Chapter 5 Cultural Resources

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Introduction

This chapter describes threats to cultural resources in the coastal zone, identifies multiple adaptation strategies to address these threats, and outlines policies and decision-making processes to assist with adaptation. Online resources will be updated to supplement this document and can be found at https://www.nps.gov/subjects/climatechange/coastalhandbook.htm.

The National Park Service manages five types of cultural resources: archeological resources, cultural landscapes, ethnographic resources, museum collections, and historic and prehistoric buildings and structures (NPS 2006), all of which are found in the coastal zone. Underwater or submerged resources, which include shipwrecks, other submerged buildings or structures, and inundated archeological sites and cultural landscapes, also occur in and are accessed from the coastal zone.

This diversity of cultural resources anchors the history of human interactions with water. While humans have lived in nearly every environment on the planet, coasts – through the access they have provided to plants and animals for food and manufacturing; to means of transportation, commerce, communication, and defense; and to areas of beauty and recreation – have high concentrations of cultural resources. These in turn hold a wide array of meanings and livelihoods for many different communities. Combined, this abundance of resources and their diverse associations create substantial challenges for the management of cultural resources in the coastal zone, particularly in regard to climate change.

Figure 5.1. The Cockspur Lighthouse at Fort Pulaski National Monument, Georgia, needs to be stabilized with a structure that can withstand ongoing erosion around the revetment, sea level rise over the next 20 years, and related impacts such as increased wave heights. Photograph by Paul Brennan.

Because cultural resources hold significance from both place and the past, they are unique and nonrenewable. Once they are lost, they are gone forever, along with their value for research and discovery, provoking public introspection, keeping and reawakening cultural memories, connecting individuals to their ancestors, and maintaining ties from generation to generation. For these reasons, National Park Service (NPS) Director Jarvis stated in NPS Policy Memorandum 14-02 "Climate Change and Stewardship of Cultural Resources" (PM 14-02, NPS 2014a) that cultural resource management "must keep in mind that (1) cultural resources are primary sources of data regarding human interactions with environmental change; and (2) a changing climate affects the preservation and maintenance of cultural resources." This chapter provides an overview of the current state of the art for understanding the threats of climate change for cultural resources in the coastal zone (see phrase 2 above), and for integrating unique and significance aspects of cultural resources into adaptation in the coastal zone (see phrase 1 above).

Climate Change Threats to Cultural Resources in the Coastal Zone

Environmental forces have always affected cultural resources. Climate change, however, is accelerating, intensifying, recombining, and adding to these forces. Evidence of a wide range of climate change impacts on different types and forms of cultural resources are accumulating throughout different coastal environments of the National Park System. The potential and observed impacts of the many dimensions of climate change on the five categories of NPS cultural resources are outlined briefly in table 5.1 and table 5.2 (Rockman 2015; for more detailed descriptions, see Morgan et al. 2016 and Graphic 2 in the *NPS Cultural Resources Climate Change Strategy* [Rockman et al. in review]). This chapter focuses on the impacts of climate change specific to cultural resources in the coastal zone.

Table 5.1. Synthesis of diverse climate change impacts across the five categories of cultural resources (CR) managed by the National Park Service: archeological sites (AS), historic and prehistoric buildings and structures (B/S), cultural landscapes (CL), ethnographic resources (E), and museum collections (MC). Table from Rockman (2015).

Impact	Environmental Forces	CR Affected	Rate
Submersion	Sea Level Rise (SLR)	AS, B/S, CL, E	Trend
Erosion	SLR, Storm surges	AS, B/S, CL, E	Event, Trend
Inundation	Storm surges, Flooding	All	Event
Saturation	SLR (rising water tables)	1st: AS, B/S, CL, E 2nd: MC	Trend
Deterioration	Precipitation variation Temperature variation Wind variation	AS, B/S, CL, E AS, B/S, CL, E AS, B/S, CL, E	Trend/event Trend/event Event/trend
Dissolution	Temperature increase (permafrost) Ocean acidification	AS, B/S, CL, E AS (terrestrial, underwater)	Trend Trend
Destruction	Flooding Storm (rain/wind)	All All	Event Event
Oxidation	Increased atmospheric moisture	B/S	Trend
Depletion	Ecosystem changes due to human development	AS, B/S, CL, E	Event, Trend
Conflagration	Fire (Drought) (Temperature extremes +/- insect effects)	All	Event
Dessication	Temperature extremes Drought	AS, B/S, CL, E AS, B/S, CL, E	Event (trend?) Long event
Invasion	Invasive species Mold	AS, BS, CL, E, MC BS, MC	Trend Event
Disruption	Loss of species Loss of access Looting	E E AS	Trend/event Event/trend Event

Table 5.2. Climate change related impacts on cultural resources in the coastal zone. Excerpted from Morgan et al. (2016).

Climate Indicator	Climate Change Risk	Impact on Cultural Resource
Increased global temperature	• Extreme weather events • Permafrost melt • Increased freeze-thaw cycle • Higher relative humidity • Stronger wind patterns • Species shift	• Accelerated rusting in submerged and littoral archeological resources • More rapid decay of organic materials • Faster deterioration of newly exposed artifacts and sites • Increased rate of chemical decay of collections • Increased crystallization of efflorescent salts due to increased evaporation rates, leading to increased rates of structural cracking, deterioration • Damage to foundations • Reduced access to marine hunting grounds due to shifting sea ice • Changes in historic/ culturally significant vegetation patterns
Precipitation Change	• Saturated soils • Flooding • Drought	• Increased exposure from vegetation loss and erosion • Destabilization of wetland or waterlogged sites • Exposure of submerged sites due to lower water levels in lakes • Erosion of supporting ground around structure • Increased pressure to relocate or elevate structures and/or surrounding structures • Loss of landscape features • Damage to structures • Increased risk of post-flood subsidence • Impacts from post-flood mitigation
Sea level rise	• Inundation and flooding • Increased storm surge height • Increased coastal erosion • Higher water table • Salt water intrusion	• Submersion of coastal sites • Increased post-flood cracking due to associated ground heave and subsidence • Increased pressure to relocate or elevate structures • Loss of coastal sites and artifacts • Loss of culturally significant symbols, plants, and animals • Loss of or limited access to culturally important sites • Increased rusting, corrosion, and salt deposits

The changing climate will affect cultural resources in the coastal zone through discrete events such as hurricanes and through ongoing changes such as changing sea and lake levels (both vertical rise or fall and rate of change), ocean acidification, and water temperature change. The abilities of cultural resources to withstand these and other effects without substantial change are related to the condition of the specific resource. A well-protected resource such as a shipwreck with a healthy covering of seagrass, or a resource in good condition such as a recently painted wooden building, will be better able to withstand particular destructive pressures of climate change, and for a longer period of time.

