SE CASC Project 042 Final Report

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Project Title:
Enhancing Cultural Resource Adaptation Planning and Assessing Sediment Budget Research
Needs at Gulf Islands National Seashore

Agreement Number:
G19AP00042

Project Period:
04/30/2019 – 06/30/2021

Total Funding:
$49,163

Report Date:
September 15, 2021

Public Summary
Barrier islands are subject to natural and anthropogenic changes, such as hurricanes, sea level rise and dredging. These changes can influence the persistence of natural and cultural resources. For example, a single storm event can drastically alter barrier islands, damaging or destroying cultural resources and impacting (either negatively or positively) habitat. Moreover, dredging can change the natural rates of lateral sand transport and placement of dredge materials can also influence natural rates of lateral sand transport, both of which can have positive (sand accretion) or negative (sand erosion). These changes to barrier islands can also influence the ability of the islands' dunes to serve as a first-line of defense for the mainland during storm-events. A better understanding of sediment budgets related to coastal vulnerability (storm events and dredging) can enhance the protection of both natural and cultural resources and guide future nourishment and placement of dredge materials. This work supports the conservation stewardship mission of the National Park Service by providing science to inform management of its natural and cultural resources at Gulf Islands National Seashore. Specifically, this project enhanced ongoing research at Gulf Islands National Seashore related to cultural resource adaptation planning and identified priorities for future research to better conserve the cultural and natural resources on the barrier islands. Intended outcomes from the project include (a) enhancing efficiency in adaptation planning of vulnerable coastal resources and (b) enabling future funding decisions based on research priorities that will help predict changes of barrier islands and reducing the negative impacts associated improperly placed dredge material.

Technical Summary
Barrier islands are exposed to a range of natural and human-caused changes, including hurricanes, sea-level rise, and dredging. These changes have the potential to influence the ability of barrier islands to serve as a first-line of defense for the mainland during storm events. Gulf Islands National Seashore, a National Park Service unit in the northern Gulf of Mexico between Florida and Mississippi, is predominantly comprised of barrier islands and faces immediate challenges, including erosion that washes out roads and sand dunes and the adverse impacts on cultural and natural resources from exposure to saltwater. The National Park Service (NPS), in collaboration with the U.S. Geological Survey (USGS), recognizes the need to steward cultural and natural resources on barrier islands vulnerable to climate change threats. More specifically, managers require realistic estimates of both the vulnerability of the park's natural and cultural resources to these threats, as well as the likelihood of the potential harmful consequences of exposure to these threats. This project advances the Secretary of the Department of the Interior's priority of conservation stewardship by providing science to inform management of its natural and cultural resource at Gulf Islands National Seashore. Project goals included (1) supporting efficient adaptation planning of vulnerable coastal resources in the Gulf Islands National Seashore region and (2) identifying research priorities that will help predict future changes to barrier islands and enhance natural and cultural resource stewardship.

Goal 1 Outcomes: Researchers updated an existing decision support framework designed to assist the National Park Service in prioritizing adaptation strategies for vulnerable historic

structures under a range of budget constraints. This framework uses the Optimal Preservation (OptiPres) Model that considers the combined effects of the historic structures' exposure and sensitivity to threats such as storm surge, and the costs and benefits of various management actions taken to address these threats. Results suggest that triage decisions for lower-valued structures may be necessary at certain budget levels to maintain higher-valued structures and the overall significance of a park unit's cultural assets. Additional modeling insights revealed that the timing of higher-cost strategies that minimize decay and avoids a structure falling below a condition threshold may be outweighed by their costs. However, the study revealed that undesirable management outcomes are likely given that budgets are insufficient to maintain large structures, like Fort Pickens, let alone support adaptation strategies.

