ABSTRACT

KNIGHT, ELEANOR. Archeological Site Stewardship in a Changing Climate: Perceptions of Agency Capacity and Judgments of Site Sensitivity. (Under the direction of Dr. Erin Seekamp).

Archeological sites located in areas exposed to climate stressors with characteristics that also make them sensitive to those stressors are at risk for destruction or loss. This study seeks to understand 1) perceptions of the National Park Service's capacity to implement climate adaptation strategies for archeological sites and 2) understand how archeological expertise can be integrated when determining the sensitivity of archeological sites to climate change threats. Archeological sites present unique considerations when creating policy for preservation, and because climate change presents constant and multifaceted impacts, understanding capacity constraints is necessary. Additionally, risk assessments are often based on static additive or multiplicative equations of the vulnerability attributes, rather than weighted systems that account for perspectives of which attributes more or less influence risk of archeological site. Thus, there is a definite need for a weighted approach to risk assessment that address multiple factors to enhance the transferability of prioritization frameworks. This multiphase study used time series online survey research of National Park Service archeologists, co-production of a sensitivity framework, and pilot testing of a sensitivity framework to better understand capacity perceptions and archeological expertise integration. Through expert judgments of site sensitivity and understanding of capacity barriers that challenge the implementation of adaptation strategies for archeological sites, we can guide policy and adaptation planning for enhanced archeological site stewardship.

Archeological Site Stewardship in a Changing Climate: Perceptions of Agency Capacity and Judgments of Site Sensitivity

by
Eleanor Knight

A Thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Master of Science

Parks Recreation Tourism Management

Raleigh, North Carolina
2022

APPROVED BY:

Dr. Erin Seekamp Committee Chair	Dr. Yu-Fai Leung
Dr. Jelena Vukomanovic	Dr. John Millhauser

BIOGRAPHY

Eleanor Knight was born in Milwaulkie, Oregon, and introduced to parks and the outdoors at a young age. After completing her undergraduate education at the University of Central Florida in Anthropology, she decided to apply her technical archaeology background to her interest in climate change studies by continuing her education at North Carolina State University.

ACKNOWLEDGMENTS

I would first like to recognize the traditional knowledge that makes this work possible, and the continued need for supporting traditional knowledge in the field of archaeology and climate change. Thank you to the members of the Confederated Salish and Kootenai Tribes who contributed to this work.

I would also like to thank the members of our National Park Service team and the teams at Colonial National Historical Park, Glacier National Park, and Valley Forge National Historical Park for their continued support and dedicated work towards this project.

Thank you to Dr. Erin Seekamp for your guidance and encouragement, and thank you to my committee Dr. John Millhauser, Dr. Yu-Fai Leung, and Dr. Jelena Vukomanovic for your insight and time.

Lastly, I would like to acknowledge the unwavering support of my family, my mother Rochelle Knight, my father Roger Knight, my brothers Samuel Knight and Riley Knight, as well as my extended family for their thoughts and support. Thank you for your love and patience.

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CHAPTER 1: INTRODUCTION

Introduction

Climate change is rapidly affecting the planet and our lives, cultures, and heritages. As our ecosystems become stressed by the climate, humans must adapt and mitigate the effects changes will have on our cultures (Sullivan & Mackay, 2012). Archeological sites are defined as places containing remains of land use and settlement or occupation by human groups (Cleere, 2000). Cultural heritage through connections to archeological sites develops from the very basics of what culture is: the view of humans by humans to identify ourselves, and the values, traditions, and materials we produce as part of that identity (Cleere, 2000). Yet, archeological sites, such as those stewarded by the National Park Service (NPS), are vulnerable to extreme loss due to climate change stress (National Park Service, 2010). Vulnerability is defined as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes," and "…is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2001).

Climate adaptation guidance for cultural resources is typically designed as national-level strategies for broad classifications of heritage resources (e.g., Rockman et al., 2016) and as such has been critiqued for being vague and often inapplicable to a variety of sites and stressors (e.g., Daly, 2014). In other words, site managers are often uncertain as to how to implement broad strategies at a park or site level (Fatorić & Seekamp, 2017a). Prioritizing archeological sites for adaptation is an important step for site managers to take (Pollard-Belsheim et al., 2014; Robinson et al., 2010). Yet, capacity constraints exist; lack of money and limited personnel are frequently cited issues in implementing conservation management plans (Demas, 2002) and for adapting heritage sites and resources (Fatorić & Seekamp, 2017b). Assessment frameworks developed in the past included *significance* and *vulnerability* as the main factors for prioritizing archeological site protection in a changing climate (e.g., Carmichael et al., 2018), which are also the key considerations for NPS adaptation prioritization efforts as the agency views adaptive capacity as the adaptation actions implemented (NPS, 2014).

To better understand how to prioritize archeological sites based on significance and vulnerability, a team of researchers from North Carolina State University (NCSU) and partners in the NPS began developing a framework for quantifying the factors that can be used to assess sites.

Although that project includes the development of both significance and vulnerability metrics, the topic of this thesis focuses on the creation and pilot testing of the sensitivity framework for future vulnerability assessments and prioritization of adaptation actions. The quantification of vulnerability as exposure plus sensitivity is based on the concept that risk assessments consider the combination of risk factors and the sensitivity to the risks (Daly, 2014). Development of the sensitivity metrics included a co-production of knowledge approach in which collaborative workshops and iterative elicitations result in the selection of indicators, metrics, and weighted calculations, similar to the approach used by Fatorić & Seekamp (2019). Additionally, pilot testing at several sites that are under a variety of climate change stressors enables framework refinements that enable the NPS to determine if the agency will adopt and apply the framework nationally. The intention of the vulnerability framework is to serve as a tool for engagement and consultation with communities associated with archeological sites in parks that will enhance the integration of cultural values (i.e., perceptions of significant sites) into adaptation planning and decision-making.

This thesis also seeks to document NPS personnel's (e.g., archeologists, park superintendents) perceptions of capacity constraints (management and policy guidance) related to the adaptation of archeological sites threatened by climate change on NPS stewarded land. Documenting capacity constraints can enable the agency to enhance climate adaptation planning efforts.

Background and Literature

In this section, some overarching perspectives are reviewed to provide context for the larger study and this thesis. Given the heritages of archeological sites continue to be tied to living communities of people, it is important to emphasize the recognition of cultural values and the need for processes that integrate those values into prioritization frameworks for climate adaptation. Additionally, it is important to acknowledge that Western science privileges "expert" judgment over traditional ways of knowing. That said, the approach for larger framework will attempt to integrate multiple perspectives but this thesis focuses on the integration of Western archeological perspectives into the measurement of archeological site sensitivity within the larger framework and on NPS personnel's perspective of capacity constraints for stewarding archeological resources in a changing climate.

Archeological sites and values

Current research into vulnerability of archeological sites shows the inclusion of sensitivity alongside adaptive capacity and exposure as indicators for long term assessment of vulnerability (Daly, 2014). With Arctic temperatures increasing at twice the rate as were measured in the 1980s, impacts to archeological deposits include physical and chemical damages that not only impact the materials present, but the surrounding landscape as well (Hollesen et al., 2016). Past comparisons have been made between meteorological records, laser scans, mass balance in glaciers, and the presence of archeological sites to better understand long term sensitivity to changes in temperature and erosion at exposed sites or above buried sites (Ødegård et al., 2017). Inundation of coastal sites, destruction by extended and increasingly intense wildfire seasons, and slope erosion are examples of exposure threats to archeological material directly related to climate change (Newland et al., 2017). By understanding site materials and site location, we can make observations on how a site is sensitive to climate change stressors and how managers can begin to analyze their adaptive capacity, which the NPS considers to be the adaptation strategies applied to the sites (Rockman et al, 2016).

Including associated groups in climate adaptation planning is increasingly present in literature directed towards archeological site protection (e.g., Dawson 2014, 2015; Carmichael et al., 2017, 2018). Beginning the prioritization process with "cultural inquiry", or inclusion of stakeholder values for adaptation strategies is essential for management that is positive for diverse cultural needs (Adger, 2013). Methodological approaches for community management have included indigenous knowledge through significance prioritization, and inclusion of the community in field surveys and management decisions (Carmichael et al., 2018). In developing frameworks for prioritization of archeological sites, associated communities' involvement can allow for better understanding of the individual barriers to adaptation and provides the opportunity for credible and trustworthy data because of the inclusion of values and heritage views (Daly, 2014, 2015). This inclusion provides a greater understanding of landscape and material relationships, needs for adaptation strategies, and the priorities of associated communities (Daly, 2014). Human input in the process of prioritization is essential to creating a flexible framework that can assess and account for a diverse range of needs, beliefs, and knowledge (Daly, 2014; Fatorić & Seekamp, 2017a, 2019). However, vulnerability assessments of archeological sites in the U.S. tends to be assessed through a strict Western science lens.

Cultural values are diverse and varied when considering archeological sites. Understanding place attachment as not being dependent on archeological materials is essential for predictive management (Adger, 2013). Displacement of associated groups from sites can be detrimental to cultural values because of place attachment, as there is no compensation for loss of place (Adger, 2013). Connection to cultural values will be essential to prioritization planning because of the personal and group significance that lies outside of the scientific understanding (Carmichael et al., 2018). Diverging from values-based planning would be detrimental to the groups most at risk from cultural loss due to climate change but the integration of Traditional Knowledges and Western science in adaptation prioritization frameworks have only been applied in cases where Indigenous groups have management or co-management authority (i.e., Carmichael et al.,2017)[1].

The occupational history of land is often diverse, overlapping, and intertwined. With archeological research, multicultural interests and stratified occupation can make inclusion of all stakeholders a complex process, including when considering climate adaptation options and priorities (Adger, 2013). The dynamic nature of cultural landscapes adds flexibility to the understanding of archeological sites, although this approach is one not often brought by Western researchers to conversations on prioritization. However, viewing "archeological sites priorities" as "cultural landscapes priorities" instead has shown to be beneficial to sustainable development monitoring, and the understanding of cultural values and their past development is as essential to future preservation as the material remains left from the past (Bürgi et al., 2017). As such, the approach taken in this thesis will consider NPS-delineated archeological sites while also enabling broader landscape evaluations of vulnerability.

Measurement and Prioritization Frameworks

Past methodological approaches by researchers interested in preserving heritage and archeological sites from climate change stressors show a variety of potential tools for managers and communities. For example, Paolini et al. (2012) describes risk, values, and condition assessments in risk management. Systematic approaches of risk management methodology include general risk assessments and the creation of mitigation or management strategies as part of the framework (Paolini et. al, 2012). Values assessment, or inclusion of stakeholder values in the risk

1 As stated in the introduction, this thesis will only focus on the vulnerability assessment aspect of the prioritization framework. However, it is important to acknowledge the importance of including local, contextualized, and multiple value perspectives about the meanings embedded within places. Ultimately, the broader project will address this integration but this thesis will focus on expert judgments of site sensitivity and the capacity barriers that challenge the implementation of adaptation strategies for archeological sites.

management process, is seen as essential to understanding the integrity of sites (Paolini et al., 2012). Condition assessment is also seen as essential as part of risk management for archeological sites threatened by climate change because of the prioritization process (Paolini et al., 2012). Additionally, the development of risk index systems to determine the connection between climate stress and heritage sites has also been explored as a useful methodology (Forino, MacKee, Meding, 2016). However, these types of risk assessments are often based on static additive or multiplicative equations of the vulnerability attributes, rather than weighted systems that account for perspectives of which attributes more or less influence risk of archeological sites. There is a definite need for a weighted approach to vulnerability and risk assessment that address multiple factors to enhance the transferability of prioritization frameworks.

Unfortunately, many of these studies on the vulnerability of archeological sites are the first of their kind and are just in the infant stages of understanding long term changes to archeological materials due to climate change factors. Research is often limited on the type of organic deposits and age of deposits, and a majority of measurements in speed of degradation center on glacial or permafrost environments (Hollesen et al., 2019). Gaps in projection models appear because of the difference in composition of archeological materials and the soil they are deposited in, blocking long term projections from being made (Hollesen et al., 2019). Therefore, a need for an overarching study and design that is inclusive of the flexibility needed to address specific risks and account for measurement and data uncertainties that exists to enhance planning and management decisions.

Statistical Reasoning

Throughout the framework building process, the team has followed quantitative methods with a strong focus on displaying data in a way that can be interpreted easily and efficiently to better contribute to engagement and consultation processes with associated stakeholders. This reductionist approach, characterized by "quantification, a linear-serial way of proceeding and a deductive and analytical way of reasoning" is seen as beneficial from a Western view of archeological sites (Verschuren, 2001). However, the use of snowball sampling and other holistic strategic sampling styles as defined by Verschuren (2001) were used in this project to gather survey participants, as well as the strategy of a cyclical approach generation and analysis of research material. This approach allows for the team to reevaluate the framework based on feedback from interested parties such as NPS archeologists who were selected by NPS project partners and self-

nominations. The use of participant-identified sensitivity attributes, as well as the metric scores and weighting of attributes, is appealing for this project because it allows for an evaluation process to take place, in this case, for attributes such as site condition, contextual disturbances, physiographic context, and material susceptibility. Yet given the depth and breadth of knowledge necessary for making multi-faceted evaluations, there is a need to also account for the confidence held by participants providing such expert judgments.

Needs and capacity for archeological site climate adaptation

Despite this research into the critical effects of climate on archeological material, the framework to determine site sensitivity is reliant on flexible language to allow local managers to make individual decisions toward site preservation. The NPS lacks true written definitions into what constitutes a site's vulnerability and significance (Seekamp, Fatorić, McCreary, 2020). Alongside this, there is a need to develop frameworks that connect communities and stakeholders to site risk and can allow them to contribute to the concept of value or significance based on their own cultural and social identities. For this connection to happen, there is a need for research on defining and quantifying characteristics of sensitivity at sites and of specific archeological materials that have the potential to be impacted by climate change.

Capacity constraints for park managers and staff are often similar to other government constraints recognized in research, specifically fiscal, social, political, and legal barriers (Beier et al., 2016; Fatorić & Seekamp, 2017b; Phillips, 2015). However, archeological sites present unique considerations when creating policy for preservation, and because climate change presents constant and multifaceted impacts, understanding capacity constraints will take the participation of NPS staff to truly grasp.

Research Questions and Objectives

This thesis will seek to answer the following questions:

1. How should archeological expertise be integrated when determining the sensitivity of archeological sites to climate change threats?
2. How are NPS personnel's perceptions of agency capacity influencing the ability to implement climate adaptation strategies for archeological sites?

To answer these research questions, this thesis will have four objectives. For question 1, the objectives are (1a) to determine perceptions of capacity and (1b) to consider the implications of

those perceptions on climate change adaptation strategies for archeological sites. For question 2, the objectives are (2a) to develop a sensitivity measurement framework using a co-production approach with NPS archeological experts and (2b) to consider using values as weights based on expertise and/or confidence.

Thesis Structure

This thesis is composed of separate products (Chapters 2 & 3) and a concluding section (chapter 4). Chapter 2 is written as a manuscript for submission to a refereed journal (*Environmental Science & Policy*) and addresses research question 2 and objectives 2a and 2b. Chapter 3 is written as a technical report for submission the National Park Service and addresses research question 1 and objectives 1a and 1b. Chapter 4 provides a synthesized commentary of key findings, limitations, and implications.

CHAPTER 2: MANUSCRIPT

I. Introduction

Climate change is causing worldwide loss of cultural heritage and will lead to further loss in the near future. As our lives and cultures become stressed by the climate, humans must adapt and mitigate the effects changes will have (Sullivan & Mackay, 2012). Archeological sites are defined as places containing remains of land use and settlement or occupation by human groups (Cleere, 2000). Archeological sites stewarded by the National Park Service (NPS) are vulnerable to extreme loss due to climate change stress (National Park Service, 2010), causing concern for stakeholder groups and managers of these sites. Vulnerability is defined as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001) and the quantification of vulnerability as exposure plus sensitivity is based on the concept that risk assessments consider the combination of risk factors and the sensitivity to the risks (Daly, 2014). This project seeks to answer the question "How should archeological expertise be integrated when determining the sensitivity of archeological sites to climate change threats?".

To better understand how to prioritize archeological sites based on significance and vulnerability, a team of researchers from North Carolina State University (NCSU) and partners in the NPS began developing a framework for quantifying the factors that can be used to assess sites. Although that project includes the development of both significance and vulnerability metrics, this study focuses on the creation and pilot testing of the sensitivity framework. The framework was iteratively developed using a co-production of science process (Fatorić and Seekamp, 2017) in which NPS archeologists and cultural resource managers participating in a four-part workshop series in the fall of 2020 and broader expert elicitation in the spring of 2021. Then, the framework was pilot tested on a subset of archeological sites at two different National Park Service units (one coastal and one interior) in summer of 2021. Results from the pilot tests demonstrate this co-produced framework's utility in measuring the relative sensitivity of similar and dissimilar archeological sites in both coastal and mountain ecosystems.