Coastal impacts of climate change are, at times, dramatically visible, such as heightened storm surge impacts. Other impacts may be more subtle or may result from the intersection of several forces. For example, where sea ice is diminishing and permafrost is melting, coastal archeological and ethnographic resources are eroding, changing, deteriorating, and becoming harder to access. These resources may not be well documented, making assessment of resource significance and vulnerability and prioritization of management response difficult (see Schupp, Beavers, and Caffrey 2015, "Case Study 4: Cultural Resources Inventory and Vulnerability Assessment"). For other resources, increased temperatures and humidity are affecting buildings and structures as heat accelerates the rusting of iron, and swelling and fungal decay of wood.

PM 14-02 emphasizes adding to the understanding of the range and diversity of climate change impacts on cultural resources, and directs management priorities to resources that are both significant and most at risk, because human-caused stressors will exacerbate climate impacts. For example, deeper navigation channels and increased size and frequency of associated large vessel boat wake impacts will increase the vulnerability of coastal places such as Fort Sumter National Monument, Fort Caroline National Memorial, and the Cockspur Lighthouse at Fort Pulaski National Monument by accelerating erosion of the shorelines and exposure of their foundations to storms of increased magnitude (see figure 5.1 and Schupp, Beavers, and Caffrey 2015, "Case Study 7: Lighthouse Stabilization Design Incorporates Sea Level Rise").

Threats to Archeological Resources

Archeological resources are physical evidence of past human occupation or activity across the span of human existence. Archeological sites may be located anywhere there has been previous human occupation on the current ground surface or buried. The resources are incredibly diverse; examples include a small scatter of prehistoric stone or bone tools or historic metal cans, town sites, heiau (Hawaiian temples), fish ponds, road system complexes, shell middens, and buried evidence of coastal occupation.

Climate change threats to coastal archeological resources can take many forms, including erosion, inundation, and chemical alteration. Erosion can be exacerbated by changes in water supply, such as increases in rainfall overall or the intensity of individual rainfall events; by drought (see Schupp, Beavers, and Caffrey 2015, "Case Study 1: Reservoir Water Level Change Impacts on Cultural Resources"); and by additional stresses affecting shoreline sediments, such as loss of soil structure due to melting permafrost. Unless quickly covered with sediments, sites in the intertidal zone may lose stratigraphic integrity as a result of water level rise or may be subject to physical degradation resulting from wave impacts.

A vulnerability assessment for coastal archeological sites and traditional cultural properties at Point Reyes National Seashore (Newland 2013) provides detailed analyses of climate impacts across different ecosystems within a single park, such as ocean acidification effects on cliff areas, sea level rise in tidal marshes, and wildfire along cliff tops. This report also provides a list of questions developed by the culturally associated tribe (the Federated Indians of Graton Rancheria) to help guide development of policies to manage archeological and ethnographic resources that may be increasingly exposed to weathering and unauthorized collection when exposed by storms and erosion.

Threats to Cultural Landscapes

Cultural landscapes are geographic areas, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or that exhibit other cultural or aesthetic values. Cultural landscapes may be historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes (Birnbaum 1994).

Climate-related impacts on coastal cultural landscapes include both ecosystem impacts and impacts on the built environment (when it is part of the landscape). Changing water levels may exacerbate erosion of cultural landscapes along a shoreline. Changes in temperature and precipitation patterns may stress building materials or favor different vegetation species or patterns of historic or culturally significant vegetation species. Climate change also may lead to the introduction of new pests, and may change soil fertility or water table level that affects gardens and other vegetation that are character-defining features.

For cultural landscapes, character-defining features are key foci for assessing impacts. Natural and cultural components of the landscape and the relationships between them convey different aspects of the significance of the landscape and will interact in different ways with climate change impacts.

Dyke Marsh, on the western shore of the tidal Potomac River south of Washington, DC, and part of the George Washington Memorial Parkway, is an example of a cultural landscape that will be affected by rising sea level. The marsh was formed over thousands of years from the sediment load discharged by upstream Hunting Creek. Portions of the then-650 acres were diked in the early 1800s for pasturage (Melnick, Burry-Trice, and Malinay in prep.). After abandonment of the area for grazing, shallow waters were dredged for sand and gravel. Rising sea level is affecting tidal heights in the Potomac estuary and is increasing wave impact on the south side of the marsh where a remnant dike is still visible, eroding that portion of the cultural landscape (Palinkas 2016).

Threats to Ethnographic Resources

Ethnographic resources are basic expressions of human culture and the basis for continuity of both tangible and intangible components of cultural systems, including traditional arts, native languages, religious beliefs, and subsistence activities (NPS 1998a). Ethnographic resources include tangible places such as sites, structures, and landscapes, as well as natural resources needed for cultural expression, such as salmon, sweet grass, or species of predatory birds.

Coastal climate change impacts to ethnographic resources damage tangible resources and/or disrupt or otherwise disconnect people from their arts, language, beliefs, and activities and associations with the places in which they have performed them. Impacts include permafrost melt, which can accelerate coastal erosion that in turn may force relocation of communities, separating people from subsistence resources. Changes in sea ice due to increased temperatures and changing winds may limit access to traditional hunting areas and are expected to shift migratory patterns of significant marine prey. Warming temperatures also may affect the distribution and phenology of key terrestrial and coastal plant and animal species.

Wild rice is an ethnographic resource used by the Bad River Band of the Lake Superior Tribe of Chippewa Indians that is being affected by climate change. The rice grows in ephemeral wetlands on the shore of Lake Superior in Apostle Island National Lakeshore. For centuries Anishinaabe people have harvested the rice for subsistence and trade. Climate change projections for the Great Lakes estimate that lake levels will continue to fall, depriving wetlands and the rice beds of the moisture needed to survive (Krumenaker 2014).

Threats to Historic and Prehistoric Buildings and Structures

A historic or prehistoric building or structure is "a constructed work . . . consciously created to serve some human activity" (NPS 1998b). They are usually immovable although some have been relocated and some are mobile by design. Examples include buildings and monuments, dams, millraces and canals, nautical vessels, bridges, tunnels and roads, railroad locomotives, rolling stock and track, stockades and fences, defensive works, temple mounds, ruins of all structural types, and outdoor sculptures. Preservation approaches for prehistoric structures are often similar to those for historic structures. Prehistoric structures also may be considered archeological resources, and some are ethnographic resources as well (NPS 1998a).

Climate change drivers interact variably with structural materials, architecture, and location (Sabbioni, Brimblecombe, and Cassar 2012). For example, increased rainfall may lead to accelerated rates of mortar and masonry decay, while associated ground heave and subsidence can lead to destabilization of foundations and pipes (Moss 2010; Morgan et al. 2016). Warmer, longer summers will enable new threats to wood structures as termites and other pests expand territory, and increased temperatures may increase growth of destructive mold and algae (Morgan et al. 2016).