Goal 2 Outcomes: Researchers brought together managers and technical experts to evaluate the science-based information needs related to sediment dynamics in the Gulf Islands National Seashore region, and to explore paths forward for addressing these needs. The results revealed that the most important and urgent research and data needs included mapping (e.g., elevation, habitat, cultural resources), a regional sediment budget and management plan, and dynamic modeling of sediment processes. Through the workshops it was determined that expanded communication with the broader research community was necessary to coordinate research activities and streamline potential funding opportunities, and that research and policy should be integrated through a structured decision making process. Following the workshop, a poll of the participants indicate that the presentations were effective in identifying available data and research needs, and that the goals of the workshop were achieved. The results suggest that this type of needs assessment workshop is an effective tool to determine what research capabilities and data exist, identify and prioritize research needs, and address how these efforts can capitalize on regional partnerships to advance natural and cultural resource conservation and management at our National Parks.

Purpose and Objectives
The purpose of the project was two-fold. First, the proposed research sought to advance the integration of sediment-related climate change threats to cultural resources at Gulf Islands National Seashore into an effort already underway that is testing the transferability of the Optimal Preservation (OptiPres) Model. The OptiPres Model is a planning exercise framework that integrates metrics of historic value and vulnerability, as well as cost estimates for a portfolio of adaptation strategies, to maintain as much cultural resource value across a landscape as possible across a 30-year planning horizon given a budget constraint.

The OptiPres model is the result of previously funded research, pilot tested at Cape Lookout National Seashore, by the US DOI, Southeast Climate Adaptation Center (grant agreement G15AP00141) and the National Park Service, Climate Change Response Program (DOI inter-agency agreement P17PG00197). The current effort at Gulf Islands National Seashore, funded by the National Park Service, Climate Change Response Program (task agreement number P17AC00794 under cooperative agreement P13AC00443), is stated to test the transferability of the OptiPres Model; the vulnerability assessment component of the model as currently developed does not include the ability to integrate model dynamics (particularly to increased

vulnerability or reduced historic value of impacted cultural resources) related stochastic storm events or include nourishment as an adaptation option.

Second, the proposed research sought to advance future sediment budget modeling efforts by conducting a Needs Assessment Workshop at Gulf Islands National Seashore. The purpose of the Needs Assessment Workshop was to identify the specific research and information needs regarding sediment transport budgets at Gulf Islands National Seashore that can enhance the National Park Service's efforts to conserve the islands' natural and cultural resources. The Needs Assessment Workshop was a multi-day event structured to (a) identify and document research and information needs and priorities related to sediment transport budgets within the National Park Service and specifically at Gulf Islands National Seashore, (b) explore capacities and priorities of external regional partners related to sediment transport budgets, and (c) identify funding opportunities and pathways to meet the identified research and information needs.

The list of the original project objectives and the *descriptions of how each objective was met or modified* included:

1. Advance the OptiPres Model to include consideration of stochastic storm events and compare model results to those that do not include consideration of stochastic storm events.
    - *This objective was modified due to the inability to obtain post-storm recovery budgets from NPS project partners despite the acquisition of storm sequencing data from project partner P. Soupy Dalyander (formerly USGS). The algorithm has been updated to include these data when budgetary information becomes available for GUIS or for application at another project site.*
    - *The modified objective became: Advance the OptiPres Model to include action dynamics related to the use potential objective and to enable partial funding actions on high cost historic structures.*
2. Conduct a Needs Assessment Workshop to:
    a. Document the research and information needs related to sediment budgets at Gulf Islands National Seashore (GUIS) related to conserving natural resources, cultural resources, and the facilities and infrastructure that support both management and visitor use of those resources.
        - *This objective was met, although the in-person, multi-day workshop was changed to a series of virtual, multi-day workshops due to travel restrictions and health considerations affiliated with the COVID-19 pandemic.*
    b. Identify how the research and information needs, if addressed in future research studies, can be integrated into ongoing modelling studies at GUIS and within the region, specifically related to enhancing decision support guidance and tools (e.g., the OptiPres Model application within the Fort Pickens Historic District).
        - *This objective was partially met. The delays with the distribution of this project's funds was resulted in two sediment management projects being initiated (one county-based planning project and one federally research*

project). Therefore, much of this project's efforts focused on needs related to those two efforts.

    c. Explore the capacity of regional federal and state partners to address the identified needs by understanding recent and ongoing efforts.
- *This objective was removed due to time constraints associated with the workshop format changing to a virtual workshop series.*

Organization and Approach

Objective 1: Integrate data on stochastic storm event sequencing for next 30 years that could threaten cultural resources at Gulf Islands National Seashore (supplied by collaborator Dalyander). Co-create use potential dynamics and partial funding options with current and retired GUIS personnel with experience in managing the historic structures. Update OptiPres Model algorithm and perform model runs under different management objects and fiscal scenarios.

