



FUTURE PARK LEADERS
of EMERGING CHANGE

Fiscal Year 2018
Accomplishment Report

Introduction

The Climate Change Response Program (CCRP) successfully conducted the fourth year of the Future Park Leaders of Emerging Change (FPL) Internship Program (formerly the George Melendez Wright Initiative for Young Leaders in Climate Change). The FPL is a competitive internship program in which high-achieving undergraduate and graduate students conduct rigorous and innovative projects to address high priority climate change management challenges in National Park Service (NPS) park and program offices. The FPL is an approved Direct Hire Authority for Resource Assistant Internship Program; interns who successfully complete the FPL and the requirements of their academic degree program are eligible for noncompetitive hiring. The CCRP administers this initiative in partnership with the University of Washington (UW).

Accomplishments

The CCRP received and paneled 42 project proposals between September and October 2017 from NPS park and program offices. An interdisciplinary panel awarded thirteen projects spanning a range of disciplines and resource foci across multiple regions and biomes in the U.S.

The UW launched a call for student applications on the website <http://futureparkleaders.org/>. We received 295 applications from graduate students, upper-level undergraduate students (juniors and seniors), and recent graduates. The CCRP convened thirteen separate panels consisting of (at minimum) the park/program supervisor and a representative from the CCRP to review 20-50 student applications, interview 2-4 top candidates, and award the projects to successful interns. The interns were selected from universities across the United States, and represented a diversity of age (18-33 years) and gender (62% female). The 2018 cohort claimed 8% minority or multi-racial background. See Attachments A and B for intern and project information.

The CCRP and UW collaborated to provide project supervisors and interns with an orientation to the FPL Initiative and UW employment requirements and provide ongoing support throughout the summer. Interns completed their projects between May and September 2018. A final report, related deliverables, and evaluation are available from each park or program. Both interns and their NPS supervisors provided extremely positive feedback regarding all aspects of the initiative.

Career mentorship and professional development are core elements of the FPL experience. Each intern and supervisor completed a Leadership Development and Mentorship Plan that establishes the intern's project and professional goals at the beginning of the summer. The CCRP then organized a Professional Development Symposium on August 7-9 in Fort Collins, CO to expose interns to leaders in their chosen fields and provide them with useful tools and knowledge to launch federal careers. There are now 46 alumni who possess, or will possess following completion of their degree program, direct hire eligibility.

The National Park Service provided a total of \$227,166 to administer the 2018 FPL season.

Please review the following attachments for more detailed information regarding the outcomes of this initiative. Items available upon request include: (1) the FPL Handbook; (2) an agenda for the Professional Development Symposium, (3) video recordings of student presentations, (4) supervisor and intern orientation slide decks and recordings, (5) Leadership Development and Mentorship Plans, (6) evaluations, and (7) additional project deliverables.

List of Attachments

Attachment A Project Titles and Map

Attachment B Financial Information

Attachment C Project Reports 1-13

Contact Information

Melanie Wood, Project Manager

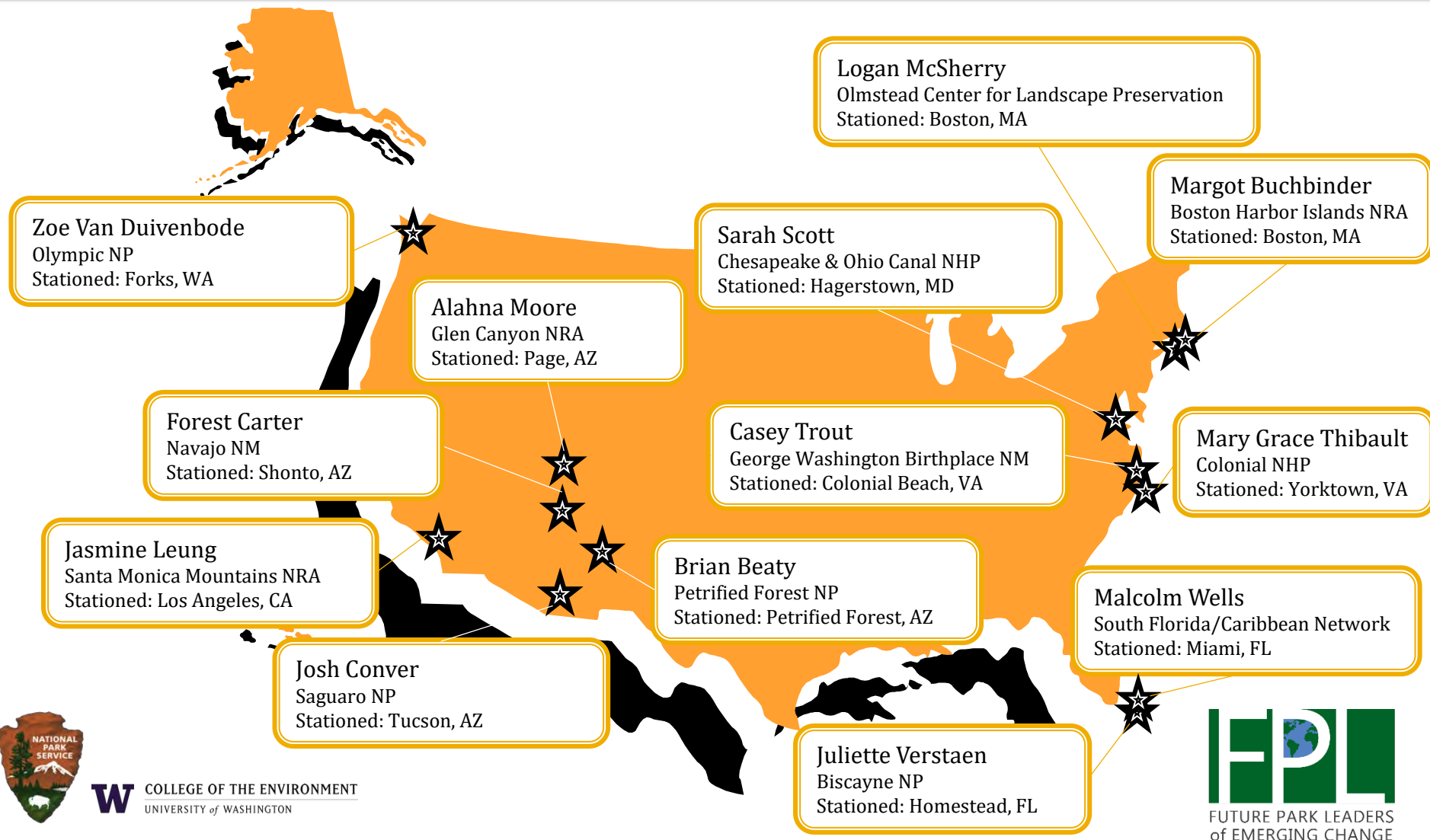
Climate Change Response Program, National Park Service, Melanie_Wood@nps.gov

2018 Internship Projects (13)

full project descriptions can be found at: <http://futureparkleaders.org/>

Park	Project	NPS Lead
BISC	Assess Reef Fish Assemblages	Vanessa McDonough
BOHA	Develop Metrics for Living Shorelines	Marc Albert
CHOH	Implement CR CC Strategy	Sophia Kelly
COLO	Develop Strategic Plan for Archeological Sites	Dorothy Geyer
GEWA	Analyze Rate of Shoreline Erosion for Structures	Bill Doerrer
GLCA	Conduct Photogrammetry Archeology	Brian Harmon
NAVA	Implement Remote Sensing Workflow for Erosion	Greg Luna Golya
OCLP	Assess Vulnerability of Coastal Cultural Landscape	Chris Beagan
OLYM	Develop Ocean Acidification Action Toolkit	Tracy Ziegler
PEFO	Monitor CC Impacts to Backcountry CRs	Bill Reitze
SAGU	Understand Plant Community and Saguaro Change	Don Swann
SAMO	Conduct Community-Based Dialogues on CC	Vanessa Torres
SFCN	Assess Impact of Storms on Mangrove Soils	Kevin Whelan