Lighthouses and forts are iconic examples of coastal historic buildings. Facilities may include the lighthouse, the lighthouse keeper's residence, outbuildings, and docks, as well as cultural landscapes that can encompass gardens and walkways. All of these buildings and structures are impacted in different ways by dimensions of climate change depending on material composition and condition of structure. For examples of impacts and NPS adaptation strategies for Fort Jefferson and for the Cockspur and Cape Hatteras Lighthouses, see figures 5.1, 5.2, and 5.3, and Schupp, Beavers, and Caffrey (2015), "Case Study 5: Strategic Planning and Responsible Investments for Threatened Historic Structures," "Case Study 7: Lighthouse Stabilization Design Incorporates Sea Level Rise," and "Case Study 8: Relocating the Lighthouse."

Figure 5.2. Sea level rise and increased tropical storm intensity pose a serious risk to the long-term sustainability of historic Fort Jefferson at Dry Tortugas National Park, Florida. Photograph by Kelly Clark, NPS.

Figure 5.3. After multiple hard stabilization protection efforts proved unsuccessful, the Cape Hatteras lighthouse at Cape Hatteras National Seashore, North Carolina, was moved inland from the eroding beach using a railway in 1999. Photograph by NPS.

One historic district that is particularly vulnerable to maritime effects of climate change is Portsmouth Village, which is part of Cape Lookout National Seashore and is located on a barrier island (Melnick, Burry-Trice, and Malinay in prep.). The village was first established in the 1700s; extant historic buildings date to the 19th and early 20th century. As the barrier islands move westward in response to the complex interactions between sea level rise and ocean currents, the sea moves closer and closer to the village. Shifting of the low mobile sand dunes on which the village stands will impact the integrity of design, materials, and workmanship of any buildings that survive high winds and the direct impact of storm surges.

Threats to Museums and Collections

Museums will play increasingly important roles in future cultural resource preservation. The National Park Service is the steward of the largest network of museums in the United States and is responsible for the welfare of more than 44.5 million museum objects and 74,000 linear feet of archives (NPS Museum Management Program 2014). In addition to ongoing work to address backlogs in cataloguing and accessioning new collections (Wilson 2015), additional facilities and funds will be needed for monitoring and mitigation programs.

A review by the NPS Museum Management Program in 2014 found that 233 parks have museum facilities in high-risk flood zones (NPS Museum Management Program 2014), including facilities in the interior and along the coast. Other types of impacts can affect the museum facility building itself, such as through rising damp from changes in local ground water level and increased tree fall (Sonderman 2016). Additional impacts can affect collections, such as through loss of climate controls or exposure to new species of insect pests. Museums and collections are clearly vulnerable to floods and storm surges.

Impacts from hurricanes provide opportunities to implement adaptation strategies to meet the challenges of climate change. For example, in 2003, Hurricane Isabel (National Hurricane Center 2016) inundated the Colonial National Historical Park museum facility located in the basement of the visitor center within the flood zone of the James River. The water inundated the building to a height of 5 feet (1.5m) and damaged archeological collections and records from excavations at Jamestowne. Restoration of these collections and records took four years. In another example, Hurricane Sandy caused the loss of electrical power and mechanical systems in the Ellis Island museum collection. See "Chapter 9 Lessons Learned from Hurricane Sandy."

Threats to Underwater Resources

Consideration of cultural resources within coastal adaptation planning does not stop at the water's edge. Submerged cultural resources can comprise or contribute to archeological and ethnographic resources, cultural landscapes, and structures. Many coastal cultural resources managed by NPS units are littoral or submerged resources. Submerged historic structures, shipwrecks, submerged maritime landscapes, and other underwater cultural sites are equally as vulnerable as terrestrial sites to the effects of climate change, and perhaps are more vulnerable because they can be difficult to recognize and their threats can be easily overlooked (figure 5.4).

Figure 5.4. Dry Tortugas National Park protects submerged resources in south Florida. Photograph by NPS.

Submerged cultural resources can have different vulnerabilities than their terrestrial counterparts (Wright 2016). While inundation concerns may be diminished, mechanical damage from storm surge and changing wind and current patterns can scatter, disrupt, erode, or destroy submerged sites. The depth changes associated with sea level rise can affect the retreat of protective seagrass beds and corals, water chemistry changes associated with water depth, sediment coverage and mobility, and changes in anoxic environments conducive to preservation. Temperature rise and ocean acidification can destabilize wreck structures, increasing corrosion rates and weakening protection provided by adhering layers of calcium carbonate-based organisms.

One example of an underwater cultural resource at risk from climate change is the 100-year old steamboat *Charles H. Spencer*, which lies at the edge of the Colorado River at Glen Canyon National Recreation Area. Deficits in water supply for the entire Colorado River system have lowered the average volume of the river, exposing *Spencer*. While coastal threats from climate change are often framed in terms of sea level rise, decrease in water supply also can be destructive. Uncontrolled drying of waterlogged remains damages archeological materials, particularly wooden remains such as components of *Spencer*.

Important management steps to support adaptation strategies for submerged resources include inventory and monitoring plans. The Submerged Resources Center is available to assist parks with stewardship of submerged cultural sites. Additionally, for information on park boundaries and jurisdiction (which can be particularly challenging to determine in coastal areas), see NPS 39-1 Ocean and Coastal Jurisdiction Reference Manual.

Management of Cultural Resources in the Coastal Zone under Climate Change

NPS Policy Memorandum 16-01 "Resource Stewardship for the 21st Century – Interim Policy" (PM 16-01, NPS 2016) calls for integrating natural and cultural resources management, and for using the precautionary principle when making decisions related to resource stewardship; in the context of climate change, this means that the National Park Service must address climate adaptation as part of its cultural resources management strategy.

The NPS adaptation strategy for cultural resources recognizes that, because many cultural resources are nonliving and so have no or limited capacity to absorb climate change impacts, the focus for cultural resource adaptation should be flexible and responsive human management. The framework for adaptation for cultural resource management set out in PM 14-02 addresses what adaptation means for cultural resources management, how to approach decision-making for cultural resources in light of climate change, and the important role of cultural resources in climate change communication (NPS 2014a, 2014b, 2015; Morgan et al. 2016).

Specific topics developed in PM 14-02 include the following:

Adaptation

- Recognize that the primary focus for adaptation for cultural resources lies in research, planning, and stewardship activities.
- Integrate natural and cultural resources. Examples include addressing shared natural and cultural resource data needs in climate modeling and environmental monitoring, and incorporating relevant information into planning, such as Resource Stewardship Strategies.