II. Literature review

Climate change and archeology

Increasing global average sea levels and temperatures are well documented and attributed to anthropogenic climate change (IPCC, 2001). Archeological sites, which are unique and dependent on their geographical context, are threatened by climate change through sea-level rise, erosion, freeze-thaw of soil, vegetation changes, and temperature changes (IPCC, 2001). These climate stressors can cause physical and chemical damage to archeological materials, which can be detrimental to archeological contexts (Hollesen et al., 2018). Thus, archeological resource stewardship needs to account for the sensitivity of archeological sites to these stressors.

In the U.S., the NPS, an agency charged with archeological resource stewardship, is increasingly concerned with climate adaptation. For example, the agency's Climate Change Response Program (CCRP) has goals of developing an "interdisciplinary approach to dealing with climate change," as well as cultural resource decision-making tools and expanding capacity for inventory and monitoring (National Park Service, 2010). Additionally, the NPS has issued policy, such as the NPS Policy Memo 14-02 (PM 14-02), to provide managers with guidance for funding cultural resource adaptation (National Park Service, 2014). Within PM 14-02, "innovation" is encouraged for setting adaptation priorities, as is integration of archeological materials and cultural resources into climate change adaptation and carbon reduction strategies (National Park Service, 2014). Additionally, the policy guidance encourages managers to "engage fully in cooperative conservation and civic engagement," including consultation and inventory reassessment by determining the *vulnerability* and *significance* of threatened areas and resources (National Park Service, 2014).

Current research into vulnerability of archeological sites shows the inclusion of sensitivity alongside adaptive capacity and exposure as indicators for long term assessment of risk to climate stressors (Daly, 2014). However, the NPS—in a cultural resource management context—conceptualizes adaptive capacity as the adaptation strategies that are implemented to preserve archeological sites and recommends a focus on sensitivity and exposure (Rockman et al., 2016). Climate change projections that estimate archeological site exposure is being increasing prevalent in the literature (e.g., Anderson et al., 2017; Fenger-Nielsen et al., 2021; Johnson, Marrack & Dolan, 2015; McCoy et al., 2018), but research on archeological site sensitivity has been predominately descriptive to date (e.g., Hollesen et al., 2018) or measured on limited scales (e.g.,

Carmichael et al., 2018; Daly, 2014). Therefore, research is needed to construct a measurement framework for estimating the relative sensitivity of archeological sites to climate change stressors to enable site managers, such as the NPS, to identify adaptation priorities within and across multiple archeological and geographic contexts.

Measurement frameworks and priorities

Frameworks for archeological site prioritization are created to be useful and flexible for use across diverse sites (Phillips, 2015). Similar measurement frameworks to the developed archeological site sensitivity framework have analyzed and assessed exposure metrics of vulnerability (e.g., Daire et al., 2012) or used general evaluations of low, moderate or high (e.g., Carmichael et al., 2018; Daly, 2014). Although these are admirable efforts, there is a need to develop a framework with the goal of assessing substantial differences among sites with relatively similar archeological materials and exposures, or among hundreds of diverse sites. These more general frameworks, while easy to implement, do not consider the relative weight of each indicator (i.e., unweighted summative or multiplicative calculations of attributes) or relative differences between different metrics when simply scored 1, 2 or 3. As such, we followed an approach that integrates expert opinion of weights and scores to create the sensitivity framework (similar to Fatorić & Seekamp, 2018, and Xiao et al., 2019).

Developing a values-based framework is essential for a number of reasons. Most importantly, co-producing a framework is likely to garner the support of those who have a stake in the product (Demas, 2013), with the product here being archeological site prioritization for climate adaptation. As such, participant selection for framework development needs to be conducted with personal values in mind, including ethical archeological work, climate change acknowledgement, and previous work in both archeology and climate change (Demas, 2013). With NPS being the managing authority of archeological sites in this study, engaging with NPS archeologists becomes necessary to improve understanding of priorities, perceptions, and values that may affect the protection of archeological sites. Therefore, we used a co-production of knowledge approach (see: Fatorić & Seekamp, 2018) to create a values-focused archaeological site sensitivity framework, which we pilot tested with a small set of archeological sites at two distinct National Park Service units (i.e., Colonial National Historic Park and Glacier National Park).

III. Methodology

Study Design

This thesis research is embedded within a larger study that employs a sequential, mixed methods research design (Creswell & Creswell, 2018; Figure 1). The past work on this project began in 2018 with a workshop series (CALO2Arch[2]) dedicated to creating a prioritization framework for assessing the relative significance and vulnerability of archeological sites stewarded by the National Park Service. That initial workshop used a co-production of science approach to draft a measurement tool for assessing archeological site significance with a diverse set of NPS personnel familiar with archeology and cultural resource management and policy (see: Fatorić & Seekamp, 2019). During elicitation surveys with a broader group of agency personnel that followed the workshop aimed at refining the significance measurements (for a description of iterative co-production of science processes, see: Lemos & Morehouse, 2005), it was determined that additional efforts were needed to integrate citizens' and staff of Tribal Nations values of archeological site significance more intentionally (not the focus of this thesis). Additionally, the CALO2Arch workshop had time constraints that resulted in the need to plan a separate workshop

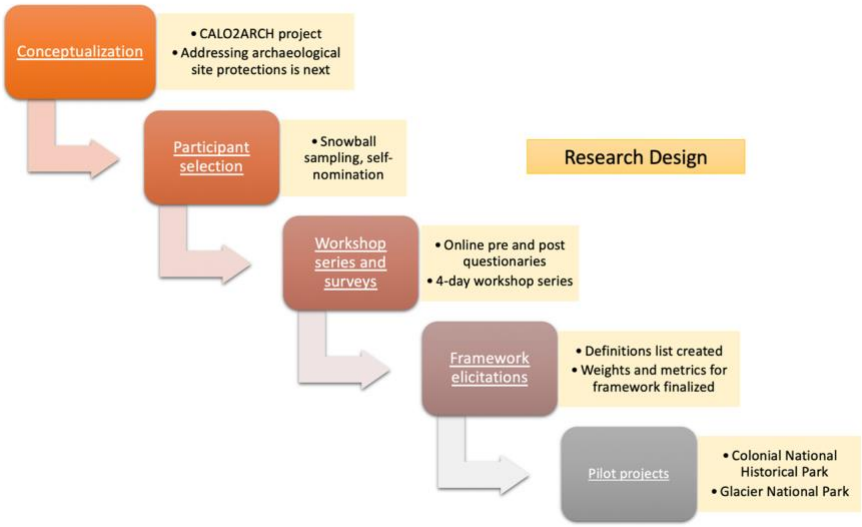

Figure 1: Flow chart depicting thesis project research design.

2 This workshop name, CALO2ARCH, represents the research project trying to determine if the process for building an adaptation planning framework developed for historic buildings at Cape Lookout National Seashore (CALO) could be transferable to archeological (Arch) sites.

and elicitation effort focused solely on constructing measures of archeological site sensitivity (the focus of this research). This latter effort began in the fall of 2020 to revise a beta framework for measuring archeological site sensitivity emerging from the 2019 workshop.

The workshop series was four days long, with a 2-week gap between the first two days and the final two days, lasting 4 hours each day, and conducted over Zoom due to the Coronavirus pandemic (1:00pm – 5:00pm EST, October 27, October 30, November 10, & November 12). Prior to the workshop, a pre-workshop survey was administered to assess participants' interest in working on specific sensitivity attributes during the workshop, as well as to collect perceptions about climate change adaptation planning capacity constraints (not the focus of this paper). The workshop began with a presentation and discussion of the pre-survey results, followed by a presentation of the beta framework with explicit explanation that breakout groups would be intended to revise the beta framework. The breakout groups each addressed one sensitivity framework attribute and had discussions about definitions, measurement levels (metrics), weights, and usefulness of each attribute and sub attributes. Revisions to the framework were made during the two-week gap in workshop sessions and those revisions were presented for group discussion and further refinement of the framework during the subsequent workshop sessions.

Some of the attributes and sub attributes were selected because of their availability in the Cultural Resources Information System (CRIS), which is utilized by NPS to house archeological site data as it is updated through condition assessments. The goal of including CRIS based attributes is to include existing data from park staff and to ease the burden of new data collection and input.

Following the workshop series, an elicitation of the framework as it stood in the final days of the workshop was distributed (administered online via Qualtrics). The elicitation asked for participants to weigh each attribute (or sub attribute) relative to the other attributes (or sub attributes) and assign a score (from 0 to 5) to each attribute's or sub attribute's metrics. This elicitation was accompanied by a post-workshop survey, which included survey questionnaire items about capacity (repeated measures from the pre-workshop survey) as well as follow-up questions/items regarding discussions from the workshop series and open-ended questions/items (more details are provided in the Survey Research Methodology section below).

Data from the elicitation surveys were cleaned in Excel and analyzed using IBM's Statistical Product and Service Solutions (SPSS). Discussions from the workshop and comments

provided in the post-workshop survey indicated the need for written definitions for each attribute to be developed, and this was done by the NCSU team and NPS collaborators using a shared document hosted in Microsoft Teams. A final framework elicitation was distributed via email, along with the written definitions, to a larger group of NPS archeologists and cultural resource managers in Spring 2021. The framework was then piloted at two sites during the summer of 2021. These sites were Colonial National Historical Park (COLO) and Glacier National Park (GLAC). The pilot studies advanced the framework development by providing opportunity for feedback on the project by NPS staff.

Participant selection

Participant selection was a collaborative endeavor through nomination by NPS personnel within the Washington Office (WASO) office and who serve as project partners. Our NPS collaborators identified 30 individuals with known expertise in archeology and climate change, as well as through an open call for self-selection posted in the NPS Archeology Program's newsletter, Archeology E-gram. Invitations to the four-part workshop series were issued by our team as well, and the final RSVP from archeologists created a full workshop participant group of 30 people, not including the project team, which consisted of three NC State University researchers and four NPS staff members.

Participants for the broader expert elicitation were selected through a similar process with additional suggestions being provided by the WASO Archeology Program Lead and regional Archeologists. The final list of participants for the broader elicitation included 72 contacts, including the workshop participants. This final framework elicitation was distributed via email, along with the written definitions, to a larger group of NPS archeologists in the spring of 2021. A total of 36 responses were received from these 72 contacts (50% response rate).

Final framework

The final framework co-produced by the workshop participants included the following five attributes: Site stability, Disturbances and threats, Assemblage susceptibility, Physiographic context, and Existing protections. All attributes, except Existing protections, were associated with two or more sub attributes, and these sub attributes, as well as the Existing protections attribute were affiliated with three or more metrics. The final definitions of each attribute, sub attribute, and metric were collaboratively developed (Appendix A).

The conceptualization of Site stability included two sub attributes: Site condition and Site condition confidence. The metrics for Site condition corresponds to what is found in the NPS CRIS database (good, fair, poor, unknown, destroyed). During the workshops, it was revealed that Site condition assessments are typically performed on 5-year cycles, there may be backlogs in performing these assessments, or that impacts may be known to have affected the Site condition listed in the NPS CRIS database. As such the sub attribute, Site condition confidence, was developed to enable weighted confidence assessments (metrics: high, moderate, or low) to influence the final score, as well as technical judgment to replace the Site condition listed in the NPS CRIS database with a perceived Site condition score associated with higher confidence (metric: technical judgment).

Disturbances & threats was selected as an attribute during the workshop to account for existing vulnerabilities of the sites being assessed. The metrics for Disturbance Severity Level correspond to what is found in the NPS CRIS database (Severe, moderate, low, unknown, not applicable). For the same reason as Site stability, the confidence measure Disturbance severity level confidence was included (metrics: high, moderate, low, technical judgement).

The attribute Assemblage perishability evolved during workshop conversations as a way to account for loss of archeological material. The metrics for the two sub attributes Artifact perishability and Site features also account for the number of stressors applied to the materials and features (Artifact perishability metrics: Perishable, Multiple Stressors, Perishable, Single Stressor, Not Perishable, Unknown; Site features metrics: Present, Threatened, Multiple Stressors, Present, Threatened, Single Stressor, Present, Not Threatened, Not Present, Unknown but Likely, Unknown but Unlikely). The sub attribute Contextual Threats allows for archeological materials to be assessed for their potential to lose context, which is important for understanding data potential of a site (metrics: likely, unlikely, unknown).

The attribute Physiographic context includes eight sub attributes that were selected to help establish the extent to which geophysical context could make a site more or less sensitive to climate stressors. The selection of the sub attributes Soil, Slope, Aspect, Substrate, Landform, Vegetation, Watershed, and Elevation was completed in the workshop, and it was discussed in the workshop that without negative metrics, which would show a benefit of the physiographic context, the metrics of no affect and protective would be represented as a single metric (metrics: Detrimental, No affect or Protective).

The attribute Existing Protections was created during workshop conversations, and is intended to allow for sites to be prioritized by the state of current management and physical protections to climate stressors (metrics: None but Needed, Existing but Damaging, Existing but Poor, Existing but Fair, Existing and Good, None but Unnecessary).

Data collection for elicitations

In the elicitation survey, respondents were tasked with weighting and scoring each attribute, sub attribute, and metric for the sensitivity framework as it was presented at the time. Respondents were asked to choose weights and scores on a sliding scale. The instructions requested that respondents consider not only the numeric values of each weight and score, but the difference between metrics. The instructions stated:

> "Also, to decipher the meaning behind differences in scores, you just need a calculator (or Excel file open) and ask yourself:
>
> **"Score A is what x% greater than score B?"**
>
> **The equation is: x = [(score B ÷ score A)*100] - 100**
>
> For example, if you are considering the distance between two levels within the metrics, some options are:
>
> - Scores of 1 & 2, which would mean that you think the metric that receives a score of 2 is 100% greater in importance than the metric that receives a score of 1.
> - Scores of 1 & 2.5, which would mean that you think the metric that receives a score of 2.5 is 150% greater in importance than the metric that receives a score of 1.
> - Scores of 0.5 & 2, which would mean that you think the metric that receives a score of 2 is 300% greater in importance than the metric that receives a score of 0.5.
> - Scores of 0 mean that you think that the metric receiving a score of 0 is not important in terms of assessing archeological site sensitivity."

For each attribute, sub attribute, and metric section in the survey, respondents were required to indicate their confidence in the scores and weights they provided. This confidence assessment was included based on the comments we heard during the workshop that not all participants felt that they had the technical knowledge to make these assessments for every attribute, sub attribute and metric.

Data analysis

All collected data were treated as confidential. Any identifiers were removed from downloaded data. After the response period for the survey was closed, the data was exported, processed, and cleaned using Microsoft Excel and IBM® SPSS® software platform.

Selection of final calculations for the sensitivity scores was determined through a team discussion about the range of responses. The attribute and sub attribute weights were calculated as mean responses (Table 1). The metric scores were tested for statistical sensitivity as means and medians, with the removal of responses marked as "not very confident" by the respondent. There was also testing of weighting responses based on the confidence scales, from 3 to 1 and 2 to 0 (Very confident, somewhat confident, not very confident) using data collected at one of the pilot sites. Final metric scores were selected as mean responses weighted by confidence from 2 to 0 without the removal of outliers.

Table 1. Sensitivity framework attributes and sub attribute weights with metrics and scores

Attribute	**Sub attribute**	**Weights**	**Metrics**	**Scores**	**Range of Scores**
Site stability		21.7			
	CRIS site condition	62.1			
			Destroyed	1.54	0.0 – 5.0
			Poor	3.15	1.0 – 4.6
			Fair	3.05	1.8 – 4.0
			Good	2.95	1.0 – 4.0
			Unknown	2.31	0.0 – 4.5
	CRIS site condition confidence	37.9			
			Low	1.59	0.5 – 4.0
			Moderate	2.58	1.1 – 4.0
			High	3.30	0.5 – 5.0
			Technical Judgement	3.18	0.0 – 5.0
Disturbances and threats		25.8			
	Disturbance severity level	60.4			
			Severe	3.71	0.5 – 5.0
			Moderate	2.91	2.0 – 4.0
			Low	2.36	1.0 – 4.5

Table 1 (Continued)

			Unknown	2.20	0.0 – 4.1
			Not Applicable	1.36	0.0 – 5.0
	Disturbance severity level confidence	39.6			
			High	3.75	1.0 – 5.0
			Moderate	2.53	1.5 – 3.4
			Low	2.04	1.0 – 4.0
			Technical judgment	3.40	0.0 – 5.0
Assemblage Perishability		20.8			
	Artifact perishability	33.0			
			Perishable, Multiple Stressors	3.71	0.6 – 5.0
			Perishable, Single Stressor	3.10	0.7 – 4.5
			Not Perishable	1.65	0.0 – 5.0
			Unknown	2.93	1.0 – 5.0
	Site features	31.4			
			Present, Threatened, Multiple Stressors	3.79	0.0 – 5.0
			Present, Threatened, Single Stressor	3.24	0.0 – 4.5
			Present, Not Threatened	2.26	0.0 – 4.1
			Not Present	1.66	0.0 – 5.0
			Unknown but Likely	3.16	0.7 – 4.1
			Unknown but Unlikely	2.33	1.0 – 4.9
	Contextual threat	35.6			
			Likely	4.44	2.0 – 5.0
			Unlikely	2.48	0.0 – 5.0

Table 1 (Continued)

			Unknown	2.39	0.0 – 4.5
Physiographic context		15.4			
	8 Sub attributes (Soil, Slope, Aspect, Substrate, Landform, Vegetation, Watershed, and Elevation)		Detrimental	4.22	1.0 – 5.0
			No affect or Protective	2.34	0.0 – 5.0
Existing protections		16.3			
			None but needed	3.89	0.5 – 5.0
			Existing but damaging	2.77	0.0 – 5.0
			Existing but Poor	2.41	0.0 – 4.0
			Existing but Fair	2.18	0.0 – 4.0
			Existing and Good	1.75	0.0 – 5.0
			None but Unnecessary	1.48	0.0 – 5.0

Framework calculations began with deriving the sub attribute score (or attribute score for Existing protections), followed by deriving weighted averages of the sub attributes. Then, the raw sensitivity score was calculated by deriving weighting averages of the five attributes. Final sensitivity scores were calculated by normalizing the metric scores to make the attribute and sub attributes scores comparable on a 0 to 1 scale. Normalized scores were calculated by subtracting the minimum score within metric span from the metric score applied to a site, then dividing that value by the span of the metric scores ([Metric score - Minimum score]/Span of metric scores).