2018 Future Park Leaders



**NPS George Melendez Wright Initiative for Young Leaders in Climate Change
P.I. Lisa Graumlich**

Task Agreement					Year 4: 2017-2018	
Updated: 12/13/2018		Unit	Cost	Planned Amount	Actual Expenditures	
Salaries:		# of months	Monthly \$	Project Salaries	10/1/2017-9/30/2018	
Director/PI						
Lisa Graumlich		0.15	\$ 25,347	\$ -		
Assoc. Director						
Stephanie Harrington		0.5	\$ 14,623	\$ -		
Administrator						
Adrienne Karpov		2.75	\$ 7,344	\$ 20,196	\$ 25,784	
Software Engineer						
Davina Spencer		0	\$ 8,342	\$ -	\$ 1,750.00	
Total Administrative Personnel:				\$ 20,196	\$ 27,534	
Internship Salaries:		Hourly Rate	No. of Hours	Amount		
Total Internship salaries:		\$ 16.00	480	\$ 99,840.00	\$ 100,538	
# of Interns		13				
Total Salaries:				\$ 120,036	\$ 128,072	
Benefits:		Rate				
Professional Staff		32.50%		\$ 6,564	\$ 9,087	
Hourly staff (Interns)		20.70%		\$ 20,667	\$ 20,874	
Total Benefits:				\$ 27,231	\$ 29,961	
Operations:		No.	rate	Amount		
Background Checks		13	\$ 81	\$ 1,053	\$ 653.00	
IT for database/web interface revisions/support			\$ 500	\$ -	\$ -	
Application development and revisions JUMP App)		1	\$ 5,500	\$ 5,500	\$ 4,624.00	
Publications/Materials/Design				\$ 500	\$ 0	
Workshop Organization					\$ 659.00	
Housing Stipend Fund		2	\$ 2,518	\$ 5,036	\$ 7,399.00	
Total Operations:				\$ 12,089	\$ 13,335	
Travel:		# of Students	Est. cost per trip			
Student project-supported travel		2	\$ 1,000	\$ 2,000	\$ 704.00	
Student Travel to Prof. Dev. Symposium		13	\$ 1,500	\$ 19,500	\$ 21,261.00	
Student Travel to George Wright Society mtg.			\$ 1,000	\$ -	\$ -	
Total Travel:				\$ 21,500	\$ 21,965	
Direct Costs:				\$ 180,855	\$ 193,333	
Indirect Costs:			17.50%	\$ 31,649.66	\$ 33,833	
TOTAL PROJECT COSTS:				\$ 212,505	\$ 227,166	

Attachment C Project Reports 1-13

This attachment provides brief overview reports for each project. Full, detailed reports and additional deliverables are available upon request.

Project Cover Sheet	Page
Biscayne NP, Juliette Verstaen	7
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Chesapeake and Ohio Canal NHP, Sarah Scott	13
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Does the health of coral affect reef fish species assemblages in Biscayne National Park?

Juliette Verstaen

Abstract

There is no known link between the health of the coral and the size and abundance of popular recreationally caught reef-associated fish such as hogfish, snappers, and groupers in Biscayne National Park. This report outlines the first steps taken to a better understanding of the relationship between these two important ecological resources.

Problem

The health of the coral reefs in Biscayne National Park (BISC) has been steadily declining over the last few years due to a multitude of environmental and human factors such as pollution, bleaching, diseases, and large storm events. Disease outbreaks have been particularly detrimental and are a major factor for declines in coral cover in South Florida¹. It is understood that the decline of corals affects the overall health of the ecosystem, particularly the organisms that use the structure as habitat or consume the coral, but the relationship between coral health and the fish that utilize coral reef habitat is poorly understood².

Objectives

A better understanding of the relationships between coral health and both reef fish species commonly targeted by recreational fishers and overall assemblages could help resource managers predict changes in the fish populations, allowing them to preemptively make changes to management before declines in the fish populations can be detected (which requires a process which time and labor intensive). The goal of this project was to determine if such a relationship occurs.

Approach

A more comprehensive view of the coral health and targeted reef fish relationship required the simultaneous collection of two data sets over the course of the 2018 summer. The first data set collected was part of a multi-agency effort throughout south Florida called Reef-Fish Visual Census Surveys (RVCs)³. During these surveys, divers record the identity, abundances, and sizes of all fish species present in their 7.5m radius sample cylinder that spans the surface to the sea floor. The second data set collected was a survey of coral cover and health. Coral presence, abundance (as coral cover), species

¹ Walton et al (2018)

² Friedlander and Parrish (1998)

³ Brandt et al (2009)

identification, and various health parameters such as bleaching, disease and paling were recorded along a 30-meter transect every 3 meters with a 1 meter squared quadrat. These two data sets were collected simultaneously during July-September 2018 at 50 sites throughout the reef-tract of the park and varying depths between 10 and 60 feet.

These data were used to assess the relationship between coral health and the sizes and abundances of targeted reef fish by creating exploratory graphs, running Pearson's r correlation tests, and running both linear and multi-linear regressions. Spatial and temporal analyses on coral health were also done.

Results

Despite exhaustive data analyses to explore relationships between coral and reef fish health, results proved to be inconclusive.

Relationships among coral health parameters and coral cover were explored to establish a baseline of factors at play. While there may be a mild downward trend between coral cover and the percent of corals that are bleaching and/or paling (Graph 1), there was no significant correlation. Temporal exploration of coral health throughout the summer didn't hint at any trends either (Graphs 2 and 3). Regressions of all the coral health parameters and reef locations (latitude and longitude in the park) yielded no significant results. Mapping coral species richness did not yield any new insight (Figure 1).

Relationships between coral health and targeted fish were explored next. The relationships between coral cover and targeted reef-fish abundance (Graph 4), coral health and reef fish abundance (Graph 5), and coral health and average reef fish size (Graph 6) were explored, none of which resulted in significant correlations. In these graphs, the -1 on the x-axis represents a lack of any coral at that site. Using coral species richness as a health parameter yielded similar results (Graph 7). Regression models were created for all the above relationships and more, with no significant results.

Recommendations

The study provided no further insight to the mechanism within BISC between coral health and targeted reef fish species. The lack of significant findings for this project was troublesome, but highlights how little coral cover actually remains. None of the sites sampled had more than 11.2% coral cover and 9 sites had 0% cover.

Management is imperative to limit further harm to corals and allow for opportunity to recover. While there is little the park can do to prevent disease progression and climate change, measures can be taken to prevent or limit physical harm to the reef. First, there are currently many commercial lobster traps deployed in BISC. These large cumbersome traps are deployed on or near the reef and sometimes left behind, creating a wrecking ball effect on the reef during surge. Banning or limiting these traps would be beneficial to coral health. Second, park goers frequently anchor on the reef,

unintentionally destroying coral and other organisms. Installation of mooring buoys would decrease harmful anchoring. Third, intense recreational fishing often litters the reef with fishing gear such as monofilament, wire leaders, steel weights, etc. Creation of a few no-fishing zones would reduce negative interactions between coral and fishing gear. Implementation of some or all of these recommendations would alleviate stress on coral health and provide the possibility of recovery.

Deliverables

1. Outreach brochure outlining the four main factors, which have caused such a drastic decrease in coral cover in BISC. These include coral bleaching, disease, pollution/marine debris, and increase in large storm events
2. RMarkdown document outlying all statistical tests done with regards to this project.

References

Brandt, M. E., Zurcher, N., Acosta, A., Ault, J. S., Bohnsack, J. A., Feeley, M. W., ... & Patterson, M. E. (2009). A cooperative multi-agency reef fish monitoring protocol for the Florida Keys coral reef ecosystem.

Friedlander, A. M., & Parrish, J. D. (1998). Habitat characteristics affecting fish assemblages on a Hawaiian coral reef. *Journal of Experimental Marine Biology and Ecology*, 224(1), 1-30.

Walton, C. J., Hayes, N. K., & Gilliam, D. S. (2018). Impacts of a Regional, Multi-Year, Multi-Species Coral Disease Outbreak in Southeast Florida. *Frontiers in Marine Science*, 5, 323.

Coastal Resilience Baseline Monitoring: Cover Sheet Boston Harbor Islands National & State Park

Margot Buchbinder
Future Park Leaders of Emerging Change Intern

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September 2018

Abstract

This project involved the creation of a baseline dataset describing intertidal and nearshore subtidal habitats in Boston Harbor Islands National and State Park. This dataset will be used to guide future shoreline work in the Boston Harbor Islands and to contribute to planning of shoreline protection projects in the harbor.

Problem Statement

Coastal areas in Boston Harbor Islands National & State Park are faced with mounting challenges from climate change, particularly with regard to sea level rise and increased storm intensity. Although previous studies have characterized habitat zones in the park, there is no established mechanism to assess intertidal or subtidal sites and to determine changes or impacts to these areas. Additionally, planned projects to place dredged material offshore of the islands may further impact coastal areas. Standardized methods to monitor coastal areas on the Boston Harbor Islands are needed in order to establish baseline data and to assess future changes.

Objectives

This project aimed to expand current knowledge of the intertidal and subtidal habitats in Boston Harbor Islands National & State Park, with the goal of providing a baseline understanding of shorelines in the park and informing future management decisions of coastal areas. Specifically, the project aims to:

- A. Develop standardized protocols to assess and characterize intertidal and subtidal zone habitats in Boston Harbor Islands National & State Park.
- B. Utilize these protocols to thoroughly document intertidal and subtidal habitats in targeted areas within the National & State Park where future shoreline protection projects may be proposed.
- C. Provide guidance on current conditions to planners to support the development of living shorelines and shoreline protection projects in Boston Harbor.
- D. Involve citizen scientists and agency partners in intertidal and subtidal surveys to build relationships and connect the public to intertidal areas in the Boston Harbor Islands.