- Use innovative actions to address emergent threats. For example, reallocate funds where appropriate when budgetary cycles do not accommodate the urgency of actions.
- Incorporate cultural resources into sustainability actions. For example, adaptively reuse historic buildings.
- Evaluate siting of museum facilities and collections, starting with a vulnerability study and a plan to improve stewardship of museum facilities and collections.

Decision Making

- Refocus inventory responsibilities onto lands that have not been investigated in areas that are most vulnerable to climate change impacts.
- Direct management decisions and funding to resources that are both significant and most at risk.
- Identify, develop means to address, and communicate to the public the range of climate change effects on cultural resources, including subtle and inland effects such as the impacts of more freeze/thaw cycles on stone walls.
- Consult a broad array of stakeholders to inform the assessment of resource significance.
- Value information from the past and incorporate the capacity of cultural resources to provide unique information about human adaptation to climatic and environmental variability through time into assessments of resource significance.
- Recognize the potential for loss in management options, work to balance sustainability with preservation, and coordinate decisions on management options servicewide.

Communication

Every place has a climate story. Cultural resources embody:

- climate change impacts at human scales that can be seen and touched;
- traditional ecological knowledge and changes in experience and lifeways;
- past human successes and failures of adaptation; and
- origins of modern climate situations.

In response to this directive, an assessment of the vulnerability of NPS museum facilities to climate change is being developed and will inform the upcoming servicewide revision of the collections storage plan (NPS Museum Management Program 2014).

Building on PM 14-02, the NPS Preserving Coastal Heritage workshop identified additional opportunities to improve the development of viable management alternatives for threatened coastal cultural resources (NPS 2014b):

- Engage interdisciplinary expertise.
- Establish short- and long-term goals before the inventory begins, and identify where goals may conflict. Revisit the goals throughout the planning process.
- Establish thresholds for monitoring and reassessment that allow change over time. Assume that new data and documentation will influence the planning process.
- Engage the public every step of the way.
- Establish vulnerability metrics so that resources can be evaluated and compared. Assess the risk of saving one resource at the expense of another.
- Update collections management plans to include an emergency plan that donors, owners, and the public can agree on in advance.
- Use the planning process as an opportunity to enhance public awareness about climate change.

Broad approaches and tools for addressing the impacts of climate change to cultural resources are being incorporated into the NPS *Cultural Resources Climate Change Strategy* (Rockman et al. in review). The following sections discuss some of these management approaches directed toward resources and impacts in the coastal zone.

Two-fold Approach to Cultural Resources and Climate Change

Management of cultural resources in the coastal zone must balance response to the effects of climate change on cultural resources with the significance that those resources hold for the communities that use and value them. The NPS *Cultural Resources Climate Change Strategy* (Rockman et al. in review) sets out a concept framework that applies these two areas of responsibility (i.e. "Impacts" and "Information") across the four pillars of NPS climate change response (NPS 2010): science, adaptation, mitigation, and communication (table 5.3). This concept framework is designed to support resource management decision-making across cultural and natural resources and facilities management by setting out the diversity of cultural resource impacts and information topics in relation to climate change, many of which overlap with natural resource, science, and facilities management topics.

Such overlap may be particularly useful in developing and selecting adaptation options, in which an option for a given resource is likely to have implications across multiple other resources.

While the cultural resources in the coastal zone can contribute generally to the topics in the Information columns, they have particular capacity to provide information in the areas of coastal science and coastal adaptation. For example, coastal archeological sites, cultural landscapes, and associated museum collections can hold paleoclimatic data, information about past fluctuations in shorelines, and evidence of past human and other plant and animal responses to those fluctuations. A recent report about Shackleford Banks, part of Cape Lookout National Seashore, used archeological sites to refine our understanding of the island's geomorphological evolution (Riggs, Ames, and Mallinson 2015). Traditional ecological knowledge can describe both long-term patterns in use and settlement in coastal environments and ways of matching human activity to those patterns. PM 16-01 specifically calls for an increase in our understanding and use of traditional ecological knowledge to strengthen stewardship of cultural and natural resources (NPS 2016).

Table 5.3. Concept framework for cultural resources in relation to climate change. This framework applies needs of resource managers to address the impacts of climate change on cultural resources (Impacts) and the capacity to learn about long-term human interactions with environmental and climatic change (Information) across the four pillars of NPS climate change response: science, adaptation, mitigation, and communication (NPS 2010). Table from Rockman et al. (in review).

Science		**Mitigation**	
Impacts	**Information**	**Impacts**	**Information**
• Climate science at cultural heritage-relevant scales • Cultural resource (CR) vulnerability assessments • CR inventory/monitoring techniques and protocols • Integrated CR databases-GIS • Preservation science • Documentation science	• Paleoclimate • Traditional ecological knowledge • Social climatic thresholds • Shifting baselines • Past land use and human impacts on environments • Paleogenetics	• Integration of historic buildings into energy efficiency plans • Resource conservation through historic or native landscapes • Reduce carbon footprint of CR management practices	• Past architectural and landscape techniques suited to local environments • Cultural heritage to conserve/ reestablish sense of place and community stewardship
Adaptation		**Communication**	
Impacts	**Information**	**Impacts**	**Information**
• Scenario planning • Adaptation options • Decision frameworks • Disaster risk reduction/ response connections • Policies and standards • Contexts/theme studies to support decision frameworks	• Past social adaptability per environmental change • Traditional ecological knowledge • Relating past adaptability to current issues, methods, and decisions	• Cultural resources climate change (CR-CC) literacy • Dialogue between impacts and information in all pillars • Links between CR-CC managers (local-international) • CR-CC links to public	Every Place has a Climate Story: • Change in material culture • Change in experience and lifeways • Insights on change from past societies • Origins of the modern climate situation

Vulnerability and Prioritization

As set out in "Chapter 1 Introduction," vulnerability is the degree to which a system is susceptible to adverse effects of climate change. Within natural resource management, vulnerability with respect to climate change is often expressed in the following formula:

> Vulnerability = Exposure + Sensitivity – Adaptive Capacity

As noted previously, cultural resources themselves are largely non-living and, as such, have limited or no capacity to adapt to changing conditions. As a result, climate change adaptation for cultural resources lies in our use and management of them. Further, adaptive use and management can draw from a wide range of options (see below). Therefore, for cultural resources, a variation of the vulnerability formula that separates adaptive capacity from exposure and sensitivity is more appropriate:

> Vulnerability = Exposure + Sensitivity

This same formula has been developed and adopted for park infrastructure and facilities, as discussed in "Chapter 6 Facility Management."

Building out these terms, "exposure," as a measure of the amount of climatic and environmental change that a geographic region or given resource is likely to experience, is an equivalent concept across resources. "Sensitivity" for cultural resources incorporates the adverse effects of climate change on the material components of a resource, and how those adverse effects may affect integrity and significance of the resource.