IV. Results: Pilot testing

For the full framework scores for both pilot projects, see Appendix B.

Colonial National Historical Park (COLO)

Connections and partnerships with the resident park archeologist, who also participated in the workshop series, resulted in the selection of Colonial National Historical Park (COLO) for pilot testing. Additionally, the abundance of archeological sites with historic archeological material was beneficial to piloting the significance framework. To apply the framework at this park, the archeologist pre-selected ten sites for pilot testing, which were all located on Jamestown Island. The sites were visited by the NCSU team with the park archeologist to better understand their physiographic context and geographic location in relation to each other. The pilot sites were all of similar physiographic context (wooded low-lying coastal lands proximate to shorelines), geographic area (Jamestown Island), and historic period (from 16th century to 19th century). The park archeologist then assisted in filling out the framework for each site.

Sensitivity scores for the COLO pilot sites are presented in Table 2. This pilot test demonstrated that despite the similarity of the selected pilot sites, final normalized sensitivity scores allow for prioritization of sites based on the sensitivity score (range: 0.638 to 0.865; Table 2).

Glacier National Park (GLAC)

The pilot at Glacier National Park (GLAC) provided the experience of using the framework in the field at nine sites with a variety of geographies, materials, and contexts. The utilization of both field site visits and office consultation with park archeologists provided a unique view at the applicability of the framework. Due to the site and nature of archeological sites at GLAC, we realized that the use of the framework with a primary focus on field work or site visits would not be realistic or useful for this park or similar size parks.

Sensitivity scores for the GLAC pilot sites are presented in Table 3, which also demonstrate that the final normalized sensitivity scores are likely different enough to allow for prioritization of sites based on the sensitivity score (range: 0.530 to 0.895; Table 3). The sites were selected to show the effect of the framework on a variety of physiographic contexts, data potentials, and material types. The consultation with park archeologists showed the amount of time for a consensus on each sub attribute and completion of five framework entries (with also the

consultation on site entries previously filled out by our team using CRIS and GIS) would take about two hours. This is something to be considered as a barrier to effectiveness of the framework at this particular site.

Table 2. Pilot testing results from Colonial National Historical Park

Attribute Subattribute	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Site Stability										
Condition	Poor	Good	Good	Fair	Fair	Fair	Good	Good	Good	Poor
Condition Confidence	High	High	High	High	High	High	High	High	High	High
Disturbances and Threats										
Disturbance Level	Low	Low	Low	Moderate	Moderate	Low	Low	Low	Moderate	Severe
DSL Confidence	High	High	High	High	High	High	High	High	High	High
Assemblage Susceptibility										
Perishability	Perishable, single stressor	Perishable, single stressor	Perishable, multiple stressors	Unknown	Perishable, multiple stressors	Perishable, single stressor	Perishable, single stressor	Perishable, single stressor	Perishable, multiple stressors	Perishable, multiple stressors
Features	Unknown but likely	Unknown but likely	Present, threatened	Not present	Unknown but likely	Unknown but likely	Unknown but likely	Unknown but likely	Unknown but likely	Unknown but likely
Contextual Disruption	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely
Physiographic Context										
Soil	No effect	No effect	Protective	No effect	Detrimental	No effect	No effect	Protective	No effect	Detrimental
Slope	No effect	No effect	No effect	Detrimental	No effect	Detrimental	No effect	Detrimental	No effect	No effect
Substrate	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Landform	No effect	No effect	No effect	No effect	Protective	Protective	No effect	No effect	No effect	No effect
Vegetation	No effect	Detrimental	Detrimental	Protective	No effect	Detrimental	No effect	Protective	Detrimental	Detrimental
Aspect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Watershed	Detrimental	No effect	Detrimental	No effect	Detrimental	Detrimental	Protective	Detrimental	Detrimental	No effect
Elevation	No effect	Detrimental	Detrimental	No effect	Detrimental	Detrimental	Detrimental	No effect	Detrimental	No effect
Existing Protections	None but needed	None but needed	None but needed	None but needed	None but needed	None but needed	None but needed	Existing but Poor	Existing but fair	None but needed
Final, Normalized Sensitivity Score	**0.755**	**0.739**	**0.797**	**0.759**	**0.823**	**0.766**	**0.739**	**0.638**	**0.715**	**0.865**

Table 3. Pilot testing results from Glacier National Park

Attribute Subattribute	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**
Site Stability									
Condition	Good	Fair	Good	Poor	Fair	Fair	Fair	Good	Poor
Condition Confidence	High	High	High	Moderate	High	High	High	High	High
Disturbances and Threats									
Disturbance Level	Low	Low	Moderate	Severe	Severe	Moderate	Moderate	Low	Moderate
DSL Confidence	High	Moderate	High	High	High	High	High	High	High
Assemblage Susceptibility									
Perishability	Perishable, multiple stressors	Perishable, multiple stressors	Perishable, single stressors	Unknown	Perishable, multiple stressors	Unlikely	Not perishable	Unknown	Not perishable
Features	Yes, not threat	Unknown unlikely	Unknown unlikely	Unknown unlikely	Present, threat, multi	Unknown likely	Unknown likely	Unknown likely	Present, threat, single
Contextual Disruption	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely
Physiographic Context									
Soil	No effect	No effect	No effect	No effect	No effect	No effect	Detrimental	No effect	Detrimental
Slope	No effect	No effect	No effect	Detrimental	Detrimental	No effect	Detrimental	No effect	Detrimental
Substrate	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Landform	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Vegetation	No effect	No effect	No effect	No effect	Detrimental	No effect	Detrimental	Detrimental	Detrimental
Aspect	No effect	Protective	Protective	Protective	Protective	Protective	Protective	Protective	Protective
Watershed	No effect	Detrimental	No effect	Detrimental	Detrimental	No effect	No effect	Detrimental	No effect
Elevation	No effect	No effect	No effect	No effect	No effect	No effect	Detrimental	No effect	Detrimental
Existing Protections	None but unnecessary	Existing but fair	None but unnecessary	None but needed	None but needed	None but needed	None but needed	None but needed	None but needed
Final, Normalized Sensitivity Score	**0.530**	**0.534**	**0.548**	**0.780**	**0.895**	**0.739**	**0.774**	**0.733**	**0.784**

V. Discussion and Conclusions

Condition assessments and other types of frameworks that assess sensitivity are essential to prioritizing archeological sites; however, research on how to integrate perceptions or values is limited (Paolini et al., 2012). Additionally, the development of risk index systems to determine the connection between climate stress and heritage sites has also been explored as a useful methodology, but not implemented into a framework approach (Forino, MacKee, Meding, 2016). The results from pilot testing the archeological site sensitivity framework show that there can be variability in perceptions by park archeologists but that the framework as it stands is able to detect differences between contextually similar sites. However, our pilot testing also revealed that the framework would benefit from some changes to enhance applicability. The variability in perceptions of archeological site sensitivity by park archeologists was further observed during the GLAC pilot test, where we worked with a group of four archeologists associated with the park. With nine pilot sites at GLAC, we were able to complete framework entries for four sites prior to meeting with the group and had the five sites completed by the archeologists with NCSU team guidance to compare. Based on conversations with park archeologists at GLAC, they worked together to complete the framework entries, including confidence assessments for Site Condition. There was active discussion about each site and how to properly decide on metrics for the sites based on their recent field visits. If the NPS were to adopt this framework, such a collaborative approach should be encouraged, particularly at sites with recent turnover among the archeology staff.

In terms of evaluations of the framework by the archeologists engaged during the pilot tests, we received feedback that the framework could be applicable and useful with some modifications. The park archeologist at COLO provided feedback that the framework can detect differences at extremely similar sites, but the presentation of sensitivity scores should include guidance on how to further prioritize sites once final sensitivity scores are derived. From the GLAC pilot test, the framework was perceived as being somewhat tedious and overwhelming, and the suggestion was that the framework be simplified. In discussions with the NCSU team and NPS partners after both pilot parks, we are exploring the idea of simplifying the Physiographic context attribute to be one attribute rather than consisting of eight sub attributes. If this modification is made, the eight sub attributes would be considerations made when assessing whether or not there

are physiographic characteristics that are detrimental (or not) to multiple stressors or a single stressor.

Conclusion

Based on the results of this study and the feedback from pilot testing partnerships, the framework, while effective, is not efficient. Work completed in pilot studies represents a fraction of the total amount of work needed to be done to have all park sites assessed, and the amount of time required to complete the framework in its current state, when considering the workload and capacity issues of cultural resources staff at NPS parks (e.g., many parks do not have even one archeologist), makes that an unreasonable goal. Future research would be necessary to determine the extent to which suggested changes—specifically, assessing Physiographic context by one attribute rather than eight sub attributes—affects the final sensitivity scores in diverse contexts like those in the two pilot studies presented here. Alternatively, a new approach, such as measuring sensitivity from a cultural landscape lens rather than a site by site, could perhaps be more appropriate due to the overlap in heritage places and material culture (see Daly, 2014).

Further work on this project would include the integration of exposure data with the sensitivity data to express a vulnerability score. This work, and future development is essential to meet the guidance of NPS for assessing cultural heritage for prioritization of funding. Elicitations with parks staff to understand the best way to integrate exposure data and combine the sensitivity scores with exposure scores would be essential. To better understand the capacity needs for completing this framework at the full scale of all archeological sites in a NPS park unit, the framework would need to be tested and evaluated to determine if simplification would improve the usability of the framework. Some limitations for this work included the COVID-19 pandemic, which made it difficult to meet with partners including project partners and the workshop series being conducted online. To present the sensitivity score in a digestible manner that is useful for managers to establish priorities for archeological sites, we utilized grid quadrants where the x-axis is the sensitivity score, and the y-axis is the significance score (as established through the significance framework pilot done concurrently). By presenting data to managers on such a quadrant, sensitivity and significance of a site can be combined to show the overlap of climate change risk or damage to a site and the known cultural heritage significance. This comparison, while not a combination of scores, can help managers visualize prioritization needs based on sensitivity and significance.

The integration of archeological expertise was essential at every step of this project. Beginning with the pre-workshop survey and continuing through the workshop discussions and final elicitation survey, archeologists provided insight on the prioritization of archeological sites and their needs for prioritization. The elicitation surveys, which were used for creating, modifying, and scoring the attributes, sub attributes, and metrics for the framework, allowed for the development of a framework that reflects the respondents' values and knowledge about archeological sites in a changing climate. Due to the low *n* on the final elicitations, and the range of responses, there should be another elicitation with a larger group of experts (archeologists who have climate change experience) in order to better understand the range of responses and the values of this group. With the wide range of scores for most metrics, it is important to continue elicitations and reevaluations of weights and metrics, possibly through a consensus-based group process rather than individual assessments.

To determine how archeological expertise can be integrated into archeological site assessments for sensitivity determination and prioritization, this project conducted a series of workshops and elicitations to better understand how experts view archeological site sensitivity. Through these elicitations, the project team was able to develop an archeological site sensitivity framework, which could be applied at the park level to better prioritize archeological sites for NPS management actions. The framework was reviewed and tested in two pilot projects, which allowed for understanding of how the framework functioned when used with sites of similar or vastly different contexts, age, archeological material, and stressors. This testing showed that the framework is somewhat effective but needs further improvements for full implementation at NPS park units. Future work on this topic should include full implementation at a single NPS park unit and improvements based on that project, as well as the inclusion of exposure data and significance scores into the framework to have a complete archeological site assessment for prioritization framework.

CHAPTER 3: TECHNICAL REPORT

I. Abstract

Archeological sites stewarded by the National Park Service (NPS) are affected by climate change impacts such as extreme wildfires, shoreline degradation, soil freeze-thaw, and secondary impacts such as human activity changes and animal disturbances (Rockman et al., 2016). Current guidance for climate adaptation planning of cultural resources (including but not limited to archeological sites) was issued in NPS Policy Memo 14-02, which instructs park managers and staff to consider resources' *vulnerability* and *significance* when prioritize adaptation actions and making stewardship funding decisions. Yet as climate adaptation planning tools are in their incipient stages, park managers and staff face constraints (Fatorić & Seekamp, 2017b) and the specific constraints facing archeological site stewardship—management of a type of cultural resource that is often also associated with consultation requirements based on the treaty rights of Tribal Nations—is unknown. This report documents perceptions of the agency capacity strengths for and barriers to archeological site climate adaptation planning. The findings presented in this report may enable the agency to enhance climate adaptation planning efforts of archeological sites.

II. Background

The National Park Service (NPS) is mandated to identify and plan for "the protection of cultural resources significant at the local, state, and national levels," which represent "the material evidence of past human activity" (NPS, 1998). Cultural resources are "unique and irreplaceable" and the threat of climate change is cause for concern for destruction or loss of context of materials (National Park Service, 2014). One type of cultural resources, archeological sites, are increasingly documented in history as being threatened by climate change stressors. For example, sea-level rise threatens coastal sites, erosion and permafrost melt exposes previously buried materials, and changes in vegetation and seasonal temperatures alters the risk for site damage (IPCC, 2001; NPS, 2010). Increased frequency and intensity of certain extreme weather events, including hurricanes and wildfires, adds unpredictability to climate change adaptation planning (NPS, 2010).

The NPS has created programmatic initiatives—such as the Climate Change Response Program (CCRP)—to develop an "interdisciplinary approach to dealing with climate change" (NPS, 2010), crafted strategies—such as the Climate Change Response Strategy—to set goals for

developing cultural resource decision-making tools and expanding capacity for inventory and monitoring (NPS, 2010), and issued policy guidance—such as the NPS Policy Memo 14-02 (PM 14-02)—to provide strategic priorities for funding cultural resource adaptation (National Park Service, 2014). Within PM 14-02, the agency uses language that encourages "innovation" for decision makers and managers, as well as the integration of archeological materials and cultural resources into climate change adaptation and carbon reduction strategies (National Park Service, 2014). Moreover, the guidance encourages managers to "engage fully in cooperative conservation and civic engagement," including consultation and inventory reassessment according to the *vulnerability* and *significance* of threatened areas and resources (National Park Service, 2014). Yet, on-the-ground implication of adaptation for managers is challenged by institutional, technical, and financial barriers (Fatorić & Seekamp, 2017).

Understanding capacity constraints, such as lack of money and limited personnel, is essential in implementing conservation management plans (Demas, 2002) and for adapting heritage sites and resources to climate impacts (Fatorić & Seekamp, 2017b). For the NPS, climate adaptation planning necessitates assessments of the *vulnerability* of archeological sites, which includes "connecting exposure to climate impacts with resource-specific sensitivities to determine impact risk at site-specific and regional scales" (Rockman et al., 2016, p.10). Additionally, managers are instructed to "prioritize cultural resource funding and management actions on projects that integrate vulnerability and resource significance" (NPS, 2014). However, specific guidance is lacking for understanding how significance can be quantified and applied to prioritization (Fatorić & Seekamp, 2017).

For archeological sites, consultation is particularly relevant in climate adaptation planning, as consultation is mandated by Section 106 of the National Historic Preservation Act (NHPA) of 1966. Archeological sites with associated Tribal Nations (historic, cultural, and religious sites) are subject to the trust responsibility and consultation provisions—including specification of consultation as a right—were further specified in the Archeological Resources Protection Act of 1979, the Native American Graves Protection and Repatriation Act of 1990, and the 1992 Amendments to NHPA (Routel & Holth, 2013). Yet, consultation requirements remain vague in that "early" in the planning process isn't well defined (beyond prior to archeological surveys, according to ACHP's regulation [36 CFR § 800.4(a)(3)]) and agency-specific guidance for to climate adaptation planning consultation remains admittingly vague (e.g., managers should

“consult broadly” and decisions to accept “loss cannot be made lightly nor without appropriate consultation” but “as with many aspects of climate change adaptation, as yet there are no specific guidelines for these decisions”; NPS, 2014, p. 4).