Approach

This project builds on approaches previously and currently used to characterize and quantify intertidal habitats in the Boston Harbor Islands, including the Bell et al. (2002) study that characterized intertidal habitat types and distributions in the park, and methods used by the NPS Northeast Temperate Network at established long-term rocky intertidal monitoring sites (Long and Mitchell 2012). Study sites were selected based on predictions that certain centrally-located islands, including Georges, Gallops and Lovells islands, would be the focus of future shoreline protection projects, as well as based on observations of existing eroded areas and known construction that could impact intertidal habitats. Following site selection, surveys were conducted employing repeated line transects and quadrats in the intertidal, and qualitative presence and abundance surveys in the subtidal. These surveys quantified both habitats at the sites in the form of substrate type, as well as sessile and mobile organism cover and abundances.

Results

Intertidal areas in the selected sites on Georges, Gallops and Lovells islands were dominated by mixed coarse sediments; one site, Gallops Nixes Shore, also included mussel bed habitat. Organism diversity and richness varied widely across sites for both sessile and mobile organisms, with similar trends found across organism type. The highest values for diversity and richness were found at the Nixes Shore site, whereas the lowest values were found at the Lovells Central Shore site that was characterized by high bare cover, and across the study area both Shannon diversity and taxon richness increased as total site cover increased. Analyses indicated that there were community differences between sites, but no explanation for these differences from habitat or environmental data were apparent. Qualitative surveys in subtidal areas revealed similar levels of taxon richness across sites, although percent cover did vary widely, indicating that subtidal areas may support diverse biological communities even when adjacent intertidal areas support fewer species.

Recommendations

This project provides a starting point for continued monitoring of the intertidal and nearshore subtidal habitats and biological communities in Boston Harbor Islands National & State Park. Further work to expand on these surveys is recommended to more fully characterize the habitats here, including the implementation of quantitative line transect or quadrat surveys of the nearshore subtidal on SCUBA to more effectively characterize and monitor these areas. Intertidal habitats are inherently variable, and therefore long-term data is needed to detect changes or impacts to these habitats. Therefore, continued monitoring of these sites is essential to long-term understanding of how future projects may impact these sites, and to detect habitat shifts due to sea level rise or other environmental changes. Additionally, efforts to place dredged material offshore of islands to enhance the protective effect of the islands on the mainland are being planned. Conducting monitoring of targeted sites early in the planning process is recommended to inform planners of special considerations that may need to be taken into account for successful and streamlined permitting of future projects, and to track impacts to coastal areas as a result of project implementation.

Deliverables

FPL Project Report
Photo and video directory available on BOHA shared drive

Works Cited

- Bell, R., M. Chandler, R. Buchsbaum and C. Roman. 2002. Inventory of Intertidal Habitats: Boston Harbor Islands, a national park area. Technical Report NPS/NERBOST/NRTR-2004/1
- Long, J. D., and B. R. Mitchell. 2012. Northeast Temperate Network long-term rocky intertidal monitoring protocol: 2012 Revision. Natural Resource Report NPS/NETN/NRR—2012/495. National Park Service, Fort Collins, Colorado.

PROJECT TITLE

Planning for the (Un)expected: Integrating Climate Planning into Cultural Resource Management at Chesapeake and Ohio Canal National Historical Park

OVERVIEW

This report presents the findings of a three-month study that researched best practices in climate planning for cultural resource management in order to apply them to the Chesapeake and Ohio Canal National Historical Park (C&O Canal NHP), a unit of the National Park Service (NPS).

PROBLEM STATEMENT

Cultural resource managers at C&O Canal NHP identified a need to address the projected impacts of climate change on its cultural resources. The park currently experiences infrequent, though devastating, flooding, both riverine flooding from the Potomac River and flash flooding from the river's tributaries. While flooding is not a new threat, due to climate change, it will become an increasing threat to park management's ability to carry out the park's purpose. As a result, it is imperative that cultural resource managers at C&O Canal NHP are prepared with the appropriate information and strategies to make difficult decisions about preserving the significant heritage in the park.

OBJECTIVES OF THE PROJECT

This project sought to ground the recommendations from the NPS *Cultural Resources Climate Change Strategy* in the specificities of the cultural resources and context of C&O Canal NHP. The objectives were to understand the types and conditions of cultural resources; explain climate science for the area of the park and how it might impact cultural resources (including historical impacts, current trends, and future vulnerabilities); explain the NPS response to climate change (including the *Cultural Resources Climate Change Strategy*); and explain best practices in comprehensive disaster planning (including preparedness, response, and recovery).

Together, these objectives accomplished the goal of providing cultural resource managers with an actionable understanding of best practices in climate planning. The report recommends four key interventions with specific steps that can be taken to implement those recommendations. It also outlines additional considerations that relate to the four pillars of climate response identified by the NPS: science, mitigation, adaptation, and communication. The ultimate goal is to facilitate discussions among park management to consider how climate change impacts its work and what actions it can take to better prepare the park for responding to climate change.

APPROACH/METHOD USED TO ACCOMPLISH THE OBJECTIVE

Before recommending strategies for action, the study first analyzed C&O Canal NHP's inherent strengths and weaknesses as well as external opportunities and challenges related to its capacity to respond to climate change (known as a SWOC analysis). This analysis was based on reviewing existing park documents (e.g. plans, studies, reports, and policies); identifying best practices; and interviewing park staff, other NPS staff, and other experts in the fields of cultural resource management and climate change response. Taking a critical look at the park's capacity to respond to climate change enabled the final report to offer more tailored recommendations to park management.

The study then researched existing frameworks within and outside of the NPS that identify various strategies for responding to climate change. Since climate change will be experienced as an increase in the severity and frequency of natural disasters, it also looked at frameworks for incorporating disaster planning into cultural

resource management, with a focus on flooding. Using this research and the results of the SWOC analysis, the report proposes recommendations for specific actions.

RESULTS OF THE INTERNSHIP

While there is a wealth of existing guidance from the NPS to support park units in their efforts to respond to climate change, there are currently no mandates that require this response. This means that individual parks are responsible for choosing how to address this significant threat to the preservation of cultural resources. As a result, C&O Canal NHP will need to establish its own framework for cultural resource climate change response, which will require a commitment of park resources and staff time.

Cultural resource managers at the park are experienced with thinking about how management actions will impact the ability of future generations to benefit from the park. However, planning for climate change is an iterative process that requires regular data collection, feedback, and analysis with a focus on both short- and long-term decision-making. While park management would benefit from acting on the recommendations listed in this report, the best thing that it can do is to incorporate climate change considerations into the park's regular practices. By doing so, it will ensure that the history of the canal and the recreational opportunities that it provides continue to be enjoyed by generations to come.

RECOMMENDATIONS

Currently, climate planning and disaster planning are viewed as two separate approaches with the former focused on the long-term and the latter focused on the short-term. However, C&O Canal NHP would benefit from integrating the two since the park will experience climate change through natural disaster events. Ideally, both climate planning and disaster planning are iterative processes that are regularly updated when new information becomes available and best practices are improved. In addition, climate planning and disaster planning should interface with other aspects of park management. This comprehensive approach requires thinking about the long-term implications of an action. It also requires embedding concepts of sustainability and resiliency into everyday decision-making, rather than treating them separately.

As a result, this report recommends four interventions: expanding the flood response plan, updating resource inventories, creating a standardized damage assessment procedure, and conducting a vulnerability assessment. The report outlines both general recommendations and specific actions for each intervention. While these are framed as four distinct interventions, they are best done in concert. They would also benefit from collaboration with the National Capital Region office, the CCRP, other NPS park units that have undergone similar work, and non-Federal agencies and organizations with appropriate expertise.

DELIVERABLES

Final report, "Planning for the (Un)expected: Integrating Climate Planning into Cultural Resource Management at Chesapeake and Ohio Canal National Historical Park"

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Mary Grace Thibault
Future Park Leaders of Emerging Change (FPL)
Summer 2018
Colonial National Historical Park (COLO)
Supervisor: Dorothy Geyer

Jamestown Island Archaeology: Significance and Vulnerability Assessment

Overview

Jamestown Island, operated by Colonial National Historical Park and Preservation Virginia, contains archaeology spanning a 10,000-year period. Climate projections indicate most of Jamestown Island will fall victim to sea level rise within the next few decades. The NPS seeks methods to determine what archaeology, and consequently historic narratives, to preserve.

Problem Statement

Jamestown Island is most famous for its post-contact, 17th-century role as the first permanent English settlement in the United States. Its archaeology encompasses the pre-contact period, including Archaic and Woodland, up to the present day. Archaeological assessment of the island indicates 59 NPS sites containing pre- and post-contact material. The majority of sites have only undergone Phase I testing (see Blanton et al. 2000, Horning and Edwards 2000, Brown and Horning 2006), which uses shovel test sampling techniques to make statements about a given archaeological site at large. The resulting data, supplemented with other archaeological data sources, must be used to determine the relative values of vulnerability and significance of each site so that measures can be implemented to properly foster NPS resources in the face of expected areal loss.

Objectives

The Colonial National Historical Park FPL project sought to develop a numerical approach to determining the relative importance of its Jamestown Island archaeology sites. Ultimately, the structure of this approach should be relevant and transferable to other parks in need of similar archaeological assessments. Thus, the following intermediary objectives were established.