As noted above, exposure to essentially all climate change phenomena can occur in the coastal zone. Exposures specific to the coastal zone include sea level rise (causing inundation, increased severity of storm surges, and increased rates of erosion) and changes in water table (causing soil saturation, expansions of wetlands, and salt water intrusion). Sensitivity of cultural resources to these exposures is also diverse; several examples are listed for each resource type in the sections above, and detailed sensitivity lists are included in table 5.1 and in *Climate Change Impacts on Cultural Resources* (Morgan et al. 2016).

PM 14-02 states that management decisions and funding should be directed to resources that are both significant and most at risk. Currently, several projects are underway to assess vulnerability of cultural resources and to convey identified vulnerabilities in such a way that they can be readily displayed and compared. Projects include work in the Cultural Landscapes program (Melnick, Burry-Trice, and Malinay in prep.) to develop a vulnerability assessment system for all cultural landscapes in the Pacific West Region, and two projects addressing vulnerability of National Historic Landmarks (NHL). The NHL projects include a process and assessment of six NHLs in Alaska (Anderson 2014) and for NHLs across the Pacific West Region (Stein Espaniola in prep.). To date, a consistent method of merging vulnerability assessments with resource significance has not yet been developed. One potential model of doing so has been implemented by international colleagues in Scotland through the work of the Scottish Coastal Archaeology and the Problem of Erosion Trust (SCAPE) (see discussion below).

Cultural Resources Adaptation Strategies

Adaptation strategies should seek to preserve not just an object or structure itself but also the components of the resource that convey its significance. To be significant, a cultural resource must have important historical, cultural, scientific, or technological associations, and it must manifest those associations in its physical substance (NPS 2002). A character-defining feature of a historic property is a prominent or distinctive aspect, quality, or characteristic that contributes significantly to its physical character. Structures, objects, vegetation, spatial relationships, views, furnishings, decorative details, and materials may be such features (NPS 2002). For example, at Fort Jefferson at Dry Tortugas National Monument, the moat wall, which forms a distinctive ring around the main structure of the fort, is a character-defining feature. It was designed to keep enemy ships away from the fort walls and now functions as a breakwater (see figure 5.2, and Schupp, Beavers, and Caffrey 2015, "Case Study 5: Reconsidering Investment Strategies for Threatened Historic Structures"). All cultural resources have connection to place, and the integrity and significance of cultural resources may change as those places change. However, decisions to make such changes are difficult, such as raising the moat wall to improve its current function as a breakwater, which would alter its historic form and use.

Cultural resources adaptation options were presented and further developed during the Preserving Coastal Heritage workshop (NPS 2014a, also described in "Chapter 9 Lessons Learned from Hurricane Sandy"). The current set of adaptation options is described in table 5.4. The current draft of the cultural landscapes climate change adaptation report (Melnick, Burry-Trice, and Malinay in prep.) develops examples of these options specifically for cultural landscapes. These cultural resources adaptation management options roughly parallel natural resource management adaptation strategies (figure 5.5 and table 4.2). However, they do not fit easily within the adaptation continuum set out in "Chapter 1 Introduction": resist change, accommodate change, and direct change, which has its roots in natural resource adaptation. The objective of cultural resources management is the preservation of as much or as many cultural resources as possible; this objective aligns most closely with the concept of "resist change." Aspects of the "accommodate change" approach are also important because the aspects of cultural resources that anchor their significance are in large part non-living and non-renewable, so their adaptation depends on the selection and implementation of management actions by resource managers. Management actions for cultural resources range from no active intervention (when necessary) to active preservation measures. Different measures will be appropriate for different resources depending on the nature of the resource and the nature and severity of the observed or assessed risk from periodic and long-term climate change impacts (figure 5.6).

Each of these options can be used in combination with others. Status of the resources and actions taken should be documented throughout the process. The final option on the list, interpret the change, addresses not only preservation of the history of the resource, but also the interactions between climate change and the story of that place. The underlying premise of this option is that climate change is the heritage of the future. As with the other options, the interpret the change option may be used on its own or in combination with other actions.

Table 5.4. Seven Climate Change Adaptation Options for Cultural Resources. Table from Rockman et al. (in review).

Adaptation	Description
No active intervention	Taking no action is a decision. This may be an appropriate decision in situations of low vulnerability (no action warranted) or when, due to one or more of a range of constraints, including lack of technological or economic feasibility, no action can be taken. This decision may include assessment of the need for monitoring of resource condition, with a plan to revisit a no action decision at a future point in time.
Offset stress	Removing or deflecting a stress is one or more actions taken away from the resource or a component of the resource to reduce or remove the environmental or other force(s) acting on the resource or component. The goal of this option is to enhance survival of a resource while minimizing changes to the physical materials and setting of the resource. Constraints on this option are likely to include impacts of actions to surrounding resources, such as natural habitat or infrastructure. Examples include temporary measures such as sandbags or levee plugs; an offsite retaining structure or living shoreline to reduce shore erosion; upstream re-vegetation to reduce flood hazards; and changes in adjacent forest management to reduce wildfire risk.
Improve resilience	Improving resilience consists of one or more actions that change the nature of a resource and/or the immediate setting of a resource and that are designed to make a resource more resistant or resilient to environmental or other forces. The goal of this option is survival of the resource despite possible impacts of actions on integrity of the resource, although this option does not necessarily mean the resource will be impaired. Examples include treatment of structural materials to better withstand increased moisture, wind, or an invasive species; elevation of a building to raise it above projected flood level; addition of a cap over an archeological site; changes in landscape plantings or soil treatments; and alternate storage arrangement of museum materials.
Manage change	Managing change is an action or set of actions that incorporate change into the form of the resource and/or into its management plan. The goal of this option is to maintain character-defining features of a resource, even if original specific materials or individual species are no longer part of the resource. An example is changing tree species on cultural landscapes by removing the original species that has died and replacing it with a species that is healthy in that environment and will provide similar shade and foliage conditions.

