Geoscientists-In-The-Park Summer Internship Mapping Shoreline Change with the National Park Service

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Mapping Shoreline Change

Geoscientists-In-The-Park Summer 2016 Internship Mapping Shoreline Change with the National Park Service

Michael Endicott

May 2017

A Master’s Paper

Submitted to the faculty of Clark University, Worcester, Massachusetts, in partial fulfillment of the requirements for the degree of Masters of Science in Geographic Information Sciences for Development and Environment in the department of International Development, Community, and Environment

And accepted on the recommendation of

Yelena Ogneva-Himmelberger, Project Advisor
Abstract

Geoscientists-In-The-Park Summer 2016 Internship Mapping Shoreline Change with the National Park Service

Michael Endicott

This project paper details the activities carried out as a Geologist/GIS Specialist in the Gateway National Recreation Area as a part of the Geoscientists-In-The-Park internship program. The focus of this position was on supporting the geomorphological monitoring efforts of the National Park Service. This was accomplished through a combination of field data collection, GIS analysis, report writing, and project work. By the end of the internship, substantial progress was made to the formation of Gateway’s Annual 1D and 2D report for 2015-2016, field data were collected for the 2016 summer season, changes in geomorphology were explored and summarized for the Sagamore Hill National Historic Site, and feedback was provided to refine the 3D monitoring protocol document.

This paper is organized into five chapters. Chapter 1 serves as an introduction to the internship and organizations. Chapter 2 describes the organizational structure within which the internship operated. Chapter 3 gives an account of the responsibilities of the internship. Chapter 4 consists of an assessment of the internship, while Chapter 5 provides concluding remarks.

Yelena Ogneva-Himmelberger, Project Advisor
Academic History

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Place of birth: New Brunswick, NJ                          Date: November 5th, 1992

Baccalaureate School: Rutgers University                   Date: May 2015

Baccalaureate Subject: Geography

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to GISDE program following graduation from Rutgers in 2015.

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Dedication

I dedicate this Masters Project Paper and the culmination of my graduate education that it represents to my family and close friends. I am fortunate to be supported by family and friends full of love, kindness, wisdom, and intelligence. The person I have become and the success I have found are results of the support they have consistently and unconditionally provided me throughout the years.
Acknowledgements

I would like to acknowledge the faculty of Clark University and the faculty of the geography department at Rutgers University for their invaluable contributions to my geographic education. I would also like to acknowledge the support of Marc Albert and Duncan Fitzgerald for mentoring me in my first experience with the National Park Service. Additionally, I would like to acknowledge my peers at both Rutgers University and Clark University for the collaborative learning atmosphere. Finally, I would like to acknowledge my supervisor, Norbert Psuty, and other coworkers in the Gateway National Recreation Area for providing a compelling internship experience.
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Chapter 1: Introduction

My experience as a Geoscientists-in-the-Parks (GIP) intern at Sandy Hook in the Gateway National Recreation Area is a core part of the fulfillment of the requirements of the practitioner track of the Master’s of Science in Geographic Information Science for Development and Environment (GISDE) at Clark University. In addition to intensive coursework in a wide variety of technical and content-based GIS courses, students in the practitioner track must take on a summer internship with a GIS focus between the first and second year of their program. I was offered the position as a GIP intern following an application process including an interview and the submission of a resume, cover letter, and responses to essay prompts. The responsibilities of this position were to perform surveys gathering elevation of coastal features, to contribute to the formation of reports produced by the office, and to engage with other projects focused around coastal geomorphology in US national parks. I was well prepared to take on the responsibilities of this internship given past experiences performing similar fieldwork along with my proficiency in GIS acquired from courses at Clark University and in my undergraduate education at Rutgers University.

The internship placed me with a team of geologists from Rutgers University as they worked to support geomorphological monitoring of the National Park Service’s coastlines. My supervisor, Norbert Psuty, is a geologist and Professor Emeritus from Rutgers University. I found the work I engaged with to be varied, compelling, and helpful to my career trajectory. This report will describe the structure of the organizations my internship was placed under, the responsibilities of my internship, and an assessment of the internship.
Chapter 2: Organization Description

My summer internship was carried out under the NPS Geoscientists-in-the-Parks (GIP) internship program. This program’s mission is to work with partners to place students and young professionals in National Parks to focus on research in geosciences and other natural resource topics (US NPS GIP Program). The program offers positions ranging from 3 months to 1 year located in National Parks all across the United States. My internship in the Gateway National Recreation Area was one of dozens of positions offered for the summer season.

