the carbon sequestration value of salt marsh ranges between \$56 and \$1,861 ha⁻¹ yr⁻¹.⁹ These studies are not a direct representation of South Carolina’s coastal marshes and wetlands but serve as a good indication of the potential value in these coastal resources. Regulating services provided by coastal marshes and



wetlands are highly valuable to South Carolina, especially as development and growth, sea-level rise, and coastal storm intensity increases.

Cultural Ecosystem Services

Cultural services are ecosystem services that describe the benefits that an ecosystem has to the culture of the people living in or around it. In South Carolina, the coast and its resources are an integral part of the identity of its people and are responsible for an immeasurable number of benefits to the region. Coastal marshes and wetlands in South Carolina provide numerous cultural ecosystem services including coastal tourism, boating, kayaking and canoeing, recreational saltwater fishing, waterfowl hunting, photography, and aesthetic beauty. Cultural services are vital to the physical and mental health of South Carolina, and also generate a significant contribution to the state’s economy. South Carolina has hundreds of thousands of acres of coastal marshes and wetlands, allowing humans to enjoy the many cultural services that they provide, helping drive the state’s economy. The total annual economic contribution (effect) of coastal tourism on the South Carolina economy is \$9 billion and 99,325 jobs.⁸ While the few dollar estimates for the cultural services provided by South Carolina’s coastal marshes and wetlands are substantial, this resource also provides spiritual and therapeutic benefits that cannot be monetarily valued but are immensely important to the state and its people.

Supporting Ecosystem Services

Supporting services are ecosystem services that are necessary for the production of all other ecosystem services. South Carolina’s coastal marshes and wetlands, like most other ecosystems, share a similar base of supporting services including biomass production, soil formation, nutrient and water cycling, oxygen production, and habitat provisioning. Global value estimates for coastal wetland nutrient cycling of the elements carbon, oxygen, hydrogen, nitrogen, sulfur, and phosphorous, as well as the macronutrients calcium, magnesium, potassium, sodium, and chlorine, have been estimated between \$139 and \$33,745 ha⁻¹ yr⁻¹, which gives an indication of the potential value that South Carolina’s nearly 600,000 acres of coastal marshes and wetlands could provide.¹² While most supporting services can be difficult to value directly, their pivotal relationship to the rest of the ecosystem values is quite easy to recognize. The breakdown of plant material in coastal marshes forms an ever-increasing layer of peat soil, which acts as a growing wall of defense against sea-level rise. Coastal marshes and wetlands provide food, refuge, or nursery habitat to roughly 75% of fisheries species, including many finfish, blue crabs, and various species of shrimp.¹³ These are just a few examples of why supporting services are incredibly important to the ecological and economic functions that coastal marshes and wetlands provide. Supporting services are what allow every other ecosystem service to occur, setting the groundwork for a healthy and prosperous South Carolina.

Ecosystem Service Values of Coastal Marshes and Wetlands

Scores of studies have used different economic valuation techniques to estimate the economic value of ecosystem services provided by various habitat types prevalent in coastal marshes and wetlands. It should come as no surprise that those estimates markedly differ depending on economic techniques used and wetland components that are considered, and this makes it difficult to make a comparison among those studies. Table 3 provides dollar estimates for the ecosystem services provided by the three habitat types prevalent in South Carolina’s coastal ecosystem.¹³ The nutrient recycling service (i.e., storage, internal recycling, processing, and acquisition of nutrients) was higher priced as compared to other benefits from the estuaries and seagrass habitats. Similarly, the waste management (i.e., waste treatment, pollution control, and detoxification) and disturbance regulation (i.e., storm protection and flood control) were higher valued benefits as compared to other benefits from the tidal marshes.

Table 3. The average global value of annual ecosystem services provided by major habitat types common in coastal marshes and wetlands (2018, \$/ha/yr).

Ecosystem services	Tidal marshes	Seagrass	Estuaries
Recreation	\$1,114.90	N/A	\$645.55



Food production	\$789.58	N/A	\$882.77
Habitat/refugia	N/A	N/A	\$221.96
Waste management	\$11,345.56	N/A	N/A
Nutrient cycling	N/A	\$32,196.59	\$35,751.40
Disturbance regulation	\$3,115.96	N/A	\$960.73

Note: Values were taken from the average global value of annual ecosystem services.¹³ Original dollar estimates were adjusted for inflation and converted to 2018 prices using the Consumer Price index. Units are provided in the same units as in the original study. N/A means data not available in the original study.

These global average values of coastal ecosystem services could serve as important tools to educate the public about the protection of coastal ecosystems in South Carolina, but one should take caution while using these estimates for planning purposes. Multiple studies have shown that coastal ecological functions exhibit spatial and temporal variability, such as seasonal and location variability of recreation values.¹ Many coastal studies have attempted to evaluate selected ecosystem benefits in specific locations at different periods in time, while others have taken a more holistic view to assess all ecosystem services and estimate the global total. Recently, meta-analysis, a process to integrate results of multiple similar studies, has also been increasingly used to estimate the economic value of various ecosystem services and functions despite inherent complexities involved in summarizing studies that used different estimation techniques.¹⁵ Moreover, the importance of site-specific and direct valuation studies to minimize limitations of global estimates and meta-analysis cannot be overstated. Very few studies particularly focused on quantifying social and economic values of coastal marshes and wetlands are currently available in South Carolina.¹⁶ Economic values could serve as useful information for quality extension programming related to coastal marshes and wetlands conservation and restoration in South Carolina.¹⁷

Conclusions

South Carolina's coastal marshes and wetlands provide a tremendous benefit to the coastal counties and the state as a whole. The supporting services, provisioning services, regulating services, and cultural services made possible by coastal marshes and wetlands offer both market and non-market goods and services that are responsible for billions of dollars of economic output annually and are a major contributing factor to the state's general welfare. While some of South Carolina's coastal wetland ecosystem services have been valued directly, there is still a heavy reliance on other state's original research to roughly estimate the economic value of many of these services. Going forward, it is imperative that economists focus on providing the original dollar value estimates of the ecosystem services coastal marshes and wetlands provide in South Carolina so that these resources can be better understood and therefore conserved. Whether it is the dampened winds of a hurricane, an oyster roast with friends and family, or clean water to swim in, South Carolina's coastal marshes and wetlands and the ecosystem services they provide are the sources of these values.

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