Table 5.4. Continued

Adaptation	Description
Relocate/ facilitate movement	Relocating/facilitating movement includes two types of actions: (1) moving a resource, and (2) allowing movement to happen. The strategy of moving a resource is an action or set of actions that move all or a portion of a resource that cannot move on its own to a less vulnerable location. The iconic example of this option is the moving of the Cape Hatteras Lighthouse inland from the coast (see Schupp, Beavers, and Caffrey 2015, "Case Study 8: Relocating the Lighthouse"). Another example is temporary relocation of the museum collections from Ellis Island to a facility in Maryland following Hurricane Sandy (see "Chapter 9 Lessons Learned from Hurricane Sandy"). Assisting with relocation of a human community to a safer location and assisted migration of a culturally important species to a refugium that it would not have been able to reach on its own (for instance, moving salmon species to a new watershed) are also examples of this strategy. The strategy of allowing movement to happen is an action or a set of actions that enable movement of living portions of resources to less vulnerable or more stable locations, or halting actions that would otherwise impede movement of living portions of resources to less vulnerable or more stable locations. Examples include allowing ecosystems such as a marsh or barrier island with cultural significance or which contains culturally significant species to migrate landward, or allowing species with cultural significance to shift ranges. Such shifts may move all or components of a resource outside of documented resource or park boundaries. Movement is not feasible for a whole cultural landscape but may be appropriate for character-defining features of a landscape once the whole cannot be saved.
Document and release	This strategy is a set of actions to record a resource and then subsequently allow the geographic location of the resource to undergo full effects of environmental or other forces that are likely to destroy or remove all or portions of the resource. Documentation may be exhaustive, such as data recovery (full excavation) of an archeological site or detailed recording of a building or structure or cultural landscape (such as a Historic American Building Survey [HABS], Historic American Engineering Record [HAER], Historic American Landscape Survey [HALS]), or a cultural landscape inventory, possibly in combination with laser scanning documentation techniques. Documentation may also be done at a less-than exhaustive level. This approach may be appropriate when exhaustive approaches are infeasible (due to limitations in access, time, human capacity, or financial constraints), not warranted (due to nature and scale of impacts), or there is merit in not recovering or preserving the whole of the resource (such as an archeological site that may become inaccessible because of submersion but is not anticipated to be fully destroyed). This option further differs from the data recovery option in that it requires consideration and documentation of the resource sampling and preservation approach. Other examples of documentation techniques that may be used in either approach include collection of pollen, seeds, or plant cuttings, and oral histories and video.
Interpret the change	Interpreting the change is an action or set of actions that preserves and then serves to engage people in the future with the effects of climate change on a resource. This option may be used on its own or in combination with any of the other options. A dramatic example would be preservation of a coastal resource such that its location and form remain either intact or otherwise visible from the coast once it is offshore or partially submerged (e.g., construction of a cover or large buoy at the former location of a lighthouse or archeological site). Other examples include interpretation signage of changing ecosystems and photo series of changes in garden phenology or vegetation across a landscape. While interpretation may be developed across any of the adaptation options on this list, for this option, interpretation addresses not only preservation and history of the resource, but also climate change itself, and seeks to tell the story of the place and climate change and how they are interacting.

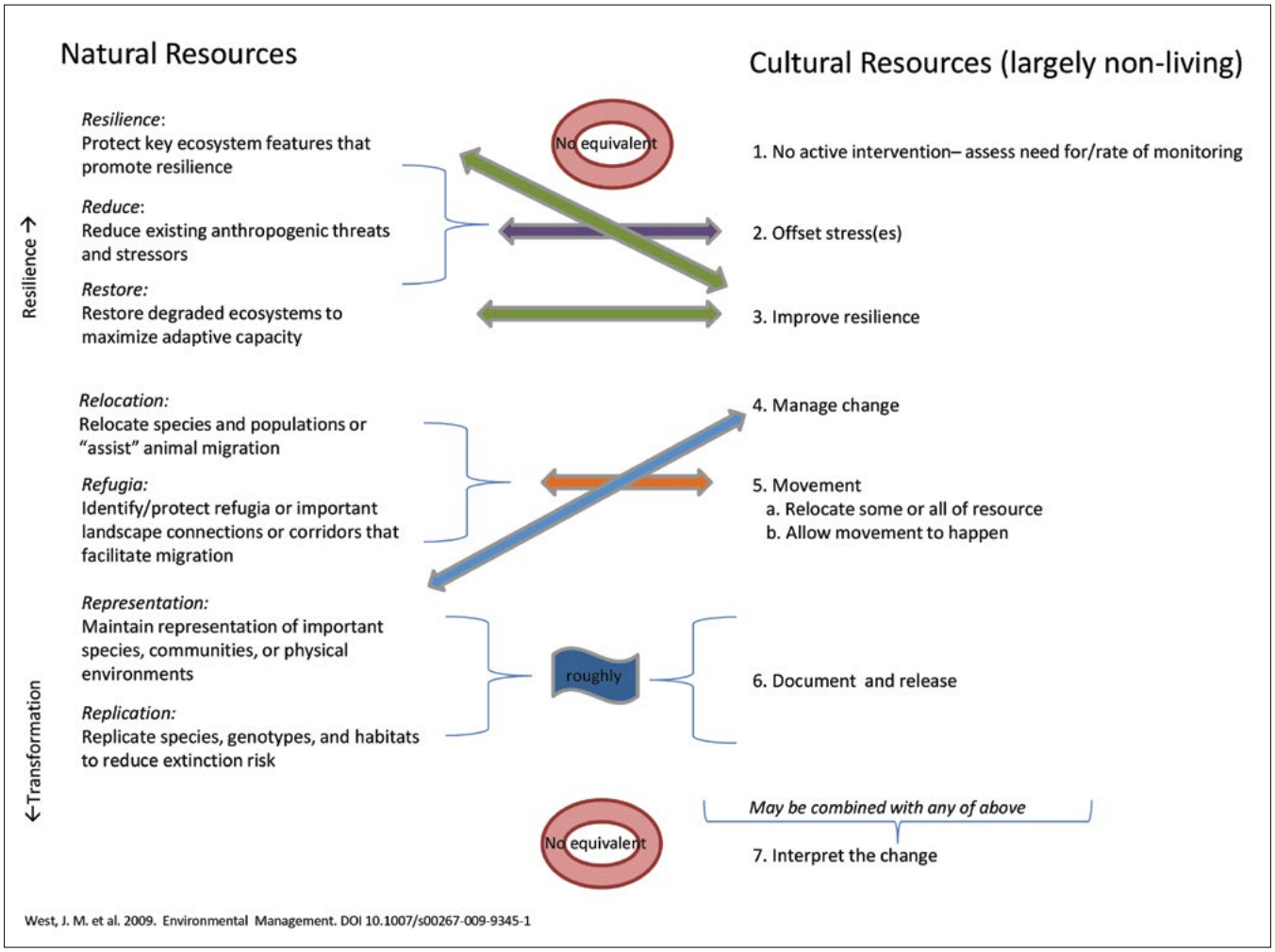

Figure 5.5. Cultural Resources Adaptation Strategies Parallel Management Strategies Used in Natural Resource Management. Graphic by M. Rockman, NPS.