The GIP program is hosted by a partnership of several organizations including the National Park Service, the Geological Society of America, Environmental Stewards, and AmeriCorps. Each of these organizations have their own mission and purview. The National Park Service is committed to preserving unimpaired the nature and history of the country’s 413 parks (NPS What We Do). The Geological Society of America seeks to promote stewardship of the environment as well as the research and practice of the geosciences (GSA Homepage). Environmental Stewards is a non-profit organization that provides support to young people seeking to assist land and water management agencies and other non-profit organizations in their projects (Environmental Stewards Homepage). Finally, AmeriCorps is dedicated to engaging members in intensive service projects across a wide variety of institutions in the United States (AmeriCorps Homepage). These organizations come together to host the GIP Internship Program, which can be characterized by the emphasis it places on service, environmental stewardship, and cutting-edge geological research. However, each position offered by the program operates within its own context. The remainder of this chapter will cover the details of the organizations that the work of my internship operated in.

In an operational sense, my internship was nested under two organizations—the National Park Service and the Rutgers University Department of Marine and Coastal Sciences. The
Department of Marine and Coastal Sciences falls under Rutgers University’s School of Environmental and Biological Sciences and is located in New Brunswick, New Jersey (Department of Marine and Coastal Sciences Homepage). The Department of Marine and Coastal Sciences is an academic department that offers coursework and degrees related to marine and coastal sciences; faculty perform biological, chemical, physical, and geological research. The team of geologists I directly worked with included a Professor Emeritus, Dr. Norbert Psuty, and others employed by Rutgers University. The National Park Service is a federal government agency situated within the US Department of the Interior (Bureaus and Offices of the Department of the Interior). My work focused mostly on the park I was stationed at—the Gateway National Recreation Area, located in coastal areas of New Jersey and New York, but included research into coastal processes of other parks.

The team of Rutgers geologists I worked with constitutes the central office for the geomorphological monitoring program for the Northeast Coastal Barrier Network (NCBN). The NCBN is one of the 32 Inventory and Monitoring Networks of the NPS; it consists of 8 park units with similar coastline features (namely shifting sand ecosystems like beaches, dunes, and barrier islands) along the Atlantic Seaboard (NCBN Homepage). The Inventory and Monitoring Network is designed to systematically observe environmental variables of interest to park managers—the Network includes monitoring protocols for salt marshes, landscape change, forest health, estuarine nutrient enrichment, and coastal geomorphology (NCBN Monitoring Protocols). Each monitoring protocol draws off of spatial and non-spatial sciences to track species and features of interest. It is within the coastal geomorphological monitoring for the NCBN that the team of Rutgers geologists plays a central role.
Including myself, the team was composed of 6 researchers led by Dr. Psuty. It is based on Sandy Hook within the Gateway National Recreation Area (GATE). The overarching goal of the team is to support the geomorphological monitoring protocol for the entire NCBN. This includes the production of monitoring protocols for different kinds of data collection to be used by all units in the NCBN. In addition to the production and maintenance of these protocols, the Rutgers team produces annual (1 year) and trend (5 year) reports of data products from the monitoring protocols for several units in the NCBN. The team also performs seasonal data collection of shoreline position (1-dimensional), shoreline profiles (2-dimensional), and elevation surfaces (3-dimensional) in the GATE. Members of the team also engage in coastal geomorphological projects for select sites of interest in the National Park Service beyond the NCBN.

The use of Geographic Information Systems (GIS) is central to the NCBN geomorphological monitoring protocol and the work performed by the Rutgers team. The GIS work can be thought of as split into two distinct areas—field surveys and data processing/analysis. Field surveys use a variety of different GPS equipment to gather different kinds of data on coastal features, while data processing and analysis took place primarily through the use of ArcGIS, Excel, and programming environments. The office also deals with occasional data from remote sensing sources (primarily LiDAR). Data collection and production of results took place in a well-structured database environment that is subject to formatting and structure required by the various protocols for data collection and processing. The organized structure within which the Rutgers team’s GIS work takes place ensures its success in supporting the geomorphological monitoring responsibilities for the NCBN.
It is within this larger context that I conducted my internship. Moving forward in this paper, it will be noted how different data products I contributed fit into the larger operations of the Northeast Coastal Barrier Network.
Chapter 3: Internship Responsibilities

My internship in Sandy Hook had me involved in several different projects with varied responsibilities and requisite skills. It is easiest to understand my internship as having four distinct areas of work: field surveys, contributions to the development of data monitoring protocol, analysis of coastal processes at Sagamore Hill National Historic Site (SAHI), and production of figures for the GATE 2015-2016 Annual Report for 1D and 2D Surveys.

