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What is the Value of Ecosystem Services Provided by Recent Restoration Efforts on the Northern Gulf Coast?

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PROJECT REPORT

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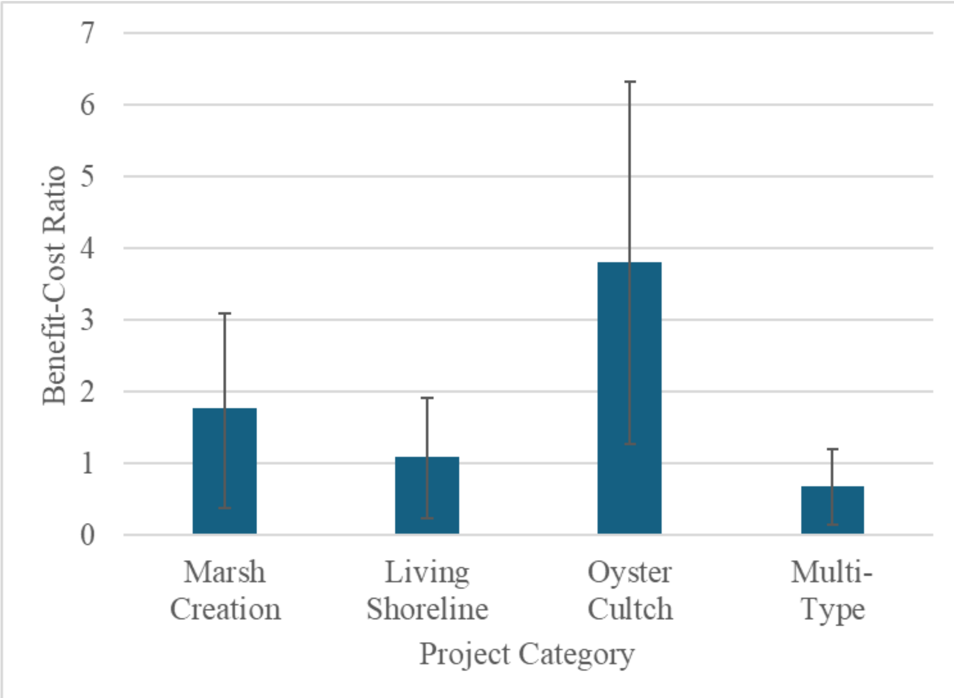
EXECUTIVE SUMMARY

Numerous coastal restoration projects have been funded and implemented in Alabama and Mississippi, but very little effort has gone into estimating the value of the services provided by these projects. Our work focused on 23 coastal habitat restoration projects in Alabama and Mississippi, most of which were constructed as a result of post-Deepwater Horizon funding. We organized projects into four categories: marsh creation, living shorelines, oyster cultch, and beach enhancement. We collected cost and benefit information for each project. Benefits were organized into nine categories: marsh habitat created, restored, or enhanced; marsh habitat protected; bottom reef habitat created; breakwater reef habitat created; oysters produced; benthic secondary production enhanced; beach/dune habitat created; recreational beach trips enhanced; and residential property values enhanced. Benefits were quantified based on data found in project documentation, including project summaries, monitoring reports, and other information obtained from project personnel. Benefits were monetized using benefit transfer, a method that takes existing benefit values from one or more existing studies and applies them to a new study. Fortunately, a handful of valuation projects have been completed in recent years specifically for our study area and habitat types, making benefit transfer relatively straightforward.

Median, lower-bound, and upper-bound benefit values were estimated and benefit-cost (B-C) ratios were calculated. Of the fifteen completed projects, ten of them have positive estimated median net benefits, that is, median total benefits generated by the project exceed project cost. All but two projects have positive estimated net benefits under the upper-bound benefit values. Only one project has positive estimated net benefits even under the lower-bound benefit values. Ten of the fifteen projects have median benefit-cost ratios greater than 1.0. Five projects have median benefit-cost ratios greater than 2.0, meaning that for every dollar invested, they yielded over $2 in benefits. Two projects have median ratios greater than 3.0. Projects with construction or monitoring ongoing had incomplete benefit information, making a complete analysis infeasible.

We also evaluated projects at the categorical level. This analysis was limited to projects with construction complete. Here, we placed multi-category projects into their own category. Of the five marsh creation projects analyzed, four have median B-C ratios greater than one. Two of the four living shoreline projects have B-C ratios greater than one, all three of the oyster cultch projects have B-C ratios greater than one, and one of the three multi-category projects have B-C ratios greater than one. At the categorical level, the oyster cultch category is estimated to have the highest average B-C ratio, followed by marsh creation, living shoreline, and multi-category projects (Figure ES1). Overall, oyster cultch, marsh creation, and living shoreline categories are estimated to have average B-C ratios greater than 1.0, whereas multi-category projects are estimated to have an average B-C ratio less than 1.0. Based on our set of projects, this analysis indicates that oyster cultch projects tend to deliver the most "bang for the buck", delivering an average of $3.80 -- and potentially substantially more -- in benefits for every dollar invested. Marsh creation projects deliver an average of $1.77 for every dollar invested. Living shoreline projects deliver an average of $1.10. Multi-category projects are estimated to cost more than the value of their benefits, on average. We wish to note however, that some muti-category projects have other components that were not fully monetized here.

Figure ES1. Benefit-Cost Ratios by Project Category.



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Introduction

This project was a direct response to the MASGC research priority: *Using existing datasets, calculate the value of ecosystem services provided by coastal restoration projects that have been implemented in Alabama and Mississippi within the last five years.*

Coastal restoration efforts in Alabama and Mississippi include a wide variety of activities, from small-scale inland stream restoration activities to large-scale offshore living shorelines. These projects are implemented in response to chronic, long-standing problems like persistent flooding to acute events like the Deepwater Horizon oil disaster. Such efforts are intended to improve ecosystem performance and enhance the quality of life of the people living around them. Those benefits provided by nature that enhance our quality of life, and are themselves enhanced by restoration efforts, are called ecosystem services. There are both market and non-market ecosystem services. When a fish is harvested in the wild and sold to a consumer, that is a market ecosystem service. When a wetland processes nutrients, the water quality improvement that results in fishable, swimmable, or drinkable water is a non-market ecosystem service. It is a "non-market" service because it is not traded in a market, yet we are better off because of it. Ecosystem service valuation (ESV) is the process of assigning a monetary value to a unit change in the provision of an ecosystem service for some particular purpose. For example, an organization considering a wetland restoration project may wish to compare the cost of the project to the expected benefits. If that project provides multiple ecosystem services that are measured in a variety of units over different time spans, then ESV can be a vehicle for getting an "apples to apples" comparison. ESV converts all benefits into dollar terms, and when combined with benefit-cost analysis methods, such as discounting to adjust for differences in when benefits are delivered, benefits can then be compared directly to each other and to costs. Such estimates can also be used to compare that same project to alternative restoration projects or to completely different uses of resources, so long as all costs and benefits have been monetized. It must be emphasized that ESV should not be undertaken merely for the sake of "putting a dollar on it". The method is valuable to the extent that it facilitates decision-making in a resource-constrained world by providing a measure of the relative importance of goods and services that may otherwise go unmeasured, or worse, be ignored. As an example, the monetization of non-market benefits is an essential part of the Environmental Protection Agency's effort to justify new environmental regulations against their costs: non-market benefits account for nearly all of the accrued benefits (Petrolia et al. 2021).

Numerous coastal restoration projects have been funded and implemented in Alabama and Mississippi, but very little effort has gone into estimating the value of the goods and services provided. We are aware of only two instances where the ecosystem service values associated with restoration projects in Alabama or Mississippi were estimated: Kroeger and Guannel (2014) monetized the fisheries enhancement, nitrogen abatement, and shoreline protection benefits of the Swift Tract (Bon Secour Bay, AL) and Barton Island (Grand Bay, AL) living shorelines projects; and Moffatt and Nichol (2018) estimated the values associated with ecosystem services enhanced by the Lighting Point Restoration Project in Bayou La Batre (Portersville Bay, AL). Prior to our work here, we believe that no unified effort to quantify and monetize these services across multiple such projects has taken place. The closest study to ours is Brooke and Alfasso (2022), who inventory all oyster-focused projects listed in the Deepwater Horizon Tracker (2024). They summarize funding levels, amount of oyster habitat created or restored, status of restored habitats, and monitoring activities. Like our study, they point to the fact that information for projects funded by NFWF-GEBF is limited because this funding source does not post project documentation and updates publicly, as is done for NRDA-funded projects.

Numerous coastal restoration projects have been funded and implemented in Alabama and Mississippi, but very little effort has gone into estimating the value of the services provided by these projects. Our work focused on 23 coastal habitat restoration projects in Alabama and Mississippi, most of which were constructed as a result of post-Deepwater Horizon funding. We organized projects into four categories: marsh creation, living shorelines, oyster cultch, and beach enhancement. We collected cost and benefit information for each project. Benefits were organized into nine categories: marsh habitat created, restored, or enhanced; marsh habitat protected; bottom reef habitat created; breakwater reef habitat created; oysters produced; benthic secondary production enhanced; beach/dune habitat created; recreational beach trips enhanced; and residential property values enhanced. Benefits were quantified based on data found in project documentation, including project summaries, monitoring reports, and other information obtained from project personnel. Benefits were monetized using benefit transfer, a method that takes existing benefit values from one or more existing studies and applies them to a new study. Fortunately, a handful of valuation projects have been completed in recent years specifically for our study area and habitat types, making benefit transfer relatively straightforward.

This proceeds with a summary of how projects were selected for analysis, followed by a description of projects. Project costs are then analyzed by project category on a per-unit basis. The process of categorizing, quantifying, and monetizing benefits is then discussed. The benefit-cost analysis is then presented, followed by the conclusion that includes a set of recommendations.

Projects Included in Study

Project Selection

Project selection was done according to the following steps.

1. We began with the set of all Deepwater Horizon-funded projects across all five Gulf Coast states, as listed in the Deepwater Horizon Project Tracker (2024). A total of 1,828 projects are listed.
2. We then retained only those projects located in Alabama or Mississippi, including multi-state projects, as indicated by the "State Province" variable including "AL" or "MS". A total of 532 projects remained.
3. We then sorted projects based on their purpose, as indicated by the "Concatenated Project Actions" variable. We identified those actions that had the potential to include some kind of restoration activity, including:
    - Engineering and Construction
    - Engineering and/or Construction
    - Erosion Prevention or Control

- Habitat Restoration and Enhancement
- Land Acquisition/Protection
- Resilience
- Species Restoration

We then dropped those projects that did not include at least one of the above actions. A total of 235 projects remained.

4. We then considered the reported restoration metrics, including “Acres Acquired”, “Land Restoration Acreage”, “Aquatic Restoration Acreage”, “Restoration Mileage”, and “Restoration Feet”, and dropped those projects whose values were blank for all of these. NOTE: Project #1534: Hancock County Marsh Living Shoreline were blank in the aforementioned cells, but indicated 0.43 acres erosion control” under “Additional Metrics Text”. These cells were also blank for Project #402: Point aux Pins Living Shorelines, but project lead TNC indicates that a breakwater was constructed as part of this project. Thus, these two projects were not purged in this step. A total of 84 projects remained.
5. Each of the remaining projects were then considered individually. Projects that we determined were not primarily restoration projects were then dropped. These projects were primarily focused on planning, land acquisition, research, off-bottom farming, oyster cultch research, stormwater retrofits, boat launches, broad watershed restoration activities, invasive species control, vegetative plantings, research/education, visitor center, workforce development, tribal youth programs, private forest landowner programs, offshore fishing/reefs, or living shorelines mixed with several other components (particularly, Project # 753: Mobile Bay Shore Habitat Conservation Acquisition Initiative – Phase II). Project # 270: Mississippi Artificial Reef Habitat Project was also dropped. Although the project constructs reefs, project goals were not focused on oysters. So although the project had the potential to provide benefits, those benefits fell outside of the scope of this work. After these projects were dropped, a total of 22 projects remained. The final set of projects taken from the DWH Tracker are listed Table A1 in the Appendix.
6. After closer inspection of project documentation, we combined Project #342: Mississippi Hancock County Marsh Living Shoreline Project and Project #1534: Hancock County Marsh Living Shoreline into a single combined project. This step brought the total number of projects to 21.
7. After consultation with staff at Mississippi Departments of Environmental Quality and Marine Resources and reception of new documentation, we reconsidered how to include four beneficial use of dredged material projects listed in the DWH Tracker:
   - Project #287: Utilization of Dredge Material for Marsh Restoration in Coastal Mississippi
   - Project #757: Utilization of Dredge Material for Marsh Restoration in Coastal Mississippi - Phase II
   - Project #1597: Activity #9: Beneficial Use of Dredge Material for Marsh Creation and Restoration in Mississippi
   - Project #1922: Deer Island Beneficial Use Site Implementation

These projects appear to have evolved over time and that the original data in the DWH Tracker may not necessarily match the current situation. Some projects with different project names had been completed using some combination of the original funds, though it is not clear exactly how that was done. To maintain the connection to the original projects, we decided to list the alternative projects under all four of the original DWH Tracker project ID#s, though we acknowledge that this may not reflect the true relationship. The alternative projects included, all listed as falling under the same combined Project #287-757-1597-1922, are:

- Project #287-757-1597-1922: Greenwood Island Beneficial Use Project
- Project #287-757-1597-1922: Round Island Marsh Restoration Project
- Project #287-757-1597-1922: Wolf River Beneficial Use Project

These changes reduced the total number of projects by one, to a total of 20.

8. In collaboration with project partner TNC, we also augmented the project list with three additional projects not included in the Deepwater Horizon Project Tracker:
   - Coffee Island Living Shoreline (Alabama, completed in 2010)
   - Pelican Point Living Shoreline (Alabama, completed in 2013)
   - Taylor's Riverview Park Living Shoreline (Alabama, completed in 2014)

   These additions brought the final number of projects to 23. Projects that had multiple phases were combined into one project so that their total cost was the sum of the two phases' costs. The Phase I project number was added to the Project ID, and the "Phase" language was dropped from the project name. This pertained to Projects #1069, #1420, #1701, #1702, and #1880, all funded with NFWF-GEBF funds. The exception is Project #1699: Graveline Bay Marsh Restoration – Phase II, because Phase I was part of a larger island-wide project (Alabama Barrier Island Restoration Assessment) and it was not obvious how to combine the two. Project #30: Fowl River Watershed Restoration – Phase I did not actually have a Phase II, so "Phase I" was dropped from the name.

Project Descriptions and Categories

Table 1 reports key summary information for the selected projects, including project category, funding source, project lead, construction completion year, and cost. Sixteen projects are located in Alabama and seven are located in Mississippi.

Project funding source information was taken from the DWH Tracker (2024). Ten projects were funded by the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund (NFWF-GEBF) and seven were funded by the Natural Resource Damage Assessment (NRDA). We assume that the three Mississippi beneficial use projects were funded by some combination of NFWF-GEBF and Gulf Coast Ecosystem Restoration Council (GCERC) "Bucket 2" and "Bucket 3" funds. The three TNC projects were funded by a combination of sources.

Project lead information was taken from the DWH Tracker (2024). Six of the projects were led or co-led by the Mississippi Department of Environmental Quality (MS-DEQ), five were led by The Nature Conservancy (TNC), four led by the Alabama Department of Conservation and Natural Resources (AL-DCNR), three led or co-led by the Mobile Bay National Estuary Program (MBNEP), two led or co-led by NOAA, two led by the Mobile County Commission, two led by the Town of Dauphin Island, and one co-led by the Alabama Marine Environmental Sciences Consortium (AL-MESC).

Construction status was taken from a variety of sources. Construction has been completed on seventeen of the projects and is ongoing on the remaining six projects. Completion year ranges from 2010 to 2023.

It should be noted that documentation for projects funded by NFWF-GEBF is limited because this funding source does not post project documentation and updates publicly, as is done for NRDA-funded projects. Thus, characterizations of these projects in this report are more likely to suffer from inaccuracies or be outdated.

Table 2 reports cost and benefit data sources for each project.

We organized projects into four categories:

- Marsh creation
- Living shoreline
- Oyster cultch
- Beach enhancement

Table 3 reports the categories each project is assigned to. Seven projects fall into more than one category. Twelve projects have a marsh creation component, twelve have a living shoreline component, six have an oyster cultch component, and one is beach enhancement.

Table 1. Project Names, State, Funding Sources, Leads, Construction Completion Years, and Costs.