Objective 2. Create a repository (hosted by project collaborator, Jim Flocks, USGS) of the recent and ongoing efforts of local, state, regional, and federal governmental agencies and provide workshop participants with access to those reports. Identify specific workshop participants to create presentations of current state of knowledge, adding those presentations to the repository. Host an initial workshop to collect data on Gulf Islands' sediment budget research and information needs, and a follow-up workshop with regional partners to collect data on the region's sediment budget research and data needs. Collect ranking data using an online elicitation of the importance and urgency of those needs to develop separate needs priority lists: (a) Gulf Islands National Seashore's needs, and (b) regional needs. Twenty-four individuals participated in the GUIS workshop, with 19 individuals (5 GUIS staff, 12 other NPS staff, 2 USGS staff) completing the final elicitation survey (79% response rate). Fivety-seven individuals participated in the regional workshop, with 23 individuals (5 GUIS staff, 8 other NPS staff, 2 USGS staff, 3 BOEM staff, 1 FL DEP staff, 1 MS DEQ staff, 1 Escambia County staff, and 2 Water Institute of the Gulf staff) completing the final elicitation survey (40% response rate).

Project Results

Objective 1: It is likely that storm sequencing data can be integrated into future projects that utilize the OptiPres Model, as the algorithm was piloted with research-derived post-storm fiscal scenarios. The additional enhancements to the OptiPres Model enabled more realistic management conditions to be reflected.

Objective 2: In total, 58 GUIS-specific research and data needs were identified and categorized into six thematic categories: cultural resources (8), natural resources (11), general geomorphology (8), specific geomorphology (22), mapping (3), and management and policy (6). In total, 37 regional research and data needs were identified and categorized into six thematic categories: cultural resources (4), natural resources (4), sediment (10), mapping and modeling (7), and management and policy (12).

Analysis and Findings

Objective 1: Specifically, the model enhancements found that:
- Use potential dynamics, which account for human safety, enhance budgetary effectiveness in the model. However, use potential dynamics result in lower accumulated resource values at the end of the 30-year planning horizon, as declines in condition are also affiliated with declines in the potential for operation, third-party and visitor use.
- Enabling core and shell preservation to be selected within 10-year cycles during the planning period, which reflects more typical timing of preservation treatments, results in higher accumulated resource values at the end of the 30-year planning horizon. It seems that decay associated with not applying annual maintenance periodically on some buildings to accommodate the benefits of cyclic maintenance might be an appropriate tradeoff in the stewardship of historic structures given extreme fiscal constraints.
- Partial funding for the maintenance of Fort Pickens did not minimize losses to its historic value. Yet, this partial funding approach to annual maintenance may be worthy of future exploration as a new category of actions that could be applied in future modeling efforts. However, the algorithm may need to be updated in such a way that if partial annual maintenance was selected in one year, it must be selected in each subsequent year until the structure is fully maintained.