3.1: Field Surveys

An essential role of the Rutgers team of geologists is to conduct field surveys of the various coastal monitoring sites located throughout the Gateway National Recreation Area. As a part of the team, I took a share of the responsibilities in planning and implementing surveys for the summer season. As mentioned earlier, surveys are conducted for the collection of 1D, 2D, and 3D data in accordance with their corresponding monitoring protocols. 1D data are a representation of shoreline position by the location of the high tide during neap tide conditions. 2D data are a representation of shoreline profiles by the elevation of a cross-shore transect. 3D data are a representation of continuous coastal elevation surfaces by raster surfaces interpolated from cross-shore transects of elevation data. 1D is gathered through the use of any standard handheld GPS unit with a horizontal accuracy of less than 1 meter while 2D and 3D data are gathered using survey-grade Real Time Kinematic (RTK) GPS units with 1-2 centimeter accuracy horizontally and vertically. For my tenure as an intern, I participated in close to a dozen survey days at various sites for 2D and 3D data collection (I left the position before the beginning of the 1D collection season in the early fall).
My responsibilities with survey planning included the identification of survey time windows where tides were low in spring tide (more extreme high tides and low tides) to plan the day and time of 2D and 3D surveys. 2D and 3D surveys needed to planned around low tide conditions to maximize exposure of the beach face to access with GPS equipment during the survey. Another part of planning for surveys included the preparation of the equipment—ensuring all necessary batteries are charged and all handheld units had the proper files uploaded to guide surveying in the field. Other survey planning I was involved with included the logistics of arranging transport to survey sites and deciding which team members would be surveying at which sites.

On the implementation of the survey itself, it was my responsibility to gather elevation data according to the protocols established in the protocol documents for each kind of data collection. On surveys where it was my responsibility to gather data closer to the water on transects, I would use one of the available survey wheels to guide the GPS receiver over the coastline’s more gradual features (Figure 1). On surveys were it was my responsibility to gather data of the more varied features (e.g. sand dunes) further inland on each transect, I would carry a GPS receiver mounted to a 2 meter rover pole (Figure 2).
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Figure 1: Collection of elevation data at Sandy Hook using a survey wheel

Figure 2: Collection of elevation data at a site on Staten Island using GPS receivers mounted on a rover pole
The final component of the field survey portion of my internship consists of post-processing of survey results. After each survey, the resulting data points collected on each receiver needed to be transferred from the receiver to the network where survey results are stored. Data collected on multiple receivers from the same site needed to be collated and stored. In addition, each surveyor was required to fill out a field data form documenting details of the survey and any noteworthy events or challenges with the data collection. It was important to be methodical and meticulous in the post-processing of data because the large quantity of survey data collected makes it essential that all data are systematically organized in order to facilitate future analysis and reporting of survey results.

3.2: Review of Draft 3D Protocol

Another responsibility of my internship was to provide extensive feedback on the draft form of the 3D Monitoring Protocol being developed by one of the team members. The review requested of me pertained to all aspects of the document since I was able to provide a fresh perspective as the newest member of the team, but I was told to give particular attention to the parts of the protocol regarding the GIS methods used. My feedback, upon a thorough review of the 40-page document, included recommendations for improvements of GIS methods used, corrections of grammar, ideas for improving the documents format, and suggestions for rearranging the logical flow of sections of the document. My review was documented through track changes in Microsoft Word and sent to the team member leading the development of the draft for him to compile with others’ feedback. Beyond reviewing the document, I participated in group discussions meant to decide among various suggestions made by different people with regards to the changes to be made to the protocol. This work was essential to be a part of because the final protocol released for the
3.3: Analysis of Coastal Change at Sagamore Hill National Historic Site