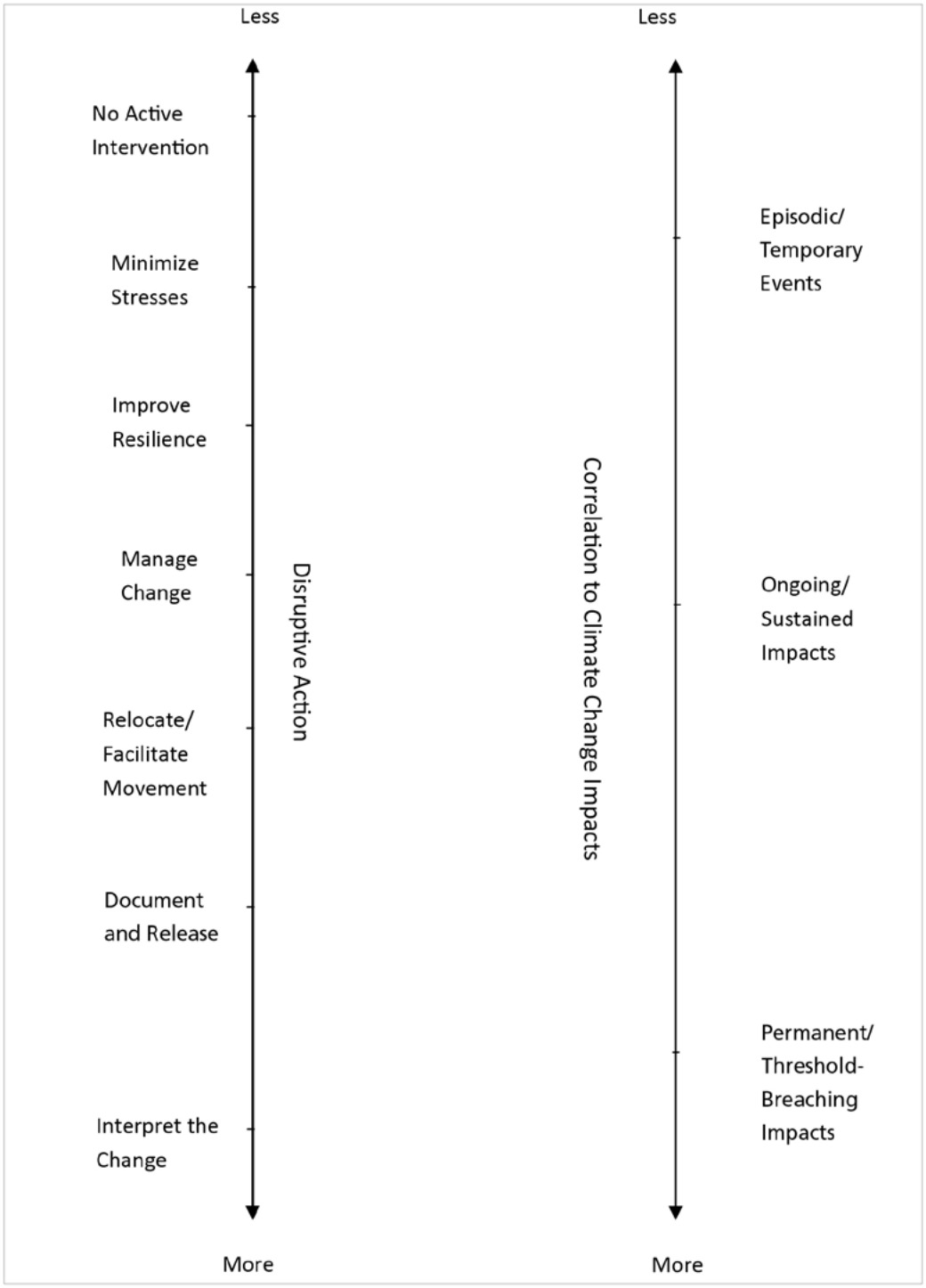

Figure 5.6. Cultural Resources Adaptation Strategies vary with Respect to the Disruptive Nature of each Strategy and the Temporal Nature of each Climate Change Impact. Graphic by M. Morgan, NPS.

Any work done on cultural landscapes, historic properties, or historic structures must consider The Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR 68). The standards are a series of concepts about maintaining, repairing, and replacing historic materials, as well as designing new additions or making alterations. They are written in nontechnical language to promote historic preservation best practices. The standards offer four distinct approaches to the treatment of historic properties: preservation, rehabilitation, restoration, and reconstruction, with guidelines for each. The guidelines, which are advisory rather than regulatory, offer general design and technical recommendations on applying the standards to a specific property. Together, they provide a framework and guidance for decision-making about work on or changes to a historic property. The choice of treatment of historic properties depends on a variety of factors, including the property's historical significance, physical condition, proposed use, intended interpretation, and mandated code requirements. Together with Section 106 of the National Historic Preservation Act of 1966 (Public Law 102-575), "Protection of Historic Properties" (36 CFR 800), these documents guide the National Park Service in planning and executing actions to minimize harm to cultural resources. More information is available on the NPS cultural resource management website at http://www.nps.gov/history/howto/PAToolkit/parkcrm.htm.

When choosing an adaptation option, managers must recognize that addressing vulnerability may change the resource and therefore may be considered an adverse impact. Implementing an adaptation strategy that causes an adverse impact on natural resources or other cultural resources may be feasible and may be the best option in some cases. There are a variety of resources to help managers ensure that adaptation strategies align with NPS policies; checklists and guidelines are described in "Chapter 2 Policy."

Guidance for developing and selecting adaptation actions in national parks is currently in development, including *Planning for a Changing Climate* (in progress) (see "Chapter 3 Planning" for additional information). At the Preserving Coastal Heritage workshop it was determined that more guidance is needed to integrate climate change into existing cultural resource planning processes. An integrating framework for cultural resources and climate change that addresses inventory, significance assessment, and prioritization will be included in the NPS *Cultural Resources Climate Change Strategy* (Rockman et al. in review).

In-progress or completed adaptation projects for coastal cultural resources are discussed in the following sections.

Archeology

At Canaveral National Seashore in Florida, impacts from sea level rise and increased storm activities are predicted to accelerate erosion and cause the loss of shell mounds and the archeological and ecological data within them (see figure 5.7, and Schupp, Beavers, and Caffrey 2015, "Case Study 3: Shell Mound Sites Threatened by Sea Level Rise and Erosion"). The park is reducing shoreline erosion by planting vegetation and deploying oyster shell as recruitment substrate (Walters et al. 2013).

Parks are also addressing diverse impacts with a variety of solutions that are highlighted in Schupp, Beavers, and Caffrey (2015):

- Amistad National Recreation Area in Texas (see figure 5.8, and "Case Study 1: Reservoir Water Level Change Impacts on Cultural Resources"),
- Olympic National Park in Washington (see "Case Study 2: Preparing for Impacts to Archeological Sites and Traditional Resources"), and
- Bering Land Bridge National Preserve and Cape Krusenstern National Monument in Alaska (see "Case Study 4: Cultural Resources Inventory and Vulnerability Assessment").