The acknowledgement of cultural resource loss due to climate change is critical, as climate change can result in unanticipated or unprecedented losses (Rotherham, 2013) and “the costs of adaptation are likely beyond the scope of current capabilities and mechanisms” (Seekamp & Jo, 2020). According to Fatorić & Seekamp (2019), “not all [archeological] sites can be simultaneously adapted due to financial and human capital constraints” (p. 689) and numerous challenges to archeological site preservation and climate adaptation planning exist, such as “predictability of budgets” and the inability to “prioritize unknown sites” (p. 693). NPS guidance directs managers to focus “resource inventory work on lands not yet investigated in those areas most vulnerable to observed and projected climate change impacts and other threats” (NPS, 2014, p. 3). As such, the development of management strategies for preserving at-risk archeological sites includes increasing capacity for inventory and monitoring (NPS, 2010). While the inclusion of these goals and strategies are a starting point for parks staff stewarding archeological sites, there is a lack of understanding regarding expectations for monitoring and management, how prioritization is being done, and how capacity is currently affecting adaptation strategies in the 10 years following the inception of the CCRP.

This report provides insights into capacity strengths and challenges for climate adaptation planning and implementation of climate adaptation strategies for archeological sites as perceived by NPS personnel. Studies that assess the perceptions of climate change awareness among resource managers demonstrate the importance of clear and specific guidance on adapting management strategies (Sousa-Silva et al., 2018, Moser & Tribbia, 2006). Coastal zones are some of the most threatened by climate change, yet constraints such as monetary and staffing limitations constrain the implementation of adaptation actions, even as climate change impacts are increasing in severity (Moser & Tribbia, 2006). Understanding current perceptions of climate change and adaptation strategies can lead to solution building that is effective and sustainable, like knowledge sharing, data sharing, and adaptive policy (Sousa-Silva et al., 2018). This report seeks to answer the question: How do NPS personnel perceive the agency’s capacity to implement climate adaptation strategies for archeological sites?

III. Methods

In 2020, NC State University researchers and NPS collaborators hosted a four-part virtual workshop series to develop a NPS constructed measurement framework for assessing the relative sensitivity of archeological sites to climate change stressors. The workshop series (four half day sessions on October 27, October 30, November 10, November 12) used a co-production of science approach—similar to the one that used by Fatorić and Seekamp (2019)—to develop a NPS constructed framework for assessing the relative significance of archeological sites. Workshop participants were identified by NPS collaborators and included a mix of park- and regional-level NPS archeologists who self-selected to attend the workshop series (n=32). As part of that effort, the team determined that assessing the participants' perceptions of agency capacity for climate adaptation planning and implementation would be opportunistic as part of the workshop effort. This report provides the results of this specific effort to identify perceived capacity barriers and strengths for climate adaption of archeological sites within the NPS.

To document perceptions of agency capacity, we utilized time series online survey research methodology (Vaske, 2019), with a pre- and post-workshop survey questionnaire distributed via a link in an email to registered participants on (October 19, 2020 and November 16, 2020), with 3 reminder emails each. The survey questionnaires were administered using Qualtrics, an online software tool. By including a pre-workshop questionnaire instrument, we were able to collect open-ended comments that helped us assess gaps in the instrument and expand the post-workshop questionnaire items. Additionally, open-ended response questions were included as a space for respondents to express concerns, ideas, experiences, and perceptions that were not addressed in the metric response portion of the surveys (Appendix C). Additionally, the results of the pre-survey questionnaire were presented in the first workshop session and the facilitated discussion that coincided with the presentation further enhanced the refinement of the post-workshop instrument. Specifically, participants saw preliminary visualizations of the pre-workshop questionnaire data and were encouraged to discuss these results. This discussion helped the research team understand responses that may be against expectations and encouraged participants to suggest further topics of research or discussion, which were then included in the post-workshop questionnaire. For example, the pre-workshop questionnaire addressed general perceptions of challenges of building relationships with stakeholders, which was described and elaborated on in the post-workshop questionnaire.

The pre-workshop questionnaire included items to capture participants' experience relevant to archeology and climate adaptation and perceptions of capacity constraints. Additionally, some questionnaire items assessed perceptions of adaptation priorities and challenges, which were replicated those applied in an earlier workshop series (Fatorić & Seekamp, 2018). We developed the items for the pre-workshop questionnaire using the following procedure: (a) identification of capacity constraints for NPS staff and managers, (b) identification of policy and management guidance, (c) initial development of items, (d) consultation with NPS partners to ensure proper language, and (e) validation by NPS partners. The pre-workshop questionnaire included references to specific NPS policy guidelines regarding climate adaptation planning, and these references had embedded links provided to the guidelines. The post-workshop questionnaire items were developed using the following procedures: (a) replicating select items from the pre-workshop questionnaire, (b) thematically analyzing open-ended responses from the pre-workshop questionnaire and developing metric-based items to include open-ended responses as collectable data, (c) ensuring proper repetition of pre-workshop questionnaire items, (d) consultation with NPS partners to ensure proper language, and (e) validation by NPS partners. There were a limited number of open-ended questions on the post-survey, mainly asking for perceptions of the workshop. Repeat measures of metric response questions helped us to assess opinion change related to workshop participation. Additionally, as the primary purpose of the workshop was focused on developing the archeological site sensitivity framework, the post-workshop questionnaire included some additional questionnaire items specific to the framework that are not presented in this report.

The survey questionnaires can be found in Appendix D, Table D.1 (pre-workshop) D.2 (post-workshop). Examples from this instrument included:

1. How challenging are the following uncertainties (e.g., timing of climate impacts, stakeholders' values & priorities) in archeological preservation and climate adaptation planning? (Matrix response categories: Not at all challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging, Unsure)
2. To what extent do the following site characteristics influence the selection of adaptation options (e.g., build off-site protections, relocate, excavate, document, and prepare for loss) suggested by the NPS website? (Matrix response categories: Not at all, A little, A moderate amount, A lot, A great deal, Unsure)

3. In your opinion, how challenging are each of these recommendations (e.g., refocus inventory responsibilities, recognize loss potential) identified by NPS Memorandum 14-02[3] to implement? (Matrix response categories: Not at all challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging, Unsure)
4. What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS? (Open-ended response)
5. What suggestions do you have to enhance engagement with partners and stakeholders regarding the adaptation of vulnerable archeological sites? (Open-ended response)
6. Please list any specific challenges to archeological site preservation (particularly relevant to climate adaptation planning) you face related to limitations in data availability, acceptability, and/or suitability. (Open-ended response)

Matrix table data were processed by converting metric scale points to values on a scale from the "not at all" response being a 0 to the "extremely/very much" being the highest value (e.g., 4 or 5, depending on the number of response options) (Appendix D). Other metric scale responses were better assessed on a scale from "strongly disagree" -2 to "strongly agree" +2, with the midpoint of 0 being represented as ambivalent (See Appendix D and Figure 1). "Unsure" responses were coded and treated as "missing" data. "Ambivalent", coded as 0, and "unsure" responses in the questionnaires are important to this research and were included for all matrix questions, as they provide a different type of insight into capacity constraints. We analyzed the quantitative data utilizing descriptive statistics in IBM® SPSS® Statistics software. Additional background data was collected during the pre-workshop questionnaire to help describe the sample, including agency region(s) where work is performed, number of years working in archeology, and number of years working on climate change issues (Appendix E, Table E.1, Table E.2). Open-ended questions were coded thematically (thematic analysis) (Appendix F). These analyses provide an understanding of current capacity strengths and barriers related to climate adaptation planning of archeological sites and an assessment of the influence of the workshop on individuals' opinions. This report has also

3 This is the policy memorandum that provides park managers with guidance to prioritize the cultural resources that are "most at risk and significant" for climate adaptation.

been developed into a visual, 2-page briefing report, which was distributed to NPS staff serving as project collaborators on July 19, 2021 (Appendix G).

All procedures were reviewed and approved by NC State University's Institutional Review Board (IRB) to protect the confidentiality of participants. Specifically, workshop participants were assigned a participant number and asked to enter that number on the first page of the pre- and post-workshop survey questionnaires, and the master list was stored in a separate file to enhance confidentiality.

Limitations

We received many questions about vocabulary and intentional wording during the pre-workshop survey distribution period. Despite a long response period, the post-workshop survey had a low *n* compared to the pre-workshop survey. Additionally, this study was affiliated with a workshop in which participants, and hence survey respondents, were strategically selected and limited in the total number of participants to ensure productive group processes. As such, these data cannot be considered representative of all agency personnel working in archeology. Rather, the findings provide a glimpse into the capacity constraints facing some NPS archeologists in a changing climate.

IV. Results

Of the 30 participants registered for the workshop series, 21 completed the pre-workshop survey questionnaire (70% response rate) and 13 completed the post-workshop survey questionnaire (43% response rate). Most respondents were park-level management (22%), park-level staff (26%), or regional-level staff (26%) (Appendix E, Table E.1). Fifty-six percent (56%) of participants had master's level education, 36% had doctoral education, and 4% had undergraduate education (Appendix E, Table E.2). The largest proportion of respondents (39%) have been in their current position for 1 to 5 years, while smaller proportions (15%) of respondents reported falling into the following categories: 6 – 10 years, 11 – 15 years, and more than 15 years (Appendix E, Table E.2). For "years in archeology", the majority of respondents (65%) reported "more than 15 years" (Appendix E, Table E.2).

Priorities for Adaptation of Archeological Sites

The survey questionnaires assessed the importance of 14 adaptation priorities (13 in the pre-workshop instrument [n=21] and 4 in the post-workshop instrument [n=10], three of which were repeated from the post-workshop instrument). The means and standard deviations for all items can be viewed in Appendix D. The most important priorities for climate adaptation included archeological sites that are actively used for cultural practices (M = 3.84, SD = 0.37, n = 25) and those that hold stakeholder meaning (M = 3.56, SD = 0.57, n = 25) (Appendix D, Table D.1). The least important priorities for climate adaptation included sites experiencing deferred maintenance (M = 1.83, SD = 0.85, n = 20), sites that have previously had a preservation treatment applied (M = 1.92, SD = 1.08, n = 20), and sites within cultural landscapes that are damaged by non-climatic impacts (M = 2.08, SD = 1.00, n = 20). For the priorities that repeated on the post-workshop instrument, the perceived importance of those priorities declined by 0.54 (the nature of the site making it sensitive to climate change impacts), 0.45 (the site location being exposed to climate change threats), and 0.31 (the site facing immediate climate change impacts) on the five-point response scale.

Other priorities for climate adaptation noted by participants in open-ended responses included: long-term efficacy of treating the site (included in the post-workshop instrument; M = 2.57, SD = 0.938, n = 14); desires of those who occupied or built the site concerning its fate; identified by park as a high priority for preservation (i.e., mentioned in enabling legislation); sites containing human remains and burials; sites with exposure from ongoing research that expedite climate change threats and impacts.

Data Availability and Sufficiency Constraints

The pre-survey requested that participants list specific challenges to archeological site preservation that they face relating to data availability, acceptability, or suitability. One participant said they were challenged by the "ability to assess the site thoroughly and monitor changing conditions due to lack of positions to do the work." Another said "inconsistencies in data acquisition and formatting are the first challenge. Working through data integration we may lose more information than gain. Second, the inconsistencies in data management (systems and file structures) are a major challenge."

Understanding how park staff perceive adaptation strategies implemented by NPS can lead to building more productive policies for adaptation. Participants generally disagreed that NPS has sufficient adaptation strategies for archeological sites, with a stronger consensus of disagreement following the workshop series (Appendix D). Some respondents indicated that while they have access to data, they lack "enough information on treatment alternatives, what works, what doesn't, when to treat/stabilize and when to retreat and head into data recovery" and also that the "data is difficult to find and access (there is too much)? It's just not easy to know the "go to" source for each type of data needed." Because of the diversity of location of participants, there were some contradictory statements to these. One stated that many of their sites lacked updated condition assessment data, or that timely entry of data was lacking. Communication is also lacking, including the "ability to share information outside the immediate park due to federal law, secretarial orders, Director's Orders, or Superintendent's orders." This causes issues with "consistent data across platforms (SHPO, THPO, Park)" that have detrimental effects on larger combined data sets.

In terms of lacking data, respondents had a variety of views on what is missing information for climate adaptation planning. Missing data, such as downscaled climate projections, current and detailed condition assessments, and additional GIS (Geographic Information Systems) data are restricting climate adaptation. Soil erosion and streambank erosion data are essential for "baseline info." Reliable and accessible modeling is missing, as one participant stated "we [archeologists] need the science done, we need it 'thrown over the wall' and we need the super-science people to climb over the wall and directly assist with community outreach and consultation. Otherwise, we end up treating climate change as an interpretive issue, not a science issue, and it winds up in the hands of non-scientific park guides and rangers to manage on their own."

Capacity to Implement NPS Climate Adaptation Guidance and Policy

Survey respondents indicated that changing administrations and inconsistent guidance from leadership caused challenges for implementing current NPS adaptation recommendations. Lack of staff and personnel affected the ability to implement adaptation strategies as well. The response of "funding" (33% of respondents) as the main capacity constraint for protecting climate-vulnerable archeological sites barrier shows the need for funding prioritization for these strategies (Appendix G). One respondent explained in an open-ended response about challenges for implementing adaptation recommendations stated:

> "The NPS climate adaptation policy is not particularly actionable and has not been applied in a blanket manner across NPS. At the end of the day, if there isn't money for adaptations to be made, they don't happen."

In response to the matrix response question "To what extent do you agree or disagree about the following descriptions of the agency's adaptation policy and guidance for archeological sites?", respondents disagree that policy is specific enough for on the ground application (M = -0.45, SD = 0.99, N =10) and easy to implement (M = -0.18, SD = 1.11, N = 10), and that limited staff with technical expertise is an issue (M = 1.18, SD = 0.94, N = 10). When presented with a variety of capacity statements (Figure 2), respondents agreed that the agency lacks support tools for climate adaptation planning (M = 0.73, SD = 0.75, N = 10), and also disagreed that the agency has guidance for prioritizing sites for adaptation when the sites are of equal vulnerability (M = -0.36, SD = 1.3, N = 10).

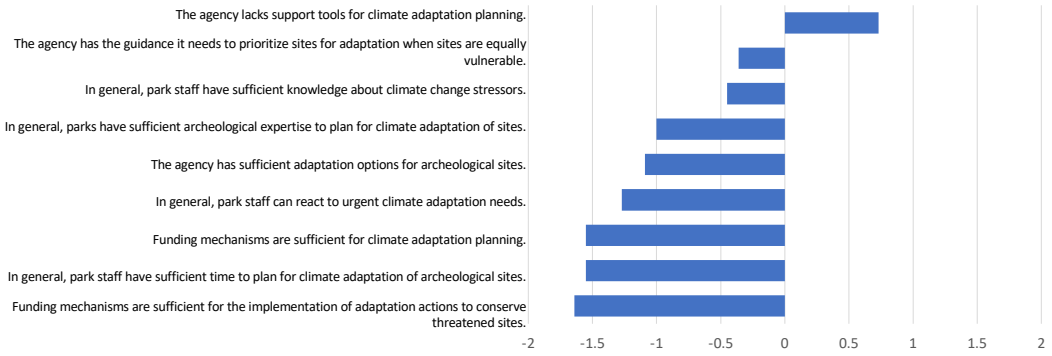

Figure 2: Post-workshop survey questionnaire response mean responses to capacity statements "Please indicate the extent to which you agree, disagree, neither agree nor disagree (i.e., are ambivalent, or are unsure with the following statements." No respondents indicated an "unsure' response (n=10).

Capacity to Engage with Tribal Nations on Climate Adaptation of Archeological Sites

Engagement with stakeholders and partners is essential during climate adaptation planning of archeological sites, and consultation is mandated when sites have associated communities. Perceptions of relationships between stakeholders and NPS staff can enhance or challenge climate

adaptation of archeological sites. Respondents reported in the pre-workshop survey that Tribal Citizens' relationships with prior park service management and staff were moderately challenging (M = 2, SD = 0.74, N = 25), without change in repeat measures (Table E.1). A respondent suggested that staff "might think outside of legally mandated significance, and understand what significance, vulnerability, and sensitivity means to tribal nations" to enhance engagement. "Communicating early and often", "build[ing] relationships, be[ing] honest, be[ing] transparent," and "improved relationship building and consultation outside of that which is required through compliance" are suggestions from respondents for enhancing engagement with stakeholders. One respondent stated:

> "Tribal capacity to participate can be a huge issue. It seems like tribes often have one or only a few people that routinely attend meeting and represent the tribe. They can be asked to attend MANY meetings - with NPS, USFWS, USFS, local governments, etc. They simply don't have the time or capacity to participate and engage in all the activities they're asked to engage in. This can be a showstopper."

Effective consultation is an ongoing process and barrier to adaption as indicated by the following response:

> "With some exceptions, the agency does not do particularly well engaging tribes on these issues. We need consultations to happen at all levels of the NPS national, regional, and local. Each level brings different opportunities and groups of stakeholders that can provide input at multiple scales to address impacts to preservation. This requires staff time, funds, and skilled facilitators to effectively have these conversations. Everything with tribal consultation starts with relationship building. We lack these relationships across the NPS. We also need tribal perspectives within the NPS and need more indigenous voices helping guide management and set priorities within the agency."

Another respondent suggested meetings take place "at tribal locations rather than park [locations]" and that participating tribal members should be adequately funded for their consultation and time. Some other suggestions were increased time, funding, and parks personnel, as well as including social media and citizen science into engagement.

