Connections Across People, Place, and Time

Proceedings of the 2017 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites

Edited by Samantha Weber

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On the cover
Parker River National Wildlife Refuge, Massachusetts. Photo by Samantha Weber.

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Introduction and Acknowledgments

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Connections are the heart of place-based conservation. Parks, protected areas, and cultural sites are embedded in a world of interrelated ecological and cultural networks, and success in protecting them depends on an awareness of connections across many dimensions. Promoting that awareness is a core part of what we do in the George Wright Society. Our 2017 conference emphasized that aspect of the GWS mission. Titled "Connections Across People, Place & Time," it brought together over 350 people who contributed to more than 100 sessions over the week of March 29–April 3. We met in Norfolk, Virginia—one of the U.S. cities most susceptible to the climate change that looms as the biggest challenge conservation faces today. This proceedings volume will give you a taste of the variety of intellectual engagement that is a hallmark of our conferences.

GWS2017 was the nineteenth in a series of conferences whose origins date back to 1976. Over the years since 1982, when the GWS became the organizer and primary sponsor of the conferences, they have expanded to include all fields in natural and cultural resources and have helped cement the GWS's reputation as a leader in interdisciplinary approaches to conservation of our most precious places.

We extend our deep appreciation to our major organizational sponsor, the U.S. National Park Service, and we were delighted to welcome back VHB as a conference supporter. We especially thank the following individuals who helped arrange sponsorships for GWS2017: the Park Service's Ray Sauvajot, Stephanie Toothman, and Julia Washburn, and VHB's Rosemary Morris.

The Norfolk conference was the result of months of hard work by the GWS2017 Conference Committee, co-chaired by Lynn Wilson and Dave Harmon. Gina Depper, Shaun Eyring, David Graber, Melia Lane-Kamahele, David Parsons, and David Reynolds were the other members. We sincerely thank them for their efforts, as we do the members of our Indigenous Involvement Working Group for theirs. The IIWG put in many hours planning activities to engage with, and

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give a platform to, Indigenous people at the conference. For GWS2017, the members of the IIWG were Deanna Beacham, Melia Lane-Kamahele, Peter Lariviere, Freddie Romero, and Angela Mooney D'Arcy. Last but not least, we thank Samantha Weber for once again taking on the job of editing these proceedings, and doing it so expertly.

GWS2017 also marked a milestone in terms of the history of our Society. In Norfolk, long-time Executive Director Dave Harmon stepped down to pursue his interest in writing, handing over the reins to our new Executive Director, Jennifer Palmer—a culmination of a long-planned-for transition to the next phase of our organizational development.

Dave continues to work with GWS as co-editor of our journal, *The George Wright Forum,* which, like much else with the Society, will be undergoing a refresh in the coming months and years.

Jennifer is working closely with the GWS Board of Directors and members to develop a successful strategy that better serves GWS members and expands membership, shares the GWS story and mission to a more broad audience, and elevates the opportunity to connect our community and share best practices. A few key goals and aspirations for GWS in 2018 include:

- *Launch new regional and thematic professional training and exchange opportunities.*
- *Strengthen communication platforms to better share relevant and timely information with our community via The George Wright Forum, the GWS website, social media, webinars, podcasts, and live stream events.*
- *Build a new strategy to shift and diversify our funding sources.*
- *Expand membership and partnerships, nationally and internationally.*
- *Extend student chapter, emerging leadership, and Park Break programs.*
- *Increase diversity in protected areas workforce.*
- *Support the vision of our Indigenous Involvement Working Group*

The GWS conference is the leading major professional meeting to actively seek participation from across the entire spectrum of disciplines and activities that are necessary for successful management of parks, protected areas, and cultural sites.

Meetings such as GWS2017 that advance thought and practice by connecting people across boundaries are needed now more than ever. Even so, the future of the GWS conference series is under development as a number of factors have emerged that challenge the GWS to find new ways to bring people together to share their experiences. The executive team and Board of the George Wright Society are diligently exploring alternatives to traditional large-scale conferences that better fit today's budgetary and administrative realities. We invite readers of these proceedings to stay in touch with us as we move forward on this front.

Please keep up with the GWS through our various social media platforms and at our new, redesigned website: www.georgewrightsociety.org.

Thank you all for your support and dedication!