- The FPL COLO project sought to assess and organize the available archaeological data for 58 of the 59 (excluding New Towne) archaeological sites on Jamestown Island for the purpose of establishing a site inventory.
- The site inventory would then be used to establish general attribute categories by which the sites could be described. An example of this would be the attribute "Components," which would describe the time periods associated with each site.
- These attributes could then be summarized by site to provide 58 accurate site descriptions, incorporating both qualitative and quantitative data.
- Site descriptions would then be used to produce a set of written metrics that would describe different degrees of importance associated with each attribute.
- A score for each site attribute could then be normalized and weighted accordingly. Ultimately, all 58 sites could receive a score normalized to fall between 0 and 1. The relative distribution of said scores would then indicate each site's relative importance in terms of significance and vulnerability.

Approach/Methodology

The methodology employed to accomplish this project's objectives was modeled on a study performed at Cape Lookout National Seashore, which determined the relative importance of historical structures to determine proper allocation of park resources in the face of climate-related challenges (Fatorić and Seekamp 2017). This study differed in that the park resources were archaeological sites, meaning the resources are buried and their full extent unknown. Structurally and quantitatively, the approaches of Cape Lookout and COLO were very similar. Materially, however, the resources, and so the data utilized, were dissimilar.

Archaeological information was pulled from a variety of sources (see *Thibault draft methodology* for complete citations). The data was assembled and structured in such a way as to categorize each data attribute as a characteristic of significance or vulnerability, the latter of which was subdivided into exposure and sensitivity. A written metric of attribute definitions and values was developed by an archaeological/hydrological team. This metric was used to determine significance, vulnerability, and combined (significance and vulnerability) scores for each of the 58 sites. The scores produced underwent normalization and weighting so that all final scores fell between 0 and 1, with 0 indicating low value, and with 1 indicating highest value for a given score.

Results of the Internship

As of FPL involvement with this project, all 58 sites had received preliminary significance, vulnerability, and final combined scores. The methodology and scores, the latter plotted in various ways, were presented to the COLO superintendent and staff and then again at the FPL conference in Colorado. The scores are considered preliminary because all attributes and categories (i.e. significance, vulnerability, sensitivity, exposure) were equally weighted, a choice that could change as the project develops and more experts are consulted.

A calculation procedure was set forth in Excel that enables any future numerical adaptations that may arise through peer review to be performed easily. Additionally, a detailed explanation of the work done was produced as a rough draft for internal COLO usage. The progress made on the project was deemed viable and work on the project is ongoing. Ultimately, these results will allow COLO to make informed decisions about future excavations and site preservation techniques on Jamestown Island.

Recommendations

- One item identified was the need for new LiDAR data, the most recent being from 2011, to better understand erosion rates.
- Additionally, archaeological site conditions reports are on file for some Jamestown Island archaeology sites. Major data gaps exist, however, for the sites that have not been assessed. For the archaeology sites to be properly addressed, ground assessments will be necessary.
- In terms of internal NPS consistency, there were some data inaccuracies discovered within the ASMIS records concerning the archaeology sites. The ASMIS records should be checked for quality and updated with any new information since their inception (c. 2000).
- Another aspect of the project involves the statistics employed in the scoring, normalizing, and weighting framework. The statistics employed were modeled on the Cape Lookout report. Email correspondence with Sandra Fatorić also provided some quantitative clarification of the Cape Lookout work. Further COLO work should involve someone with statistical expertise to verify the framework that has been established.
- Peer Review will be needed as the project progresses. An item that should be addressed is the statistical methodology and, more specifically, the weighting of significance and vulnerability.

- Mapping site risk distributions over Jamestown Island would also prove useful in conveying the most physically vulnerable areas of the island. Interactive maps that could instantly reflect changes to site scores would also be tremendously helpful for future work.

Deliverables

- A draft write-up of the sources, methods, and results of this study concluded the on-site involvement of the FPL portion of the COLO project. It is meant for internal park use.
- 58 Rap Sheets containing site descriptions, maps, and graphs for each of the 58 archaeological sites studied were compiled.
- An Excel spreadsheet book was developed to accommodate the need for automatic scoring during the scoring, weighting, and normalization process. This spreadsheet book contains several sheets with detailed explanations of their functions. Most notably within this book are Quick_View and The_Calculator. The latter sheet contains all of the formulas needed to produce the significance, vulnerability, and final combined scores. Quick_View is a sheet that fields the input of raw scores and summarizes the final scores produced in The_Calculator. It also contains a suite of graphs that visualize the final scoring. With these two sheets, it is possible to instantaneously update scoring so that various scoring and weighting approaches are rendered fast and simple.

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Understanding Shoreline Erosion, Sea Level Rise, and Climate Change Projections at George Washington Birthplace National Monument

Future Park Leaders of Emerging Change Internship Program Final Report
Prepared by Casey Trout
August 3, 2018



Project Overview Erosion along the park shoreline has accelerated in recent years and increasing frequency of intense precipitation events has resulted in damage to park resources. This project addresses these changes and provides resources for park staff to use when planning for the park's future.

Problem statement Park employees were aware of accelerated erosion along the Potomac shoreline at George Washington Birthplace National Monument. However, they were unsure of the rate that the shoreline within Popes Creek, which is a tributary of the Potomac bordering the park, was eroding. Some of the park's most valuable facilities, such as the Visitor Center and Visitor Center parking lot, lie in close proximity to this shoreline. Park staff were also noticing increasing frequency of strong winds, heavy precipitation events, and flooding in recent years, which were damaging the park's facilities and cultural sites.

Objectives of the project The overall objective of this project is to improve park staff's understanding of the extent of erosion along park shorelines and climate change projections for the park, including sea level rise. This information will be used to help park staff make management decisions concerning how to plan for the park's changing landscape.

Approach/method used to accomplish the objective In order to accomplish this objective, the FPL intern conducted an extensive literature review of the resources that currently exist relating to shoreline erosion at the park, projections for sea-level rise, and other climate change projections. This information was summarized into a handful of short documents with a specific focus (for example, one document solely addresses projections for sea level rise at the park).

The intern also used orthorectified historical aerial imagery of the park to create shapefiles in ArcMap of the park's historic shoreline. These shapefiles were overlaid onto historical aerial imagery from other years in order to create a visual depiction of the extent of shoreline recession over time. To provide additional visualizations, the intern created maps using GIS data found online depicting the extent of inundation under various sea level rise scenarios, flood risk at the park, and expected inundation of park shorelines under various hurricane categories.

The intern worked with park staff and the regional office to collect GPS data for the shoreline within Popes Creek that can be used as baseline data.

Results of the internship Park staff have a greater understanding of what the future landscape of the park may look like with a changing shoreline and climate. Staff also have a handful of useful reference documents and maps that they can refer to in the future when making management decisions relating to park resources that are vulnerable under a changing climate. These reference documents, maps, GPS data of Popes Creek shoreline, and pictures from the project are easily accessible in a folder on the park's public drive.

The internship also resulted in immense professional and personal growth for the FPL intern. The intern learned a substantial amount about climate change projections for the Northeast region and for the park, furthered their technical skills with ArcMap and GPS, and made connections with NPS staff at the park and the Northeast Regional Office. They were also given the opportunity to participate in trainings throughout their time at the park, which included an Essential Leadership Skills training, Civil Treatment for Leaders, and a multitude of trainings relating to safety, health, and wellness.

Recommendations The overarching recommendation for park staff is to consider how they can make their facilities and resource management more flexible and resilient to a myriad of potential future scenarios for shoreline and climate change at the park when making planning decisions. By making proactive plans for mitigating the effects of shoreline erosion, sea level rise, and climate change, park staff will not need to respond reactively when environmental forces damage park resources in the future.

Some specific management suggestions to apply this overarching strategy include: document cultural sites in close proximity to shorelines in preparation for erosion, relocate trails in close proximity

to the water to be higher above the current high water line, elevate walkbridges in Dancing Marsh, improve drainage systems along park roads, implement a preventive tree management strategy to reduce damage to park resources during high wind events, ensure that new facilities constructed at the park are above the flood line under even the highest sea-level rise scenarios, and implement routine monitoring through GPS collection of Popes Creek shoreline if staff notice that erosion within Popes Creek is accelerating.

Deliverables

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A Changing Shoreline at GEWA.....	4
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Acknowledgments Amanda Babson, the Coastal Landscape Adaptation Coordinator for the Northeast Region, was instrumental in providing resources to the intern during the literature review process. She kindly also reviewed and provided feedback on preliminary drafts of some of the summary documents. Dennis Skidds, the Data Manager for the Northeast Coastal & Barrier Network, visited GEWA to provide GPS training to the intern and other park staff, and helped the intern immensely with GPS collection and post-processing the data. Mike Arndt, the IT Specialist at GEWA, supported the intern in downloading needed programs to complete the project. Staff at GEWA were always willing and happy to chat with the intern to provide feedback on the project progress and recommendations for further research.

Photogrammetric Monitoring of Archaeological Sites in Glen Canyon National Recreation Area
Project completed by Alahna Moore - Future Park Leaders of Emerging Change Intern Summer 2018

Overview

The purpose of this research was to establish a photogrammetry protocol for monitoring topographic change at archaeological sites using high resolution 3D spatial datasets. Using aerial photogrammetry, 3D spatial data can be collected quickly, cost-effectively, and repetitively, allowing for enhanced monitoring of erosion at dynamic fluvial archaeology sites.