DWH Tracker Project ID & Project Name	State	Funding Source	Project Lead	Construction Completion Year	Project Cost (Nominal)	Project Cost (2023$)
#7 Marsh Island (Portersville Bay) Restoration Project	AL	NRDA	AL-DCNR	2017	$6,733,639	$8,233,422
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	AL	NFWF-GEBF	MBNEP, MESC	2017	$3,044,946	$3,723,147
#47 Restoration and Enhancement of Oyster Reefs in Alabama	AL	NFWF-GEBF	AL-DCNR	2016	$3,716,355	$4,625,461
#269 Mississippi Oyster Cultch Restoration Project	MS	NRDA	MS-DEQ	2014	$9,920,953	$12,580,918
#287-757-1597-1922 Greenwood Island Beneficial Use Project	MS	NFWF-GEBF / GCERC-Bucket 2, 3	MS-DEQ	2023	$25,749,118	$25,749,118
#287-757-1597-1922 Round Island Marsh Restoration Project	MS			2020	$10,693,608	$12,407,735
#287-757-1597-1922 Wolf River Beneficial Use Project	MS			2023	$4,164,145	$4,164,145
#315 Alabama Oyster Cultch Restoration	AL	NRDA	AL-DCNR	2015	$3,233,986	$4,063,352
#316 Alabama Swift Tract Living Shoreline	AL	NRDA	NOAA	2017	$4,863,538	$5,946,794
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	MS	NRDA	NOAA, MS-DEQ	2018	$42,733,800	$51,081,619
#402 Point aux Pins Living Shoreline	AL	NRDA	AL-DCNR	2020	$3,640,263	$4,223,777
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	MS	NRDA	MS-DEQ	2022	$14,768,642	$15,306,944
#689-1069 Lightning Point Acquisition and Restoration Project	AL	NFWF-GEBF	TNC	2020	$22,481,100	$26,084,698
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	AL	NFWF-GEBF	MBNEP	Ongoing	$16,993,874	$16,993,874

#752 Salt Aire Shoreline Restoration	AL	NFWF-GEBF	Mobile County Commission	Ongoing	$12,700,000	$12,700,000
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	AL	NFWF-GEBF	MBNEP	Ongoing	$18,138,409	$18,138,409
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	AL	NFWF-GEBF	Mobile County Commission	Ongoing	$28,612,000	$28,612,000
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	MS	NFWF-GEBF, MOSTF, Tidelands	TNC	Ongoing	$6,589,871	$6,589,871
#1591-1880 East End Beach and Dune Restoration	AL	NFWF-GEBF	Town of Dauphin Island	Ongoing	$27,466,000	$27,466,000
#1699 Graveline Bay Marsh Restoration - Phase II	AL	NFWF-GEBF	Town of Dauphin Island	2023	$6,437,000	$6,437,000
Coffee Island Living Shoreline	AL	NOAA-ARRA	TNC	2010	$1,689,000	$2,304,078
Pelican Point Living Shoreline	AL	NFWF, USFWS, SARP, Private	TNC	2013	$348,312	$449,390
Taylor's Riverview Park Living Shoreline	AL	NFWF	TNC	2014	$8,800	$11,159

Table 2. Project Cost and Benefit Data Sources.

Project	Project Cost	Acreage	Shoreline Length	Erosion Rates	Oysters
#7 Marsh Island (Portersville Bay) Restoration Project	NOAA (2024)	NOAA (2023)	Thompson Engineering (2023)	Thompson Engineering (2023)	*Not applicable*
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	Kudulis (2024)	NFWF (2014)	*Not applicable*	*Not applicable*	*Not applicable*
#47 Restoration and Enhancement of Oyster Reefs in Alabama	DWH Project Tracker (2024)	Alabama DCNR (2024a)	*Not applicable*	*Not applicable*	Alabama DCNR (2024a)
#269 Mississippi Oyster Cultch Restoration Project	NOAA (2024)	Mississippi DEQ (2021)	*Not applicable*	*Not applicable*	Mississippi DEQ (2021)
#287-757-1597-1922 Greenwood Island Beneficial Use Project	Mississippi DEQ (2024)	City Council of Pascagoula (2020)	*Not applicable*	*Not applicable*	*Not applicable*
#287-757-1597-1922 Round Island Marsh Restoration Project	Mississippi DEQ (2024)	Mississippi DEQ (2016)	*Not applicable*	*Not applicable*	*Not applicable*
#287-757-1597-1922 Wolf River Beneficial Use Project	Mississippi DEQ (2024)	Mississippi DEQ (2019)	*Not applicable*	*Not applicable*	*Not applicable*
#315 Alabama Oyster Cultch Restoration	NOAA (2024)	Alabama DCNR (2024b)	*Not applicable*	*Not applicable*	Alabama DCNR (2024b)
#316 Alabama Swift Track Living Shoreline	NOAA (2024)	*Not applicable*	NOAA (2024)	HDR Engineering, Inc. (2023)	HDR Engineering, Inc. (2018-2023)
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	NOAA (2024)	NOAA (2024)	NOAA (2024)	Anchor QEA (2024)	Anchor QEA (2018-2024)
#402 Point aux Pins Living Shoreline	NOAA (2024)	*Not applicable*	NOAA (2024)	Stantec Consulting Services, Inc. (2023)	Stantec Consulting Services, Inc. (2022-2023)

#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	NOAA (2024)	NOAA (2024)	NOAA (2024)	*Not available*	*Not available*
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	Kudulis (2024)	DWH Project Tracker (2024)	*Not available*	*pre-project data not available;* post-project: Kudulis (2024)	*Not applicable*
#689-1069 Lightning Point Acquisition and Restoration Project	DWH Project Tracker (2024)	Dauphin Island Sea Lab (2021)	Calculated	Moffatt & Nichol (2021)	The Nature Conservancy (2023)
#752 Salt Aire Shoreline Restoration	DWH Project Tracker (2024)	DWH Project Tracker (2024)	Calculated	pre-project: Moffatt & Nichol (2023b), *post-project data not available*	*Not applicable*
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	Kudulis (2024)	Kudulis (2024)	Kudulis (2024)	pre-project: Kudulis (2024); *post-project data not available*	*Not applicable*
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	DWH Project Tracker (2024)	DWH Project Tracker (2024)	*Not available*	*Not available*	*Not available*
#1378 Enhancement of St. Louis Bay Oyster Reef	Mohrman (2024)	Mohrman (2024)	*Not applicable*	*Not applicable*	*Not available*
#1591-1880 East End Beach and Dune Restoration	DWH Project Tracker (2024)	Town of Dauphin Island (2024)	*Not applicable*	*Not applicable*	*Not applicable*
#1699 Graveline Bay Marsh Restoration - Phase II	DWH Project Tracker (2024)	Moffatt & Nichol (2023a)	*Not applicable*	*Not applicable*	*Not applicable*
Coffee Island Living Shoreline	The Nature Conservancy (2010)	*Not applicable*	Calculated	Blomberg et al. (2018)	*Not applicable*

Pelican Point Living Shoreline	The Nature Conservancy (2013)	*Not applicable*	Calculated	Blomberg et al. (2018)	*Not applicable*
Taylor’s Riverview Park Living Shoreline	The Nature Conservancy (2014)	*Not applicable*	Calculated	The Nature Conservancy (2014)	*Not applicable*

Table 3. Project Categories Assigned to Projects.

DWH Tracker Project ID & Name	State	Project Category: Marsh Creation (MC)	Living Shoreline (LS)	Oyster Cultch (OC)	Beach (B)
#7 Marsh Island (Portersville Bay) Restoration Project	AL	X	X		
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	AL	X			
#47 Restoration and Enhancement of Oyster Reefs in Alabama	AL			X	
#269 Mississippi Oyster Cultch Restoration Project	MS			X	
#287-757-1597-1922 Greenwood Island Beneficial Use Project	MS	X			
#287-757-1597-1922 Round Island Marsh Restoration Project	MS	X			
#287-757-1597-1922 Wolf River Beneficial Use Project	MS	X			
#315 Alabama Oyster Cultch Restoration	AL			X	
#316 Alabama Swift Tract Living Shoreline	AL		X		
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	MS	X	X	X	
#402 Point aux Pins Living Shoreline	AL		X		
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	MS		X	X	
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	AL	X	X		
#689-1069 Lightning Point Acquisition and Restoration Project	AL	X	X		
#752 Salt Aire Shoreline Restoration	AL	X	X		
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	AL	X	X		
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	AL	X	X		
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	MS			X	
#1591-1880 East End Beach and Dune Restoration	AL				X
#1699 Graveline Bay Marsh Restoration	AL	X			
Coffee Island Living Shoreline	AL		X		
Pelican Point Living Shoreline	AL		X		
Taylor's Riverview Park Living Shoreline	AL		X		

Project Costs

This section analyzes the per-unit costs of projects. Marsh creation and beach enhancement projects are on a per-acre basis, living shoreline projects are on a per-foot basis, and oyster cultch projects are on both per-cubic-yard of cultch and per-acre bases. In an effort to provide a fairer comparison for multi-category projects, we apportion these projects' costs by dividing cost by the number of categories a project falls into. For example, the Marsh Island project falls into both the marsh creation and living shoreline categories. Ideally, we would consider only the cost of constructing the marsh component, and ignore the cost of the living shoreline component, to calculate the cost per acre of marsh constructed. However, cost data at this level of detail were not available. Thus, we use the number of project categories as a proxy. Thus, we divide the Marsh Island project's total cost of $8,233,422 by two to yield an apportioned project cost of $4,116,711.

Per-Unit Costs of Marsh Creation and Beach Enhancement Projects

Table 4 reports the number of acres created, project cost, and cost per-acre for each project. For the Marsh Island and East End Beach projects, we also found documentation that some acres were lost post-construction, so we also report acres lost and net acres created. Total acreage ranges from a low of twelve acres for the Fowl River project to a high of 219 acres for the Greenwood Island project. For the marsh creation projects, cost per-acre ranges from a low of $62,039 for the Round Island Marsh Restoration project to a high of $465,798 for the Lightning Point project. To be fair, the latter project, and several other projects – indicated by an asterisk, have multiple components, so the reported cost efficiency could be inflated. Focusing only on single-component projects, the maximum cost per-acre is the Fowl River project at $310,262 per acre. The one beach enhancement project, East End Beach and Dune, has a per-unit cost of $638,744 per acre.

Per-Unit Costs of Living Shoreline Projects

Table 5 reports the constructed shoreline length (miles and feet), project cost, and cost per-foot for each project. Project length ranges from a low of 264 feet for Pelican Point to a high of 3.3 miles for the Dauphin Island Causeway project. Cost per-foot ranges from a low of $35 per foot for Taylor's Riverview Park to $5,496 per foot for Deer River. To be fair, Deer River and several other projects – indicated by asterisks, were multi-component projects, so the per-unit costs may be inflated. Ignoring multi-component projects, the maximum per-unit cost is Pelican Point at $1,702 per foot.

Per-Unit Costs of Oyster Cultch Projects

Table 6 reports the volume of cultch deployed (in cubic yards), reef acreage, cubic yards of cultch per acre, project cost, cost per cubic yard, and cost per acre for each project. The Restoring Living Shorelines and Reefs in Mississippi project is broken down into its five subproject cultch-based components, with a total of 73,001 CY of cultch deployed across these five components. Cultch volume ranges from a low of 55,434 CY for the Mississippi Hancock County Marsh Living Shoreline Project to a high of 188,859 CY (1,430 acres) for the Mississippi Oyster Cultch project.

Utilization of cultch per acre varied widely across projects, from 76 CY per acre for the Restoration and Enhancement in Alabama project to 1,547 CY per acre for the Enhancement of St. Louis Bay Reef (Tony Trapani Reef) project. Cultch per acre can vary depending on site-specific factors, but generally reflects the desired reef height. Higher-relief reefs may last longer and perhaps perform better.

Cost per CY ranged from $62 to $307 per acre. Ignoring the multi-component projects, the next-highest cost per CY is the Enhancement of St. Louis Bay Reef (Tony Trapani Reef) project at $106 per CY. Cultch costs may vary depending on availability, timing, and type of cultch. Projects 47, 269, and 315 procured cultch in 2014-2016, whereas Project 1378 procured cultch in 2024.

Cost per acre ranged from $5,820 to $370,157 per acre. The wide range in cost per acre can be explained primarily by cultch utilization rate (i.e., CY per acre). The project with the highest cost per acre has a cultch utilization rate that is 16 times greater than the one with the lowest cost per acre.

Table 4. Project Costs per Unit: Marsh Creation and Beach Enhancement Projects

Project	Acres Created	Acres Restored or Enhanced	Restored Acres Lost	Net Acres Created, Restored, or Enhanced	Project Cost	Apportioned Project Cost		Apportioned Cost per Acre
Marsh Creation								
#7 Marsh Island (Portersville Bay) Restoration Project	50		7	43	$8,233,422	$4,116,711	*	$95,737
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)		12		12	$3,723,147	$3,723,147		$310,262
#287-757-1597-1922 Greenwood Island Beneficial Use Project	219			219	$25,749,118	$25,749,118		$117,576
#287-757-1597-1922 Round Island Marsh Restoration Project	200			200	$12,407,735	$12,407,735		$62,039
#287-757-1597-1922 Wolf River Beneficial Use Project	26			26	$4,164,145	$4,164,145		$160,159
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	46			46	$51,081,619	$17,027,206	*	$370,157
#752 Salt Aire Shoreline Restoration	30			30	$12,700,000	$6,350,000	*	$211,667
#689-1069 Lightning Point Acquisition and Restoration Project	28			28	$26,084,698	$13,042,349	*	$465,798
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	35			35	$28,612,000	$14,306,000	*	$408,743
#1699 Graveline Bay Marsh Restoration - Phase II	60			60	$6,437,000	$6,437,000		$107,283
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project		40		40	$16,993,874	$8,496,937	*	$212,423
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	19	23		42	$18,138,409	$9,069,205	*	$215,933
Beach Enhancement								
#1591-1880 East End Beach and Dune Restoration	86		43	43	$27,466,000	$27,466,000		$638,744
* For multi-category projects, apportioned project cost divides project cost by the number of project categories.								

Table 5. Project Costs per Unit: Living Shoreline Projects.

DWH Tracker Project ID & Name	Length (Miles)	Length (Feet)	Approximate Habitat Acreage (Assuming 15 ft Width)	Project Cost	Apportioned Project Cost		Apportioned Cost per Foot
#7 Marsh Island (Portersville Bay) Restoration Project	0.56	2,957	1.02	$8,233,422	$4,116,711	*	$2,785
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)				$3,723,147	$3,723,147		
#316 Alabama Swift Track Living Shoreline	*1.75*	9,240	3.18	$5,946,794	$5,946,794		$644
#342-1534 Hancock County				$51,081,619	$17,027,206	*	$1,612
-Phase I	*2.00*	*10,560*	3.64				
-Phase II	*2.00*	*10,560*	3.64				
-Phase III	*2.00*	*10,560*	3.64				
#402 Point aux Pins Living Shoreline	0.57	3,010	1.04	$4,223,777	$4,223,777		$1,403
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries				$15,306,944	$7,653,472	*	$1,584
-Wolf River Living Shoreline	*0.30*	*1,584*	*0.55*				
-Big Island Living Shoreline	*1.53*	*8,078*	*2.78*				
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	1.02	5,376	1.85	$16,993,874	$8,496,937	*	$3,161
#689-1069 Lightning Point Acquisition and Restoration Project	1.08	5,702	1.96	$26,084,698	$13,042,349	*	$4,574
#752 Salt Aire Shoreline Restoration	1.41	7,445	2.56	$12,700,000	$6,350,000	*	$1,706
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	0.63	3,300	1.14	$18,138,409	$9,069,205	*	$5,496
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	3.30	17,424	6.00	$28,612,000	$14,306,000	*	$1,642
Coffee Island Living Shoreline	1.09	5,755	1.98	$2,304,078	$2,304,078		$400
Pelican Point Living Shoreline	0.05	264	0.11	$449,390	$449,390		$1,702
Taylor's Riverview Park Living Shoreline	0.06	317	0.36	$11,159	$11,159		$35

* For multi-category projects, apportioned project cost divides project cost by the number of project categories.

Table 6. Project Costs per Unit: Oyster Cultch Projects.

DWH Tracker Project ID & Name	**Cultch (CY)**	**Acres**	**CY / Acre**	**Project Cost**	**Apportioned Project Cost**		**Apportioned Cost per CY**	**Apportioned Cost per Acre**
#47 Restoration and Enhancement of Oyster Reefs in Alabama	60,501	795	76	$4,625,461	$4,625,461		$76	$5,820
#269 Mississippi Oyster Cultch Restoration Project	188,859	1,430	132	$12,580,918	$12,580,918		$67	$8,798
#315 Alabama Oyster Cultch Restoration	65,540	524	125	$4,063,352	$4,063,352		$62	$7,754
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	55,434	46	1,205	$51,081,619	$17,027,206	*	$307	$370,157
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries				$15,306,944	$7,653,472	*	$105	$54,088
-Deer Island Subtidal Reef	45,000	90	500					
-Wolf River Subtidal Reef	14,667	30	489					
-Grand Bay Point Aux Chenes Subtidal Reefs	6,300	7	969					
-Graveline Bay Intertidal and Subtidal Reef	6,300	12	525					
-Grand Bay Bangs Bayou Intertidal Reef	734	3	245					
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	46,350	25	1,854	$4,858,000	$4,858,000		$105	$194,320
* For multi-category projects, apportioned project cost divides project cost by the number of project categories.								

Project Benefits

Benefit Categories

Each project has the potential to provide a unique set of benefits. However, we expect that all projects in a given category should provide a common set of benefits. We devised a method to attempt to reconcile benefits attributed to a project by its own project documentation, benefits attributed to other projects in the same category, and benefits we considered likely to be attributable to a project in a given category. We first identified project deliverables, objectives, and/or benefits explicitly mentioned in a project's own documentation, including the project title, the DWH Tracker project description, the DWH Tracker project action categories, fact sheets (if available), and project monitoring plans (if available). This step included either explicit deliverables, objectives, and benefits, as well as terms and phrases that implied project deliverables, objectives, or benefits.