Other Climate Adaptation Capacity Constraints

A frequent response to questions about general capacity challenges for NPS staff to protect climate-vulnerable archeological sites is personnel related, specifically due to hiring or reductions. One participant stated that "effective reduction in staffing by 45-60% from 1994 to present has severely curtailed any research or forward-looking research in archeology." Another suggested that "Expansion of capacity would be enhanced if there could be an increase in the number/occurrence of new positions (assigned to individual or multiple parks, or at regional offices) that focus on climate-change adaptation (for both CR [cultural resources] & NR [natural resources], preferably integrated)." This participant went on to explain in detail the capacity constraints they face, stating that "current CR staff are already maxed out in their workloads, and CC [climate change] response needs folks who can be dedicated to CC-issues, serving to support and advise Park and Region staff in devising and implementing adaptation assessment and response. These positions can also help to gather and coordinate informal teams of staff at diverse parks or regions with content- or stressor-specific expertise and passion."

V. Discussion

Key takeaway 1: Capacity constraints include but are not limited to lack of Tribal input, climate-related positions, lack of actionable work, inventory inconsistency, lack of funding, challenges with data access, constrained relationships, and current guidance not being actionable.

Several central themes relating to capacity constraints appeared in discussions, the survey series, and the workshop series. To better develop policy and procedures for protecting sensitive archeological sites, it is important to understand how capacity constraints are perceived by and affecting NPS staff. The greatest capacity constraints reported by respondents include lack of Tribal input, climate-related positions, lack of actionable work, and inventory inconsistency.

Open-ended feedback from respondents indicated that expanded actionable guidance and personnel are essential to building agency capacity. Additionally, limited "programmatic support" for developing adaptation strategies creates a substantial barrier to identifying at-risk sites and potential impacts. As suggested by participants, the development of specific and actionable guidance from NPS or partners for protecting archeological sites from climate change stressors would support managers in decision making and prioritization of sites for protection strategies.

Tribal Citizens' or other external stakeholders' access to culturally relevant archeological sites was nearly universally perceived by respondents (91%) as being moderately or extremely challenging to relationship building.

Limitations in data, such as cultural resources inventories and Geographic Information Systems (GIS) mapping, were mentioned in about 55% of open-ended survey responses about limitations for archeological site protections. The prevalence of up-to-date inventory data and access to GIS maps not only confirms data insufficiencies but also highlights the need for accessible data that can help managers consider the significance and vulnerability of sites. In other words, there is a need for agency focus on data collection and organization to aid managers in protecting archeological sites with knowledge of sites' materials, conditions, and climate change risk.

Open-ended responses showed that funding is a capacity constraint for protecting climate-vulnerable archeological sites. With park guidance calling for managers to prioritize sites based on vulnerability and significance (NPS, 2014) for funding cultural resource adaptation strategies, additional research is needed to document how these priorities are being applied in parks with archeological sites at risk. Without access to site locations and site information, these stakeholders may not be able to effectively contribute to planning and decision-making efforts about climate adaptation priorities for archeological sites. As such, managers will be challenged to have productive integration of associated communities' values and priorities, which could further deteriorate these relationships. Therefore, it seems important for the NPS to reassess associated communities' access to archeological sites, records, and collections as part of the redevelopment of guidance for archeological site management.

Key takeaway 2: Tribal engagement is essential for stakeholder participation and relationship building.

The archeological sites stewarded by NPS are connected to associated stakeholders and their beliefs, history, and spirituality. Continued transparent communication and relationship building is essential for protecting archeological sites (Rockman & Hritz, 2020). As one survey respondent commented, "Prioritize Tribal engagement and then listen." Respondents commonly indicated that relationship building beyond the required consultation is necessary for adaptation of

vulnerable archeological sites, and that this consultation would require greater training for NPS personnel. This inclusion and engagement with associated groups is related to the concern of Tribal government capacity for engagement, which was viewed by respondents as limiting effective relationship building, particularly due to limited funding distribution to Tribal Nations. Yet, developing priorities for archeological site adaptation with Tribal governments is needed to meet the requirements of "significant" cultural resource evaluation as stated by NPS guidance (National Park Service, 2014). Significance must be co-defined with associated groups of cultural resources to ensure adaptation strategies meet the values and priorities of these groups while protecting archeological sites from climate change threats (Fatorić & Seekamp, 2019; Seekamp & Jo, 2020).

VI. Conclusions

This project was used to determine the perceptions and needs for archeological site managers when considering how to prioritize archeological sites for management action. The workshop series and subsequent pre- and post-workshop surveys were utilized to gather data on perceptions and needs for prioritization. Findings demonstrated that the key needs for archeological site managers are funding, data access, relationship building, and actionable guidance. Managers also indicated that associated tribal group involvement is essential to prioritization of archeological sites. Future research is needed to gather information from associated groups about their needs and priorities, which could even duplicate measures from this study to enable comparisons. These takeaways can help NPS management and policy makers improve their guidance for protecting archeological sites and can help the agency improve relationship building with associated groups to better protect sites from climate change.

CHAPTER 4: CONCLUSIONS

Key takeaway: Tribal engagement is essential for protecting archeological sites from climate change.

As climate change continues to threaten cultural heritage, including archeological sites, it is important to build and maintain connections to associated groups (Fatorić and Seekamp, 2019). Inclusion in policy decisions and management actions can help protect archeological sites in ways perceived as valuable by associated groups. This work shows that the integration of expert knowledge into site assessments is necessary for understanding how to best prioritize archeological sites for management actions. However, it is necessary to include associated groups as "experts", as it is their cultural heritage and ancestral objects that this work seeks to preserve and protect from climate change threats. Therefore, future work on this project must include continued relationship building and inclusion of associated groups. The NPS is responsible for creating and maintaining these relationships while conducting archeological work on lands that they are stewarding; yet, the federal lands are located on the traditional lands of indigenous people. As such, it is important to have continued engagement with citizens and staff of Tribal Nations on the priorities, needs, and anticipated actions regarding archeological sites and ancestral objects from those with ancestral heritages.

Reflection

Relevance of work

Climate change is and will continue to affect all of us. While we reconcile with what that means with society and life, we must also consider what that means for the land we inhabit, and the connections we have to our places and materials (Newland et al., 2017). Archeological sites have value, not only as a way to understand the past, but also as a connection between people, land, and time (Adger, 2013). Climate change is not a new concept, and societies have always been faced with changes due to natural climate change, but the speed at which we are faced with anthropogenic climate change is new and potentially devastating (Hollesen et al., 2016, Newland et al., 2017). Heritage, which is so dependent on places and landscapes, is something that must be preserved and protected according to the values of those who are linked to them (Daly, 2014).

The NPS has been stewarding land and protecting areas of concern already, but heritage sites are complex and unique. Archeologists are aware and familiar with the effects of climate

change on heritage sites, but the priorities of the NPS are not only on archeological sites and the capacity of the agency is stretched thin.

This work, while still in the beginning stages, has shown that NPS has gaps in the policies that guide NPS archeologists in their work to protect sites from climate change. The agency has produced policy and guidance that is general, which goes against the unique and individual needs of archeological sites. General policy can be used for understanding how funding and management action will be taken but does not help park staff prioritize the sites in their care for this type of action. These views, determined by the surveys presented in Chapter 3, were helpful in the production of the framework in Chapter 2. While the framework has improvements to be made, it demonstrates how using a values-based framework with NPS archeologists can be a productive way of determining priorities. Each park will be able to make their own determinations of risk, based on the sensitivity of a site to climate change stressors. However, it will be important for the agency to also integrate sensitivity assessments with exposure assessments to more fully understand archeological sites' vulnerability. As this framework is reassessed for its application in park units, there will be improvements in how it can be used to determine sites that need management action from NPS.

Moving forward

An ongoing area of interest for this project is, of course, engagement with associated groups and Tribal partners. Through conversations with our partners at Glacier National Park, we have several new angles and considerations for this project moving forward. This includes everything from the scope of the project to the scale of the project, to the framework application and usability.

This project is designed to be flexible, and the need for the framework to be tested and reassessed makes it a tool that could possibly be utilized outside of the current project scope in the future. One of the challenges faced at National Park units is the amount of input needed to have fair and equal consideration of values for prioritizing archeological sites. Lands and archeological sites can have multiple Tribal groups associated with them. In the future of this project, there needs to be considerations on how to include all of the voices necessary to properly prioritize sites. Another consideration is the usability of this work for archeological sites that are not associated with Tribal groups, and how this framework could be transformed for historic sites, and the inclusion of stakeholder groups such as the Black community.

The possibility of changing this project from “archeological sites” to “cultural landscapes” is also under consideration. While there is not a consensus amongst the team on what that new framework would look like, it could possibly allow for a less Western approach to heritage areas. However, the complexity lies in the translation of cultural landscapes to a form of prioritization that NPS can use for funding and management, which is one of the goals of this work, and would also be constraining on the capacity (time, personnel) of NPS.

Values

This project utilizes value-based judgements to determine weights and scores. The values are of the archeologists who participated in this project, which is important to consider moving forward when engaging associated groups. For example, archeologists who participated in the development of scores and weights for this project discussed and determined that destroyed sites are of less value than sites that are in poor condition. This view could be different for tribal values. During discussions with Tribal partners on this project, the team learned about the value of place and landscapes of archeological sites, or heritage places, and their value outside of material culture.

Understanding the difference between loss of “material” and loss of cultural heritage is essential for determining the best way to prioritize archeological sites (Cleere, 2000). While the development of this project began with the need of archeologists to protect sites vulnerable to climate change, as we delve deeper into the issue it became apparent that archeology goes beyond the surface in both ways. For certain indigenous groups, and perhaps for many other stakeholders, places have just as much if not more meaning than the material that is housed beneath them (Adger, 2013). Even without considering compensation for loss, federal groups that steward these sites must consider the cultural, personal, social, and spiritual loss that occurs when climate change damages or destroys heritage sites (Daly, 2014). As conversations with our tribal partners have shown, quantitative approaches are a Western view of heritage, and we must view sites and the context they are in as important themselves, and not just the materials that are present. Prioritizing archeological sites in the context of significance and vulnerability should contribute to preserving cultural heritage, and to do that effectively we must ask and attempt to understand what is valuable to the people associated with these sites; sense of place and place connection are valuable concepts for ongoing community wellbeing.

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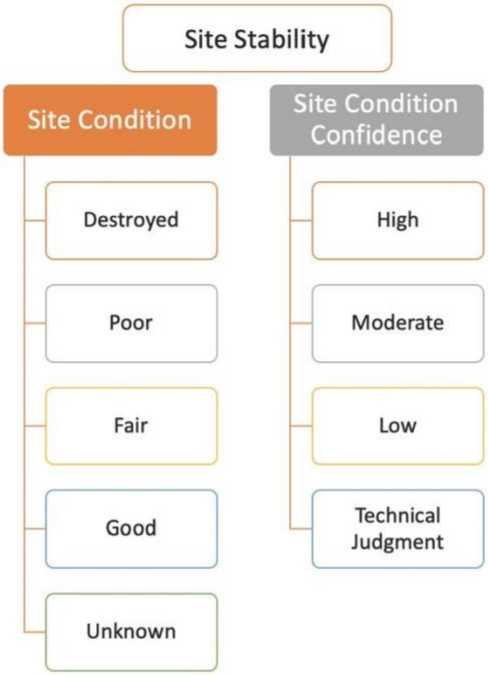
APPENDICES

Appendix A:

Archeological Site Sensitivity
Attribute and Sub-attribute Definitions List

Site Stability



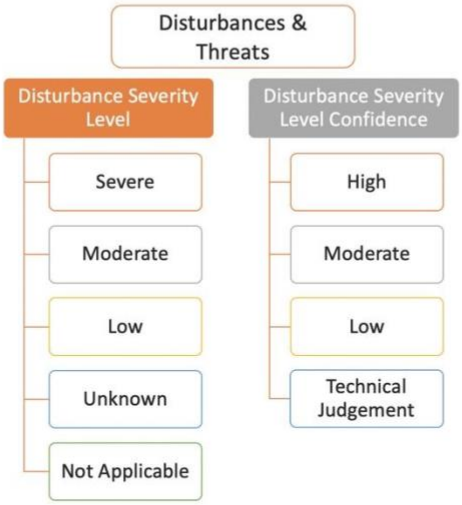
a) Site Condition: The site's physical stability and amount/degree of deterioration as recorded in CRIS.
   - Destroyed: Site is completely gone, or so severely damaged that the research value is insufficient to warrant archeological monitoring or investigation.
   - Poor: Unstable and severe deterioration/ damage.
   - Fair: Somewhat stable with evidence of deterioration/ damage.
   - Good: Stable and no noticeable deterioration.
   - Unknown: The site condition is not known, the available info. is not sufficient to evaluate the condition, or the condition has not been assessed.

b) Confidence in CRIS Site Condition: Accuracy of the current site condition assessment (for example, based on the likelihood of recently deteriorated conditions).
   - Low: Little confidence in the accuracy of the Site Condition as recorded in CRIS, OR, the Site Condition is Unknown.

This framework is a product of Task Agreement Number P17AC00794 under Cooperative Agreement P13AC00443 between the US DOI National Park Service and North Carolina State University; last updated April 26, 2021.

- Moderate: Some confidence in the accuracy of the Site Condition as recorded in CRIS.
- High: High confidence in the accuracy of the Site Condition as recorded in CRIS.
- Technical Judgement: Site Condition attribute has been changed during framework data entry, as it has been judged to be, or is likely, a different condition than listed on last assessment (differs from what is listed in CRIS).

Existing Disturbances and Threats

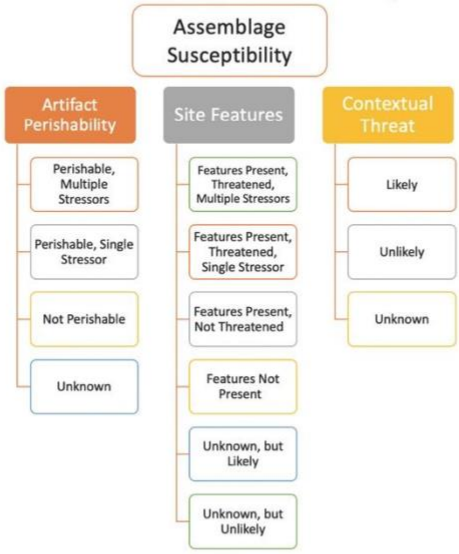


a) Site Disturbance Severity Level: A professional summary evaluation of the cumulative negative effects of all documented disturbances and threats as recorded in CRIS.
   - Severe: Disturbances are causing (or Threats may very soon cause) major site damage, and the site is in danger of being irretrievably lost within two years.
   - Moderate: Disturbances are causing (or Threats may soon cause) moderate site damage, and the site is in danger of being destroyed within five years.
   - Low: Disturbances are (or Threats are predicted to be) minimal, and have not resulted in significant damage to the site.
   - Unknown: The level of damage is not known.
   - Not Applicable: Nothing of the site remains, because it has been completely excavated or destroyed.

b) Confidence in CRIS Site Disturbance Severity Level (for example, based on the likelihood of more recent disturbances).

- Low: Little confidence in the accuracy of the Site Disturbance Severity Level as recorded in CRIS, OR, the Site Disturbance Severity Level is Unknown.
- Moderate: Some confidence in the accuracy of the Site Disturbance Severity Level as recorded in CRIS.
- High: High confidence in the accuracy of the Site Disturbance Severity Level as recorded in CRIS.
- Technical Judgement: Site Disturbance Severity Level attribute has been changed during framework data entry, as it has been judged to be, or is likely, a different level of disturbance severity than listed during last assessment (differs from what is listed in CRIS).

Assemblage Susceptibility: The susceptibility of all aspects of a site (artifacts, features, and matrix/ context in the surface and subsurface) to climate change stressors.



a) Artifact Perishability: The likelihood of artifacts to be lost or destroyed from climate stressors.
   - Perishable, Multiple Stressors: Artifacts are perishable due to multiple climate stressors.
   - Perishable, Single Stressor: Artifacts are perishable due to a single climate stressor.
   - Not Perishable: Artifacts are not perishable.
   - Unknown: It is not known whether the artifacts are perishable or not.

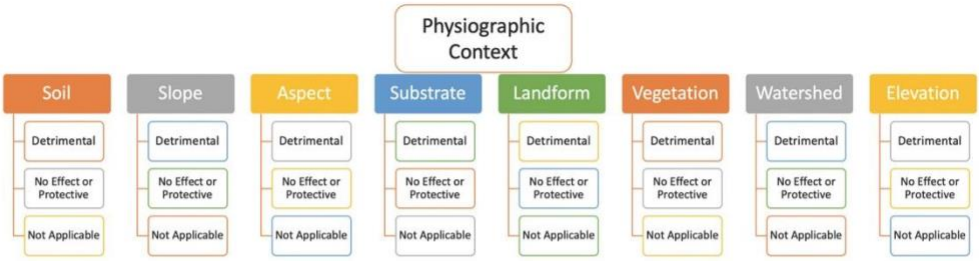
b) Site Features: The risk from climate stressors to the unmovable portions of a site that represents non-portable activities.