Problem Statement

The construction of Glen Canyon Dam has had unforeseen impacts on the Colorado River, the terraces that embank the river, and the archaeological deposits within these terraces. Occasionally, the Bureau of Reclamation, who manages Glen Canyon Dam, conducts high flow experiments where large volumes of water are released from Lake Powell into the Colorado River with the goal of pushing sediment into the Grand Canyon. Variation in fluvial energy and sedimentation caused by the dam has secondary impacts along the GLCA section of the Colorado River as well, but a lack of data renders it difficult to quantify these impacts.

Objectives

Five archaeological sites were selected for initial photogrammetric survey, and data collection protocol was drafted in order to suit the specific needs and obstacles present at each site. Following access issues with the initially selected sites, two additional sites were included in order to ensure there would be multiple datasets for comparison. Photogrammetric equipment was purchased for terrestrial and pole-based photogrammetry, as well as aerial photogrammetry using balloons. Data collection workflows were developed for a variety of methods so that future users could adjust their approaches based on accuracy needed and terrain obstacles. The primary objectives of this project are listed below:

- 1) Examine the feasibility of using photogrammetry as a viable means of monitoring erosion at archaeological sites along the Colorado River
- 2) Determine a standard operating procedure for future photogrammetric surveying
- 3) Develop monitoring process that is:
 - expedited
 - inexpensive
 - repeatable
 - comparative
- 4) Create user friendly documentation for all hardware, software, and processes
- 5) Compare results with previous photogrammetric surveys, LiDAR, other terrain data
 - Where is sediment moving?
 - How much sediment has been gained / lost?

Methods

In order to meet these goals, the FPL intern collected photogrammetric data at multiple sites in Glen Canyon National Recreation Area with the goal of troubleshooting the proposed photogrammetric methods and developing a best practice protocol on a site by site basis.

Three sites in particular were studied:

- an approximately two acre site with one large elongated terrace, consisting of easily walkable flat sand terrain
- an approximately 100 square meter site with a steep slope covered in large boulders
- an approximately 70 square meter artifact scatter eroding from a terrace on a cliff face above a commonly used road

These sites were selected to gain experiential knowledge for how to document a variation of sites depending on their size and topography. Each site was remotely examined for obstacles using Google imagery and previous site monitoring forms. Next, an appropriate documentation method was designed based on the site topography and then data was collected and processed. Following data processing, the results were evaluated and the methods were assessed based on photo coverage and physical limitations faced during the data collection process. These evaluations were used to develop a standard operating procedure including metrics for when to utilize specific methods and equipment.

Results

After a failed attempt to document the two acre site using the pole method, it was determined that sites exceeding an acre in size should be documented from a higher altitude using the balloon in order to capture more land per photograph. Similarly, the exceptionally steep site was able to be captured using the pole method, however the steep and uneven terrain made this method dangerous for operators and equipment safety. Although this site was ideal in size for utilizing the pole method, it was determined that balloon photogrammetry would work best for sites that are difficult to transverse on foot. The site on the cliff face was ideal for pole based photogrammetry for multiple reasons, including the unaccessible nature of the site, the small size, and the proximity to a flat road that was used to stabilize the pole and tripod. These findings were used to inform the decision making process for photogrammetric data collection and to develop a standard operating procedure for photogrammetry at Glen Canyon National Recreation Area.

Recommendations

It is recommended that these three sites are photogrammetrically monitored at least two times in the coming year using the suggested data collection method proposed in the manual generated during this research endeavor. In order to examine topographic change at these sites, multiple datasets collected at differing times of the year are necessary, and especially informative if collected directly after a major weather event such as a flood or a monsoon. In order for these data to be easily comparable, it is recommended that ground control points are established at all sites that will be photogrammetrically monitored. This requires installing a permanent marker, such as rebar or wooden stakes, and then surveying these points in order to identify the exact coordinate for the marker's location. Data from Summer 2018 should be georeferenced by surveying existing ground control points.

Finally, the data collected during the summer of 2018 should be utilized as sample material for future processing and visualization workflow development using ArcGIS and CloudCompare. Documentation for these softwares was provided to GLCA from outside sources, but specific procedures should be developed to suit the needs of Glen Canyon NRA.

Deliverables

- “Monitoring Erosion of Archaeological Sites using Photogrammetry” methods manual
- Photogrammetric spatial data for:
 - AZ:C:2:50 (08/14, 08/30)
 - AZ:C:2:11 (07/31, 08/30)
 - AZ:C:2:30 (08/30)
- Photogrammetric monitoring data sheet

Works Cited

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Forest Carter
Navajo National Monument
Future Park Leaders 2018 Intern

Erosion Monitoring via Android App

Overview:

Anecdotal evidence and historical aerial photo analysis show dramatic change in the streambed and arroyos in Keet Seel Canyon. However, due to financial and logistical limitations, no consistent erosion monitoring program exists. This project seeks to engage visitors by empowering them to upload photos of erosion sensitive sites using a custom built Android App.

Problem Statement:

Navajo National Monument primarily protects three Ancient Puebloan cliff dwelling sites: Betatakin, Keet Seel, and Inscription House. The streams near Keet Seel and Inscription house are semi-perennial, and subject to flash flooding during the monsoon season. Significant precipitation events can cause dramatic sediment accretion and erosion, as well as the creation of new channels. Repeat photography and aerial photo analysis have shown arroyo incising and streambed widening. Cultural resource staff at Navajo National Monument are interested in monitoring and analyzing erosion process near the cliff dwelling sites to understand potential threats to site access and to the resources themselves. However, the most significant erosion sites, Keet Seel and Inscription House, are located in remote canyons that are difficult and costly to access. Current financial and logistical resource limitations at the monument do not allow for frequent erosion monitoring fieldwork.

Objectives:

This primary objective of this project is to offer a low cost erosion monitoring program that gives staff access to a database of photo time series. This will offer opportunities for park staff to better understand erosion processes in the canyon, as well as the effects of individual precipitation events.

The secondary objective of this project is to engage visitors in a citizen science project. This objective seeks to spark a more dynamic visitor experience by involving them in a collaborative natural and cultural resource preservation effort. Visitors will also be exposed to the importance of monitoring landscape changes in an era of changing precipitation patterns.

Methodology:

An Android app was developed with the goal of providing visitors with an easy to use tool to take repeat photos at six erosion sensitive sites. Android was chosen as the platform in order to provide access to the greatest proportion of visitors. The app provides a map component that shows the user's current location, as well as numbered icons for the six photo sites. Users can tap an icon to view an example photo and instructions. Users later enter the date that the photos were taken and upload them to a cloud-based database. The database is hosted by Microsoft Azure BLOB storage, which was found to be both low-cost and have an API receptive to Android photo uploads. Staff at Navajo are provided access credentials and modification privileges to the database. Photos are named in accordance with the date and location of acquisition.

Results:

The expected results of this project include a time series of photos at six erosion sensitive sites along the Keet Seel Canyon hiking trail. This photos will be time stamped by date and location. This will enable long-term monitoring of the sites at little or no cost. This will also enable analysis of changes caused by individual precipitation events. When photos are captured before and after a single event, the changes can be studied in terms of precipitation intensity, duration, and extent. This technique can be used in conjunction with the Google Earth Engine Virtual Rain Gauge product that a NASA-DEVELOP team created for Navajo National Monument in early 2018.

This project will also serve to engage visitors in a citizen science initiative. By empowering visitors to contribute to ongoing science in the park, they will gain a more comprehensive view of the erosion processes at Navajo National Monument. This will also encourage a dialogue between natural resource staff, interpretation staff, and the public regarding threat to the cliff dwelling site and possible mitigation strategies. This effort could be supplemented by publishing the collected time series photos either in an online platform or as a physical display in the visitor's center.

Recommendations:

Although the app is fully functional, there are a few steps remaining to get full approval to upload it to the Google Play Store. The app still needs to go through the Department of Homeland Security App Carwash - <https://sharedservices.dhs.gov/carwash/about> . After the APK file is uploaded and approved, it can be listed on the Google Play Store for public download.

Another crucial component of this project will be public outreach. Keet Seel hikers are required to obtain a permit before entering the canyon, and this could be an ideal outreach opportunity. Visitors must be made aware of how to download and use the app before they start their hike. Small rewards such as t-shirts or stickers could incentivize initial users.

The database produced by this project can be utilized for time series analysis and for public outreach. Time series analysis could yield important insight into erosion dynamics in Keet Seel canyon. A public facing website could display changes over time in several locations that could be used as a visitor education tool, as well as incentive further data collection using the app.

Deliverables:

- a. Android Studio App folder
- b. APK App file (for eventual upload to Google Play Store)
- c. Database access instruction
- d. Pecha Kucha Presentation

Internship Report Cover Sheet

Logan M. McSherry

Project Title

Coastal Cultural Landscape Vulnerability Assessment

Overview

This Olmsted Center for Landscape Preservation (OCLP) project introduces the process of evaluating climate change impacts to cultural resources and park facilities at coastal parks, using the cultural landscapes at the William Floyd Estate (WFE) at Fire Island National Seashore (FIIS) and George Washington Birthplace National Monument (GEWA) as pilot studies.