Approximately halfway through my internship, I was tasked by my supervisor to compile data and analyze shoreline change at Sagamore Hill National Historic Site (SAHI), located in Long Island, NY. The need for this analysis arose as the owner of a boat basin directly downdrift of SAHI complained that activities of park visitors were causing sediment to choke the channel leading to the boat basin. For this project, I analyzed shoreline position data (1D) collected by a park employee in past years along with aerial imagery of the park’s shoreline over time in order to assist my supervisor in interpreting the area’s coastal processes. These analyses culminated in the production of 2 (Figure 3 and Figure 4) maps for my supervisor to bring to a meeting at SAHI to discuss the issue brought up by the boat basin owner. The conclusion reached by my supervisor and me was that the deposition of sediments in the boat basin were due to the long-term coastal process of erosion and sedimentation attributed to the along-shore current, not to park visitor activities.
Figure 3: SAHI Geomorphological Map highlighting accretionary spit north of boat basin
Figure 4: Map of shoreline change at SAHI showing major advancement of the southern spit from 2012-2016

3.4: Gateway National Recreation Area 2015-2016 Annual 1D & 2D Report

My primary responsibility that I took lead on for the summer was the development of the various figures around which the GATE 2015-2016 Annual 1D & 2D Report was to be written. The annual reports released by the office were focused on reporting the results of surveys in graphical form. The 2015-2016 report for 1D and 2D data includes results from the spring and fall
of 2015 and spring 2016 survey seasons in GATE. These reports are a central operation of the office and are therefore given great attention by all members of the Rutgers team. They are written around the figures that provide the context for surveying in that season and the results of the surveys themselves.

Figures I developed that provide context for the surveys include tide charts (Figure 5), tables of storm events (Figure 6), and tables of survey dates (Figure 7). Tide charts are important to produce alongside results of surveys because they provide context for the tidal conditions surrounding surveys. A table of storm events is a summation of the storm events seen visually on the tide charts. The table of survey dates provides a useful reference for any reader looking for more detailed information on the tidal conditions prior to any given survey.
Figure 5: Tide chart showing tide levels exceeding storm threshold along with 1D survey dates

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* Tide elevation values are referenced to Mean Lower Low Water (MLLW)

Figure 6: Storm events for the 2015-2016 survey seasons
Figure 7: Table of survey dates reporting its location and the height and time of the previous high tide (for 1D surveys)

The other figures I produced took the majority of my time in the office over the duration of my internship. These figures include maps communicating shoreline change results from the 1D data collection and graphs communicating changes in cross-shore shoreline profiles gathered from the 2D data. Figure 8 shows an example of one of the 8 shoreline position change maps (from 1D data collection) I produced for the report. A large part of the time spent on these maps was ensuring the highest cartographic standards for them. Included in each map are figures showing gain and loss in shoreline position for each pairwise comparison of the 3 survey seasons, lines representing...
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shoreline position from each survey, and statistics reported on the change in each season. Figure 9 shows an example of one of the 48 figures of shoreline profiles that I made throughout the duration of my internship. Each figure shows a cross-sectional profile of the shoreline along a given transect for each survey season. Also included in each figure is an indication of beach area (beige lines) and dune area (green lines) as well as statistics on dune area in each season. These maps and profiles constitute the core of the annual report and are the results of extensive surveying. Their creation represents the central focus of my internship.

Figure 8: Map of shoreline change at Miller Field from Spring 2015 to Spring 2016
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Figure 9: Example of seasonal changes in shoreline profile along a transect at the Sandy Hook site

3.5: Supporting Organizational Mission

These 4 distinct project areas that I participated in all support the Rutgers geologists’ mission to support the geomorphological monitoring program of the Northeast Coastal Barrier Network. Field surveys represent the monitoring itself as data of topographic features are collected each survey season. Review of the draft 3D protocol assists in the expansion of the monitoring protocol to include the systematic production of highly accurate, high-resolution elevation surfaces of coastal parks. The analysis of shoreline change at Sagamore Hill National Historic Site demonstrates the usefulness of survey data and results to inform land management concerns in and around coastal parks. The reporting of survey results is a central mechanism of the monitoring
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program, and the production of the figures for the Gateway Annual Report form the core of the report that communicates findings to park managers, scientists, and other interested parties. It was clear throughout my internship that the responsibilities I was given were all in clear support of the goals of the Rutgers team and the in support of the fulfillment of the geomorphological monitoring protocol.
Chapter 4: Internship Assessment

Considered all together, the responsibilities and experiences of my internship formed a great experience. It was a compelling opportunity that required application of skills I have learned, challenged me to learn new aspects of geospatial work, and propelled me further along my desired career path. I joined a team of geologists who all were proficient with GIS analysis, and with that starting point I was able to learn a lot from my experience. The skills I learned and the experiences I gained have prepared me well to feel ready to engage in my desired career of coastal geospatial work in US national parks.