Table A2 in the Appendix reports the DWH Tracker project "Action" and "Resource" categories for each project. There were three actions assigned across our study projects: "Habitat Restoration and Enhancement", "Erosion Prevention or Control", and "Species Restoration". There were five resources assigned across our study projects: "Wetlands / Marshes / Estuaries", "Terrestrial Habitat", "Oysters / Shellfish", "Shorelines", and Beaches / Dunes". Most projects were assigned the "Habitat Restoration and Enhancement" action. The exceptions were three of the four oyster cultch projects and #1073-1702 Deer River. "Erosion Prevention or Control" was assigned to four projects, and this excluded all of the projects with "Living Shoreline" in the project title, despite the fact that most living shoreline projects claim reduced shoreline erosion as a project goal. Three of the four oyster cultch projects were assigned the "Species Restoration" action. These categories turned out to be of limited use in assigning benefits.

We then turned to project documentation. We compiled a list of all goals, objectives, deliverables, benefits, terms, and phrases mentioned in project documentation. We then looked for commonalities and grouped terms/phrases into categories. For example, the terms "construct breakwaters", "dampen wave energy", "limit erosion", "living shorelines", and "stabilize shoreline" were grouped into the category "shoreline protected". We interpreted the "beach" and "recreation" terms to imply benefits commonly monetized in the literature, namely enhanced residential property values enhanced and recreational beach trips enhanced. The final set of benefit categories identified were:

- Marsh Habitat Created, Restored, or Enhanced
- Marsh Habitat Protected
- Bottom Reef Habitat Created
- Breakwater Reef Habitat Created
- Oysters Produced
- Benthic Secondary Production Enhanced (interpreted as fishery enhancement)
- Beach/Dune Habitat Created
- Recreational Beach Trips Enhanced

- Residential Property Values Enhanced

We then examined the benefit categories assigned to each project based on the above, and determined whether adjustments were needed. The adjustments made were:

- We added benthic secondary productivity enhanced to all oyster cultch and living shoreline projects, even if their project documentation did not mention it, because other living shoreline projects did mention it. We also deemed it to be a likely benefit of oyster cultch projects, though not mentioned in their documentation either.
- We added residential property value enhancement and recreational beach visit enhancement to #1591-1880 East End Beach even though project documentation did not mention them explicitly.
- The development of a watershed management plan was identified for #30 Fowl River, but we subsequently omitted it because the project cost obtained from Jason Kudulis (2024) excluded this component.
- We removed the recreational beach trips enhanced benefit from #1073-1702 Deer River project because this does not appear to be a true beach enhancement project, even though the word "beach" was cited in project documentation. Jason Kudulis (2024) indicates that it is a "sandy shoreline".
- Navigation and access enhancement was identified for #689-1069 Lightning Point, but this benefit was not quantified or monetized.
- Hydrology restored was identified for #1073-1702 Deer River, but this benefit was not quantified or monetized.

Table 7 reports the benefit categories attributed to each project category.

Benefit Quantification

Table 8 reports the benefit categories and quantification and monetization metrics for each category. Additional details on the quantification methods for each benefit category are provided below. Table 9 reports the benefit quantification metrics for projects with construction complete and Table 10 does so for projects with construction and/or monitoring ongoing.

Marsh Habitat Created, Restored, or Enhanced

Habitat acreage were usually readily available from project documentation. Some projects had acreage restored or enhanced, but we credited these the same as if they were created. For the Marsh Island and East End Beach projects, we also found documentation that some acres were lost post-construction, so we base final acreage on net acres created.

Marsh Habitat Protected

Acreage for the marsh habitat protected benefit was derived by estimating land area using project shoreline and/or structure length and pre- and post-project erosion data for area width. This approach allowed us to compare the actual area change over time with the project to the counterfactual area change over time in the absence of the project. We assumed a living shoreline project lifespan of 20 years. Calculations for each project are reported in Tables A3-A5 in the Appendix.

Calculations were done as follows:

Area change (acres) <u>without</u> project in year t = [shoreline length (feet) x <u>without</u>-project erosion rate in year t (feet / year)] / 43,560

Area change (acres) <u>with</u> project = [shoreline length (feet) x <u>with</u>-project erosion rate in year t (feet / year)] / 43,560

Net area change (acres) in year t = (Area change <u>without</u> project in year t) - (Area change <u>with</u> project in year t)

Cumulative net area change (acres) = $\sum_{t=1}^{20}(Net\ area\ change\ in\ year\ t)$

Bottom Reef Habitat Created

Oyster-related benefits can be quantified based on either number of oysters or on acreage. We provide three options along these lines. Under Option A, our preferred option, oyster benefits are captured via number of oysters, and thus acreage of bottom reef habitat is not quantified. Under Options B and C, oyster benefits are captured via acreage, and thus bottom reef habitat acreage is quantified. Options B and C differ in terms of how benefits are monetized. Acreage benefits were generally readily available from project documentation.

Breakwater Reef Habitat Created

Oyster-related benefits can be quantified based on either number of oysters or on acreage. We provide three options along these lines. Under Option A, our preferred option, oyster benefits are captured via number of oysters, and thus acreage of bottom reef habitat is not quantified. Under Options B and C, oyster benefits are captured via acreage, and thus bottom reef habitat acreage is quantified. Options B and C differ in terms of how benefits are monetized. Habitat acreage was based on breakwater length and an assumed width of 15 feet.

Oysters Produced

As noted above, oyster benefits can be quantified based on either number of oysters or on acreage. Under Option A, for oyster cultch projects, oyster estimates were based on annual quadrat dive samples of adult oysters obtained for each project. The two Alabama projects included control sites such that a net difference between cultch and control could be calculated. The Mississippi Oyster Cultch project did not include control sites. In this case, we assumed a control value of zero oysters. We also assumed that all oysters reported would be available for harvest, but it is possible that an oyster could be double-counted in this approach. For example, if 100 oysters were counted in one year and 200 oysters were counted the next year, it is possible that some of the 200 are the same oysters from the previous year. We assumed a cultch project life of 10 years. In some cases, dive data were available for all 10 years. In cases of missing data, we used linear extrapolation when the missing data were between observed data. In cases where there were fewer than 10 years of monitoring, we duplicated the last year of available data to fill out remaining years. Each project contained multiple cultch sites. We based benefit metrics on the acre-weighted averages across all sites with a project. Calculations for each project are reported in Tables A6-A9 in the Appendix.

Although harvest is not typical for living shorelines, it is still necessary to credit them for oysters produced. For living shorelines, the sacks of oysters metric was based on annual quadrat dive samples of adult oysters obtained for each project. We assumed a control value of zero oysters. Although oysters grown on living shorelines are unlikely to be harvested, we quantified them the same way we did for oyster cultch projects. We assumed a project life of 20 years. At most, six years of data were available. We used the average across observed years to represent counts in remaining years. Calculations for each project are reported in Table A10-A12 in the Appendix.

Benthic Secondary Production Enhanced

We credit this benefit as fishery enhancement. We do not quantify this benefit because the monetary values used for habitat acreage already include this benefit. For example, the monetary values reported in Interis and Petrolia (2016), Petrolia, Walton, and Cebrian (2022), Petrolia et al. (2025), all explicitly account for fishery enhancement as part of the set of ecosystem services (benefits) attributable to salt marsh and oyster reef acreage.

Recreational Beach Trips Enhanced

We estimated the number of beach trips enhanced per year at East End Beach by assuming 25 trips per day for 365 days, for a total of 9,125 trips per year. We assume a project life of 10 years, for a total of 91,250 trips over the life of the project.

Residential Property Values Enhanced

We estimated the number of residential properties enhanced by the East End Beach project by counting the number of parcels in direct proximity to the project footprint as they appeared on the Mobile County Revenue Commission's (2024) interactive map as of September 4, 2024, and as the project footprint appeared in Town of Dauphin Island (2024). We decided to include all parcels on or adjacent to Audubon Place (= 52) and Hernando Place (Desoto Landing = 66 and Desoto Landing Addition = 19), as well as the two condominium complexes, Dauphin Surf Club and Sandcastle, at the end of Forney Johnston Drive. We counted Sandcastle as four parcels and Dauphin Island Surf Club as eight parcels, for a grand total of 149. Figure 1 shows a screenshot of the parcels included. Based on project documentation (Town of Dauphin Island 2024), we estimate that approximately 50% of the post-construction subaerial beach footprint of 300 feet (width) will decay due to settlement, leaving approximately 150 feet of added long-term beach width.

Figure 1. Map of Parcels Included in East End Beach Valuation.

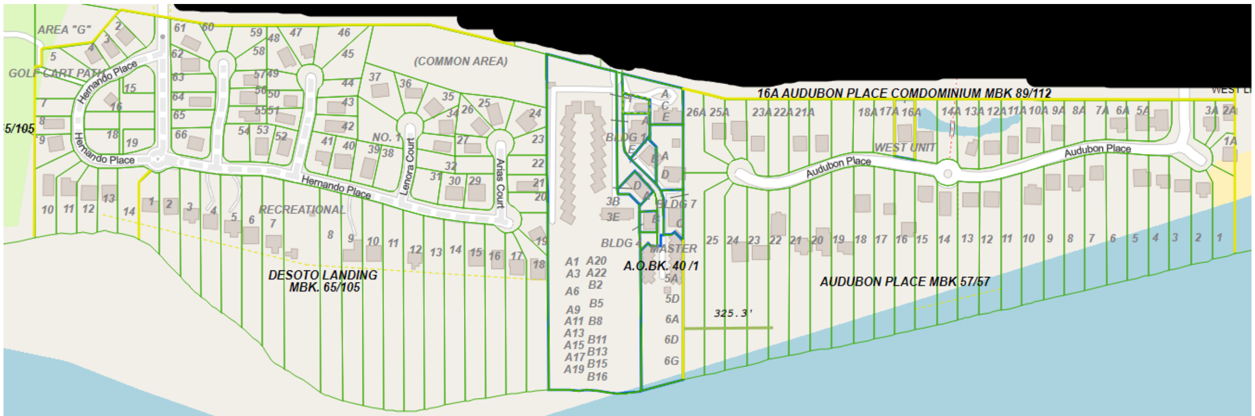


Table 7. Benefit Categories Attributed to Each Project Category.

Benefit Category	**Marsh Creation (MC)**	**Living Shoreline (LS)**	**Oyster Cultch (OC)**	**Beach (B)**
Marsh Habitat Created, Restored, or Enhanced	X			
Marsh Habitat Protected		X		
Bottom Reef Habitat Created			X	
Breakwater Reef Habitat Created		X		
Oysters Produced		X	X	
Benthic Secondary Production Enhanced	X	X	X	
Beach/Dune Habitat Created				X
Recreational Beach Trips Enhanced				X
Residential Property Values Enhanced				X

Table 8. Benefit Categories, Benefit Quantification Metrics, and Benefit Monetization Metrics.

Benefit Categories	**Benefit Quantification Metric**	**Benefit Monetization Metric**
Marsh Habitat Created, Restored, or Enhanced	Acres constructed, restored, and/or enhanced	Household WTP for restored salt marsh acres ($/acre) (Interis and Petrolia 2016)
Marsh Habitat Protected	Acres protected over 20-year project life, based on reported post-project erosion reductions relative to pre-project baseline	Household WTP for restored salt marsh acres ($/acre) (Interis and Petrolia 2016)
Bottom Reef Habitat Created	*Option A*: Not quantified - benefit captured by oysters produced *Option B*: Acres constructed *Option C*: Acres constructed	*Option A*: Not monetized - benefit captured by oysters produced *Option B*: Household WTP for increased oyster reef acres ($/acre) (Interis and Petrolia 2016) *Option C*: Market and nonmarket value for bottom reef acres ($/acre) (Petrolia, Walton, and Cebrian 2022)
Breakwater Reef Habitat Created	*Option A*: Not quantified - benefit captured by oysters produced *Option B*: Acres constructed *Option C*: Acres constructed	*Option A*: Not monetized - benefit captured by oysters produced *Option B*: Household WTP for restored oyster reef acres ($/acre) (Interis and Petrolia 2016) *Option C*: Nonmarket value for living shoreline acres ($/acre) (Petrolia, Walton, and Cebrian 2022)
Oysters Produced	*Option A*: Oyster sacks produced over 10-year project life, based on reported oyster production data *Option B*: Not quantified – benefit captured by reef habitat created *Option C*: Not quantified – benefit captured by reef habitat created	*Option A*: Household WTP for increased oyster landings ($/sack) (Petrolia et al. 2025) *Option B*: Not monetized – benefit captured by reef habitat created *Option C*: Not monetized – benefit captured by reef habitat created
Benthic Secondary Production Enhanced	Not quantified – Benefit captured by habitat created value	Not monetized – Benefit captured by habitat created value
Beach/Dune Habitat Created	Beach width increased (ft)	Household WTP for increased salt marsh acres ($/acre), as proxy for beach/dune habitat acres (Interis and Petrolia 2016)
Recreational Beach Trips Enhanced	Beach width increased (ft)	Beach visitor WTP for increased beach width ($/ft) (Whitehead et al. 2008, 2010; Parsons et al. 2013)
Residential Property Values Enhanced	Beach width increased (ft)	Increase in residential property sales values attributed to increased beach width ($/ft) (multiple sources, see discussion)

Table 9. Quantified Project Benefits for Projects with Construction Complete. Blanks indicate non-applicable benefit.

DWH Tracker Project ID & Name	Marsh Acres Created, Restored, or Enhanced (Acres)	Marsh Acres Protected (Acres)	Bottom Reef Habitat Created (Acres)	Breakwater Reef Habitat Created (Acres)	Oysters Produced (Sacks)
#7 Marsh Island (Portersville Bay) Restoration Project	43	0		1.02	
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	12				
#47 Restoration and Enhancement of Oyster Reefs in Alabama			795		66,990
#269 Mississippi Oyster Cultch Restoration Project			1,430		189,772
#287-757-1597-1922 Greenwood Island Beneficial Use Project	219				
#287-757-1597-1922 Round Island Marsh Restoration Project	200				
#287-757-1597-1922 Wolf River Beneficial Use Project	26				
#315 Alabama Oyster Cultch Restoration			524		302,424
#316 Alabama Swift Tract Living Shoreline		19		3.18	0
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	46	118	46	10.91	74,263
#689-1069 Lightning Point Acquisition and Restoration Project	28	13		1.96	13,661
#1699 Graveline Bay Marsh Restoration - Phase II	60				
Coffee Island Living Shoreline		14		1.98	0
Pelican Point Living Shoreline		0.4		0.09	0
Taylor's Riverview Park Living Shoreline		0.15		0.11	0

Table 10. Quantified Project Benefits for Projects with Construction and/or Monitoring Ongoing. Blanks indicate non-applicable benefit.

DWH Tracker Project ID & Name	**Marsh Acres Created, Restored, or Enhanced (Acres)**	**Marsh Acres Protected (Acres)**	**Bottom Reef Habitat Created (Acres)**	**Breakwater Reef Habitat Created (Acres)**	**Oysters Produced (Sacks)**	**Beach/Dune Habitat Created (Acres)**	**Recreational Beach Trips Enhanced (No. Trips)**	**Residential Property Values Enhanced (Feet Increased Beach Width)**
#402 Point aux Pins Living Shoreline		0		1.04	0			
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries		0	142	3.33	0			
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	40	0		1.85	0			
#752 Salt Aire Shoreline Restoration	30	0		2.56	0			
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	42			1.14				
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	35	0		6.00	0			
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)			25		0			
#1591-1880 East End Beach and Dune Restoration						43	91,250	150

Benefit Monetization

Table 11. Disaggregated Per-Unit Benefit Values. reports the disaggregated per-unit benefit values taken from the literature, all adjusted to 2023 dollars. Table 12 reports the final aggregated per-unit values used in the analysis. Details about the monetization process are provided in the sections below.

Overview

Monetization using existing datasets and existing literature, as requested by MASGC, implies the use of benefit transfer. Benefit transfer is the taking of existing benefit values from one or more existing studies (called the "study site") and applying them to a new one (called the "policy site") (Rolfe et al. 2015). Benefit transfer is superficially attractive because it often requires less time and money than primary research. It is the preferred approach by the EPA for benefit estimation (Smith 2018; Petrolia et al. 2021). However, the validity and accuracy of benefit transfer rely on a number of conditions. Bennett (2006) suggests the following criteria for valid benefit transfer:

1) the biophysical conditions at the study site must be similar to those at the policy site;
2) the scale of environmental change at the study site must approximate that at the policy site;
3) the socioeconomic characteristics of the population impacted by the change at the study site must approach those of the policy site;
4) the frame or setting in which the valuation was made at the study site must be close to that of the policy site;
5) the study site analysis has to have been conducted in a technically satisfactory fashion.

There are three types of benefit transfer: value transfer, function transfer, and meta-analysis. Value transfer is the simplest method. In this case, a point estimate of willingness-to-pay (WTP) from a study site (i.e., the original study) is applied directly to the policy site (i.e., the present study). The point estimate can be a single value or an average of estimates from multiple studies. Value transfer should be used only in cases where the study and policy sites are very similar. Point estimates are generally a function of several variables (e.g., income, region) and simply transferring them to a new location without accounting and controlling for those differences can lead to inaccurate results.