- Present, Threatened, Multiple Stressors: Features are present at the site and at risk from multiple climate stressors.
- Present, Threatened, Single Stressor: Features are present at the site and at risk from a single climate stressor.
- Present, Not Threatened: Features are present at the site but not currently at risk.
- Not Present: No known features are present.
- Unknown but Likely: Features are likely present due to the archeological context but have not been archeologically verified.
- Unknown but Unlikely: Features are unlikely to be present, but this has not been archeologically verified.

c) Contextual Threat: Likelihood that site material could lose archaeological context from climate stressors.

- Likely, Multiple Stressors: Site material could lose context due to multiple climate stressors.
- Likely, Single Stressor: Site material could lose context due to single climate stressor.
- Unlikely: Site material is not likely to lose context.
- Unknown: It is not known whether or not archeological site material could lose context from climate stressors.

Physiographic Context: The physical patterns and processes that determine the context within which an archeological site sits and that may affect susceptibility to climate change stressors.



a) Soil: Information contained in the USDA Soil Series Classification (e.g., drainage, consolidation), or as directly observed at the site, that may affect site susceptibility to climate stressors.

- Detrimental: The soil characteristics at the site increase the sensitivity of the site to one or more climate stressors.
- Protective or No Effect: The soil characteristics at the site reduce or does not affect the sensitivity of the site to one or more climate stressors.

- N/A: The soil characteristics at the site are not relevant to the site's sensitivity to climate change.

b) Slope: Angle of the terrain (e.g., as measured in degrees or percent).
   - Detrimental: Slope increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: Slope reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: The slope is not relevant to the site's sensitivity to climate change.

c) Aspect: Compass direction that a slope faces. Can affect the context for climate change at an archeological site (e.g., frequency of freeze-thaw, dominant wind direction, wildfire burn patterns, etc.).
   - Detrimental: Aspect increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: Aspect reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: The aspect is not relevant to the site's sensitivity to climate change.

d) Substrate: The non-anthropogenic layer underlying the archeological site deposits and features, including bedrock.
   - Detrimental: The substrate increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: The substrate reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: The substrate is not relevant to the site's sensitivity to climate change.

e) Landform: The location or positioning of the site relative to form and location in the landscape (e.g., dune, floodplain, cave, mesa, ridgetop, talus slope, glacier terminus, etc.), including the topography and subsurface bedrock.
   - Detrimental: The landform increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: The landform reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: The landform is not relevant to the site's sensitivity to climate change.

f) Vegetation: the assemblage of plants established at a site, or the vegetation community in which the site is located. Can affect site stability through percent ground cover, root depth, stabilization of waterlogged soils, resilience to alluvial processes or sheet erosion, fuels present on wildfire-prone sites, likelihood of windthrows/ treefalls, etc.
   - Detrimental: Vegetation increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: Vegetation reduces or does not affect the sensitivity of the site to one or more climate stressors.

- N/A: Vegetation is not relevant to the site's sensitivity to climate change.

g) Watershed: The land area drained by a river or stream. (For example, in floodplains this can affect how dynamic systems may be. For sites located at the base of slopes or the mouth of catchments, this can affect the severity of erosion or debris scouring in flash flood events. For sites located within or adjacent to wetlands, this can affect the likelihood of inundation or desiccation.)
   - Detrimental: The watershed increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: The watershed reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: The watershed is not relevant to the site's sensitivity to climate change.

h) Elevation: Height above sea level or relative to a common datum (e.g., NVD88). Can be used to determine if within a floodplain, proximity to changing water level (e.g., ocean, lake), likelihood of wave action and storm surges, sensitivity to freeze/thaw effects, sensitivity to climate warming.
   - Detrimental: Elevation increases the sensitivity of the site to one or more climate stressors.
   - Protective or No Effect: Elevation reduces or does not affect the sensitivity of the site to one or more climate stressors.
   - N/A: Elevation is not relevant to the site's sensitivity to climate change.

Existing Protections: The presence and sufficiency of existing protections to safeguard the archeological site from climate stressors.

- None but Needed: The site is not being protected but protection is needed to prevent or reduce extent of ongoing damages to the site.
- Existing but Damaging: Protection(s) exist, but is actually causing further damage to the site.
- Existing but Poor: Protection(s) exist, but the site is not being protected well (e.g., the protection itself is damaged or unstable).
- Existing but Fair: Protection(s) exist, and the site is being protected to some degree, but the protection needs improvement, or is only somewhat stable.
- Existing and Good: The site is being protected.
- None but Unnecessary: No protections are needed.

Appendix B, Table B.1: Colonial National Historical Park framework input with numerical weights and scores.

Attribute	**Attribute Weight**	**Sub attribute**	**Sub attribute Weight**	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Site Stability	21.7			3.207	3.083	3.083	3.145	3.145	3.145	3.083	3.083	3.083	3.207
		Condition	62.1	3.150	2.950	2.950	3.050	3.050	3.050	2.950	2.950	2.950	3.150
		Confidence	37.9	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
Disturbances & Threats	25.8			2.910	2.910	2.910	3.243	3.243	2.910	2.910	2.910	3.243	3.726
		Disturb Severity	60.4	2.360	2.360	2.360	2.910	2.910	2.360	2.360	2.360	2.910	3.710
		Confidence	39.6	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750
Material Susceptibility	20.8			3.596	3.596	3.995	3.540	3.797	3.596	3.596	3.596	3.797	3.797
		Perishability	33	3.100	3.100	3.710	2.930	3.710	3.100	3.100	3.100	3.710	3.710
		Features	31.4	3.160	3.160	3.790	3.160	3.160	3.160	3.160	3.160	3.160	3.160
		Contextual Threat	35.6	4.440	4.440	4.440	4.440	4.440	4.440	4.440	4.440	4.440	4.440
Physiographic Context	15.4			2.810	2.810	3.045	2.575	3.045	3.045	2.810	2.810	3.045	2.810
		Soil	0.125	2.340	2.340	2.340	2.340	4.220	2.340	2.340	2.340	2.340	4.220
		Slope	0.125	2.340	2.340	2.340	4.220	2.340	4.220	2.340	4.220	2.340	2.340
		Substrate	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Landform	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Vegetation	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Aspect	0.125	4.220	4.220	4.220	2.340	2.340	2.340	4.220	2.340	4.220	4.220
		Watershed	0.125	4.220	2.340	4.220	2.340	4.220	4.220	2.340	4.220	4.220	2.340
		Elevation	0.125	2.340	4.220	4.220	2.340	4.220	4.220	4.220	2.340	4.220	2.340
Existing Protections	16.3			3.890	3.890	3.890	3.890	3.890	3.890	3.890	2.410	2.410	3.890
Weighted Average before normalization				*3.262*	*3.235*	*3.354*	*3.286*	*3.412*	*3.284*	*3.235*	*2.993*	*3.157*	*3.514*
Weighted Average, Normalized				**0.755**	**0.739**	**0.797**	**0.759**	**0.823**	**0.766**	**0.739**	**0.638**	**0.715**	**0.865**

Appendix B, Table B.2: Glacier National Park framework with numerical weights and scores.

Attribute	**Attribute Weight**	**Sub attribute**	**Sub attribute Weight**	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**
Site Stability	21.7			3.083	3.145	3.083	2.938	3.145	3.145	3.145	3.083	3.207
		Condition	62.1	2.950	3.050	2.950	3.150	3.050	3.050	3.050	2.950	3.150
		Confidence	37.9	3.300	3.300	3.300	2.590	3.300	3.300	3.300	3.300	3.300
Disturbances & Threats	25.8			2.910	2.427	3.243	3.726	3.726	3.243	3.243	2.910	3.243
		Disturb Severity	60.4	2.360	2.360	2.910	3.710	3.710	2.910	2.910	2.360	2.910
		Confidence	39.6	3.750	2.530	3.750	3.750	3.750	3.750	3.750	3.750	3.750
Material Susceptibility	20.8			3.515	3.537	3.335	3.279	3.995	3.540	3.117	3.540	3.143
		Perishability	33	3.710	3.710	3.100	2.930	3.710	2.930	1.650	2.930	1.650
		Features	31.4	2.260	2.330	2.330	2.330	3.790	3.160	3.160	3.160	3.240
		Contextual Threat	35.6	4.440	4.440	4.440	4.440	4.440	4.440	4.440	4.440	4.440
Physiographic Context	15.4			2.340	2.575	2.340	2.810	3.045	2.340	3.280	2.810	3.280
		Soil	0.125	2.340	2.340	2.340	2.340	2.340	2.340	4.220	2.340	4.220
		Slope	0.125	2.340	2.340	2.340	4.220	4.220	2.340	4.220	2.340	4.220
		Substrate	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Landform	0.125	2.340	2.340	2.340	2.340	4.220	2.340	4.220	4.220	4.220
		Vegetation	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Aspect	0.125	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340	2.340
		Watershed	0.125	2.340	4.220	2.340	4.220	4.220	2.340	2.340	4.220	2.340
		Elevation	0.125	2.340	2.340	2.340	2.340	2.340	2.340	4.220	2.340	4.220
Existing Protections	16.3			1.480	2.180	1.480	3.890	3.890	3.890	3.890	3.890	3.890
Weighted average before normalization				*2.752*	*2.796*	*2.801*	*3.348*	*3.578*	*3.250*	*3.307*	*3.223*	*3.325*
Weighted Average, Normalized				**0.530**	**0.534**	**0.548**	**0.780**	**0.895**	**0.739**	**0.774**	**0.733**	**0.784**

Appendix C

Table C.1. Open ended responses provided by respondents in the pre-workshop survey

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
Q18. Please list any specific challenges to archeological site preservation (particularly relevant to climate adaptation planning) you face related to limitations in data availability, acceptability, and/or suitability.	
	Erosion effect of increased rainfall and intense rain events on Civil War earthworks; effect of climate induced vegetation change on the same; effect of increased rainfall and storms on river and streambank erosion on prehistoric and historic sites.
	ability to assess the site thoroughly and monitor changing conditions due to lack of positions to do the work.
	Consistent data across patforms (SHPO, THPO, Park). COmbined up to date datasets
	The ability to share information outside the immediate park due to federal law, secretarial orders, Director's Orders, or Superintendent's orders.
	Existing site conditions and exact extent/boundary/location in remote areas, particularly off the road/air transport system in Alaska and particularly on the coast or areas experiencing river erosion and subsidence.
	CRIS-AR Site Records can be inaccurate and unreliable, site location information can be inaccurate and unreliable, lack of GIS databases, lack of comprehensive baseline 110 inventory, not all grey literature has been digitized, ditto site records that could be used to verify accuracy and reliability of site information. Not every regional archeology program have the same reports or records from legacy park archeology projects.
	Much of existing data is not easily accessible and/or available for quantitative evaluations. Current systems are not user friendly or require significant revision to improve access and use.
	Parks have ample access to data on archeological resources if they've completed their baseline documentation. What we don't have is enough information on treatment alternatives, what works, what doesn't, when to treat/stabilize and when to retreat and head into data recovery. However, working in our park networks we are forming communities of practice (which was the goal of the Cultural Resources Climate Change Strategy but we are not getting support for feeding those networked communities and for exchanging data and information uniformly or consistently
	Lots! Inconsistencies in completeness, comprehensiveness, and quality (e.g. accuracy) of information. Data and databases can be old (or recent); databases were not designed to provide info needed to conduct climate vulnerability assessments or to inform adaptation planning, so it's not really surprising they don't meet all these needs. Lots of relevant information is held at park level, so not easily discovered or accessed (not prohibited, just hard to find).

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
	Finding or acquiring of useable base data sets (LiDAR DEMs, infrared photos, airborne photogrammetry etc.). Also need more landscape-scale geophysical data (magnetics, GPR, resistivity etc.) of known sites. More robust support for GIS modeling and ability to evaluate threats to site preservation.
	Inconsistences in data acquisition and formatting is the first challenge. Working through data integration we may lose more information than gain. Second the inconsistences in data management (systems and file structures) is a major challenge.
	There are lots of data available-but I hear from many park staff, and I agree, the data is difficult to find and access (there is too much)? Its just not easy to know the "go to" source for each type of data needed.
	Undefined threats/disturbances from climate change and a lack of a full understanding (data potential, NR eligibility, site boundaries) of the archeological resources under our care.
	Lack of Determinations of NR Eligibility for sites impacts our ability to assess significance.
	Understanding the impacts of groundwater on artifacts, features, and sites.
	Many of our sites have not had condition assessments in decades and the information collected at that time is insufficient to make a determination about current climate change threats. The GIS data for our region is not high enough resolution to work for modeling. Most of all, we don't have a complete site inventory since our parks have not been fully surveyed yet.
	Studies and research that focus on levels on how climate has and will impact archeological sites for our region and area.
	Think our agency needs to do more collaboration with indigenous and other stakeholders in informing decision-making and in management.
	Timely entry of observations (data) needs to improve.
Q27. What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS?	
	funding; changing priorities in DOI and NPS
	Funding.
	Staff
	Data, financial, (wo)man power
	The retraction DO 100 and the downgrading of Traditional Environmental Knowledge.
	Funding - convincing parks to prioritize baseline inventory, lack of WASO DCA Archeologist lead
	The NPS climate adaptation policy is not particularly actionable and has not been applied in a blanket manner across NPS. At the end of the day, if there isn't money for adaptations to be made, they don't happen.
	Cultural resources adaptation planning is far behind natural resources efforts and faces more legal nuisances

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
	I thin that we need clarity on Section 106 and NAGPRA Agreements. It is a slow-moving chronic emergency but there's no emergency declaration. As a result, we deal with things like erosion of cultural deposits as "unexpected finds" when they're not. Discussions are needed to develop agreements and to decide on what artifacts are to be accessioned, and where/how they can be accommodated. Our curation facility is full.
	Funding, fear of political reprisal
	You've hit the main ones - knowledge, capacity and/or motivation, money.
	We have not been given the tools to implement this policy. It provides a useful outline of big picture stuff. But how this is implemented is very unclear and not being coordinated at any level of the NPS currently. There needs to be programmatic support for this effort. We need programmatic approaches to identify sites and mitigate impacts. Tribal consultation is a huge challenge (for reasons on the NPS side not the tribes) and we have very little support to work with tribes on the scales required to identify and address impacts to threatened resources.
	The elephant in the room: Not politically correct to talk about climate change and to base our planning and prioritize our funding and inventory activities based on climate change concerns. There is currently a disconnect with our policy and our actions to follow through and undertake the work need that our policies call for.
	Unclear of inland effects
	Money, Money, Money and Time
	lack of resources, money, expertise, data
	Integration of indigenous perspectives is critical yet is not an institutionalize process
Q34. What suggestions do you have to enhance engagement with stakeholders regarding the adaptation of vulnerable archeological sites?	
	Begin. Start building communication, build relationships, be honest, be transparent.
	Continue to enhance public involvement with archeological projects and results, whihe deterring illegal excavations.
	We need to do a better job in reaching out all
	Communicate early and often to discuss planning and develop shared stewardship.
	continued open and transparent consultation
	Listen to them and act on what they say.
	Improved relationship building and consultation outside of that which is required through compliance.
	WASO support/guidance for regional-level prioritization and advanced coordination/planning that includes meaningful stakeholder engagement early and throughout the process

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
	Greater training, communications, and guidance to NPS personnel on importance and benefits of engaging with stakeholders, especially tribal nations.
	Native - indigenous academics who know their climate science to serve as intensive-focus engagement specialists. Somebody needs to be talking about it all the time, not just checking a box. We are relying on FA agreements with the university for this piece.
	Incorporate stakeholder involvement practices early, make them routine, listen carefully and learn from stakeholder comments, systematize ways to make sure we consider them in conducting operations.
	Tribal capacity to participate can be a huge issue. It seems like tribes often have one or only a few people that routinely attend meeting and represent the tribe. They can be asked to attend MANY meetings - with NPS, USFWS, USFS, local governments, etc. They simply don't have the time or capacity to participate and engage in all the activities they're asked to engage in. This can be a showstopper.
	These questions are a little misguided as they assume the NPS does effective consultation with tribes and stakeholders. With some exceptions, the agency does not do particularly well engaging tribes on these issues. We need consultations to happen at all levels of the NPS national, regional, and local. Each level brings different oppertunities and groups of stakeholders that can provide input at multiple scales to address impacts to preservation. This requires staff time, funds, and skilled facilitators to effectively have these conversations. Everything with tribal consultation starts with relationship building. We lack these relationships across the NPS. We also need tribal perspectives within the NPS and need more indigenous voices helping guide management and set priorities within the agency.
	I don’t see much engagement with stakeholders so increasing this would be key
	Have annual regional workshops for involving stakeholders
	Our tribes are mostly newly Federally recognized and are still in the process of developing resources. They generally do not have CR specialists or have the bandwidth to consult in a really meaningful way.
	not sure - social media, 'friends of' groups, citizen science programs?
	Training for managers on how to building a meaningful relationship with stakeholders
	It should be a critical element in making decisions!