Objective 2: Participants in both workshops perceived all identified research and data needs to be at least somewhat important and at least somewhat urgent to address. For the GUIS-specific workshop, the six most important research and data needs included:
- Mapping: Barrier island habitat mapping and use, including relation to natural and cultural resources and park assets (mean=4.63, SD=0.518)
- Geomorphology (General): Regional sediment budget (mean=4.47, SD=0.772);
- Management & Policy: Sediment management plan: A long-term plan for ensuring natural sediment transfer and associated costs (not based only on today's cost estimates; e.g., cost for Monitoring and to ensure that post dredging handling of sediment to keep it in the littoral system) (mean=4.47, SD=0.841);
- Cultural Resources: Conduct Section 110 archaeological surveys of Santa Rosa, Perdido Key, Horn & Cat Islands (mean=4.44; SD =0.737);
- Geomorphology (Specific): Regional sediment budget: Update/validate previous budget to determine whether the system, in addition to individual islands, is losing sand; and include confirmation of westward sand transport, especially west of Ship Island (mean=4.37; SD=0.761), and,
- Geomorphology (Specific): Modeling (Dynamic models that incorporate changes in all habitats along the migrating barrier island system): Study of sand transport for Pensacola Pass and downdrift GUIS shoreline (mean=4.37, SD =0.761).

The five most urgent research and data needs identified in the GUIS-specific workshop included:
- Geomorphology (General): Regional sediment budget (mean=4.32, SD=0.749);
- Geomorphology (Specific): Regional sediment budget: Update/validate previous budget to determine whether the system, in addition to individual islands, is losing sand; and

include confirmation of westward sand transport, especially west of Ship Island (mean=4.32, SD=0.820);
- Geomorphology (Specific): Modeling (Dynamic models that incorporate changes in all habitats along the migrating barrier island system): Study of sand transport for Pensacola Pass and downdrift GUIS shoreline (mean=4.21; SD=0.713);
- Management & Policy: Sediment management plan: A long-term plan for ensuring natural sediment transfer and associated costs (not based only on today's cost estimates; e.g., cost for Monitoring and to ensure that post dredging handling of sediment to keep it in the littoral system) (mean=4.21, SD=0.713); and,
- Geomorphology (Specific): Regional sediment budget: Updating (and validating) previous budget (mean=4.17, SD=0.985).

For the regional workshop, the five most important research and data needs included:
- Sediment Transport: Dynamic modeling of natural and managed sediment transport volumes and directions affecting beaches, habitats and cultural resources for the region (mean=4.40, SD=0.681);
- Mapping and Modeling: Elevation Data: Elevation data (seafloor; inlet; ebb & flood shoals); Hydrographic surveys (mean=4.40, SD=0.681);
- Sediment Transport: Update/validate previous sediment budget to determine whether the system, in addition to individual islands, is losing sand; and include confirmation of westward sand transport (esp. west of Ship Island) (mean=4.35; SD =0.671);
- Management and Policy: Comprehensive: Linking sediment management with cultural and natural resource priorities and recreational opportunities (mean=4.30; SD=0.733), and,
- Mapping & Modeling: Inlet Dynamics: Inlet studies with dynamic model inputs (mean=4.29, SD =0.717).

The five most urgent research and data needs identified in the regional workshop included:
- Sediment Transport: Update/validate previous sediment budget to determine whether the system, in addition to individual islands, is losing sand; and include confirmation of westward sand transport (esp. west of Ship Island) (mean=4.32; SD =0.582);
- Sediment Transport: Dynamic modeling of natural and managed sediment transport volumes and directions affecting beaches, habitats and cultural resources for the region (mean=4.21, SD=0.855);
- Natural Resources: Inventories & Surveys: Barrier island (beach, nearshore, back barrier) habitat mapping and use data (species of mgt concern & suitable habitat) (mean=4.15; SD=0.745);
- Mapping & Modeling: Shoals Dynamics: Modeling of nearshore morphologic processes (mean=4.06, SD=0.802); and,
- Mapping & Modeling: Inlet Dynamics: Inlet studies with dynamic model inputs (mean=4.05, SD =0.705).

Conclusions and Recommendations
Objective 1: Future modifications to improve the decision model include:
- Enhancing and standardizing cost estimates for adaptation actions,

- Integrating probabilistic events such as hurricanes and post-storm recovery dynamics but necessitate the availability of realistic post-storm recovery funding scenarios,
- Testing more complex objective functions, and
- Refining the ability to elicit and include stakeholder input.