There are 3 key takeaway lessons learned from my internship experience. The first was an exposure to the operational context of geospatial research in park management in the National Park Service. I learned what I consider to be an advantage to bureaucracy—structure. As I worked on the production of figures for the Gateway Annual Report, I had to pay mind to the organization of my data. Since the data are required to be reported in a specific format, I had to learn how to keep organized in my work. I have since applied this skill to my own project work because of the clarity it provides and the ease it grants for allowing others to engage in work I have done. The second key takeaway was my exposure to methods for analysis of coastal geomorphological change. I was exposed to the use of tools customized specifically for the analysis of coastal topographic data, thus my familiarity with methods for coastal analysis increased. Last and arguably most important, I learned the importance of collecting high quality ground data. I was given the opportunity to create the spatial data off of which all of the analysis I did was based. It was my first real opportunity to see the creation of data through to the reporting of final products and results based off of those data. This exposure gives me experience in envisioning a geospatial analysis from the start to the end. It also grants a strong understanding of the limitations of the data collected in the field (for
example, the design of cross-shore survey transects can miss the formation of important coastal features if those features lie between transects). I also learned about the difficulties behind implementing field surveys. Schedules of surveyors might not line up, inclement weather can delay surveys in already-small survey windows, and disruptions to data collection such as thick vegetation, poison ivy, and crowds of beachgoers can occur.

I felt well prepared to handle the responsibilities of this internship. My preparation was due in part to coursework taken at Clark University and in part to past fieldwork experience. Clark prepared me particularly well in 3 aspects. My courses taken in programming allowed me to quickly comprehend the functionality of several coastal analysis scripting tools used by the office, though I did no scripting myself. The Spatial Database Development course I took gave me a strong familiarity with the structure of geodatabases in ArcMap, and all files created and analyzed in my internship were required to be in a geodatabase environment. Clark also prepared me in a less tangible way by encouraging a lot of group work on course projects. The collaboration I have become accustomed to at Clark served me well in collaborating with members of the Rutgers geology team. However, Clark did not prepare me for one core aspect of my internship work—surveys. I had acquired some fieldwork experience from a previous summer internship with the Boston Harbor Islands that prepared me for performing surveys in my internship. Otherwise, skills related to the preparation, implementation, and post-processing of surveys would have had to been learned on the job. The largest set of skills I had to learn on the job were not GIS-based, rather I needed to learn much about the content of geology and geomorphology to understand the broader context for a lot of the geospatial work I was doing.

Overall, this internship matched well with my career goals. I have a strong interest in contributing to land and natural resource management in coastal regions through the application of
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GIScience. This internship gave me a great opportunity to engage in central monitoring efforts of the National Park Service’s Northeast Coastal Barrier Network. I gained significant experience with survey data collection and I was able to contribute to the provision of scientific research to park managers. The purpose of my work and its support of the NCBN’s mission helped to foster an enthusiasm that I would hope to have in my future career. I would highly recommend this internship to any IDCE student interested in coastal geomorphology or contributing to the science behind land and natural resource management in the country’s national parks. In addition to its significant work, this GIP internship offers a great experience living in a national park. The work culture was friendly and the opportunities to engage in park events and with park staff make for a summer full of meaningful work and experiences.
Chapter 5: Conclusion

I am humbled to have been given this opportunity to work as a Geoscientists-in-the-Parks Intern at the Gateway National Recreation Area. I was trusted to perform responsibilities central to the operation of the Rutgers geology office. I enjoyed a variety of office work and fieldwork, and had the chance to engage in several important projects during my internship. I gained significant exposure to the performance of geospatial analysis within the National Park Service organizational structure, and my career goal to work in coastal parks with the NPS was advanced. I was able to play a central role in assisting the production of this year’s Gateway Annual 1D and 2D report. Opportunities to contribute to the formation of new monitoring protocols allowed me to engage with the newest and most valuable work being released by the office. In all, I believe that this internship experience fit well with my experience at Clark University and it will help propel toward the career focus I seek upon graduating.
Citations


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