Other organizations have also initiated inventory efforts in recognition of climate vulnerabilities, including the Society for California Archaeology, which has developed a standard methodology for use by volunteers to survey the condition of known archeological sites (Newland 2014).

Figure 5.7. Prehistoric shell mound sites are threatened by sea level rise and erosion at Canaveral National Seashore, Florida. In this image, volunteers are building a living shoreline at Castle Windy mound site. Photograph by Margo Schwadron, NPS.

Figure 5.8. At Amistad National Recreation Area, Texas, Panther Cave contains extensive pictographs, which are threatened by fluctuating water level tied to storm events and (indirectly) to siltation. Photograph by Randy Rosales, Texas Parks and Wildlife Department.

Cultural Landscapes

A cultural landscapes climate change adaptation project is developing a series of 12 case studies, including multiple coastal examples. The current draft report, *Climate Change and Cultural Landscapes: Research, Planning, and Stewardship* (Melnick, Burry-Trice, and Malinay in prep.) includes three coastal parks in the eastern United States: Portsmouth Village at Cape Lookout National Seashore, Dyke Marsh at George Washington Memorial Parkway, and Jacob Riis Park at Gateway National Recreation Area. Additional case studies being developed about the Pacific West include coastal cultural landscapes in Redwood National Park and Pu'ukoholā Heiau National Historic Site. This project and its reports are linking climate projections to impacts on character-defining features and potential adaptation actions. To address deterioration and inundation impacts on Portsmouth Village, for example, the current draft report explores three of the adaptation options described in table 5.4: No Active Intervention, Manage Change, and Document and Release.

Ethnographic Resources

Olympic National Park is working with eight associated tribes to prepare for future effects on archeological sites, traditional burial locations, and nearshore traditional resources; the park also recognizes the need to incorporate traditional knowledge into management efforts and to recognize that people have traditions that document major events (see Schupp, Beavers, and Caffrey 2015, "Case Study 2: Preparing for Impacts to Archeological Sites and Traditional Resources"). In southern Louisiana, the US Department of Housing and Urban Development (HUD) has awarded $48 million in the National Disaster Resilience Competition to move an entire community. The Isle de Jean Charles Band of Biloxi-Chitimacha-Choctaw Indians will relocate from their subsiding island, which is 55 km (34 mi) southwest of Jean Lafitte National Park and Preserve, to "a resilient and historically-contextual community" (Louisiana Disaster Recovery Unit 2016; US HUD 2016).

Museums and Collections

In direct response to PM 14-02, the NPS Museum Management Program assessed its facilities' vulnerability to climate change (NPS Museum Management Program 2014). Currently, 331 NPS units have museum facilities, and more than 60% of these have identified mitigation actions needed to reduce their risks related to climate change. Many parks have some existing background risk and also face new and future risks due to climate change. Seventy percent of these units have reported flood risks, 38% have drought risks, and other units face additional climate-related risks related to wind, permafrost, biology, and heating, ventilation, and cooling systems (NPS Museum Management Program 2014). For examples of post-storm care of impacted collections, see "Chapter 9 Lessons Learned from Hurricane Sandy."

Buildings and Structures

Parks are using various strategies to protect historical structures, as described in the following, companion case studies (Schupp, Beavers, and Caffrey 2015):

- Revetments at Fort Pulaski National Monument (figure 5.1, "Case Study 7: Lighthouse Stabilization Design Incorporates Sea Level Rise");
- Relocation at Cape Hatteras National Seashore (figure 5.3, "Case Study 8: Relocating the Lighthouse");
- Restoration at Dry Tortugas National Park (figure 5.2, "Case Study 5: Reconsidering Investment Strategies for Threatened Historic Structures");
- Identifying options at Yellowstone National Park (figure 5.9, "Case Study 6: Eroding Shoreline Threatens Historic Peale Island Cabin"); and
- Rehabilitation at Acadia National Park ("Case Study 15: Rehabilitating Stream Crossings on Historic Roads").

Figure 5.9. Coastal impacts affect inland lakes as well as ocean shorelines. The historic Peale Island Cabin in Yellowstone National Park, Wyoming, is threatened by shoreline change that may be accelerated by tectonic uplift, tree death, and longer ice-free periods. Photograph by Yellowstone National Park.

Underwater Resources

To date, there are few documented examples of climate change adaptation undertaken for underwater resources. One example is recent research and stabilization of HMS *Fowey*. *Fowey* is an 18th century shipwreck in Biscayne National Park that has been damaged in recent years by looting, Hurricane Andrew, and Hurricane Sandy. Studies of sediments surrounding *Fowey* have established baseline information important for developing stabilization methods for the wreck and understanding sediment mobility at the site (Keller et al. 2014, Wright 2016).

Opportunities for Adaptation of Cultural Resources in the Coastal Zone

Because cultural resources in the coastal zone are increasingly vulnerable with little chance of condition improvement and high potential for permanent loss due to storm impacts and other climate change impacts, the following opportunities should be prioritized:

- Conduct inventory in the most vulnerable areas that have not yet been inventoried.
- Determine significance and vulnerability of known resources to determine the most significant at-risk resources.
- Prioritize documentation of the most vulnerable undocumented resources.
- Assess the vulnerability of museum collection locations and create a plan to reduce vulnerability, such as through modifications to a curation facility or by moving collections to less vulnerable locations.
- Recognize cultural resources as opportunities to learn and engage with the information and stories they hold.

In Scotland, the Scottish Coastal Archaeology and the Problem of Erosion (SCAPE) Trust has developed a citizen science approach to vulnerable coastal heritage (SCAPE Trust 2015). The program began with detailed analysis of site records and prioritization based on site vulnerability and significance. These results are now displayed in a mobile application through which individuals can monitor sites and contribute observations. The program has also added a community engagement initiative that enables collective decision making and community projects for heritage that cannot be saved. The philosophy of this project is that "eroding coastal heritage provides opportunities for anyone to enjoy and benefit from taking part in archeological and historical exploration and discovery."

The concepts shown under the "Information" columns in table 5.3 share this hope. Cultural resources can contribute to climate science through topics such as paleo-environmental and shifting baseline information; to adaptation planning through examples of resilience and social change; to mitigation through reuse of historic buildings and examples they provide of lower-energy practices; and to communication through interpretation of all of these considerations and stories developed under the "Every Place has a Climate Story" framework (Rockman 2015).

Take Home Messages

- Cultural resources are unique and nonrenewable resources.
- The capacity of cultural resources to move or change is limited because they are in large part non-living and have strong ties to place, part of which can be ties to a dynamic coastal landscape.
- Cultural resource adaptation strategies can be applied to coastal systems.
- Managers need NPS-level guidance for adaptation of archeological and ethnographic resources to climate change. Upcoming reports and guidance for museum collections, cultural landscapes, and built environments will include coastal-relevant adaptation strategies.

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