Key contributions of this work are in the OptiPres Model's ability to provide a multi-decadal approach to facilities management for historic structures while also considering climate change risks and vulnerabilities. While many historic structures are contributing features of historic districts and cultural landscapes, the project scope did not seek to assess the effects of adaptation on the historic setting or historic context(s). Rather, the scope of our project was to investigate a range of budgetary scenarios and analyze the effectiveness of each scenario in safeguarding accumulated resource value of all structures included in the modeling effort. It is intended, that by providing a framework for prioritizing adaptation actions, appropriate subject matter experts will have a foundation for assessing the cumulative effect on historic districts and cultural landscapes.

Objective 2: Many similar sediment budget research and information needs were identified as being very important and at least somewhat urgent at both the park-level (Gulf Islands National Seashore) and among managers and researchers working within the region (Florida panhandle, Alabama and Mississippi barrier islands). In particular, the findings suggest a need for developing a long-term, comprehensive sediment budget plan that is informed by dynamic modeling of natural and managed sediment transport volumes and directions affecting beaches, habitats and cultural resources. In other words, the plan should link sediment management with cultural and natural resource priorities and recreational opportunities.

It was suggested that a thorough assessment of the broader research community (e.g., academics) is needed to expand awareness and use of existing data, seek collaborative research funding to target the needs identified in this study, and reduce unnecessary duplication of efforts. Data quality was also discussed; for example, it was recommended that updated inlet management plans are needed that should be based on a complete inlet survey (ebb and flood shoals) for each inlet, with two or more comparable surveys. Additionally, it was suggested that explicit integration of science and policy through a structured decision making (SDM) process, like the USGS project at Dauphin Island, is needed to enhance transparency of stakeholder values and management decisions. Ultimately, this study documented that clear recommendations (e.g., action vs. no action) are needed.

Management Applications and Products
Objective 1. Two peer reviewed journal publications and one NPS published report, that include the OptiPres Model (decision support tool developed through a structured decision making process that included a co-production of knowledge approach, with simulated annealing algorithm) were developed as a result of this project (with additional funding support provided by NPS); citations are listed at the end of this report. The report has been delivered to the resource manager at GUIS.

Objective 1 Collaborators
- Project collaborator (subcontracted) included:
    o Dr. Xiao Xiao, Arizona State University
- USGS Project collaborators included:
    o Dr. P. Soupy Dalyander, The Water Institute of the Gulf (formerly USGS); Dr. Mitchell Eaton, USGS / SE CASC; and Dr. Max Post van der Berg, USGS.
- National Park Service Collaborators participating in the co-production of science process included:
    o Dan Brown, Superintendent, Gulf Islands National Seashore; Steven McCoy, Deputy Superintendent, Gulf Islands National Seashore; Catherine (Kate) Everitt, Cultural Resources Program Manager, Gulf Islands National Seashore; Gary Stansberry, Chief of Facilities, Gulf Islands National Seashore, Gulf Islands National Seashore; Frederick Francis, FMSS Specialist, Gulf Islands National Seashore; David Ogdan, retired Cultural Resource Specialist, Gulf Islands National Seashore; and Jeff Halstead, retired Historic Preservation Branch Head, Gulf Islands National Seashore.
- National Park Service Collaborators providing fiscal data:
    o Dan Brown, Superintendent, Gulf Islands National Seashore; Barbara Judy, Historical Architect, Interior Region 2 Office; and Janet Cakir, Interior Region 2 Change, Socioeconomics, and Adaptation Coordinator.
- Other National Park Service Collaborators providing project support:
    o Amanda Babson, Interior Region 1 Coastal Landscape Adaptation Coordinator; Rebecca Beavers, Coastal Geology and Adaptation Coordinator; Cat Hoffman-Hawkins, Climate Response Program Chief; Shawn Norton, Sustainable Operations Chief.
- Non-agency project collaborators providing vulnerability data:
    o Robert Young, Katie Peek, and Blair Tormey, Program for the Study of Developed Shorelines at Western Carolina University.