Function transfer uses the estimated function from which the study site's estimated WTP value was generated. Using the estimating function allows the transferred WTP estimate to control for factors that are known to influence WTP and that differ between the study and policy sites. Although function transfer can adjust for small differences between the study and policy site characteristics, they are still subject to the requirement that the study and policy sites be similar in the type and size of the environmental change and the population being evaluated.

Meta-analysis combines and synthesizes the results from multiple valuation studies to estimate a new transfer function. Meta-analysis has the advantage of drawing information on WTP from a large number of disparate sources to control for a relatively large number of variables that influence WTP. Because meta-analysis controls for the confounding attributes of the underlying studies, it is sometimes possible to make use of a larger number of studies than would be considered for a value or function transfer. There are several different forms meta-analyses may take, and the form is often determined by the type and amount of information available for use in the meta-analyses. It is important to recognize that techniques such as meta-analysis cannot correct for all study qualities or the appropriateness of the underlying studies. If the underlying studies do not provide a good match to the resource in question or do not rely on well-accepted practices for questionnaire development and/or econometric techniques, those studies should be excluded from meta-analysis.

Dollar Deflation and Discounting

All dollar values are converted to 2023 dollars using Bureau of Economic Analysis Gross Domestic Price implicit price deflator (U.S. Bureau of Economic Analysis 2024). Project costs are deflated using the construction completion year. The year 2023 is used for ongoing project costs.

The scenario used Interis and Petrolia (2016) describes their restoration project as taking five years to complete with ecosystem services lasting for 30 years. The scenario used in Petrolia et al. (2025) describes their restoration project as starting within the next three years, with project benefits expected to be achieved within the next ten years. Given that these scenarios are designed to have delivery of benefits taking place over the course of many years, we argue that they reasonably mimic the projects analyzed here. Petrolia, Walton, and Cebrian (2022) assume twenty-year project lifespan and convert the flow of annual costs and benefits to a single present value. Thus, we argue that the value estimates already account for benefits being delivered in later periods such that further discounting is unnecessary.

Marsh Habitat Created, Restored, or Enhanced

We searched the economics literature for estimates of the value of marsh, wetland, and other related habitat types. The two main sources of estimates were two recent meta-analyses of wetland valuation by Moeltner et al. (2019) and Vedogbeton and Johnston (2020). Table A13 in the Appendix reports the studies identified, categorized by coastal (salt marsh, coastal wetlands, barrier islands) and non-coastal (freshwater wetlands), adjusted to 2023 dollars. We first took the studies reported in Moeltner et al. (2019) and consolidated multiple estimates from the same study into a single average value. The exception is Interis and Petrolia (2016), which we leave unconsolidated, as discussed below. We then added studies identified by Vedogbeton and Johnston (2020) that explicitly reported the acreage change associated with the value estimate and/or a willingness to pay per acre estimate. We then supplemented the list with two additional studies. The payment mechanism differed across studies, with about half using an annual payment and half using a one-time payment. To reconcile these differences, we converted all annual payments to present value assuming 10 years of payments and a 5% discount rate. We chose a 10-year payment horizon because this is what was used in Petrolia and Kim (2011) and Kim and Petrolia (2013); the remaining studies did not specify length of payments.

We decided to use direct value transfer of a single study for our habitat valuation estimates: Interis and Petrolia (2016). This study was one of the most recently conducted surveys of willingness to pay for salt marsh restoration and was conducted for the same target population as the present study (the state of Alabama). This study also included a valuation exercise for the state of Louisiana. Because we are particularly interested in the Alabama component, we report the Alabama and the Louisiana components separately in the table. Although the study did focus on Mississippi, we argue that Alabama's WTP estimates per household are a good proxy for those of Mississippi. Thus, this study is a near-perfect match for value transfer.

Interis and Petrolia's (2016) restoration scenario included multiple benefits associated with salt marsh restoration, including increased water quality, improved flood protection, increased commercial fisheries support, and increased wading bird population. Thus the WTP estimates taken from this study are assumed to include these benefits.

Comparing our chosen estimate to the others in the literature, we see from the table that the estimate for Alabama falls nearly in the middle of the set of studies, at $0.12 per acre per household. By comparison, the Louisiana estimate from the same study is $0.40 per acre per household, and Petrolia and Kim (2009), which estimated the value of barrier island restoration in Mississippi, is $0.07 per acre per household.

Marsh Habitat Protected

We monetize marsh habitat protected using the same values as those for marsh habitat created.

Bottom Reef Habitat Created

We searched the economics literature for estimates of the value of oyster reefs (Table A14 in the Appendix). Studies are organized into three categories: those that estimate the value of oyster reef restoration directly based on public (household) willingness to pay (Petrolia et al. 2025; Interis and Petrolia 2016), those that monetize existing bottom reefs using market, non-market, replace cost and other methods combined with benefit transfer (Petrolia, Walton, and Cebrian 2022; Lai, Irwin, and Zhang 2020; DePiper, Lipton, and Lipcius 2017; Grabowski et al. 2012), and those that monetize living shoreline reefs (Petrolia, Walton, and Cebrian 2022; Moffatt and Nichol 2018; Kroeger and Guannel 2014). The most recently conducted study, Petrolia et al. (2025), estimated the value of restoration in terms of increased commercial oyster landings. All of the other studies monetize reefs in terms of acres, with the exception of Kroeger and Guannel (2014), who do so in terms of miles of reef.

Bottom reef habitat was not quantified or monetized under Option A. Under Option B, we rely on the estimates of Interis and Petrolia (2016), which is based on household willingness to pay of Alabama residents. Under Option C, we rely on the estimates of Petrolia, Walton, and Cebrian (2022), which is based on a combination of market prices, benefit transfer of non-market values, and replacement cost values.

Breakwater Reef Habitat Created

Table A15 of the Appendix summarizes the two studies that monetize breakwater (living shoreline) reef habitat. Estimates range from \$0.08 per foot to \$0.74 per foot per household. Breakwater reef habitat was not quantified or monetized under Option A. Under Option B, we rely on the oyster reef estimates of Interis and Petrolia (2016), using this as a proxy for breakwater reef. Under Option C, we rely on the estimates of Petrolia, Walton, and Cebrian (2022) for living shorelines, which is based on a combination of market prices, benefit transfer of non-market values, and replacement cost values.

Oysters Produced

We rely on the estimates of Petrolia et al. (2025) for oyster valuation under Option A because it is the most recent study conducted for this purpose, it reports estimates specific to both Alabama and Mississippi, and because it allows for value estimates to be tied to the number of oysters actually produced. Focusing on number of oysters as reported in project monitoring reports reflects "actual" benefits, whereas focusing on the acreage of reef constructed – as done under Options B and C -- merely reflects "potential" benefits because it does not account for whether oysters actually recruited to the reef.

We interpret annual oyster counts as given. It is likely that some oysters measured in one year are counted again in subsequent years, such that we are double-counting them. Our value estimates taken from Petrolia et al. (2025) are based on annual landings, which necessarily implies removal from the water. Bottom reefs in Alabama and Mississippi are generally harvestable, whereas oysters attached to breakwater/living shoreline structures are generally not. The potential upward bias is thus likely more pronounced for living shorelines than for bottom reefs. Furthermore, because our value estimates are based on landings, not merely on abundance, this means that using these estimates for oysters attached to non-harvested living shorelines leads to further potential upward bias for oyster benefits attributed to living shorelines.

Benthic Secondary Production Enhanced

This benefit is not monetized separately because the monetary values used for habitat acreage already include this benefit. For example, the monetary values reported in Interis and Petrolia (2016), Petrolia, Walton, and Cebrian (2022), Petrolia et al. (2025), all explicitly account for fishery enhancement as part of the set of ecosystem services (benefits) attributable to salt marsh and oyster reef acreage.

Beach/Dune Habitat Created

We are aware of only one study that monetizes beach/dune as habitat (Petrolia and Kim 2009), but that is for barrier island restoration in Mississippi. Rather than rely on that study, we use the same values as those for marsh habitat created (Interis and Petrolia 2016) as a proxy for beach/dune habitat.

Recreational Beach Trips Enhanced

There is one beach construction project included in the set of projects analyzed here: Project #1880: East End Beach and Dune Restoration. We monetize recreational beach trips enhanced by calculating the mean beach visitor willingness to pay for increased beach width ($/ft) as reported in Whitehead et al. (2008, 2010) and day-trippers in Parsons et al. (2013) and adjusted to 2023 dollars.

Residential Property Values Enhanced

There is one beach construction project included in the set of projects analyzed here: Project #1880: East End Beach and Dune Restoration. We searched the literature for benefit estimates associated with changes in property values attributed to changes in beach width. We found 94 estimates, though none were estimated specifically for any Gulf Coast locations (Table A15 in the Appendix). We calculated the median one-time WTP across all studies found, which is $958 per household per foot of increased beach width.

Table 11. Disaggregated Per-Unit Benefit Values.

	Median	Lower Bound	Upper Bound
Marsh Habitat Created, Restored, or Enhanced			
Value per Acre per Household (Interis and Petrolia 2016)	$0.15	$0.03	$0.25
Marsh Habitat Protected			
Value per Acre per Household (Interis and Petrolia 2016)	$0.15	$0.03	$0.25
Bottom Reef Habitat Created			
Option A	Not Monetized		
Option B - Value per Acre per Household (Interis and Petrolia 2016)	$0.34	$0.10	$0.58
Option C - Value per Acre (Petrolia, Walton, and Cebrian 2022)	$184,595	$5,293	$459,529
Breakwater Reef Habitat Created			
Option A	Not Monetized		
Option B - Value per Acre per Household (Interis and Petrolia 2016)	$0.34	$0.10	$0.58
Option C - Value per Acre (Petrolia, Walton, and Cebrian 2022)	$825,450	$402,555	$1,362,806
Oysters Produced			
Option A - Alabama - Value per Sack per Household (Petrolia et al. 2025)	$0.00009	$0.00003	$0.00015
Option A - Mississippi - Value per Sack per Household (Petrolia et al. 2025)	$0.00007	$0.00003	$0.00012
Option B	Not Monetized		
Option C	Not Monetized		
Beach/Dune Habitat Created			
Value per Acre per Household (Interis and Petrolia 2016)	$0.15	$0.03	$0.25
Recreational Beach Trips Enhanced			
Value per Beach Trip (Parsons et al. 2013; Whitehead et al. 2008, 2010)	$15.84		
Residential Property Values Enhanced			
Value per Foot Increased Beach Width per Household (Multiple Sources)	$958		

Table 12. Final Aggregated Per-Unit Benefit Values

	Median	Lower Bound	Upper Bound
Marsh Habitat Created, Restored, or Enhanced - Value per Acre			
Alabama	$281,006	$59,859	$492,177
Mississippi	$162,990	$34,720	$285,473
Marsh Habitat Protected - Value per Acre			
Alabama	$281,006	$59,859	$492,177
Mississippi	$162,990	$34,720	$285,473
Bottom Reef Habitat Created - Value per Acre			
Option A	Not Monetized		
Option B - Alabama	$653,464	$201,194	$1,114,049
Option B - Mississippi	$379,024	$116,697	$646,172
Option C	$184,595	$5,293	$459,529
Breakwater Reef Habitat Created - Value per Acre			
Option A	Not Monetized		
Option B - Alabama	$653,464	$201,194	$1,114,049
Option B - Mississippi	$379,024	$116,697	$646,172
Option C	$825,450	$402,555	$1,362,806
Oysters Produced - Value per Sack			
Option A - Alabama	$176	$58	$295
Option A - Mississippi	$83	$29	$136
Option B	Not Monetized		
Option C	Not Monetized		
Beach/Dune Habitat Created - Value per Acre			
Dauphin Island - East End Beach	$281,006	$59,859	$492,177
Recreational Beach Trips Enhanced - Value per Project			
Dauphin Island - East End Beach	$1,445,747		
Residential Property Values Enhanced - Value per Foot Increased Beach Width			
Dauphin Island - East End Beach	$142,732		

Descriptions of Studies Used for Monetary Values

Interis and Petrolia (2016)

This study provided monetary values for marsh habitat created, restored, or enhanced; marsh habitat protected; bottom reef habitat created; breakwater reef habitat created; and beach/dune habitat created

Interis and Petrolia (2016) estimated household willingness to pay to restore three coastal habitats in Mobile Bay, Alabama and Barataria-Terrebonne Bays in Louisiana: oyster reefs, salt marshes, and black mangroves. They employed a discrete choice experiment format which presented hypothetical restoration scenarios to respondents in the form of alternative restoration options that varied in the levels of ecosystem services provided. Both single- and repeated-choice versions of the survey were utilized. The restoration was presented as impacting four ecosystem services: increased water quality, improved flood protection, increased commercial fisheries support, and increased wading bird population. Sampling was conducted in 2013 and resulted in 5,196 responses from households in Alabama and Louisiana. The survey was administered by GfK Custom Research (formerly Knowledge Networks), to a pre-recruited panel of households known as Knowledge Panel. Because more observations were sought than GfK could provide with their Alabama and Louisiana panels, GfK subcontracted with some partner organizations to obtain additional “off-panel” observations in those states. GfK’s panel was known for its representativeness of the U.S. population and its state populations. Results included estimates of household-level willingness to pay for increments of the four ecosystem services as well as project-level estimates for restoration of each of the three habitats for each state.

Parsons et al. (2013)

This study provided monetary values for recreational beach trips enhanced.

Parsons et al. (2013) estimated the value associated with changes in beach width. They employed an in-person, on-site survey at seven bay beaches in Delaware and utilized a travel cost model combining revealed and stated preference data. They first estimated a model for predicting the number of visitors at each site over a 12-month period based on an on-site count of visitors. They then estimated a single-site travel cost model that combined actual and contingent trip data. They estimated the loss for narrowing beaches to a quarter current width at about $5.00 per day at the beach and the gain from widening to twice current width at about $2.75 per day at the beach. The width of the beaches during the study was between 50 and 100 feet.

Petrolia et al. (2025)

This study provided monetary values for oysters produced.

Petrolia et al. (2025) estimated household willingness to pay for oyster reef restoration in each of the five U.S. Gulf Coast states. They employed a contingent valuation survey which presented hypothetical restoration scenarios that would result in increased commercial oyster landings relative to no-action. A version unique to each state was utilized. Sampling was conducted in 2022 relying on Qualtrics panelists and resulted in 4,690 responses across the five states.

Qualtrics uses a variety of sample recruiting methods, but ultimately their method is a form of non-probability "convenience" sampling, meaning that the sample may not be representative of the population of interest. To address this shortcoming, researchers calculated sampling weights to provide alternative sets of results that may be considered more appropriate for inference to the population of interest. The survey employed videos to convey key information and follow-up questions to mitigate hypothetical bias. Researchers tested for status quo and scope effects, and compared a restricted sample of internally consistent "high-quality" responses against the full sample. Results included estimates of both household and aggregate willingness to pay, placed in the context on ongoing oyster restoration efforts and commercial landings. Results indicate that public support for oyster restoration, in terms of willingness to pay, exceeds current restoration expenditures and is consistent with the current market value of oysters. They also found that preferences were driven strongly by those who eat oysters as well as those who are saltwater anglers.

Petrolia, Walton, and Cebrian (2022)

This study provided monetary values for bottom reef habitat created and breakwater reef habitat created.

Petrolia, Walton, and Cebrian (2022) simulate expected costs, market returns, and nonmarket ecosystem benefits associated with four oyster resources: harvested bottom reefs, off-bottom aquaculture, non-harvested (restored) reefs, and living shorelines. Ecosystem service levels are based on expert opinion as reported in Petrolia et al. (2020). Benefit categories include market returns from harvest, improved water quality (reduced nitrogen), habitat for other species (blue crab and red drum), and shoreline protection. Market returns are based on commercial oyster prices, water quality benefits are monetized based on nitrogen trading payments, habitat for other species is monetized using commercial blue crab prices and recreational red drum values taken from the literature, and shoreline protection is monetized using avoided cost of bulkhead construction. All estimates are converted to a value per-acre basis. Results indicate that overall gross benefits are expected to be greater and much more variable for off-bottom aquaculture and living shorelines relative to harvested and non-harvested reefs. They find that harvested bottom reefs, off-bottom aquaculture, and living shorelines are expected to yield positive net benefits more often than not, but that non-harvested restored reefs are expected to yield positive net benefits only 36% of the time.

Whitehead et al. (2008)

This study provided monetary values for recreational beach trips enhanced.

Whitehead et al. (2008) estimated the value of beach access and width among North Carolina beachgoers. They combined revealed preference and stated preference data to estimate the changes in recreation demand that might occur with beach nourishment and parking improvements. The study area included seventeen beaches in five southeastern North Carolina counties. Bogue Banks, a barrier island, is located in Carteret County, and encompasses a twenty-four mile stretch of beach communities. Topsail Island, a barrier island, is located in both Pender and Onslow Counties and encompasses a 22-mile stretch of beach communities. New Hanover County encompasses a 13-mile stretch of beach communities and lies between Pender and Brunswick County. The Brunswick County beaches are located between the Cape Fear River and the South Carolina border and encompass a 24-mile stretch of beach communities. The target population was chosen based upon the results of an on-site survey conducted during the summer of 2003 at the study area beaches (Herstine et al. 2005). The majority of day users (approximately 73%), the primary users of public beach parking, traveled 120 miles or less to get to the beach. Survey Sampling, Inc., provided telephone numbers within the 120-mile beach travel distance study area. The telephone survey was administered by the Survey Research Laboratory (SRL) at the University of North Carolina Wilmington in 2004. The response rate was 52%. Of the survey respondents, 1,509 stated that they had considered going to an oceanfront beach in North Carolina during the past year. Of this number, 1,186 (79%) actually took an oceanfront beach trip to the North Carolina coast in 2003. Of these, 937 (79%) took an oceanfront beach trip to the southeastern North Carolina beaches in 2003. Of all respondents who took at least one trip to the southeastern North Carolina coast, 96% planned to take at least one oceanfront beach trip to this area in 2004. After deleting cases with missing RP or SP information, travel distance information, income, or other demographics, the remaining sample size was 636.