Table C.2. Open ended responses provided by respondents in the post-workshop survey questionnaire

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
Q21. What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS?	
	What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS?
	Inconsistent guidance from upper levels of Gov administration. No weighted funding decision mechanism.
	Changing administrative priorities within the park, resources division, and inconsistencies with overall strategic planning both for NPS objectives and collaboration with Tribal/outside partners.
	Effective reduction of 45-60% in CR funding from 1994 to 2020 has changed archeological funding to almost wholly compliance work.
	Funding - never enough money to implement desirable projects.
	Funding and personnel
	lack of money, lack of staff
Q26. What suggestions do you have to enhance engagement with partners and stakeholders regarding the adaptation of vulnerable archeological sites?	
	Look at KAWW developing management with Tribal Partners, look at Uluru-Kata Tjuta NP management structure, Hawai'i NHP developing co-management with Indigenous Populations
	Prioritize Tribal engagement and then listen.
	Might think outside of legally mandated significance, and understand what significance, vulnerability, and sensitivity means to tribal nations
	Have some meetings at tribal location rather than park. Where appropriate, provide funding for tribal member to participate.
	Time, funding, and personnel
	social media, citizen science
Q30. What other capacity constraints does the agency face when protecting climate-vulnerable archeological sites?	
	Lack of personnel. Inconsistency of up to date CR baseline inventory to accurate and reliable across the service. Lack of consistent personnel and consistent policy guidance. Lack of specific identification of weighted scoring / prioritizing in available CR project funding opportunities.
	Again, effective reduction in staffing by 45-60% from 1994 to present has severely curtailed any research or forward-looking research in archeology.
	incomplete inventories, lack of data - spatial, climate, site condition
	Expansion of capacity would be enhanced if there could be an increase in the number/occurrence of new positions (assigned to individual or multiple parks, or at regional offices) that focus on climate-change adaptation (for both CR & NR, preferably integrated). Current CR staff are already maxed out in their workloads, and CC response needs folks who can be dedicated to CC-issues, serving to support and advise Park and Region staff in devising and implementing adaptation assessment and response.

Pre-workshop Survey Questionnaire Item	Open-Ended Responses
	These positions can also help to gather and coordinate informal teams of staff at diverse parks or regions with content- or stressor-specific expertise and passion.

Appendix D

Table D.1: Pre survey questions and response means, standard deviations, minimums, maximums, and medians. Footnotes contain metric response items. N=25

Questionnaire Item	**MEAN**	**SD**	**MIN**	**MAX**	**MEDIAN**	**COEFFICENT OF VARIATION**
To what extent do you think participating in this workshop will influence your thoughts on archeological site preservation?[4]						
a. Archeological site preservation, generally	2.50	0.91	1.00	4.00	3.00	0.36
b. Archeological site preservation under changing climate conditions, specifically	2.79	1.00	1.00	4.00	3.00	0.36
How important, in your opinion, are the following considerations in prioritizing archaeological sites for climate adaptation planning/preservation on a 30-year time horizon?[5]						
a. A preservation treatment has been applied to the site in the past.	1.92	1.08	0.00	4.00	2.00	0.56
b. Cost of treating and maintaining the site.	2.64	0.97	0.00	4.00	3.00	0.37
c. The site holds stakeholder meaning.	3.56	0.57	2.00	4.00	4.00	0.16
d. The site is actively used for traditional cultural practices.	3.84	0.37	3.00	4.00	4.00	0.10
e. The cultural landscape (in which the site is located) is damaged by non-climatic impacts.	2.08	1.00	0.00	4.00	2.00	0.48
f. The site has high scientific value (known potential for knowledge).	3.50	0.82	1.00	4.00	4.00	0.23
g. The site holds a particular historical value because it is the only one like it (valued for uniqueness of resources).	3.50	0.71	2.00	4.00	4.00	0.20
h. The site illustrates something of national importance.	3.46	0.71	1.00	4.00	4.00	0.21

[4] 0 – 4, Not Influential, Slightly Influential, Moderately Influential, Very Influential, Extremely Influential

[5] 0 – 4, Not Important, Slightly Important, Moderately Important, Very Important, Extremely Important

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICENT OF VARIATION
i. The site is eligible for inclusion on the National Register of Historic Places.	3.04	0.79	1.00	4.00	3.00	0.26
j. The site location is exposed to climate-change threats (severity of risk).	3.38	0.75	2.00	4.00	4.00	0.22
k. The nature of the site makes it sensitive to climate-change threats (severity of risk).	3.33	0.85	1.00	4.00	4.00	0.26
l. The site faces immediate climate-change related impacts (urgency of action).	3.42	0.86	1.00	4.00	4.00	0.25
m. The site is experiencing deferred maintenance.	1.83	0.85	1.00	4.00	2.00	0.46
n. Other	4.00	0.00	4.00	4.00	4.00	0.00
How challenging are the following uncertainties in archeological preservation and climate adaptation planning?[6]						
a. Timing of climate impacts	2.96	0.84	1.00	4.00	3.00	0.28
b. Magnitude of climate impacts	3.43	0.71	2.00	4.00	4.00	0.21
c. Predictability of budget	3.26	0.74	2.00	4.00	3.00	0.23
d. Federal political environment	2.95	1.00	1.00	4.00	3.00	0.34
e. State political environment	2.32	1.10	0.00	4.00	2.00	0.47
f. Decision makers' values & priorities	2.50	0.89	1.00	4.00	2.00	0.36
g. Stakeholders' values & priorities	2.23	0.73	1.00	4.00	2.00	0.33
h. Changes in archeological policy	2.00	1.18	0.00	4.00	2.00	0.59
i. Working with SHPOs to preserve or adapt sites	1.52	1.02	0.00	4.00	2.00	0.67
j. Working with THPOs to preserve or adapt sites	1.64	1.07	0.00	4.00	2.00	0.65
k. Prioritizing areas that have not been surveyed yet	2.81	1.10	1.00	4.00	3.00	0.39
l. Prioritizing located sites that have little-to-no information	2.68	1.10	1.00	4.00	3.00	0.41
Are you a NPS employee?	1.04	0.20	1.00	2.00	1.00	0.19

[6] 0 – 4, Not Challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging

Questionnaire Item	**MEAN**	**SD**	**MIN**	**MAX**	**MEDIAN**	**COEFFICENT OF VARIATION**
Which of the following do you believe to be constraints when informing adaptation planning or decision making for archeological sites?						
Data availability	1.13	0.45	1.00	3.00	1.00	0.40
Data accessibility	1.48	0.65	1.00	3.00	1.00	0.44
Available data usability	1.26	0.61	1.00	3.00	1.00	0.48
Please indicate what dataset(s) you turn to inform climate adaptation decisions and the extent to which the data is sufficient to inform management decisions about climate adaptation.[7]						
Use - FMSS (facilities management software system)	2.22	0.72	1.00	3.00	2.00	0.32
Use - AOA (archeological overview and assessment)	1.27	0.62	1.00	3.00	1.00	0.49
Use - CRIS - AR (archeological resources)	1.30	0.69	1.00	3.00	1.00	0.53
Use - CRIS - LCS (list of classified structures)	2.05	0.82	1.00	3.00	2.00	0.40
Use - CRIS - CLI (cultural landscape inventory)	1.87	0.95	1.00	3.00	1.00	0.51
Use - CRIS - ER (ethnographic records)	2.27	0.81	1.00	3.00	2.50	0.36
Use - ARA (archeological resource assessment)	1.77	0.79	1.00	3.00	2.00	0.45
Use - Oral history/informants	1.96	0.95	1.00	3.00	2.00	0.48
Use - SHPO records	1.48	0.83	1.00	3.00	1.00	0.56
Use - THPO records	1.87	0.8	1.00	3.00	2.00	0.43
Use - Park records (e.g., 106 reports; collections reports)	1.13	0.45	1.00	3.00	1.00	0.40
Use - Academic reports	1.61	0.87	1.00	3.00	1.00	0.54
Use - GIS (geographical information systems)	1.09	0.41	1.00	3.00	1.00	0.38
Sufficiency - FMSS (facilities management software system)	1.06	0.73	0.00	2.00	1.00	0.69

[7] Use: 1 - Yes, 2- No, 3- Infrequently, Sufficiency: 0 – Not at all, 1- Minimal, 2 – Moderate, 3 – High

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICENT OF VARIATION
Sufficiency - AOA (archeological overview and assessment)	2.30	0.64	1.00	3.00	2.00	0.28
Sufficiency - CRIS - AR (archeological resources)	2.00	0.82	0.00	3.00	2.00	0.41
Sufficiency - CRIS - LCS (list of classified structures)	1.44	1.07	0.00	3.00	1.00	0.74
Sufficiency - CRIS - CLI (cultural landscape inventory)	1.64	0.88	0.00	3.00	2.00	0.54
Sufficiency - CRIS - ER (ethnographic records)	1.25	0.89	0.00	3.00	1.00	0.71
Sufficiency - ARA (archeological resource assessment)	1.89	1.21	0.00	3.00	2.00	0.64
Sufficiency - Oral history/informants	2.00	0.95	0.00	3.00	2.00	0.48
Sufficiency - SHPO records	2.00	0.98	0.00	3.00	2.00	0.49
Sufficiency - THPO records	1.68	1.13	0.00	3.00	2.00	0.67
Sufficiency - Park records (e.g., 106 reports; collections reports)	2.36	0.57	1.00	3.00	2.00	0.24
Sufficiency - Academic reports	2.13	0.68	0.00	3.00	2.00	0.32
Sufficiency - GIS (geographical information systems)	2.65	0.63	1.00	3.00	3.00	0.24
In your opinion, how challenging are each of these recommendations identified by NPS Memorandum 14-02 to implement?[8]						
Refocus inventory responsibilities	2.42	0.99	0.00	4.00	2.00	0.41
Integrate resource vulnerability and significance	2.61	0.95	1.00	4.00	2.50	0.36
Understanding and communicating climate change effects (stewardship and public awareness)	2.15	1.06	1.00	4.00	2.00	0.49
Consult broadly (Tribal or Indigenous groups, visitors, and scientific community)	2.40	1.02	0.00	4.00	2.00	0.43
Value and integrate information from the past	1.75	1.04	0.00	4.00	2.00	0.59
Recognize loss potential	2.05	1.16	0.00	4.00	2.00	0.57
To what extent do the following site characteristics influence the selection of adaptation options (e.g., build off-site						

[8] 0 – 4, Not Challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICENT OF VARIATION
protections, relocate, excavate, document and prepare for loss) suggested by the NPS website?[9]						
Site location	3.60	0.73	2.00	4.00	4.00	0.20
Site type	3.14	0.94	1.00	4.00	3.00	0.30
Site materials	3.14	1.04	1.00	4.00	4.00	0.33
Existing disturbances	3.05	0.72	2.00	4.00	3.00	0.24
Extent of excavation/inventory	3.00	0.76	2.00	4.00	3.00	0.25
Extent of collections	2.50	1.07	0.00	4.00	2.50	0.43
Singular climate threats	2.62	0.90	0.00	4.00	3.00	0.34
Multiple, compounding climate threats	3.52	0.73	2.00	4.00	4.00	0.21
Sufficient investigation/documentation	2.75	1.09	1.00	4.00	3.00	0.40
Sufficient interpretation of primary data	2.60	0.92	1.00	4.00	3.00	0.35
Sufficient interpretation of collections	2.37	0.98	0.00	4.00	2.00	0.41
Do you feel agency NPS climate adaptation policy and guidance has limited or enhanced the conservation of archeological sites?[10]	0.32	0.76	-1.00	2.00	0.00	2.38
To what extent do you believe engaging with the following stakeholders has been effective when planning for adaptation of archeological sites?[11]						
Formally associated Tribal Citizens (Affiliated Tribal groups/Indigenous communities; THPOs)	2.58	1.14	0.00	4.00	3.00	0.44
Non-affiliated Tribal groups/Indigenous communities	2.07	1.12	0.00	4.00	2.00	0.54
Contemporary ethnic/racial stakeholders (emerging communities with associations)	1.92	1.21	0.00	4.00	2.00	0.63
Other resource management agencies (e.g., SHPO)	2.38	1.17	0.00	4.00	3.00	0.49

[9] 0 – 4, Not at all, A little, A moderate amount, A lot, A great deal
[10] -2 – 2, Extremely limited, Somewhat limited, Neither limited nor enhanced, somewhat enhanced, Extremely enhanced
[11] 0 – 4, Not effective, Slightly effective, Moderately effective, Very effective, Extremely effective

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICENT OF VARIATION
External research stakeholders (e.g., academics)	2.45	0.97	1.00	4.00	2.50	0.40
Local, gateway communities (Proximate residents to park unit)	1.95	1.24	0.00	4.00	2.00	0.64
Visiting public	1.44	1.01	0.00	4.00	2.00	0.70
General public	1.17	0.83	0.00	2.00	1.00	0.71
To what extent do you feel the following challenge relationship building with stakeholders. Note: awards refer to non-monetary types of recognition, such as recognition of achievements.[12]						
The trend for personnel to relocate for advancement within the agency.	1.68	0.97	0.00	3.00	2.00	0.58
Limited internal (agency) awards or recognition structures.	0.69	0.68	0.00	2.00	1.00	0.99
Limited awards or recognition for Tribal Citizens or other external stakeholders.	1.86	1.06	0.00	3.00	2.00	0.57
Limited awards or recognition from Tribal Citizens or other external stakeholders.	1.00	0.82	0.00	2.00	1.00	0.82
Changes in Tribal Government.	1.65	0.79	0.00	3.00	2.00	0.48
Tribal Citizens' or other stakeholders' awareness of materials in park collections.	1.89	0.91	0.00	3.00	2.00	0.48
Tribal Citizens' or other external stakeholders' access to culturally-relevant archeological sites.	1.53	1.04	0.00	3.00	2.00	0.68
Tribal Citizens' relationships with prior NPS staff or management.	2.00	0.74	1.00	3.00	2.00	0.37
To what extent are the following personnel issues limiting the adaptation of archeological sites?[13]						
Amount of available personnel	2.52	0.91	0.00	3.00	3.00	0.36

[12] 0 – 3, Not at all challenging, A little challenging, Moderately challenging, Extremely challenging
[13] 0 – 3, Not limiting, Somewhat limiting, Moderately limiting, Very limiting

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICENT OF VARIATION
Amount of skilled personnel	2.24	0.87	0.00	3.00	2.00	0.39
Ability to hire personnel in a timely fashion	2.33	0.89	0.00	3.00	3.00	0.38
Retaining skilled personnel	2.10	0.83	0.00	3.00	2.00	0.40
Other personnel issues (please comment below)	3.00	0.00	3.00	3.00	3.00	0.00
Please indicate the extent to which you agree, disagree, neither agree nor disagree (i.e., are ambivalent), or are unsure with the following statements.[14]						
The agency lacks support tools for climate adaptation planning.	0.90	1.11	-2.00	2.00	1.00	1.23
The agency has sufficient adaptation options for archeological sites.	-0.62	1.33	-2.00	2.00	-1.00	-2.15
The agency has the guidance it needs to prioritize sites for adaptation when sites are equally vulnerable.	-0.76	1.34	-2.00	2.00	-1.00	-1.76
In general, parks have sufficient archeological expertise to plan for climate adaptation of sites.	-0.57	1.22	-2.00	2.00	-1.00	-2.14
In general, park staff have sufficient time to plan for climate adaptation of archeological sites.	-1.55	1.12	-2.00	2.00	-2.00	-0.72
In general, park staff can react to urgent climate adaptation needs.	-1.4	1.11	-2.00	2.00	-2.00	-0.79
In general, park staff have sufficient knowledge about climate change stressors.	-0.43	1.18	-2.00	2.00	-1.00	-2.74
Funding mechanisms are sufficient for climate adaptation planning.	-0.55	1.20	-2.00	2.00	-1.00	-2.18
Funding mechanisms are sufficient for the implementation of adaptation actions to conserve threatened sites.	-1.05	1.09	-2.00	2.00	-1.00	-1.04

[14] -2 – 2, Completely disagree, Somewhat disagree, Neither agree nor disagree, somewhat agree, Completely agree

Appendix D, Table D.2: Post survey questions and response means, standard deviations, minimums, maximums, and medians. N=10

Questionnaire Item	**MEAN**	**SD**	**MIN**	**MAX**	**MEDIAN**	**COEFFICIENT OF VARIATION**
To what extent do you think participating in this workshop influenced your thoughts on archeological site preservation?[15]						
a. Archeological site preservation, generally.	2.00	1.04	0.00	4.00	2.00	0.52
b. Archeological site preservation under changing climate conditions, specifically.	2.27	1.35	0.00	4.00	3.00	0.59
To what extent do you think this workshop demonstrated the potential for co-production of knowledge?	2.45	0.66	1.00	3.00	3.00	0.27
How important, in your opinion, are the following considerations in prioritizing archaeological sites for climate adaptation planning/preservation on a 30-year time horizon?[16]						
a. The site location is exposed to climate-change threats (severity of risk).	3.18	0.57	2.00	4.00	3.00	0.18
b. The nature of the site makes it sensitive to climate-change threats (severity of risk).	3.00	0.95	1.00	4.00	3.00	0.32
c. The site faces immediate climate-change related impacts (urgency of action).	3.36	0.64	2.00	4.00	3.00	0.19
d. Long term efficacy of treating the site.	2.55	0.89	1.00	4.00	3.00	0.35
To what extent do you believe these data issues will be constraints to informing adaptation planning or decision making for archeological sites?[17]						
Limited available data	2.55	1.16	0.00	4.00	3.00	0.45
Limited access to data	2.00	1.41	0.00	4.00	2.00	0.71
Limited useable data	2.73	0.75	1.00	4.00	3.00	0.27
Out-of-date data	2.73	0.62	2.00	4.00	3.00	0.23
Incompleteness of data	3.09	0.79	2.00	4.00	3.00	0.26