Problem Statement

Climate change challenges national parks in new ways. Sea levels are rising at an unprecedented rate, increasingly destructive storms threaten park resources, and habitat is disrupted, among other changes (National Park Service, NPS, 2018). The NPS protects and maintains some of the most iconic landscapes and cultural resources across the country. These resources are not impervious to climate change, and in many cases more vulnerable due to their historic or unique character. Coastal parks, such as WFE and GEWA, are especially at risk to climate change in the coming decades.

Objectives

This report describes the project scope and documents the methodology employed, as well as presents selected results from the work at WFE. This work will serve as a guide to inform future cultural landscape vulnerability assessments. With the workflow outlined, it may eventually allow for the effective and efficient incorporation of climate vulnerability into the Cultural Landscape Inventory (CLI) and Cultural Landscape Report (CLR) process.

With integrity playing a fundamental role in CLIs and CLRs, and the potential for climate change to effect integrity, it is important that climate change impacts be considered in addition to more traditional variables characterizing integrity. This vulnerability assessment identifies which resources are most vulnerable to climate change impacts.

The purpose of these assessments is to begin thinking about adaptive measures and justify funding requirements. Through research of which resources are highly vulnerable and determination of investment priorities, park managers can begin thinking about adaptive measures, justify funding requirements, and prioritize their

efforts to preserve these resources unimpaired for future generations to learn from and enjoy.

Method

First, the climate change impacts that are affecting or will affect the study site, or cultural landscape, were determined. Of the eleven impacts identified for WFE and GEWA, four have an inherently geographic, or spatial, component. The remaining seven impacts included this study did not contain any spatial data. Without spatial data to determine the degree to which these impacts could be felt throughout the site, determinations were made through use of existing literature, expert knowledge, and site visits.

The exposure of each resource to each climate change impact was scored on a 4-point scale, ranging from 0 to 3. The exposure scoring for the four impacts with spatial data was based on mapping, whereas the scoring for the other seven impacts features a qualitative approach based on expert judgement.

Sensitivity was also evaluated on a 4-point scale, but sensitivity scoring had no mapping component, focusing more on the characteristics of the resources as determined by expert knowledge and site visits. The vulnerability of each resource to each climate change impact was simply calculated by multiplying the exposure score by the sensitivity score, allowing comparison between the overall vulnerability scores for individual resources and between landscape characteristics.

Results

The methodology outlined above was carried out to completion for WFE. Only exposure analysis was completed for GEWA. Sensitivity scores for GEWA will be determined by OCLP staff in conjunction with a future site visit. Of the 116 resources at WFE, 97 are “highly vulnerable” to at least one impact. Any resource that received a score of 9 to any of the eleven climate change impacts was considered high vulnerability.

Many vegetation features, which includes trees, marshes, fields, and woodland, are highly vulnerable to two or three impacts. As such, vegetation has the highest average vulnerability of any of the seven landscape characteristics on site. This is largely due to the fields and woodlands’ coastal location and susceptibility to waterborne impacts such as flooding, sea level rise, and storm surge.

Buildings and structures, most of which are located a mile inland from Narrow Bay, are considered “safe” from waterborne impacts, yet still remain the second most vulnerable landscape feature due to possible exposure and high sensitivity to other impacts, such as fire and wind. Other landscape characteristics are less vulnerable overall, though many individual resources still may experience adverse impacts, as evidenced by the number of scores of 9.

Recommendations

In light of these findings, there are several steps the park can take to address climate change threats to the character of WFE. Fortunately, much of the built environment is located far enough from the water and high enough above sea level that it is unlikely to experience waterborne impacts. The obvious exception is Corduroy Road, a circulation feature, which is now underwater.

That said, many of the cultural resources found on the 613-acre site are located within a 0.1 mile radius of the Old Mastic House, the centerpiece of the estate. This historic core is where the park will likely concentrate any adaptive measures, as it contains the largest concentration of contributing features and is most central to the historic character and visitor experience.

Here, the park can trim trees and reduce brush to help alleviate the risk to wind and fire. Further, the park can and should continue to monitor impacts to resources resulting from changes in climate. If pests and diseases are observed infesting trees and wooden structures, use of insecticides and preventative chemicals may need to be considered.

Deliverables

The final deliverables include a detailed assessment report outlining the project, detailing the data sources, describing the methodology, summarizing some results, and offering adaptation strategies. The associated Excel spreadsheets containing the raw data used in analysis are also provided. There is also a separate document, or vulnerability summary, that includes the results in a more user-friendly presentation than the spreadsheets. The ArcGIS ArcMap documents used in analysis can be made available for record keeping and uploading to the system upon request.

References

National Park Service. (2018). *Climate Change And Your National Parks*. Retrieved from <https://www.nps.gov/subjects/climatechange/index.htm>

Developing an Ocean Acidification Communication Toolkit for National Parks

Zoe van Duivenbode, Future Park Leader Intern

Sept. 2018

Abstract

Ocean acidification (OA) is causing marine environments around the world to shift to more acidic conditions which is presenting new challenges for marine life and ecosystems. NPS scientists and managers are working to understand how OA will impact marine species and ecosystem in our ocean and coastal parks. In order to increase awareness and understanding of ocean acidification among NPS staff, an OA communication toolkit was developed. The toolkit is intended to equip managers and interpreters with current information and relevant resources to explain how OA is impacting marine resources across ocean and coastal parks and to help guide future management decisions. In addition, the toolkit provides effective tools for communication, interpretive programs, key talking points and interactive activities.

Problem Statement

Ocean acidification (OA) threatens the health of marine organisms which can lead to the disruption of food webs and impact ecological functions of marine ecosystems. As carbon concentrations in the ocean increases, a series of chemical reactions occurs, causing the ocean to shift to a more acidic environment. Increasing acidic ocean conditions negatively impacts marine organisms with hard shells and skeletons because OA reduces the amount of available calcium carbonate, which these organisms rely on for shell development and survival. A reduction in calcium carbonate can cause biodiversity loss in marine environments and endanger valuable ecosystem services.

Objectives

Currently there are 8 national parks, monuments and historical sites that are engaging in OA research and monitoring programs across the country to gain a better understanding of how OA impacts marine species and ecosystems. This information can be used to identify individual and community responses to increased ocean acidity and can help inform future management decisions.

Nationally, parks would like to advance the understanding of the impacts of ocean acidification and address related challenges to local ecosystems and communities. Therefore, there is a need to create materials that can help educate both park visitors and park management staff. The goal of this project is to effectively communicate the causes and effects of OA, how marine species within national parks are impacted and how national parks across the country are addressing the issue. The end product will be a suite of outreach and education materials, OA messaging tools and interpretive programs, and briefing summaries of how OA is impacting our National Parks, all of which will be developed as part of an OA Communication Toolkit. With awareness of and access to the resources created in the OA toolkit, NPS interpretive staff will be able to utilize and continue to create cutting edge communication tools that incorporate current scientific and communication research to reach a variety of audiences.

Approach

In order to develop a communication toolkit on OA, I interviewed park scientists and managers who have worked or are currently working on OA research and monitoring projects. This information was used to develop briefing summaries for OA in national parks. I also spent time in the field with NPS staff and visiting researchers to learn about the cutting edge science happening, and to collect content including images and video for digital media product development. In addition, I worked closely with staff from NOAA and the Olympic Coast National Marine Sanctuary in order to ensure consistent dialogue between partner agencies.

Deliverables

- Developed online ocean acidification communication toolkit on NPS Coast website for park staff, managers and interpreters which included:
 - An extensive summary of the science of OA.
 - Summary reports on how OA impacts national parks and how parks seek to understand and address the issue.
 - Ocean acidification in national parks factsheet.
 - Interpretative programs, interactive activities, and lesson plans on ocean acidification.
 - Useful education and outreach resources (from NOAA and other partners).
 - Ocean acidification photo bank on NP Gallery and other visual content.
 - Ocean acidification social media campaign for NPS social media channels.
- Created an educational booklet on OA with activities for middle school students (Grade 6-9)
- NPS service-wide brochure on ocean acidification in national parks.
- Updated external [NPS ocean acidification page](#).

Report Cover Sheet

Understanding Climate Impacts to Backcountry Archeological Sites in Petrified Forest National Park

Brian Beaty, Future Park Leaders of Emerging Change

Overview

At Petrified Forest National Park (PEFO), most archeological sites are preserved in stable sand sheets that threaten to reactivate in response to climate-induced vegetation dieoff. This FPL internship sought to develop field-based protocols for monitoring landscape responses to climate change around archeological sites in the park's backcountry.

Problem Statement

Among the resources most at risk from climate change are the park's over 1,300 known archeological sites. Many of these sites are preserved in sand sheets that threaten to erode in response to climate-induced vegetation die-off. From ancient pit houses to pueblos to historic structures, remnants of the people that once occupied Petrified Forest all risk damage and displacement as sand sheets transition into active dunes. While detailed proxy records of climate change exist for the Southwest as a region, little is known about how the landscape at Petrified Forest has responded to these changes over time.