Whitehead et al. (2010)

This study provided monetary values for recreational beach trips enhanced.

Whitehead et al. (2010) tested the convergent validity of several demand models using the same beach recreation data described above for Whitehead et al. (2008). Two models employ multiple site data: a count data demand system model and the Kuhn–Tucker demand system model. They explored the role of existing variation in beach width in explaining trip choices, and analyzed a hypothetical 100 foot increase in beach width. They compare these models to a single equation model in which they jointly estimated revealed and stated preference trip data. In each case they developed estimates of the change in beach trips and the welfare impacts from the increase in width. The trip change estimates from two of the three models are similar and convergent valid, though the willingness to pay estimates differ in magnitude.

Studies Estimating Residential Property Value Enhancement

We found 94 estimates across twelve studies. These studies are summarized in Table A15 in the Appendix.

Benefit-Cost Analysis

Projects with Construction Complete

Table 13 reports the estimated mean, lower-bound, and upper-bound project benefits using valuation Option A for projects with construction complete. For these projects, the two benefit categories are habitat benefits and oyster benefits. Table 14 reports project costs, estimated total benefits, and estimated net benefits for these projects. Ten out of fifteen projects are estimated to have positive net benefits. All but two projects have positive estimated net benefits under the upper-bound benefit values. Only one project, Alabama Oyster Cultch Restoration, has positive estimated net benefits even under the lower-bound benefit values.

The benefit-cost ratios provide insights into the relative magnitude of benefits relative to costs. A ratio greater than one indicates that for every dollar invested, the project yielded more than $1 in benefits. Table 15 reports median, lower-bound, and upper-bound benefit-cost ratios for these projects. Ten of the fifteen projects have median benefit-cost ratios greater than 1.0. Five projects have median ratios greater than 2.0, meaning that for every dollar invested, they yielded over $2 in benefits. Two projects have median ratios greater than 3.0: Alabama Oyster Cultch and Taylor's Riverview Park.

As discussed previously, oyster reefs can be monetized on either a per-oyster or per-acre basis and can be done using survey-based estimates of willingness to pay or market prices. The main analysis above does so on a per-oyster basis using survey-based estimates of willingness to pay. Here, we analyze how results change if done so based on habitat created, which, at least here, is independent of any oyster production metrics. Option B is a survey-based willingness to pay per acre taken from Interis and Petrolia (2016). Option C is a production-based estimate combining market value (price) and non-market values for nitrogen reduction, blue crab abundance, red drum abundance, and avoided cost of bulkhead construction (for living shorelines only) taken from Petrolia, Walton, and Cebrian (2022). These alternative approaches apply only those projects with oyster benefits, that is, oyster cultch and living shorelines.

Table 20 reports the median benefit-cost ratios for Options A, B, and C. Only one project, Alabama Swift Tract, has a B-C ratio less than 1.0 under Option A but greater than 1.0 under Options B or C. This project's B-C ratio increases from 0.9 under Option A to 1.2 and 1.3 under Options B and C, respectively. All others that have a B-C ratio less than 1.0 under Option A remain at less than 1.0 under Options B and C. All those that have a B-C ratio greater than 1.0 under Option A remain so under Options B and C. Some projects, particularly some of the oyster cultch projects, see order of magnitude increases in their B-C ratios as the metric switches from number of oysters to acres of reef habitat. Thus, the use of these alternative benefit metrics for oyster benefits do not much of an impact in terms of whether a project yields a net gain or loss of benefits.

Table 13. Estimated Project Benefits Using Valuation Option A for Projects with Construction Complete.

	Habitat Benefits (A)			Oyster Benefits (A)		
DWH Tracker Project ID & Name	**Median**	**Lower Bound**	**Upper Bound**	**Median**	**Lower Bound**	**Upper Bound**
#7 Marsh Island (Portersville Bay) Restoration Project	$12,083,272	$2,573,951	$21,163,601			
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	$3,372,076	$718,312	$5,906,121			
#47 Restoration and Enhancement of Oyster Reefs in Alabama				$11,810,510	$3,890,521	$19,730,499
#269 Mississippi Oyster Cultch Restoration Project				$15,753,001	$5,479,305	$25,798,394
#287-757-1597-1922 Greenwood Island Beneficial Use Project	$35,694,761	$7,603,618	$62,518,635			
#287-757-1597-1922 Round Island Marsh Restoration Project	$32,597,955	$6,943,943	$57,094,644			
#287-757-1597-1922 Wolf River Beneficial Use Project	$4,237,734	$902,713	$7,422,304			
#315 Alabama Oyster Cultch Restoration				$53,317,919	$17,563,550	$89,072,288
#316 Alabama Swift Tract Living Shoreline	$5,351,723	$1,140,012	$9,373,432			
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	$26,659,859	$5,679,023	$46,694,191	$6,164,602	$2,144,209	$10,095,653
#689-1069 Lightning Point Acquisition and Restoration Project	$11,546,806	$2,459,675	$20,223,991	$2,408,381	$793,349	$4,023,413
#1699 Graveline Bay Marsh Restoration - Phase II	$16,860,380	$3,591,560	$29,530,606			
Coffee Island Living Shoreline	$4,060,814	$865,025	$7,112,431			
Pelican Point Living Shoreline	$113,659	$24,211	$199,071			
Taylor's Riverview Park Living Shoreline	$40,874	$8,707	$71,589			

Table 14. Project Costs, Estimated Benefits, and Net Benefits Using Valuation Option A, for Projects with Construction Complete.

DWH Tracker Project ID & Name	Cost	Benefits (A) Median	Benefits (A) Lower Bound	Benefits (A) Upper Bound	Net Benefits (A) Median	Net Benefits (A) Lower Bound	Net Benefits (A) Upper Bound
#7 Marsh Island (Portersville Bay) Restoration Project	$8,233,422	$12,083,272	$2,573,951	$21,163,601	$3,849,850	-$5,659,471	$12,930,179
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	$3,723,147	$3,372,076	$718,312	$5,906,121	-$351,071	-$3,004,835	$2,182,974
#47 Restoration and Enhancement of Oyster Reefs in Alabama	$4,625,461	$11,810,510	$3,890,521	$19,730,499	$7,185,049	-$734,940	$15,105,038
#269 Mississippi Oyster Cultch Restoration Project	$12,580,918	$15,753,001	$5,479,305	$25,798,394	$3,172,083	-$7,101,613	$13,217,476
#287-757-1597-1922 Greenwood Island Beneficial Use Project	$25,749,118	$35,694,761	$7,603,618	$62,518,635	$9,945,644	-$18,145,500	$36,769,517
#287-757-1597-1922 Round Island Marsh Restoration Project	$12,407,735	$32,597,955	$6,943,943	$57,094,644	$20,190,220	-$5,463,792	$44,686,909
#287-757-1597-1922 Wolf River Beneficial Use Project	$4,164,145	$4,237,734	$902,713	$7,422,304	$73,589	-$3,261,432	$3,258,159
#315 Alabama Oyster Cultch Restoration	$4,063,352	$53,317,919	$17,563,550	$89,072,288	$49,254,567	$13,500,198	$85,008,936
#316 Alabama Swift Tract Living Shoreline	$5,946,794	$5,351,723	$1,140,012	$9,373,432	-$595,071	-$4,806,782	$3,426,638
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	$51,081,619	$32,824,461	$7,823,233	$56,789,844	-$18,257,157	-$43,258,386	$5,708,225
#689-1069 Lightning Point Acquisition and Restoration Project	$26,084,698	$13,955,187	$3,253,024	$24,247,404	-$12,129,511	-$22,831,674	-$1,837,294
#1699 Graveline Bay Marsh Restoration - Phase II	$6,437,000	$16,860,380	$3,591,560	$29,530,606	$10,423,380	-$2,845,440	$23,093,606
Coffee Island Living Shoreline	$2,304,078	$4,060,814	$865,025	$7,112,431	$1,756,736	-$1,439,052	$4,808,353
Pelican Point Living Shoreline	$449,390	$113,659	$24,211	$199,071	-$335,731	-$425,179	-$250,319
Taylor's Riverview Park Living Shoreline	$11,159	$40,874	$8,707	$71,589	$29,714	-$2,453	$60,430

Table 15. Benefit-Cost Ratio Using Valuation Option A for Projects with Construction Complete.

	Benefit-Cost Ratio (A)		
DWH Tracker Project ID & Name	**Median**	**Lower Bound**	**Upper Bound**
#7 Marsh Island (Portersville Bay) Restoration Project	1.5	0.3	2.6
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	0.9	0.2	1.6
#47 Restoration and Enhancement of Oyster Reefs in Alabama	2.6	0.8	4.3
#269 Mississippi Oyster Cultch Restoration Project	1.3	0.4	2.1
#287-757-1597-1922 Greenwood Island Beneficial Use Project	1.4	0.3	2.4
#287-757-1597-1922 Round Island Marsh Restoration Project	2.6	0.6	4.6
#287-757-1597-1922 Wolf River Beneficial Use Project	1.0	0.2	1.8
#315 Alabama Oyster Cultch Restoration	13.1	4.3	21.9
#316 Alabama Swift Tract Living Shoreline	0.9	0.2	1.6
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	0.6	0.2	1.1
#689-1069 Lightning Point Acquisition and Restoration Project	0.5	0.1	0.9
#1699 Graveline Bay Marsh Restoration - Phase II	2.6	0.6	4.6
Coffee Island Living Shoreline	1.8	0.4	3.1
Pelican Point Living Shoreline	0.3	0.1	0.4
Taylor's Riverview Park Living Shoreline	3.7	0.8	6.4

Table 16. Comparison of Median Benefit-Cost Ratios Under Alternative Valuation Options for Projects with Construction Completed.

	Benefit-Cost Ratio		
DWH Tracker Project ID & Name	**Option A**	**Option B**	**Option C**
#7 Marsh Island (Portersville Bay) Restoration Project	1.5	1.5	1.6
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	0.9	0.9	0.9
#47 Restoration and Enhancement of Oyster Reefs in Alabama	2.6	112.3	31.7
#269 Mississippi Oyster Cultch Restoration Project	1.3	43.1	21.0
#287-757-1597-1922 Greenwood Island Beneficial Use Project	1.4	1.4	1.4
#287-757-1597-1922 Round Island Marsh Restoration Project	2.6	2.6	2.6
#287-757-1597-1922 Wolf River Beneficial Use Project	1.0	1.0	1.0
#315 Alabama Oyster Cultch Restoration	13.1	84.3	23.8
#316 Alabama Swift Tract Living Shoreline	0.9	1.2	1.3
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	0.6	0.9	0.9
#689-1069 Lightning Point Acquisition and Restoration Project	0.5	0.5	0.5
#1699 Graveline Bay Marsh Restoration - Phase II	2.6	2.6	2.6
Coffee Island Living Shoreline	1.8	2.3	2.5
Pelican Point Living Shoreline	0.3	0.4	0.4
Taylor's Riverview Park Living Shoreline	3.7	10.1	11.7

Projects with Construction and/or Monitoring Ongoing

Table 17 reports the estimated mean, lower-bound, and upper-bound project benefits using valuation Option A for projects with construction and/or monitoring ongoing. Three of the projects have no quantified benefits at this point. For these projects, the three benefit categories are habitat benefits, oyster benefits, and beach benefits. Table 18 reports project costs, estimated total benefits, and estimated net benefits for these projects. With these preliminary data, only one of the projects has positive estimated median net benefits (East End Beach and Dune Restoration). Four projects, however, have positive estimated upper-bound net benefits Table 19 reports median, lower-bound, and upper-bound benefit-cost ratios for these projects. Consistent with the net benefits, one project has a median B-C ratio greater than 1.0, but four of them have an upper-bound B-C ratio greater than 1.0.

Table 20 reports the median benefit-cost ratios for Options A, B, and C. The three projects that had no quantified benefits under Option A have quantified and monetized benefits under Options B and C. Three projects, Restoring Living Shorelines and Reefs, Enhancement of St. Louis Bay Reef (Tony Trapani Reef), and East End Beach and Dune Restoration have B-C ratios greater than 1.0 under Options B and C.

Table 17. Estimated Project Benefits Using Valuation Option A for Projects with Construction and/or Monitoring Ongoing.

	Habitat Benefits (A)			Oyster Benefits (A)			Beach Benefits
DWH Tracker Project ID & Name	**Median**	**Lower Bound**	**Upper Bound**	**Median**	**Lower Bound**	**Upper Bound**	**Median**
#402 Point aux Pins Living Shoreline	$0	$0	$0	$0	$0	$0	
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	$0	$0	$0	$0	$0	$0	
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	$11,240,253	$2,394,373	$19,687,071	$0	$0	$0	
#752 Salt Aire Shoreline Restoration	$8,430,190	$1,795,780	$14,765,303	$0	$0	$0	
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	$11,802,266	$2,514,092	$20,671,424	$0	$0	$0	
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	$9,835,222	$2,095,077	$17,226,187	$0	$0	$0	
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	$0	$0	$0	$0	$0	$0	
#1591-1880 East End Beach and Dune Restoration	$12,083,272	$2,573,951	$21,163,601				$22,855,530

Table 18. Project Costs, Estimated Benefits, and Net Benefits Using Valuation Option A, for Projects with Construction and/or Monitoring Ongoing.

		Total Benefits (A)			Net Benefits (A)		
DWH Tracker Project ID & Name	**Cost**	**Median**	**Lower Bound**	**Upper Bound**	**Median**	**Lower Bound**	**Upper Bound**
#402 Point aux Pins Living Shoreline	$4,223,777	$0	$0	$0	-$4,223,777	-$4,223,777	-$4,223,777
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	$15,306,944	$0	$0	$0	-$15,306,944	-$15,306,944	-$15,306,944
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	$16,993,874	$11,240,253	$2,394,373	$19,687,071	-$5,753,621	-$14,599,501	$2,693,197
#752 Salt Aire Shoreline Restoration	$12,700,000	$8,430,190	$1,795,780	$14,765,303	-$4,269,810	-$10,904,220	$2,065,303
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	$18,138,409	$11,802,266	$2,514,092	$20,671,424	-$6,336,143	-$15,624,317	$2,533,015
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	$28,612,000	$9,835,222	$2,095,077	$17,226,187	-$18,776,778	-$26,516,923	-$11,385,813
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	$6,589,871	$0	$0	$0	-$6,589,871	-$6,589,871	-$6,589,871
#1591-1880 East End Beach and Dune Restoration	$27,466,000	$34,938,802	$25,429,482	$44,019,131	$7,472,802	-$2,036,518	$16,553,131

Table 19. Benefit-Cost Ratio Using Valuation Option A for Projects with Construction and/or Monitoring Ongoing.

	Benefit-Cost Ratio (A)		
DWH Tracker Project ID & Name	**Median**	**Lower Bound**	**Upper Bound**
#402 Point aux Pins Living Shoreline	0.0	0.0	0.0
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	0.0	0.0	0.0
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	0.7	0.1	1.2
#752 Salt Aire Shoreline Restoration	0.7	0.1	1.2
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	0.7	0.1	1.1
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	0.3	0.1	0.6
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	0.0	0.0	0.0
#1591-1880 East End Beach and Dune Restoration	1.3	0.9	1.6

Table 20. Comparison of Median Benefit-Cost Ratios for Projects with Construction and/or Monitoring Ongoing.

	Benefit-Cost Ratio		
DWH Tracker Project ID & Name	**Option A**	**Option B**	**Option C**
#402 Point aux Pins Living Shoreline	0.0	0.2	0.2
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	0.0	3.6	1.9
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	0.7	0.7	0.8
#752 Salt Aire Shoreline Restoration	0.7	0.8	0.8
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	0.7	0.7	0.7
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	0.3	0.5	0.5
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	0.0	2.3	1.1
#1591-1880 East End Beach and Dune Restoration	1.3	1.3	1.3

Benefit-Cost Analysis by Project Category

Focusing on the median benefit-cost ratios, we now compare project performance by project category: marsh creation, living shoreline, oyster cultch, and multi-category (Table 21). We limit this analysis to projects with construction complete. Of the five marsh creation projects, four have median B-C ratios greater than one. Two of the four living shoreline projects have B-C ratios greater than one, all three of the oyster cultch projects have B-C ratios greater than one, and one of the three multi-category projects have B-C ratios greater than one.