Objective 2: The prioritized research and data needs identified will be used to inform a separately funded effort to model the sediment dynamics of the Florida District's barrier islands at Gulf Islands National Seashore (Project-lead: James Flocks, USGS). The workshop report will be distributed to workshop participants to guide future research proposals and funding decisions (in press with USGS; citation at end of report). The repository can be found at: https://doimspp.sharepoint.com/sites/ext-usgs-nps-guis/Shared%20Documents/Forms/AllItems.aspx

Objective 2 Collaborators
- NC State Collaborator, Courtney Hotchkiss (graduate student research assistant).
- USGS Project Collaborator: James Flocks, St. Petersburg Coastal and Marine Science Center.
- NPS Project Collaborators: Linda York, DOI Region 2; and Kelly Irick, Gulf Islands National Seashore.
- NOAA Collaborators providing project facilitation: Kelly Semak; and Caitlin Young.

- Workshop participants who provided consent to be acknowledged included:
  - Albert E. Browder (Olsen Associates, Inc.), Amanda Babson (National Park Service), Ana Rice (Bureau of Ocean Energy Management), Beth Fugate (Florida Department of Environmental Protection), Caitlynn Brig (National Park Service), Catherine Everitt (National Park Service), Cathy Johnson (National Park Service), Davina Passeri (U.S. Geological Survey), Dianne Ingram (US Fish and Wildlife Service), Elizabeth S. Godsey (U.S. Army Corps of Engineers), Erin Plitsch (National Park Service), Henry Crawford (National Park Service), Jason Kenworthy (National Park Service), Jeff Bracewell (National Park Service), Jennifer Steele (Bureau of Ocean Energy Management), Jessica Mallindine (Bureau of Ocean Energy Management), Jolene Williams (National Park Service), Justin McDonald (U.S. Army Corps of Engineers), Mark Ford (National Park Service), Martha Segura (National Park Service), Meredith LaDart (U.S. Army Corps of Engineers), Michael Miner (The Water Institute of the Gulf), Monique LaFrance Bartley (National Park Service), Nick Ferina (Bureau of Ocean Energy Management), Patty Kelly (U.S. Fish and Wildlife Service), Paul Necaise (U.S. Fish and Wildlife Service), Ralph Clark (Florida Department of Environmental Protection), Randy Clark, (National Oceanic and Atmospheric Administration), Raya Pruner (Florida Fish and Wildlife Conservation Commission), RC Mickey (U.S. Geological Survey), Rebecca Beavers (National Park Service), Renee Collini (NGOM Sentinel Site Cooperative/MSU/MS-AL Sea Grant), Robbin Trindell (Florida Fish and Wildlife Conservation Commission) Robert Hellmann (National Park Service), Sara Zeigler (U.S. Geological Survey), Simone Monteleone (National Park Service), Soupy Dalyander (The Water Institute of the Gulf), Steven McCoy (National Park Service), Timothy Day (Escambia County), Timothy R. Nelson (Cherokee Nation Technologies), and William Weeks (Florida Department of Environmental Protection).

Outreach and Communication

Objective 1:
- Li, P., Xiao, X., & Seekamp, E. (2022). Climate adaptation planning for cultural heritages in coastal tourism destinations: A multi-objective optimization approach. Tourism Management, 88, https://doi.org/10.1016/j.tourman.2021.104380
- Xiao, X., Seekamp, E., Lu, J., Eaton, M., & van der Burg, M. P. (2021). Optimizing preservation for multiple types of historic structures under climate change. Landscape and Urban Planning, 214, https://doi.org/10.1016/j.landurbplan.2021.104165
- Seekamp, E., X. Xiao, M. P. van der Burg, and M. Eaton. 2021. Testing the transferability of the optimal preservation model at Gulf Islands National Seashore. Natural Resource Report NPS/GUIS/NRR—2021/2303. National Park Service, Fort Collins, Colorado. https://doi.org/10.36967/nrr-2287401

Objective 2:

- Seekamp, E., Flocks, J., Hotchkiss, C., York, L., & Irick, K. (in press). Gulf Islands National Seashore Regional Sediment Budget Research and Data Needs. U.S. Geological Survey Open-File Report.