Project Objectives

The objective of the FPL internship was to develop a climate change monitoring protocol that will improve understanding of climate impacts to cultural resources in the park and inform future management responses. In addition to outlining field-based methodologies, a secondary purpose of the internship was to more accurately define the historic range of climate variability at PEFO. The internship was intended to be the first step in the creation of a long-term climate change monitoring program for cultural resources at Petrified Forest.

Methods

The main component of the PEFO climate monitoring project is a network of microclimate stations recording temperature, precipitation, wind speed, relative humidity, and other variables throughout the park.

In addition, vegetation monitoring around these stations will enable detection of groundcover changes that may be tied with climate and future risk of erosion. Three methods for vegetation monitoring (line-point intercept, basal gap, and canopy gap measurements) were tested in Summer 2018 to determine what equipment would be needed and how long each activity would reasonably take to complete.

While not directly linked with aeolian processes, groundwater and surface water monitoring may provide insights into hydrologic changes that are controlled by the same climate factors that influence dune environments. All known wells within the park were mapped and assessed for their potential to allow long-term measurement of depth to water.

Several historical methods were used to determine whether recent trends fall within normal decadal-scale variability or exceed it: first, the analysis of instrumental records going back to 1931; second, interpretation of records of grazing, homesteads, seeps and springs, and streamflow in the context

of climate change; and third, comparison of the earliest written accounts of the region's landscape with modern observations.

Results

Locations for the installation of 5 new stations were selected based on their proximity to archeological sites, susceptibility to erosion, geographic spread, and ease of access. Detailed instructions for the operation of microclimate stations are provided in this report. Additionally, the report provides protocols for vegetation monitoring that provide relevant data on plant cover. 8 wells were determined suitable for long-term monitoring of depth to water. The Arizona Department of Water Resources has agreed to incorporate these new wells into their preexisting groundwater monitoring program, ensuring continuous data collection. Saltation sensors and sand traps could not be acquired during the Summer 2018 field season due to expense and difficulty in construction, so the wind erosion monitoring methodologies in this report have yet to be tested.

The historic range of climate variability at PEFO remains uncertain due to the paucity of detailed landscape records and the limitations of using livestock data as a proxy for climate. Sand sheets appear to have been stable for the duration of the written record (mid-1800s to present), but may have destabilized during extreme droughts in the 1600s and 900s-1300s. Because climate models predict end-of-century drought conditions rivaling these past megadroughts, dune reactivation remains possible.

Recommendations

The next step in advancing a climate monitoring program at PEFO is to produce a climate vulnerability assessment. 16 other parks have already developed vulnerability assessments for cultural resources, allowing them to prioritize options for response by identifying sites most at risk from climate change. As a first step toward a vulnerability assessment for PEFO, the data collected from microclimate stations and vegetation monitoring can help develop a park-specific wind erosion model. Model development will also require detailed topographic, vegetation, and soil data for the entire park that could be obtained through remote sensing, LIDAR, and photogrammetry. These high-cost techniques will likely necessitate new sources of funding as well as collaboration with other parks and agencies. It is recommended that a new FLP intern work on model development during Summer 2019. Once a wind erosion model is developed, park staff can easily determine climate exposure for any archeological site. If archeological sites face imminent loss from dune reactivation, potential management responses may include surface stabilization with netting, construction of barriers that reduce wind velocity over the surface, and revegetation of dunes with plant species better adapted to survive intense drought.

Joshua Conver FPL Cover Sheet

The Changing Relationship between Saguaros and their Plant Community

Overview

Facilitation is a vital process in low-productivity ecosystems like deserts. In the Sonoran Desert, nurse plants facilitate the regeneration of cacti through the development of microhabitats underneath the canopy. We sampled temperatures in biotic and abiotic nurse situations and found a significant negative linear relationship between minimum temperature in the open and under the canopy. Our findings have implications for how saguaro cacti may respond on multiple scales to both direct changes in climate, especially higher temperatures, and indirect changes as a result of changes in Sonoran Desert plant communities.

Problem Statement

Saguaro National Park has been at the center of many long-term monitoring studies of the iconic columnar cacti due to its mission to protect, study, and interpret its namesake plant. Research has shown that shifts in the abundance and composition of vegetation communities have implications for successful saguaro establishment (Niering et al. 1963, Steenbergh and Lowe 1977, Conver et al. 2017). Shifts to a more arid climate regime may result in the mortality of woody plants that facilitate establishment of saguaros and other plants (Munson et al. 2012). Successful establishment is dependent upon abiotic factors as well, and previous research noted associations between rocky habitats and saguaro density (Shreve 1931, Bowers and Pierson 2001).

Objectives

The objectives of this project were to provide high-quality scientific products that contribute to the body of work on the relationship between saguaros and the surrounding plant community while considering the multiple scales at which vegetation communities respond to environmental conditions.

1. At the micro scale, we quantified and compared the thermal benefits provided by the biotic and abiotic nurse situation for annual maximum and minimum temperature.
2. At the local scale, we revisited long-term growth data for individual saguaros to assess changes and determine potential causes behind deviations from the predicted growth rate as specified in Steenbergh and Lowe (1983).
3. At the landscape scale, we assessed the interaction between topography and climate in shaping the mosaic of vegetation communities. Here, specific task was to assess the state

of a citizen science project initiated in 2017 and make recommendations to continue high quality data collection.

4. At the regional scale, we sampled tree-rings from upslope ponderosa pine forests in order to examine the connections between saguaro regeneration and tree-ring width.
5. The final objective of this project was to effectively communicate the results of citizen science and park projects to visitors through interpretive products. In addition, a specific “citizen science” initiative was to mentor a high school student who conducted both field work and analysis on the thermal benefits that nurse trees and nurse rocks provide to saguaros.

Approach/Methods

In order to complete the objectives, I was given the time and flexibility to work independently while providing progress updates to my supervisor. These meetings kept work on track and on time. Having a flexible schedule provided the opportunity to work with the Resource Management crew in the field, meet with the Interpretation division when required, and collaborate with other researchers at the University of Arizona and York University. These collaborations allowed me to learn new statistical techniques that I applied to the datasets in the two manuscripts.

Results of the Internship

The internship resulted in drafts of two peer-reviewed papers. These papers are currently undergoing internal review with co-authors before submission to journals. The target journal for the nurse rock/temperature paper is the *Journal of Arid Environments*, while the *Journal of Botany* is the preferred journal for the paper related to saguaro growth rates through time in different habitats of the park. The former article was written in conjunction with a recent high school graduate and is the result of two months of mentorship.

In addition, I provided a road map for Saguaro National Park staff to finish field work for the citizen science “nurse tree” project during the winter of 2019-2020. The plan is for the park to work with citizen scientists, primarily high school students from inner-city schools in Tucson, to collect the remaining data. Then, I will write up and publish the results in 2020 with the assistance of my mentor at the park.

Several outreach products also resulted from the internship. I was interviewed by a film producer for a new movie that will air in the park’s Visitor Center. I was also interviewed by a German TV show for an episode on plant adaptations to arid environments. Both videos will discuss active research programs occurring at Saguaro National Park. Other outreach included visiting a local high school to discuss issues and careers in resource management; scientific consultation with a local citizen biologist about a project relating synchronous establishment between saguaros and the Tumamoc globeberry; a presentation to park and Sonoran Desert Inventory and Monitoring network staff; and review of a presentation for a future brown bag talk by the interpretive staff.

Recommendations

I recommend that Saguaro National Park continue with the long-term monitoring program through the foreseeable future. The next decadal census of monitoring plots will occur in 2020. I also recommend that the Resource Management division finish sampling the plots as part of the saguaro-nurse tree citizen science project. Most plots were subsampled, but a complete survey could be paired with the upcoming census data. The result would be a robust and thorough dataset about the association between saguaros and the surrounding vegetation community while also providing a baseline for future studies of vegetation change in response to climate change. I plan to continue to stay involved with this project and to write up the final results for a peer-reviewed paper.

Deliverables

Paper manuscript: An Examination of the Differences in Growth Rate Over Time for the Saguaro Cactus (*Carnegiea gigantea*) in Different Habitats in Saguaro National Park

Paper manuscript: A Seasonal Analysis of Temperature at Nurse Tree and Rock Sites in the Sonoran Desert

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Jasmine Leung

2018 Future Park Leaders End of Internship Cover Letter

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Santa Monica Mountains National Recreation Area (SAMO)

Project title:

Conducting Community-Based Dialogues about Sustainability and Climate Change in Los Angeles

Document Overview:

This document outlines the internship project conducted by Jasmine Leung under the 2018 Future Park Leaders program and the National Park Service Santa Monica Mountains National Recreation Area. Included in this document is information about what issue was addressed, objectives, methodology used, the internship results, and recommendations moving forward.