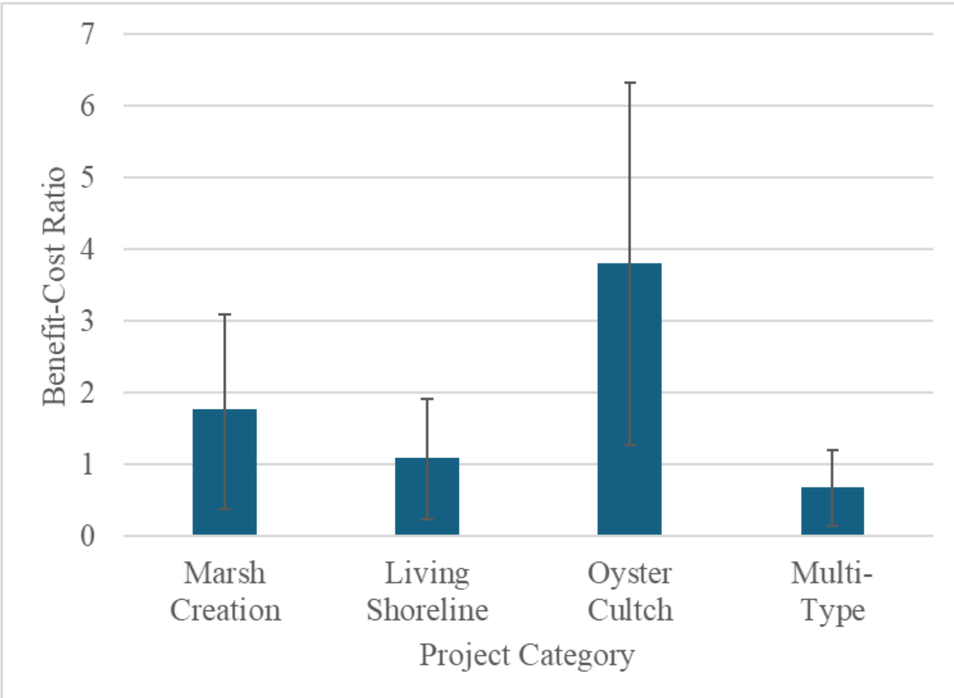
For category performance, we report two B-C cost ratios: the first is simply the mean of individual B-C ratios within a given project category. The second, which we call the "aggregate" B-C ratio, is calculated by summing total benefits and total costs across all projects in a given category, then calculating the B-C ratio using those totals. We report both B-C ratios for all three valuation Options A, B, and C. The oyster cultch category has the highest B-C ratio, regardless of ratio metric and regardless of valuation option. The category with the second-highest B-C ratio depends upon the ratio metric and valuation option used. Under the mean B-C ratio and valuation Option A, marsh creation is the category with the second-highest B-C ratio. Under Options B or C, however, living shorelines have the second-highest B-C ratio. Under the aggregate B-C ratio, marsh creation is the category with the second-highest B-C ratio. Multi-category projects consistently have the lowest B-C ratios. Overall, oyster cultch, marsh creation, and living shorelines have mean or aggregate B-C ratios greater than 1.0, whereas B-C ratios for multi-category projects are consistently less than 1.0.

Figure 2 limits the results by displaying the aggregate median benefit-cost ratios with confidence intervals, under valuation Option A. This analysis by project category indicates that oyster cultch projects tend to deliver the most "bang for the buck", delivering an average of $3.80 in benefits for every dollar invested. Oyster cultch is also the only category whose confidence interval lies entirely above 1.0 under valuation Option A. Marsh creation projects deliver an average of $1.77 for every dollar invested. Living shoreline projects deliver an average of $1.10. Multi-category projects are estimated to cost more than the value of their benefits, on average.

Table 21. Share of Projects with Benefit-Cost Ratios > 1 and Estimated Benefit-Cost Ratios by Project Category.

	Option A			**Option B**			**Option C**		
	Median	**Lower 95%**	**Upper 95%**	**Median**	**Lower 95%**	**Upper 95%**	**Median**	**Lower 95%**	**Upper 95%**
	Share of Projects with B-C Ratio > 1								
Marsh Creation	80%	0%	100%	80%	0%	100%	80%	0%	100%
Living Shoreline	75%	0%	75%	75%	25%	75%	75%	25%	75%
Oyster Cultch	100%	33%	100%	100%	100%	100%	100%	0%	100%
Multi-Type	33%	0%	67%	33%	0%	67%	33%	0%	67%
Mean of Individual Benefit-Cost Ratios									
Marsh Creation	1.71	0.36	3.00	1.71	0.36	3.00	1.71	0.36	3.00
Living Shoreline	1.64	0.35	2.88	3.50	0.92	6.05	3.99	1.49	6.76
Oyster Cultch	5.64	1.87	9.41	79.87	24.59	136.17	25.50	0.73	63.48
Multi-Type	0.88	0.20	1.54	0.99	0.23	1.73	0.98	0.23	1.75
Aggregate Benefit-Cost Ratio									
Marsh Creation	1.77	0.38	3.10	1.77	0.38	3.10	1.77	0.38	3.10
Living Shoreline	1.10	0.23	1.92	1.50	0.36	2.61	1.61	0.48	2.76
Oyster Cultch	3.80	1.27	6.33	66.00	20.32	112.51	23.86	0.68	59.39
Multi-Type	0.69	0.16	1.20	0.86	0.21	1.50	0.82	0.19	1.50

Figure 2. Aggregate Median Benefit-Cost Ratio (Bars) and Confidence Intervals (Whiskers) for Each Project Category, under Valuation Option A.



Conclusions and Recommendations

An unprecedented amount of funding has been and continues to support coastal restoration in the northern Gulf of Mexico. Understanding the benefits and costs for these projects is paramount to delivering projects with the greatest returns. While this project has helped quantify and monetize many of those returns, it also highlights inconsistent metrics, gaps, and further analyses needed to better grasp the full suite of benefits. The bullets below address several conclusions and provide recommendations for future funders, implementers, and researchers.

- Documentation for projects funded by NFWF-GEBF is limited because this funding source does not post project documentation and updates publicly, as is done for NRDA-funded projects. Thus, characterizations of these projects in this report are more likely to suffer from inaccuracies or be outdated.
  - We recommend that NFWF-GEBF follow NOAA's lead in creating and maintaining a public website where updated project information is posted.

- Economic evaluation can be conducted across a wide variety of projects when based on fairly coarse but easily observable metrics like the ones used in this report (e.g., acres of marsh or reef constructed). However, acreage does not necessarily capture differences in benefits actually delivered. For example, the amount of cultch deployed per acre varies widely across the cultch projects analyzed here, and those projects that deployed more cultch are likely to last longer and deliver more benefits. In short, not all acres are created equal. Additionally, other metrics used in this report, such as pre- and post-project erosion rates and oyster counts are not always available and require additional assumptions to quantify and monetize benefits.
  - We recommend developing a suite of metrics to support project evaluations that can be shared with funders and project implementers for incorporation into project monitoring plans.

- Although the benefit categories identified in this report likely capture the bulk of benefits provided by projects, they do not capture all of them and they may not be well-suited to all projects. For example, the benefits of the Fowl River project and the Deer River project are not likely captured by such metrics. Another example is Lightning Point, which includes a public boat launch and fishing space. Accounting for the benefits associated with these components is beyond the scope of the current project. These projects likely require a more thorough analysis that requires researchers to focus on a single project and work with project managers to identify additional metrics for a full accounting.
  - We recommend a study to focus on multi-component projects that outlines a process to evaluate full project accounting and apply this to that suite of projects for a more thorough evaluation of benefits.

- Monitoring efforts appear to be insufficient for a thorough evaluation of projects. For example, the expected project life of a living shoreline is typically 20 years, yet monitoring on most projects is for three to five years or fewer. Thus, project performance in the latter 15 years must be based on the first few years, which may or may not be representative. This limitation is likely due to limited funding.

    - We recommend that future projects include funding for monitoring that extends beyond the first few years or even on a three-year cycle over a longer time frame, e.g. 15-20 years for a limited suite of metrics.

- There exists a fundamental difference in the metrics of interest across disciplines. Economists require metrics that fall into the "ecosystem service" category, that is, metrics easily recognized, understood, and valued by the public. Biologists, ecologists, and other environmental scientists tend to focus on metrics that economists would categorize as "ecosystem functions", that is, metrics that are important and necessary for scientific inquiry, but somewhat removed from what the public would recognize as meaningful and important. For example, several project monitoring reports include counts of certain sea grasses or invertebrates. While these are important, such metrics are not readily monetizable by economists. Economists need metrics that are recognizable by the public such as sacks of oysters harvested. Thus, these metrics require some sort of "bridge", usually in the form of one or more assumptions, from ecosystem function to ecosystem service. Another example concerns metrics typically monitored for water quality. Most of the metrics in monitoring reports are at the level of ecosystem function, whereas water-quality metrics at the ecosystem service level are whether the water is "fishable, swimmable, or drinkable".
    - We recommend using the DWH NRDA metrics for ecosystem function for consistency across projects, but add metrics that also support economic evaluation.

- Another issue concerns what constitutes economic analysis. The present report is grounded in efficiency analysis and what economists call "welfare theory". That is, it is concerned with the question of whether a given project generates more societal benefits than societal costs. This is benefit-cost analysis. It is important to note that things like job creation or increased tax revenue to a regional economy are outside of the scope of this kind of analysis. Those kinds of questions require very different measures of economic activity and are dealt with in a different branch of economics called "regional economic analysis" or "economic development". While regional economic analysis answers questions of great importance to stakeholders, it should not be used to determine whether the benefits of a project outweigh its costs. And while benefit-cost analysis is very useful for determining whether a project delivers more benefits than it costs, it does not project a full picture of the impacts to a local community or region. Thus, each type of analysis has its own unique set of capabilities and limitations, and answers very different kinds of questions. Ideally, both are necessary for a full perspective of the economic implications of a given action.
    - Similar to the regulatory impact analyses conducted by the EPA for proposed regulatory changes, we recommend the inclusion of both benefit-cost analyses and regional economic analyses that captures both kinds of economic information to provide a more holistic understanding of the economic impacts of projects.

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Appendix

Table A1. Initial Set of DWH Tracker Projects.

DWH Tracker Project ID	DWH Tracker Project Name
7	Marsh Island (Portersville Bay) Restoration Project
30	Fowl River Watershed Restoration - Phase I
47	Restoration and Enhancement of Oyster Reefs in Alabama
269	Mississippi Oyster Cultch Restoration Project
287	Utilization of Dredge Material for Marsh Restoration in Coastal Mississippi
315	Alabama Oyster Cultch Restoration
316	Alabama Swift Tract Living Shoreline
342	Mississippi Hancock County Marsh Living Shoreline Project
402	Point aux Pins Living Shorelines
541	Restoring Living Shorelines and Reefs in Mississippi Estuaries
752	Salt Aire Shoreline Restoration
757	Utilization of Dredge Material for Marsh Restoration in Coastal Mississippi - Phase II
1069	Lightning Point Acquisition and Restoration Project - Phase II
1378	Enhancement of St. Louis Bay Oyster Reef
1420	Dauphin Island Causeway Shoreline Restoration Project- Phase II
1534	Hancock County Marsh Living Shoreline
1597	Activity #9: Beneficial Use of Dredge Material for Marsh Creation and Restoration in Mississippi
1699	Graveline Bay Marsh Restoration - Phase II
1701	Fowl River Watershed Restoration: Coastal Spits and Wetlands Project – Phase II
1702	Deer River Coastal Marsh Stabilization & Restoration - Phase II
1880	East End Beach and Dune Restoration - Phase II
1922	Deer Island Beneficial Use Site Implementation

Table A2. DWH Tracker Project Action and Resource Categories.

	Actions			Resources				
	Habitat Restoration & Enhancement	**Erosion Prevention or Control**	**Species Restoration**	**Wetlands / Marshes / Estuaries**	**Terrestrial Habitat**	**Oysters / Shellfish**	**Shorelines**	**Beaches / Dunes**
#7 Marsh Island (Portersville Bay) Restoration Project	X			X				
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)	X	X		X	X		X	
#47 Restoration and Enhancement of Oyster Reefs in Alabama			X			X		
#269 Mississippi Oyster Cultch Restoration Project			X			X		
#287-757-1597-1922 Greenwood Island Beneficial Use Project*	X			X				
#287-757-1597-1922 Round Island Marsh Restoration Project*	X			X				
#287-757-1597-1922 Wolf River Beneficial Use Project*	X			X				
#315 Alabama Oyster Cultch Restoration			X			X		
#316 Alabama Swift Tract Living Shoreline	X			X				
#342-1534 Mississippi Hancock County Marsh Living Shoreline Project	X			X			X	
#402 Point aux Pins Living Shoreline	X			X				
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries	X			X				
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project	X			X				
#689-1069 Lightning Point Acquisition and Restoration Project	X	X		X				
#752 Salt Aire Shoreline Restoration	X	X		X			X	
#1073-1702 Deer River Coastal Marsh Stabilization & Restoration		X		X				
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	X						X	
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)	X					X		
#1591-1880 East End Beach and Dune Restoration	X							X
#1699 Graveline Bay Marsh Restoration - Phase II	X			X				
Coffee Island, Pelican Point, and Taylor's Riverview Park Living Shorelines not listed in DWH Tracker								
*Actions and Resources listed are those common to all four original projects.								

Table A3. Calculations of Marsh Habitat Acres Protected by Living Shoreline Projects #7, #30, #316, and #342-1534.

#7 Marsh Island (Portersville Bay) Restoration Project

Shoreline length (mi) 0.56

Thompson Engineering report states no significant change in erosion rates due to project. But NOAA Gulf Spill Restoration Site reports in As-Builts that 24 acres protected due to breakwaters.

#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)

Jason Kudilis (personal communication, July 15, 2024) indicates some surveying conducted first few years post-construction, with no erosion behind breakwaters. Pre-project baseline erosion rates not available.

#316 Alabama Swift Tract Living Shoreline

	Pre-project	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Shoreline length (mi)	1.75	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
W/O Project Erosion rate (ft/year)	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9
Area change (acres)		-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52
W/Project Erosion rate (ft/year)	-1.9	0.95	3.80	2.50	1.20	1.00	1.00	0.80	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
Area change (acres)		0.26	1.03	0.68	0.33	0.27	0.27	0.22	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Net change (acres)		**0.77**	**1.55**	**1.19**	**0.84**	**0.79**	**0.79**	**0.73**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**
Cumulative net change (acres)		**0.77**	**2.32**	**3.52**	**4.36**	**5.15**	**5.93**	**6.67**	**7.62**	**8.57**	**9.52**	**10.47**	**11.43**	**12.38**	**13.33**	**14.28**	**15.24**	**16.19**	**17.14**	**18.09**	**19.04**

#342-1534 Hancock County Marsh Living Shoreline Project

-Phase I

	Pre-project	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Shoreline length (mi)	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
W/O Project Erosion rate (ft/year)	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00
Area change (acres)		-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45
W/Project Erosion rate (ft/year)		-2.2	-0.9	-1.00	1.5	-0.5	0.9	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37
Area change (acres)		-0.53	-0.22	-0.24	0.36	-0.12	0.22	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Net change (acres)		**0.92**	**1.24**	**1.21**	**1.82**	**1.33**	**1.67**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**
Cumulative net change (acres)		**0.92**	**2.16**	**3.37**	**5.19**	**6.52**	**8.19**	**9.56**	**10.93**	**12.29**	**13.66**	**15.02**	**16.39**	**17.75**	**19.12**	**20.48**	**21.85**	**23.22**	**24.58**	**25.95**	**27.31**

-Phase II

	Pre-project	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Shoreline length (mi)	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
W/O Project Erosion rate (ft/year)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Area change (acres)		-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42
W/Project Erosion rate (ft/year)		-10.00	-10.00	-10.00	-0.50	3.20	-0.70	0.70	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Area change (acres)		-2.42	-2.42	-2.42	-0.12	0.78	-0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Net change (acres)		**0.00**	**0.00**	**0.00**	**2.30**	**3.20**	**2.25**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**
Cumulative net change (acres)		**0.00**	**0.00**	**0.00**	**2.30**	**5.50**	**7.76**	**10.35**	**12.94**	**15.53**	**18.12**	**20.70**	**23.29**	**25.88**	**28.47**	**31.05**	**33.64**	**36.23**	**38.82**	**41.41**	**43.99**

-Phase III

	Pre-project	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Shoreline length (mi)	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
W/O Project Erosion rate (ft/year)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Area change (acres)		-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42	-2.42
W/Project Erosion rate (ft/year)		-10.00	-10.00	-10.00	-1.00	4.00	0.40	1.50	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
Area change (acres)		-2.42	-2.42	-2.42	-0.24	0.97	0.10	0.36	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Net change (acres)		**0.00**	**0.00**	**0.00**	**2.18**	**3.39**	**2.52**	**2.79**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**
Cumulative net change (acres)		**0.00**	**0.00**	**0.00**	**2.18**	**5.58**	**8.10**	**10.88**	**13.61**	**16.33**	**19.05**	**21.77**	**24.49**	**27.21**	**29.93**	**32.65**	**35.38**	**38.10**	**40.82**	**43.54**	**46.26**
																				Grand Total	**117.57**

Table A4. Calculations of Marsh Habitat Acres Protected by Living Shoreline Projects #402, #541, #688-1701, and #689-1069.