[15] 0 – 4, Not Influential, Slightly Influential, Moderately Influential, Very Influential, Extremely Influential
[16] 0 – 4, Not Important, Slightly Important, Moderately Important, Very Important, Extremely Important
[17] 0 – 4, Not at all, A little, A moderate amount, A lot, A great deal

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICIENT OF VARIATION
Shallowness (not thoroughness) data	3.00	0.74	2.00	4.00	3.00	0.25
To what extent do you agree or disagree about the following descriptions of the agency's adaptation policy and guidance for archeological sites?[18]						
Easy to implement	-0.18	1.11	-2.00	2.00	0.00	-6.17
Specific enough for on the ground application	-0.45	0.99	-2.00	1.00	0.00	-2.20
Applicable across all types of archeological sites	0.36	0.77	-1.00	1.00	1.00	2.14
Applicable across various types of archeological site settings	0.45	0.99	-2.00	1.00	1.00	2.20
Applicable when multiple stressors are present	0.64	1.15	-2.00	2.00	1.00	1.80
Applicable to different types of climate threats/impacts	0.82	0.83	-1.00	2.00	1.00	1.01
Not actionable	0.10	1.14	-1.00	2.00	0.00	11.40
Lacking coordination from leadership	0.40	1.11	-1.00	2.00	0.50	2.78
Lacking support from leadership	0.55	1.16	-1.00	2.00	1.00	2.11
Limited park-level staff	1.09	0.90	-1.00	2.00	1.00	0.83
Limited staff with technical expertise	1.18	0.94	-1.00	2.00	1.00	0.80
In your opinion, how challenging are each of these recommendations identified by NPS Memorandum 14-02 to implement?[19]						
Refocus inventory responsibilities	2.00	1.28	0.00	4.00	2.00	0.64
Integrate resource vulnerability and significance	2.18	0.94	1.00	4.00	2.00	0.43
Understanding and communicating climate change effects (stewardship and public awareness)	2.00	1.21	0.00	4.00	2.00	0.61
Consult broadly (Tribal or Indigenous groups, visitors, and scientific community)	2.36	0.88	1.00	4.00	2.00	0.37
Value and integrate information from the past	1.91	1.24	0.00	4.00	2.00	0.65

[18] -2 – 2, Strongly disagree, Disagree, Ambivalent, Agree, Strongly agree
[19] 0 – 4, Not at all challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICIENT OF VARIATION
Recognize loss potential	2.18	1.27	0.00	4.00	2.00	0.58
To what extent do you feel that the language (terminology/lexicon) used in agency adaptation guidance and policy is...[20]						
Easy to interpret for site managers	1.50	0.92	0.00	3.00	2.00	0.61
Inclusive of stakeholder values	1.36	0.88	0.00	3.00	1.00	0.65
Effective for multi-site use	1.70	1.00	0.00	3.00	1.50	0.59
Do you feel agency NPS climate adaptation policy and guidance has limited or enhanced the conservation of archeological sites?[21]	0.55	0.50	0.00	1.00	1.00	0.91
Which of the following strategies do you think will be most beneficial for the stewardship of archeological sites facing climate change stressors?[22]						
Programmatic agreements for Section 106	3.10	1.14	1.00	4.00	3.00	0.37
Programmatic agreements for NAGPRA	1.82	1.11	0.00	3.00	2.00	0.61
Programmatic framework to address site loss	2.73	0.86	1.00	4.00	3.00	0.32
Collaboration with DOI/USGS Climate Adaptation Science Centers (CASCs)	3.00	1.28	0.00	4.00	3.00	0.43
Citizen science monitoring programs	2.36	0.98	0.00	4.00	2.00	0.42
Enhancing the scale of archeological projects	2.45	0.89	1.00	4.00	3.00	0.36
Park archeologists becoming comfortable with loss	2.27	0.96	0.00	3.00	3.00	0.42
Public-Private partnerships to fund adaptation	2.64	0.98	1.00	4.00	3.00	0.37
Foundations/Philanthropy to fund adaptation	2.55	0.99	1.00	4.00	3.00	0.39
Other	3.33	0.47	3.00	4.00	3.00	0.14

[20] 0 – 4, Not at all, A little, A moderate amount, A lot, A great deal
[21] -2 – 2, Extremely limited, Somewhat limited, Neither limited nor enhanced, Somewhat enhanced, Extremely enhanced
[22] 0 – 4, Not at all beneficial, Slightly beneficial, Somewhat beneficial, Very beneficial, Extremely beneficial

Questionnaire Item	**MEAN**	**SD**	**MIN**	**MAX**	**MEDIAN**	**COEFFICIENT OF VARIATION**
To what extent do you feel the following challenge relationship building with stakeholders. Note: awards refer to non-monetary types of recognition, such as recognition of achievements.[23]						
The trend for personnel to relocate for advancement within the agency.	2.00	1.04	0.00	3.00	2.00	0.52
Limited internal (agency) awards or recognition structures.	0.78	0.79	0.00	2.00	1.00	1.01
Limited awards or recognition for Tribal Citizens or other external stakeholders.	1.22	0.92	0.00	3.00	1.00	0.75
Limited awards or recognition from Tribal Citizens or other external stakeholders.	0.56	0.68	0.00	2.00	0.00	1.21
Changes in Tribal Government.	2.09	0.67	1.00	3.00	2.00	0.32
Tribal Citizens' or other stakeholders' awareness of materials in park collections.	1.36	0.88	0.00	3.00	1.00	0.65
Tribal Citizens' or other external stakeholders' access to culturally-relevant archeological sites.	1.82	0.94	0.00	3.00	2.00	0.52
Tribal Citizens' relationships with prior NPS staff or management.	2.22	0.63	1.00	3.00	2.00	0.28
Please indicate the extent to which you agree, disagree, neither agree nor disagree (i.e., are ambivalent), or are unsure with the following statements.[24]						
The agency lacks support tools for climate adaptation planning.	0.73	0.75	-1.00	2.00	1.00	1.03
The agency has sufficient adaptation options for archeological sites.	-1.09	0.79	-2.00	0.00	-1.00	-0.72

[23] 0 – 4, Not at all challenging, Slightly challenging, Moderately challenging, Very challenging, Extremely challenging
[24] -2 – 2, Strongly disagree, Disagree, Ambivalent, Agree, Strongly agree

Questionnaire Item	MEAN	SD	MIN	MAX	MEDIAN	COEFFICIENT OF VARIATION
The agency has the guidance it needs to prioritize sites for adaptation when sites are equally vulnerable.	-0.36	1.30	-2.00	1.00	-1.00	-3.61
In general, parks have sufficient archeological expertise to plan for climate adaptation of sites.	-1.00	0.95	-2.00	1.00	-1.00	-0.95
In general, park staff have sufficient time to plan for climate adaptation of archeological sites.	-1.55	0.50	-2.00	-1.00	-2.00	-0.32
In general, park staff can react to urgent climate adaptation needs.	-1.27	0.62	-2.00	0.00	-1.00	-0.49
In general, park staff have sufficient knowledge about climate change stressors.	-0.45	0.89	-1.00	1.00	-1.00	-1.98
Funding mechanisms are sufficient for climate adaptation planning.	-1.55	0.50	-2.00	-1.00	-2.00	-0.32
Funding mechanisms are sufficient for the implementation of adaptation actions to conserve threatened sites.	-1.64	0.48	-2.00	-1.00	-2.00	-0.29
To what extent do you think the urgency of taking action for adaptation is shared among the following:[25]						
Agency Staff and Leadership	1.73	1.05	0.00	3.00	2.00	0.61
Agency Personnel and THPOs	1.71	0.70	1.00	3.00	2.00	0.41
Agency Personnel and SHPOs	2.00	0.67	1.00	3.00	2.00	0.34
The Agency and the Public	1.25	0.97	0.00	3.00	1.00	0.78
The Agency and External Researchers/Cooperators	2.10	0.83	1.00	3.00	2.00	0.40

[25] 0 – 3, No alignment, Minimal alignment, Modest alignment, Substantial alignment

Appendix E

Table E.1: Respondent NPS characteristics[26]

Characteristic	Response Category	Percent
NPS Affiliation	Academic Cooperator	4%
	National-level management	4%
	National-level staff	4%
	Regional-level management	15%
	Regional-level staff	26%
	Park-level management	22%
	Park-level staff	26%
DOI Region	Region 1: North Atlantic-Appalachian	37%
	Region 2: South Atlantic-Gulf	4%
	Region 4: Mississippi Basin	7%
	Region 5: Missouri Basin	7%
	Region 7: Upper Colorado Basin	19%
	Region 8: Lower Colorado Basin	7%
	Region 9: Columbia-Pacific Northwest	4%
	Region 11: Alaska	11%
	Region 12: Pacific Islands	4%

[26] Rounding percentages to the nearest whole numbers resulted in total percent not equaling 100.

Table E.2: Respondent experience characteristics[27]

Characteristic	**Value**	**Percent**
Education level	Undergraduate education (e.g., BA, BS)	4%
	Master's level education (e.g., MA, MSc)	56%
	Doctoral level education (e.g., Ph.D.)	36%
	Other	4%
Years in current position	More than 15 years	15%
	11-15 years	15%
	6-10 years	15%
	1-5 years	39%
	Less than 1 year	12%
Years in archeology	More than 15 years	65%
	11-15 years	15%
	6-10 years	4%
	1-5 years	12%
	Less than 1 year	4%
Years in climate change adaptation	More than 15 years	8%
	11-15 years	29%
	6-10 years	29%
	1-5 years	25%
	Less than 1 year	8%

[27] Rounding percentages to the nearest whole numbers resulted in total percent not equaling 100.

Appendix F. Table F.1: Open ended response themes[28]

Survey	Open ended responses (*Themes*)	Percent of responses
Q21 POST	What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS?	
	Climate related positions	6%
	Data	6%
	Guidance	6%
	Priorities	6%
	Funding mechanism	13%
	Inventory consistency	13%
	Funding	25%
	Personnel	25%
Q26 POST	What suggestions do you have to enhance engagement with partners and stakeholders regarding the adaptation of vulnerable archeological sites?	
	Citizen science	10%
	Co-management	10%
	Personnel	10%
	Social media	10%
	Time	10%
	Funding	20%
	Tribal engagement	30%
Q30 POST	What other capacity constraints does the agency face when protecting climate-vulnerable archeological sites?	
	Funding mechanism	14%
	Climate related positions	14%
	Data	14%
	Personnel	29%
	Inventory consistency	29%
18 PRE	Please list any specific challenges to archeological site preservation (particularly relevant to climate adaptation planning) you face related to limitations in data availability, acceptability, and/or suitability.	
	Damage to sites	6%
	Ability to share data	6%
	Tribal engagement	6%
	Access to sites	11%
	Data consistency	11%
	Inaccurate data	11%
	Treatment data	11%
	Undefined climate threats	11%

[28] Rounding percentages to the nearest whole numbers resulted in total percent not equaling 100. Responses were not mutually exclusive.

Survey	Open ended responses (*Themes*)	Percent of responses
	Completeness of data	11%
	Access to data	17%
19 PRE	What, if any, specific types data do you feel are consistently missing but would be helpful for informing climate adaptation planning of archeological sites?	
	Collaborations with climate science centers	6%
	Tribal engagement	6%
	Baseline data	11%
	Condition assessments	11%
	CRIS updates	11%
	Data potential	11%
	GIS (general)	17%
	Climate projections/data	28%
25 PRE	How has the application of NPS adaptation policy and guidance led to positive adaptation of vulnerable archeological sites (please describe any positive outcomes with which you are familiar)?	
	Policy needs improvement	7%
	Consultation	7%
	Partnerships/Programs	7%
	Still gathering data	7%
	Unknown	7%
	Partial protections enacted	14%
	Provided direction of actions	14%
	Successful adaptations enacted	14%
	None	21%
26 PRE	What strategies, if any, have you used to apply current NPS adaptation policy and guidance to vulnerable archeological sites?	
	Applied for funding	8%
	Communication	8%
	Scenario planning	8%
	Partially used policy for project	8%
	N/A	17%
	Used policy for project	25%
	Have not used	25%
27 PRE	What other challenges, if any, do you face with implementing the adaptation recommendations currently identified by the NPS?	
	Legal issues	4%
	Curation	4%
	Time	4%
	Expertise	4%
	Tribal engagement	4%

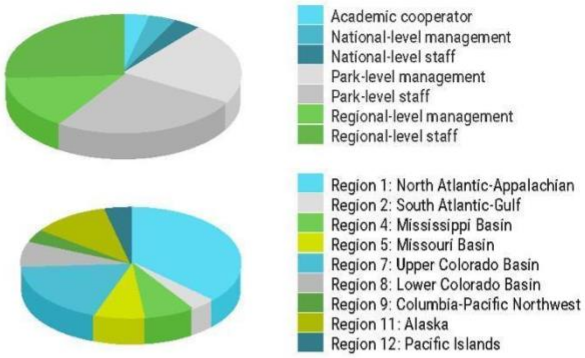
Survey	Open ended responses (*Themes*)	Percent of responses
	Data	8%
	Other specific needs	8%
	Political Issues	8%
	Staff	12%
	Policy not actionable	12%
	Funding	32%
28 PRE	Please list any additional concerns related to NPS climate adaptation policy and guidance for archeological sites.	
	Not included in funding decisions	10%
	Data	10%
	Political Issues	10%
	Expert personnel	10%
	Other specific issues	10%
	Capacity constraints	20%
	Leadership priorities	30%
32 PRE	What suggestions do you have to enhance engagement with stakeholders regarding the adaptation of vulnerable archeological sites?	
	Leadership support	4%
	Public engagement	8%
	Tribal capacity	8%
	Training	8%
	Tribal engagement	13%
	Relationship building	17%
	Consultation	17%
	Communication	25%
35 PRE	What other personnel issues limit capacity of the agency to protect climate-vulnerable archeological sites?	
	Travel restrictions	10%
	Tribal engagement	10%
	National coordinated response	10%
	Hiring	20%
	Expert personnel	20%
	Cultural resources staff	30%

Appendix G: Visualization Report of pre and post survey data for internal NPS distribution, 2021

Barriers to Archeological Site Protection

This survey was conducted by North Carolina State University researchers with the goal to understand barriers to archeological site protection and preservation from climate change stressors.

The survey items focused on experiences working in archeology and climate adaptation of archeological sites, as well as perceptions of the challenges and priorities for archeological site climate adaptation planning with the National Park Service.



65% of survey participants have more than 15 years experience in archeology.

Participants were selected based on their expertise in archeology, climate change, and adaptation planning.

Participants have used climate adaptation strategies like scenario planning, adaptation assessments, and monitoring vulnerable archeological sites.

33% reported funding

is the main capacity constraint the agency faces when protecting climate-vulnerable archeological sites.

Capacity constraints and challenges

Other reported capacity constraints include lack of Tribal input, climate-related positions, lack of actionable work or projects, and inventory consistency and capacity. Respondents also indicated that increased guidance, personnel, understanding of priorities and planning, and data would increase agency capacity for site protection.

Participants offered suggestions for increased stakeholder engagement.

"Think outside of legally mandated significance, and understand what significance, vulnerability, and sensitivity means to tribal nations."

This framework is a product of Task Agreement Number P17AC00794 under Cooperative Agreement P13AC00443 between the US DOI National Park Service and North Carolina State University; last updated April 26, 2021.

Participant responses and suggestions

Participants shared insight about specific challenges to archeological site preservation related to limitations in data availability, acceptability, and/or suitability.

"There are lots of data available - but I hear from many park staff, and I agree, the data is difficult to find and access... It's just not easy to know the 'go to' source for each type of data needed."

55% *of survey participants mentioned inaccessible or incomplete data as a limitation for archeological site preservation.*

67%

of survey participants

have 6 years or more experience in climate change adaptation.

"Parks have ample access to data on archeological resources if they've completed their baseline documentation. What we don't have is enough information on treatment alternatives, what works, what doesn't, when to treat/stabilize and when to retreat and head into data recovery."

How actionable is current NPS climate adaptation policy?

91% *of survey respondents stated that Tribal Citizens' or other external stakeholders' access to culturally-relevant archeological sites is moderately or extremely challenging to relationship building.*

"There needs to be programmatic support for this effort. We need programmatic approaches to identify sites and mitigate impacts. Tribal consultation is a huge challenge (for reasons on the NPS side, not the tribes) and we have very little support to work with tribes on the scales required to identify and address impacts to threatened resources."

Funding and data are main capacity constraints.

Tribal Engagement is essential for stakeholder participation and relationship building.

Programmatic support is needed for policy guidance and applicability.

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