Problem statement:

Southern California is already being affected by changing climate and it is predicted that Los Angeles will experience warmer weather, rising oceans, water shortages, and other negative effects. Under-served and marginalized communities, especially those in high density populations such as Los Angeles, are at higher risk to predicted climatic changes due to a variety of factors, one of which is lack of access to green space. Despite these trends, these same communities historically have often been excluded or absent in conversations around issues and mitigation of climate effects, creating gaps in access to green space, climate resiliency, and environmental justice.

Project Objective:

This projects seeks to continue the work of last year's intern in creating and facilitating community dialogues and other programming around topics of sustainability, environmental issues, and climatic changes, and connecting these topics with issues relevant to local communities, such as healthcare, safe public spaces, clean water, education, etc. The dialogues, discussion, and programming encompassed in this project are aimed to have a positive impact on community participants by providing spaces and programming for community participants to not only learn and reflect on such issues but also become empowered through self-generated and personally relevant ideas and solutions created in the discussions.

Project Methodology:

The project was split into two sub-projects which were carried out simultaneously throughout the internship period.

One project involved finding local community organizations to partner with to conduct community-based facilitated dialogues. Several weeks were spent researching, contacting, and coordinating with different local community organizations. After a relationship was established with community

organizations, the intern developed facilitated dialogues specific to each community group. This process involved feedback sessions with NPS staff who were experienced in conducting facilitated dialogues as well as meeting with and conferring with community group contacts on dialogue topics and activities which would best suit or appeal to the community members involved.

The other project involved working with local museums on programming connecting sustainability, changes in climate, and environmental issues to local communities which are connected to the museums. The beginning of the project involved researching different and contacting local museums. After the partner museums had been decided, the intern met with museum contacts to discuss details and scope of the partnership programming. The intern then developed the programming remotely while sending in regular updates and requesting feedback or guidance of project progress from museum partners.

Project Results:

Three community-based facilitated dialogues were conducted. The first dialogue was developed with a NPS SAMO staff member Adali Olivares and the community group was the NPS Summer 2018 Youth Ambassador Program (YAP). The second dialogue was in partnership with the Los Angeles Historic State Park's Prometorx program community group. Finally, the last dialogue was held at the Eastmont Community Center working with one of their senior citizen programs. The dialogue was primarily conducted by Gabriela Meza, another NPS SAMO intern, who conducted the dialogue in Spanish, which was the Eastmont community members' preferred language. Another community-based dialogue was also scheduled with another organization, but communication issues prevented a dialogue date from being settled before the internship's end and ultimately the dialogue with this community group was not able to happen.

Programming was developed in partnership with two museums, the Chinese American Museum (CAM) and the Museum of Social Justice (MoSJ). Programming involved developing interactive and informative exhibits which could be temporarily used by the museums. Events such as facilitated dialogues were considered and discussed with the museums, but due to time restrictions it was determined that such events could not be organized with the museums in the time frame given.

Recommendations:

It is recommended that the LA office of the Santa Monica Mountains National Recreation Area continue to maintain the relationships with the community organizations and local museums which were developed through this internship. In particular, the Prometorx group, as a community group of individuals who seek to be leaders and advocates of their own communities, could be a great group for NPS staff to reach out to local communities. More in-depth training with Prometorx members on facilitated dialogue skills and climate and environmental issues could be used to help these members start dialogues and programming in their own communities. In addition, the Chinese American Museum and Museum of Social Justice could be used in the future as partners for community events and outreach, given enough time and planning.

Due to staffing limitations in the LA office, it would be difficult for permanent staff to make time to develop additional dialogues with new organizations and community groups, although this can be a project possibly continued by future interns. In doing so, SAMO can increase its network and relationship with local, urban communities and help them become aware of and empowered to better address or adapt to emerging issues.

Project Deliverables:

Project deliverables include a 30 page report which includes the outlines of the community-based facilitated dialogues and detailed reflationary reports of each dialogue session. In addition, the report also includes information, reflationary reports, and documentation of the partnership programming done with the Chinese American Museum and the Museum of Social Justice.

Digital copies of the informational posters made for the museum programming can be sent upon request. Smaller copies of some of the posters are present in the report.

Developing Computer Software for the Analysis of Soil Elevation Table Monitoring Data

Malcolm Wells

Abstract

The goal of my Future Park Leader internship was to aide in the analysis soil elevation data, as well as determine the impact of Hurricane Irma and Hurricane Maria on soil elevation in National Parks in South Florida and the Caribbean. I wrote computer code that can be used to visualize and compare changes in soil elevation over time at various levels. To accompany the computer code, I developed several standard operating procedures (SOP) which articulate how to run the code and analyze the data.

Problem Statement

Hurricane Irma and Hurricane Maria impacted South Florida (EVER, BISC) and Caribbean park units (VIIS, SARI) leaving them in disarray and disrupting mangrove communities within these parks. Mangroves are important ecosystems in these parks and consequently, an emerging management issue is the long term health of the mangrove community. To manage mangroves it is necessary to understand changes in soil elevation because of its direct effects on mangrove seedling survival. Increased flooding levels are associated with decreased mangrove seedling survivorship (lack of recruitment) which facilitates a transition to open water mangrove communities. Will the parks have reduced nursery areas, will the parks need to have restoration activities to supplement natural mangrove recruitment or will there be sufficient natural recruitment?

Project Objectives

The goal of my internship will be to aide in the analysis of data collected as part of the soil elevation monitoring program through the South Florida and Caribbean Monitoring Network. To this end, I will write R code and develop standard operating procedures (SOP) which can be used to visualize and compare changes in soil elevation over time. For the SET data, I will develop visualizations at the pin, arm, and SET level within a singular site. For the marker horizon (MH) data, I will develop visualizations at the plot and benchmark level. I will also formulate R code that can be used to run various statistical models on both the SET and MH data. This code will analyze the data at various levels, similar to how the visualization code will depict the data at various levels. I will write an SOP to accompany each visualization and statistical test which will explain how to execute the computer code, as well as real life questions that can be answered and some of the ecological insights that can be gained from each model. Ultimately, I will utilize the code I developed to analyze trends in soil elevation within and between National Parks in South Florida and the Caribbean. Specifically, I will attempt to determine the impact of global climate change by comparing trends in soil elevation with sea level rise and the effect of recent hurricanes.

Approach/Method

The various models which are appropriate for analyzing the data used, have already been detailed in Justification of the analysis for RSETs of the South Florida / Caribbean Network, thus the R code I develop will correspond with the models and methods for analysis found in this document. In addition, I will utilize *SOP 8: SET and Marker Horizon Data Analysis* found in The Surface Elevation Table and Marker Horizon Technique to conduct my analysis and

formulate my SOP's. The SOP for this visualization will specifically be modeled off *SOP 8: SET and Marker Horizon Data Analysis* and use *SOP 10: Data Analysis Using PRIMER Software* found in *Periphyton Monitoring in Big Cypress National Preserve* as an example as to the level of detail needed. The SOPs which I create, will be beta tested by the Resource Monitoring Intern at SFCN, Christian Fernandez, for functionality and reviewed by the Data Manager at SFCN, Judd Patterson, for parsimony. Finally, I will then present this to colleagues here at the South Florida and Caribbean Monitoring Network.

Results

Principally, I developed R code which can be used to visualize soil elevation monitoring data gather by SFCN. This code seeks to visualizally display changes in soil elevation over time and is accompanied by an standard operating procedure (SOP) that I wrote. This SOP articulates how to execute the code and insights that can be gleaned from various visualizations. Given the complexity of the monitoring scheme utilized by the SFCN, I also developed R code for several different models which seek to articulate changes in soil elevation over time. These models vary in complexity and potentially accuracy, given their utilization of the statistical power in the experimental design. The three models which I used to model and compare changes in soil elevation over time were a *T*-test, a general linear model, and a mixed-effect autoregressive model. The third model seeks to address issues of temporal autocorrelation which have been posited by critics of the monitoring scheme. I wrote standard operating procedures to accompany each of these models that include a rigorous assessment of all of the assumptions associated with each individual model and articulate how the assumptions are to be checked and what to do if they are violated.

Recommendations

This work is critical and the present momentum of the project provides an impetus for addressing and resolving issues in a timely manner. Principally, those at SCFN involved in the soil elevation monitoring program should collaborate with the regional office in Atlanta Georgia and others involved in similar projects across the DOI to decide on the proper method of analysis. Coming to a consensus on how the data should be analyzed would make it easier to communicate results/trends and eliminate extraneous work associated with unnecessary forms of analysis. Subsequently, these individuals should work to corroborate the computer code which I developed. This will ensure not only that the code is doing what we want, but that it can also be utilized by other organizations in their soil elevation monitoring programs. There is also impetus for completing this project given that there are a host of soil elevation table monitoring programs throughout the DOI spread all along the Eastern seaboard.

Deliverables

“Soil Elevation Table and Marker Horizon Data Visualizations”

“Soil Elevation Table Accretion T-test” and “Soil Elevation Table Analysis T-test”

“Soil Elevation Table Analysis General Linear Model”

“Marker-Horizon Analysis T-test”

“Standard Operating Procedure - Analysis”

“Standard Operating Procedure - Data Visualization”

“Developing Computer Software for the Analysis of Soil Elevation Table Monitoring Data”