#402 Point aux Pins Living Shoreline																					
	Pre-project	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Shoreline length (mi)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
W/O Project Erosion rate (ft/year)	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50	-7.50
Area change (acres)		-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52
W/Project Erosion rate (ft/year)	no data; Year 2 Monitoring report says Year 3 report needed to comment on erosion.																				
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries																					
-Wolf River Living Shoreline																					
Shoreline length (mi)	0.30																				
no additional data; project ongoing																					
-Big Island Living Shoreline																					
Shoreline length (mi)	1.53																				
no additional data; project ongoing																					
#688-1701 Fowl River Watershed Restoration: Coastal Spits and Wetlands Project																					
Shoreline length (mi)	1.02																				
no data; project ongoing																					
#689-1069 Lightning Point Acquisition and Restoration Project																					
	Pre-project	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Shoreline length (mi)	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
W/O Project Erosion rate (ft/year)	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
Area change (acres)		-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65
W/Project Erosion rate (ft/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area change (acres)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net change (acres)		**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**
Cumulative net change (acres)		**0.65**	**1.31**	**1.96**	**2.62**	**3.27**	**3.93**	**4.58**	**5.24**	**5.89**	**6.55**	**7.20**	**7.85**	**8.51**	**9.16**	**9.82**	**10.47**	**11.13**	**11.78**	**12.44**	**13.09**

Table A5. Calculations of Marsh Habitat Acres Protected by Living Shoreline Projects #752, #1073-1702, #1084-1420, Coffee Island, Pelican Point, and Taylor's Riverview Park.

#752 Salt Aire Shoreline Restoration	Pre-project	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Shoreline length (mi)	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
W/O Project Erosion rate (ft/year)	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61	-4.61
Area change (acres)		-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79
W/Project Erosion rate (ft/year)	no data																				

#1073-1702 Deer River Coastal Marsh Stabilization & Restoration	
Shoreline length (mi)	0.63

Jason Kudilis (personal communication, July 15, 2024) indicates shoreline erosion on western shore approx. 12' per year, with site losing approx. 51 ac historically. No post-project data thus far.

#1084-1420 Dauphin Island Causeway Shoreline Restoration Project	
Shoreline length (mi)	3.30

Meg Goecker says no erosion metrics available.

Coffee Island Living Shoreline	Pre-project	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Shoreline length (mi)	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
W/O Project Erosion rate (ft/year)	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27	-12.27
Area change (acres)		-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62	-1.62
W/Project Erosion rate (ft/year)	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80	-6.80
Area change (acres)		-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90
Net change (acres)		**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**
Cumulative net change (acres)		**0.72**	**1.45**	**2.17**	**2.89**	**3.61**	**4.34**	**5.06**	**5.78**	**6.50**	**7.23**	**7.95**	**8.67**	**9.39**	**10.12**	**10.84**	**11.56**	**12.28**	**13.01**	**13.73**	**14.45**

Pelican Point Living Shoreline	Pre-project	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Shoreline length (mi)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
W/O Project Erosion rate (ft/year)	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18
Area change (acres)		-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
W/Project Erosion rate (ft/year)	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
Area change (acres)		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Net change (acres)		**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**
Cumulative net change (acres)		**0.02**	**0.04**	**0.06**	**0.08**	**0.10**	**0.12**	**0.14**	**0.16**	**0.18**	**0.20**	**0.22**	**0.24**	**0.26**	**0.28**	**0.30**	**0.32**	**0.34**	**0.36**	**0.38**	**0.40**

Taylor's Riverview Park Living Shoreline	Pre-project	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Shoreline length (mi)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
W/O Project Erosion rate (ft/year)	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Area change (acres)		-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
W/Project Erosion rate (ft/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area change (acres)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net change (acres)		**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Cumulative net change (acres)		**0.01**	**0.01**	**0.02**	**0.03**	**0.04**	**0.04**	**0.05**	**0.06**	**0.07**	**0.07**	**0.08**	**0.09**	**0.09**	**0.10**	**0.11**	**0.12**	**0.12**	**0.13**	**0.14**	**0.15**

Table A6. Calculations of Oysters Produced by Oyster Cultch Project #47.

Parcel	Area VI - 2014 Plant	Cedar Point East - 2014 Plant	Cedar Point West - 2014 Plant Pass-aux-Huite	Cedar Point East - 2016 Plant North Side	Cedar Point East - 2016 Plant South Side	Cedar Point West - 2016 Plant North Side	Cedar Point West - 2016 Plant South Side	Heron Bay - Beacon 2014 Plant	Heron Bay - Cedar Point Beach 2014 Plant	Heron Bay - Half Moon 2014 Plant	Heron Bay - Pass-aux-Bar 2014 Plant	Relay Reef - North 2014 Plant	Relay Reef - South 2014 Plant
Acres	***36***	***57***	***57***	***50***	***124***	***52***	***92***	***25***	***77***	***84***	***105***	***70***	***62***
							Total Sacks						
2014 Pre-project	-	*383*	*383*	*383*	*383*	*383*	*383*	*471*	*471*	*471*	*471*	-	-
2014	-	383	153	-	-	-	-	168	414	2,146	-	-	-
2015	-	1,073	307	-	-	-	-	269	828	1,468	-	-	-
2016	-	153	536	-	-	-	-	168	207	226	-	-	-
2017	-	-	383	-	-	-	-	168	-	-	-	-	-
2018	-	-	77	-	-	-	-	-	-	113	-	-	-
2019	-	-	115	-	-	559	-	471	1,760	621	565	-	-
2020	-	-	307	-	-	-	-	-	3,520	1,355	1,129	-	-
2021	-	51	613	-	-	2,517	-	-	207	4,291	1,694	-	-
2022	-	102	1,992	-	-	5,873	247	67	1,863	7,228	565	-	-
2023	-	153	10,537	-	-	4,614	495	538	6,004	12,649	2,259	-	-
							Net Project Sacks						
2014	-	-	-	-	-	-	-	-	-	*1,675*	-	-	-
2015	-	*690*	-	-	-	-	-	-	*358*	*998*	-	-	-
2016	-	-	*153*	-	-	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	*176*	-	-	*1,289*	*151*	*94*	-	-
2020	-	-	-	-	-	-	-	-	*3,049*	*885*	*659*	-	-
2021	-	-	*230*	-	-	*2,134*	-	-	-	*3,821*	*1,223*	-	-
2022	-	-	*1,609*	-	-	*5,489*	-	-	*1,393*	*6,757*	*94*	-	-
2023	-	-	*10,154*	-	-	*4,231*	*112*	*67*	*5,534*	*12,178*	*1,788*	-	-
Total	**-**	**690**	**12,146**	**-**	**-**	**12,030**	**112**	**67**	**11,623**	**26,464**	**3,859**	**-**	**-**
												Total Sacks	***66,990***

Table A7. Calculations of Oysters Produced by Oyster Cultch Project #269.

					Adult oysters/m2									
Stratum			**North**					**Central**				**South**		
Parcel	**4A**	**4B**	**5**	**8**	**11**	**1**	**2**	**3A**	**3B**	**6**	**7**	**13**		
Acres	***121***	***100***	***65***	***203***	***48***	***71***	***85***	***179***	***111***	***224***	***139***	***100***		
2014	1.50	-	1.80	1.50	2.30	1.00	-	-	-	-	-	-		
2015	2.38	-	12.25	0.75	12.53	7.75	0.25	6.38	0.13	-	-	6.88		
2016	3.25	-	22.70	-	22.75	14.50	0.50	12.75	0.25	-	-	13.75		
2017	2.25	-	0.75	-	0.08	0.38	-	1.38	-	-	-	4.20		
2018	-	-	0.71	-	0.14	0.38	-	0.20	-	-	-	1.88		
2019	-	-	0.36	-	0.07	0.19	-	0.10	-	-	-	0.94		
2020	-	-	-	-	-	-	-	-	-	-	-	-		
2021	-	-	-	-	-	-	-	-	-	-	-	-		
2022	-	-	-	-	-	-	-	-	-	-	-	-		
2023	-	-	-	-	-	-	-	-	-	-	-	-		
4047	*m2/acre*													
300	*oysters/sack*													
					sacks/parcel									
Stratum			**North**					**Central**				**South**		
Parcel	**4A**	**4B**	**5**	**8**	**11**	**1**	**2**	**3A**	**3B**	**6**	**7**	**13**		
Acres														
2014	2,448	-	1,578	4,108	1,489	958	-	-	-	-	-	-		
2015	3,877	-	10,741	2,054	8,110	7,423	287	15,394	187	-	-	9,274		
2016	5,305	-	19,904	-	14,731	13,888	573	30,788	374	-	-	18,549		
2017	3,673	-	658	-	52	359	-	3,320	-	-	-	5,666		
2018	-	-	623	-	91	359	-	483	-	-	-	2,529		
2019	-	-	311	-	45	180	-	241	-	-	-	1,265		
2020	-	-	-	-	-	-	-	-	-	-	-	-		
2021	-	-	-	-	-	-	-	-	-	-	-	-		
2022	-	-	-	-	-	-	-	-	-	-	-	-		
2023	-	-	-	-	-	-	-	-	-	-	-	-		
							sacks/acre							
Stratum			**North**					**Central**				**South**		
Parcel	**4A**	**4B**	**5**	**8**	**11**	**1**	**2**	**3A**	**3B**	**6**	**7**	**13**	**Wtd Avg**	**Total**
Acre Shares	***0.08***	***0.07***	***0.04***	***0.14***	***0.03***	***0.05***	***0.06***	***0.12***	***0.08***	***0.15***	***0.10***	***0.07***		***1,430***
2014	20	-	24	20	31	13	-	-	-	-	-	-	7	10,464
2015	32	-	165	10	169	105	3	86	2	-	-	93	40	56,712
2016	44	-	306	-	307	196	7	172	3	-	-	185	72	102,960
2017	30	-	10	-	1	5	-	19	-	-	-	57	9	13,575
2018	-	-	10	-	2	5	-	3	-	-	-	25	3	4,040
2019	-	-	5	-	1	3	-	1	-	-	-	13	1	2,020
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2023	-	-	-	-	-	-	-	-	-	-	-	-	-	-
													Total Sacks	**189,772**

Table A8. Calculations of Oysters Produced by Oyster Cultch Project #315.

			Adult oysters/Acre					
Parcel	Heron Bay	HBNat	Cedar Point West	CPWNat	Cedar Point East	CPENat		
Acres	*199.3*		*111.1*		*213.5*			
2015	726	1129	242	242	0	0		
2016	363	4598	0	0	0	0		
2017	0	1452	3872	0	0	0		
2018	0	968	242	0	0	0		
2019	8470	0	22022	0	484	0		
2020	23958	0	21296	0	13552	0		
2021	34848	0	31944	0	484	0		
2022	16698		46222		5808			
2023	16698	0	46222	0	5808	0		
2024	16698	0	46222	0	5808	0		
180	*oysters/sack*							
			Sacks/acre					
Parcel	Heron Bay	HBNat	Cedar Point West	CPWNat	Cedar Point East	CPENat		
2015	4.0	6.3	1.3	1.3	0.0	0.0		
2016	2.0	25.5	0.0	0.0	0.0	0.0		
2017	0.0	8.1	21.5	0.0	0.0	0.0		
2018	0.0	5.4	1.3	0.0	0.0	0.0		
2019	47.1	0.0	122.3	0.0	2.7	0.0		
2020	133.1	0.0	118.3	0.0	75.3	0.0		
2021	193.6	0.0	177.5	0.0	2.7	0.0		
2022	92.8	0.0	256.8	0.0	32.3	0.0		
2023	92.8	0.0	256.8	0.0	32.3	0.0		
2024	92.8	0.0	256.8	0.0	32.3	0.0		
				NET sacks/acre				
Parcel	Heron Bay		Cedar Point West		Cedar Point East		NET Wtd Avg	Total
Acre Shares	*0.38*		*0.21*		*0.41*			*524*
2015	0.0		0.0		0.0		0.0	0
2016	0.0		0.0		0.0		0.0	0
2017	0.0		21.5		0.0		4.6	2,390
2018	0.0		1.3		0.0		0.3	149
2019	47.1		122.3		2.7		44.9	23,545
2020	133.1		118.3		75.3		106.4	55,745
2021	193.6		177.5		2.7		112.4	58,875
2022	92.8		256.8		32.3		102.9	53,907
2023	92.8		256.8		32.3		102.9	53,907
2024	92.8		256.8		32.3		102.9	53,907
							Total Sacks	**302,424**

Table A9. Calculations of Oysters Produced by Oyster Cultch Projects #342-1534, #541, and #1378.

#342-1534 Hancock County Marsh Living Shoreline Project										
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Oysters >25mm	0	162	0	5	0	10	201	54	54	54
# Stations	25	25	25	25	25	25	25	25	25	25
Avg per station	0	6.48	0	0.2	0	0.4	8.04	2.16	2.16	2.16
Density (#/m2)	0	31	0	1	0	2	38	10	10	10
Density (#/acre)	0	125,353	0	3,869	0	7,738	155,531	41,784	41,784	41,784
Total Oysters (46 acres)	0	5,766,256	0	177,971	0	355,942	7,154,429	1,922,085	1,922,085	1,922,085
									Total Oysters	**19,220,854**
Acres	46								**Total Sacks**	**64,070**
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries										
-Wolf River Subtidal Reef										
no data; project ongoing										
-Grand Bay Point Aux Chenes Subtidal Reefs										
no data; project ongoing										
-Deer Island Subtidal Reef										
no data; project ongoing										
-Grand Bay Bangs Bayou Intertidal Reef										
no data; project ongoing										
-Graveline Bay Intertidal and Subtidal Reef										
no data; project ongoing										
#1378 Enhancement of St. Louis Bay Oyster Reef (Tony Trapani Reef)										
No data; project ongoing										

Table A10. Calculations of Oysters Produced by Living shoreline Projects #7, #30, and #316.

#7 Marsh Island (Portersville Bay) Restoration Project																				
Oyster enhancement not an objective																				
#30 Fowl River Watershed Restoration (Tip of Mon Louis Island)																				
Oyster enhancement not an objective																				
#316 Alabama Swift Tract Living Shoreline																				
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Oysters >25mm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# Stations	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Avg per station	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Density (#/m2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Density (#/acre)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total oysters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																			Total Oysters	**0**
																			Total Sacks	**0**

Table A11. Calculations of Oysters Produced by Living shoreline Project #342-1534.

#342-1534 Hancock County Marsh Living Shoreline Project																				
segment length (ft)	180																			
segment width (ft)	15																			
segment height - subaq. (ft)	3																			
gaps (ft)	30																			
total length per phase (mi)	2																			
total length (ft)	10560																			
# segments	50																			
surface area (sq ft)	58,834																			
surface area (ac)	1.4																			
-Phase I																				
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Oysters >25mm	0	182	0	0	0	0	21	29	29	29	29	29	29	29	29	29	29	29	29	29
# Stations	10	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Avg per station	0	18.2	0	0	0	0	1.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Density (#/m2)	0	87	0	0	0	0	7	9	9	9	9	9	9	9	9	9	9	9	9	9
Density (#/acre)	0	352,073	0	0	0	0	27,083	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400	37,400
Total oysters	0	475,527	0	0	0	0	36,579	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514	50,514
-Phase II																				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Oysters >25mm	0	7	0	6	73	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
# Stations	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Avg per station	0	0.7	0	0.6	7.3	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Density (#/m2)	0	3	0	3	35	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Density (#/acre)	0	13,541	0	11,607	141,216	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273	33,273
Total oysters	0	18,289	0	15,677	190,733	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940	44,940
-Phase III																				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Oysters >25mm	0	0	0	16	115	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
# Stations	10	10	10	10	10	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Avg per station	0	0	0	1.6	11.5	2.62	2.38181818	2.1833	2.0154	1.8714	1.7467	1.6375	1.5412	1.4556	1.3789	1.31	1.2476	1.1909	1.1391	1.0916667
Density (#/m2)	0	0	0	8	55	13	11	10	10	9	8	8	7	7	7	6	6	6	5	5
Density (#/acre)	0	0	0	30,951	222,464	50,683	46,075	42,236	38,987	36,202	33,789	31,677	29,814	28,157	26,675	25,342	24,135	23,038	22,036	21,118
Total oysters	0	0	0	41,805	300,470	68,455	62,232	57,046	52,658	48,896	45,637	42,784	40,268	38,031	36,029	34,227	32,598	31,116	29,763	28,523
																			Total Oysters	**3,058,121**
																			Total Sacks	**10193.735**

Table A12. Calculations of Oysters Produced by Living Shoreline Projects #402, #541, #689-1069, #752, #1084-1420, Coffee Island, Pelican Point, and Taylor's Riverview Park.

#402 Point aux Pins Living Shoreline																				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Oysters >25mm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# Stations	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Avg per station	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Density (#/m2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Density (#/acre)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total oysters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																			Total Oysters	**0**
																			Total Sacks	**0**
#541 Restoring Living Shorelines and Reefs in Mississippi Estuaries																				
No data																				
#689-1069 Lightning Point Acquisition and Restoration Project																				
	length (ft)	height (ft)	A = l x h	# Sides	Subtotal	Total														
Long side	500	5	2,500	2	5,000	5,350														
Short side	35	5	175	2	350															
	# structures	Sq. Ft.	Acres																	
breakwaters 2020-2023	7	37,450	0.9																	
breakwaters 2024-present	11	58,850	1.4																	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Oysters >25mm (#/m2)	70	11	14	2	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25	24.25
Density (#/acre)	283,290	44,517	56,658	8,094	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140	98,140
Total oysters	243,554	38,273	48,711	6,959	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588	132,588
																			Total Oysters	**2,458,901**
																			Total Sacks	**13,661**
#752 Salt Aire																				
No data; project ongoing																				
#1084-1420 Dauphin Island Causeway Shoreline Restoration Project																				
Project ongoing; oyster habitat not mentioned specifically as project goal																				
Coffee Island Living Shoreline																				
No data																				
Pelican Point Living Shoreline																				
No data																				
Taylor's Riverview Park Living Shoreline																				
No data																				

Table A13. Marsh Valuation Studies.

Author	Target Population	Land Type	Acre Change	Reported $WTP (2023$)	$WTP/ Acre	Payment Frequency	Present Value (10yrs, 5%)
		Coastal					
Johnston et al. (2002b)	All RI HHs	Salt marsh	7	$319	$36.25	Annual	$293.63
Johnston, Makriyannis, and Whelchel (2018)*	All CT HHs	Salt marsh	19	$9	$7.16	Annual	$58.00
Johnston et al. (2005)*	All RI HHs	Salt marsh	5	$11	$6.94	Annual	$56.19
Johnston et al. (2002a)*	All RI HHs	Coastal, unspec.	?		$0.21	Annual	$1.71
Eastern Research Group (2016)	MSAs in NJ, PA, DE, MD	Salt marsh	3,000	$220	$0.06	Annual	$0.49
Bauer, Cyr, and Swallow (2004)	All RI HHs	Salt marsh	83	$45	$0.44	One-time	$0.44
Interis and Petrolia (2016)	All LA HHs	Salt marsh	1,500	$729	$0.40	One-time	$0.40
Udziela and Bennett (1997)*	All CT HHs	Salt marsh	70	$22	$0.17	One-time	$0.17
Interis and Petrolia (2016)	**All AL HHs**	**Salt marsh**	**1,500**	**$219**	**$0.12**	**One-time**	**$0.12**
Petrolia and Kim (2009)**	All MS HHs	Barrier islands	4,495	$408	$0.065	One-time	$0.07
Petrolia and Kim (2011)**	All LA HHs	Coastal, unspec.	448,000	$3,103	$0.005	Annual	$0.04
Kim and Petrolia (2013)	All LA HHs	Coastal, unspec.	448,000	$805	$0.001	Annual	$0.01
Petrolia, Interis, and Hwang (2014)	All U.S. HHs	Salt marsh	234,000	$1,785	$0.01	One-time	$0.01
He, Dupras, and Poder (2017)*	All QC HHs	Coastal, unspec.	988,420	$659	$0.001	Annual	$0.004
Interis and Petrolia (2014)*	All U.S. HHs	Coastal, unspec.	234,000	$1,136	$0.004	One-time	$0.004
		Non-Coastal					
MacDonald, Bergstrom, and Houston (1998)	Atlanta region, GA	Freshwater, unspec.	330	$132	$0.33	Annual	$2.65
Awondo, Egan, and Dwyer (2011)	Maumee Bay SP, OH, visitors	Freshwater, unspec.	2,499	$236	$0.08	Annual	$0.63
Mullarkey and Bishop (1999)	All WI HHs	Freshwater, forested	110	$78	$0.58	?	$0.58
Newell and Swallow (2013)	Two townships, RI	Freshwater, forested	45	$15	$0.28	One-time	$0.28
Blomquist and Whitehead (1998)	All KY HHs	Freshwater, forested	500	$11	$0.02	Annual	$0.15
Whitehead et al. (2009)	Selected counties, MI	Freshwater, unspec.	1,125	$89	$0.06	One-time	$0.06
Loomis et al. (1991)	All CA HHs	Freshwater, unspec.	49,000	$418	$0.01	Annual	$0.06
de Zoysa (1995)	Selected MSAs, OH	Freshwater, unspec.	3,000	$133	$0.04	One-time	$0.04
Beran (1995)	All SC HHs	Freshwater, forested	2,500	$39	$0.01	One-time	$0.01
Poor (1999)	All NE HHs	Freshwater, unspec.	41,000	$55	$0.001	Annual	$0.01
Whitehead and Blomquist (1991)	All KY HHs	Freshwater, forested	5,000	$23	$0.004	One-time	$0.004

* Paper identified in Vedogbeton and Johnston (2020); ** paper identified by authors; all others identified in Moeltner et al. (2019).

Table A14. Oyster Reef Valuation Studies.

Author	**Target Population**	**Reported Value (2023$)**	**Units**	**Payment Frequency**	**Present Value (10yrs, 5%) / Acre**	**Present Value (10yrs, 5%) / Foot**	**$WTP/ Acre / HH**		**$WTP/ Foot or Sack / HH**	
			Direct Household Valuation - Subtidal Reefs							
Petrolia et al. (2025)	All AL HHs	$88	per project per HH	One-time			$0.02	*	$0.00009	/sack
Petrolia et al. (2025)	All MS HHs	$72	per project per HH	One-time			$0.02	*	$0.00011	/sack
Interis and Petrolia (2016)	All AL HHs	$525	per project per HH	One-time			$0.35			
Interis and Petrolia (2016)	All LA HHs	$938	per project per HH	One-time			$0.63			
			Benefit Transfer and Other Methods - Subtidal Reefs							
Petrolia, Walton, and Cebrian (2022)	All AL HHs	$184,595	per acre - aggregate	One-time	$184,595		$0.10			
Petrolia, Walton, and Cebrian (2022)	All MS HHs	$184,595	per acre - aggregate	One-time	$184,595		$0.16			
Lai, Irwin, and Zhang (2020)	All AL HHs	$9,031	per acre - aggregate	Annual	$73,155		$0.04			
Lai, Irwin, and Zhang (2020)	All MS HHs	$9,031	per acre - aggregate	Annual	$73,155		$0.07			
DePiper, Lipton, and Lipcius (2017)	All AL HHs	$274,131	per acre - aggregate	One-time	$274,131		$0.14			
DePiper, Lipton, and Lipcius (2017)	All MS HHs	$274,131	per acre - aggregate	One-time	$274,131		$0.24			
Grabowski et al. (2012)	All AL HHs	$5,585	per acre - aggregate	Annual	$45,237		$0.02			
Grabowski et al. (2012)	All MS HHs	$5,585	per acre - aggregate	Annual	$45,237		$0.04			
			Benefit Transfer and Other Methods - Living Shorelines							
Petrolia, Walton, and Cebrian (2022)	All AL HHs	$825,450	per acre - aggregate	One-time	$825,450	$284	$0.43		$0.0001	/foot
Petrolia, Walton, and Cebrian (2022)	All MS HHs	$825,450	per acre - aggregate	One-time	$825,450	$284	$0.74		$0.0003	/foot
Kroeger and Guannel (2014)	All AL HHs	$117,969	per 3.6 mi reef - aggregate	Annual	$163,063	$50	$0.08	†	$0.00003	/foot
Kroeger and Guannel (2014)	All MS HHs	$117,969	per 3.6 mi reef - aggregate	Annual	$163,063	$50	$0.15	†	$0.00004	/foot

* Assumes 200 sacks per acre.

† Assumes 5.86 acres, based on reported total project footprint.

Table A15. Beach Width Valuation Studies.

	Source	Valuation Method	Study State	Lot size (acres)	Reported WTP	Convert to 2023$	Convert reported WTP to per foot	Final one-time WTP per HH per foot shoreline width -
1	Landry, Turner, and Allen (2022)	RP	NC	1.00	$35.26	$60.63		$60.63
2	Landry, Turner, and Allen (2022)	RP	NC	1.00	$157.58	$270.95		$270.95
3	Landry, Turner, and Allen (2022)	RP	NC	1.00	$2,374.55	$4,082.96		$4,082.96
4	Landry, Turner, and Allen (2022)	RP	NC	1.00	$142.51	$245.04		$245.04
5	Landry, Turner, and Allen (2022)	RP	NC	1.00	$33.92	$58.32		$58.32
6	Landry, Turner, and Allen (2022)	RP	NC	1.00	$155.44	$267.27		$267.27
7	Landry, Turner, and Allen (2022)	RP	NC	1.00	$1,026.05	$1,764.26		$1,764.26
8	Landry, Turner, and Allen (2022)	RP	NC	1.00	$138.47	$238.09		$238.09
9	Landry, Turner, and Allen (2022)	RP	NC	1.00	$25.84	$44.43		$44.43
10	Landry, Turner, and Allen (2022)	RP	NC	1.00	$120.13	$206.56		$206.56
11	Landry, Turner, and Allen (2022)	RP	NC	1.00	$401.15	$689.76		$689.76
12	Landry, Turner, and Allen (2022)	RP	NC	1.00	$160.86	$276.59		$276.59
13	Landry, Turner, and Allen (2022)	RP	NC	1.00	$24.79	$42.63		$42.63
14	Landry, Turner, and Allen (2022)	RP	NC	1.00	$105.26	$180.99		$180.99
15	Landry, Turner, and Allen (2022)	RP	NC	1.00	$240.57	$413.65		$413.65
16	Landry, Turner, and Allen (2022)	RP	NC	1.00	$134.23	$230.80		$230.80
17	Landry, Turner, and Allen (2022)	RP	NC	1.00	$23.65	$40.67		$40.67
18	Landry, Turner, and Allen (2022)	RP	NC	1.00	$92.76	$159.50		$159.50
19	Landry, Turner, and Allen (2022)	RP	NC	1.00	$168.26	$289.32		$289.32
20	Landry, Turner, and Allen (2022)	RP	NC	1.00	$92.17	$158.48		$158.48
21	Landry, Turner, and Allen (2022)	RP	NC	1.00	$23.27	$40.01		$40.01
22	Landry, Turner, and Allen (2022)	RP	NC	1.00	$87.36	$150.21		$150.21
23	Landry, Turner, and Allen (2022)	RP	NC	1.00	$132.44	$227.73		$227.73
24	Landry, Turner, and Allen (2022)	RP	NC	1.00	$32.35	$55.62		$55.62
25	Landry, Turner, and Allen (2022)	RP	NC	0.39	$3,421.76	$5,883.60		$5,883.60
26	Landry, Turner, and Allen (2022)	RP	NC	0.39	$4,772.95	$8,206.93		$8,206.93
27	Landry, Turner, and Allen (2022)	RP	NC	0.39	$3,235.36	$5,563.09		$5,563.09
28	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,769.08	$3,041.87		$3,041.87
29	Landry, Turner, and Allen (2022)	RP	NC	0.39	$3,094.07	$5,320.15		$5,320.15
30	Landry, Turner, and Allen (2022)	RP	NC	0.39	$4,260.62	$7,325.99		$7,325.99
31	Landry, Turner, and Allen (2022)	RP	NC	0.39	$2,746.02	$4,721.69		$4,721.69
32	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,575.52	$2,709.05		$2,709.05
33	Landry, Turner, and Allen (2022)	RP	NC	0.39	$2,145.46	$3,689.05		$3,689.05
34	Landry, Turner, and Allen (2022)	RP	NC	0.39	$2,717.61	$4,672.84		$4,672.84
35	Landry, Turner, and Allen (2022)	RP	NC	0.39	$953.80	$1,640.03		$1,640.03
36	Landry, Turner, and Allen (2022)	RP	NC	0.39	$773.10	$1,329.32		$1,329.32
37	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,879.31	$3,231.41		$3,231.41
38	Landry, Turner, and Allen (2022)	RP	NC	0.39	$2,163.89	$3,720.74		$3,720.74
39	Landry, Turner, and Allen (2022)	RP	NC	0.39	$557.11	$957.93		$957.93
40	Landry, Turner, and Allen (2022)	RP	NC	0.39	$648.92	$1,115.80		$1,115.80
41	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,720.28	$2,957.96		$2,957.96
42	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,786.09	$3,071.12		$3,071.12
43	Landry, Turner, and Allen (2022)	RP	NC	0.39	$379.60	$652.71		$652.71
44	Landry, Turner, and Allen (2022)	RP	NC	0.39	$809.77	$1,392.37		$1,392.37
45	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,606.36	$2,762.08		$2,762.08
46	Landry, Turner, and Allen (2022)	RP	NC	0.39	$1,494.33	$2,569.45		$2,569.45
47	Landry, Turner, and Allen (2022)	RP	NC	0.39	$285.03	$490.10		$490.10
48	Landry, Turner, and Allen (2022)	RP	NC	0.39	$927.50	$1,594.81		$1,594.81
49	Catma (2020)	RP	SC	0.33	$3,012.00	$3,748.80		$3,748.80
50	Catma (2020)	RP	SC	0.33	$1,642.00	$2,043.67		$2,043.67

	Source	Valuation Method	Study State	Lot size (acres)	Reported WTP	Convert to 2023$	Convert reported WTP to per foot	Final one-time WTP per HH per foot shoreline width -
51	Landry, Shonkwiler, and Whitehead (2020)	SP + RP	NC		$0.25	$0.32	$0.10	$0.10
52	Landry, Shonkwiler, and Whitehead (2020)	SP + RP	NC		$0.48	$0.63	$0.19	$0.19
58	Gopalakrishnan et al. (2011)	RP	NC		$1,440	$1,964.40		$1,964.40
59	Gopalakrishnan et al. (2011)	RP	NC		$674	$919.45		$919.45
60	Gopalakrishnan et al. (2011)	RP	NC		$8,800	$12,004.67		$12,004.67
61	Gopalakrishnan et al. (2011)	RP	NC		$4,211	$5,744.51		$5,744.51
62	Landry and Hindsley (2011)	RP	GA	0.19	$640	$873.07	$266.10	$266.10
63	Landry and Hindsley (2011)	RP	GA	0.19	$553	$754.38	$229.93	$229.93
64	Landry and Hindsley (2011)	RP	GA	0.19	$587	$800.77	$244.06	$244.06
65	Landry and Hindsley (2011)	RP	GA	0.19	$357	$487.01	$148.43	$148.43
66	*Huang, Poor, Zhao (2007)*	*SP*	*NH, ME*		*-$3.65*	*-$6.14*		-$6.14
67	*Huang, Poor, Zhao (2007)*	*SP*	*NH, ME*		*-$4.33*	*-$7.28*		-$7.28
68	*Huang, Poor, Zhao (2007)*	*SP*	*NH, ME*		*$3.75*	*$6.31*		$6.31
69	*Huang, Poor, Zhao (2007)*	*SP*	*NH, ME*		*$4.45*	*$7.48*		$7.48
70	*Kriesel, Landry, Keeler (2005)*	*SP*	*GA*		*$8.70*	*$15.17*		$15.17
71	*Kriesel, Landry, Keeler (2005)*	*SP*	*GA*		*$8.18*	*$14.26*		$14.26
72	Landry, Keeler, and Kriesel (2003)	RP	GA	0.19	$325	$443.35	$135.13	$135.13
73	*Parsons and Powell (2001)*	RP	*DE*		*$291,450,000*	*$490,036,933.12*		$490,036,933.12
74	*Parsons and Powell (2001)*	RP	*DE*		*$33,130,000*	*$55,703,975.28*		$55,703,975.28
75	*Parsons and Powell (2001)*	RP	*DE*		*$195,140,000*	*$328,103,644.29*		$328,103,644.29
76	*Parsons and Powell (2001)*	RP	*DE*		*$293,320,000*	*$493,181,105.58*		$493,181,105.58
77	*Parsons and Powell (2001)*	RP	*DE*		*$395,220,000*	*$664,513,284.29*		$664,513,284.29
78	*Parsons and Powell (2001)*	RP	*DE*		*$466,860,000*	*$784,967,035.84*		$784,967,035.84
79	*Parsons and Powell (2001)*	RP	*DE*		*$672,180,000*	*$1,130,187,084.24*		$1,130,187,084.24
80	*Parsons and Powell (2001)*	RP	*DE*		*$318,570,000*	*$535,635,840.74*		$535,635,840.74
81	*Parsons and Powell (2001)*	RP	*DE*		*$49,160,000*	*$82,656,426.94*		$82,656,426.94
82	*Parsons and Powell (2001)*	RP	*DE*		*$214,230,000*	*$360,201,105.44*		$360,201,105.44
83	*Parsons and Powell (2001)*	RP	*DE*		*$320,240,000*	*$538,443,738.07*		$538,443,738.07
84	*Parsons and Powell (2001)*	RP	*DE*		*$432,970,000*	*$727,985,215.07*		$727,985,215.07
85	*Parsons and Powell (2001)*	RP	*DE*		*$518,570,000*	*$871,910,970.68*		$871,910,970.68
86	*Parsons and Powell (2001)*	RP	*DE*		*$722,450,000*	*$1,214,709,838.15*		$1,214,709,838.15
87	Pompe and Rinehart (1999)	RP	SC		$143	$195.08		$195.08
88	Pompe and Rinehart (1999)	RP	SC		$343	$467.91		$467.91
89	Pompe and Rinehart (1999)	RP	SC	0.60	$103	$140.51		$140.51
90	Pompe and Rinehart (1999)	RP	SC	0.60	$549	$748.93		$748.93
91	Pompe and Rinehart (1995)	RP	SC		$1,226	$1,672.47		$1,672.47
92	Pompe and Rinehart (1995)	RP	SC		$558	$761.21		$761.21
93	Pompe and Rinehart (1995)	RP	SC	0.29	$1,656	$2,259.06		$2,259.06
94	Pompe and Rinehart (1995)	RP	SC	0.29	$362	$493.83		$493.83
							Mean	$93,015,272.25
							Median	$957.93
							Minimum	-$7.28
							Maximum	$1,214,709,838.15