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Sea Turtles, Light Pollution, and Citizen Science: A Preliminary Report

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Introduction

Sea turtles are an important ecological resource for Gulf Islands National Seashore's (Gulf Islands) waters and shorelines. Regionally, sea turtles face anthropogenic threats from situations such as entanglement in fishing gear and ingestion of marine debris, as well as possible changes in sex ratios due to increasing temperatures related to human-induced global warming. Locally, light pollution from residential, commercial, and industrial neighborhoods from nearby cities impacts the entirety of Gulf Islands, which spans 160 miles along the Gulf Coast, from Florida to Mississippi, and includes critical habitat for threatened and endangered sea turtles. Because light pollution has been hypothesized to negatively impact sea turtle nesting and hatchling survival, Gulf Islands undertook an effort to understand the relationship between light pollution and sea turtles and create unique educational and outreach opportunities by launching a citizen science program called Turtle Teens Helping in the Seashore (Turtle THIS). At the onset, the Turtle THIS program had two primary goals: quantify the association between light pollution and sea turtle nesting and hatching events using rigorous scientific methods; and initiate a citizen science volunteer program to provide youth with hands-on science and environmental stewardship roles, where they also gain employable skills and career opportunities. With multiple scientific hypotheses to consider, the development of a citizen science program became crucial. Such circumstances allowed Turtle THIS to grow a volunteer and intern program, quantify hypothesized light effects on sea turtles through developed methods, and begin to gather preliminary findings.

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Hypothesized light effects on sea turtles

Sea turtles are important contributors to Gulf Island's barrier island and salt water ecosystems. They maintain healthy seagrass beds, which serve as fish nurseries, and entire food webs by controlling populations such as jellyfish. Most critical to the barrier island are the benefits gained when sea turtles lay nutrient rich eggs into nutrient depleted dune systems. Nest remains help contribute to the overall ecosystem, but also promote vegetation growth which strengthens shoreline protection (Bouchard and Bjorndal 2000; STC 2015; Pries, Miller, and Branch 2008).

The importance of sea turtles to the area, and their status as federally protected species, has created concern among park biologists at Gulf Islands as they have noticed certain factors affecting sea turtle reproductive success. For example, many adult female sea turtles lay their nests in close proximity to Gulf waters, at low elevations, where inundation by seawater can reduce hatchling survival rates. Although Gulf Islands is relatively undeveloped, the occurrence of low profile dunes permits the trespass of two types of light sources onto nesting beaches: sky glow, a form of indirect light from sources miles away, and direct light from nearby developed areas. The light from these sources is hypothesized to interfere with selection of nest sites higher on the beach and at higher elevations. One study determined that light does affect nesting sea turtles; specifically, direct light reduces the number of emergences (Witherington 1992). Although some studies discuss the relationships between light, dunes, and site selection (Salmon et al. 1995; Witherington 1992), we are aware of none that discuss the relationship between indirect light or nest site selection (i.e., proximity to water or low elevation) and light pollution. The understanding of light effects on nesting sea turtles is still in its infancy, but there is enough evidence to suggest that Gulf Islands hypotheses are worth investigating.

Since the 1950s, studies have confirmed hatchling disorientation from light pollution along shorelines affects survivability (Verheijen 1985; Witherington, Martin, and Trindell 2014). Hatchlings observed at Gulf Islands are frequently disoriented or travel toward the lights of a nearby city rather than toward the natural moonlight and starlight reflecting off the waters of the Gulf. In 2016, 71% of nests, where hatching observances took place, were classified as disoriented. This disorientation effect from artificial light is well understood and documented in sea turtle hatchlings, but recent studies indicate that blue wavelengths of light tend to affect disorientation in hatchlings more substantially (Witherington and Bjorndal 1991). This information led park biologists to hypothesize that blue light in Gulf Island's lightscape may intensify disorientation in hatchlings, as well as adults.

In an effort to obtain corroborating evidence that light pollution, specifically blue wavelengths, was contributing to the observed adult sea turtle nesting behavior and hatchling disorientation, Gulf Islands initiated the Turtle THIS program. The program conducts scientific research through a team of citizen science volunteers responsible for carrying out the many tasks required for success.

The need for citizen science

Citizen science is an important facet of the Turtle THIS program. Citizen science is a term that describes an everyday individual's contribution to scientific projects, particularly on a subject the individual values and wants to get involved in. A citizen scientist can provide data using their personalized skill sets, with data analysis conducted by a scientist (Bonney et al. 2009). The use of

citizen science is growing throughout the world in the natural science community as it contributes to large, long term scientific projects, engages communities in learning about the natural world, and provides benefits for the individuals involved (Bonney et al. 2009). Enabling individuals to participate in scientific projects enhances the ability of natural scientists to collect and analyze data that would otherwise be cost-inhibitive or difficult to acquire. Ideally, in such studies, data collection procedures are simple and easy, but require time and effort that citizen scientists are able to provide.

Turtle THIS first created a volunteer program to recruit citizen scientists, which has been vital to the success of the program. Program participants range from middle school, high school and college age students, families, park visitors, retired locals, and conservation groups. Although originally designed to promote future leaders through youth volunteers, the program found it necessary to diversify and further expand the program's reach while also keeping the original goal and name "Teens Helping in the Seashore." All volunteers aide in some portion of the data collection process (Figure 1). Turtle THIS utilizes individual skills to enhance the program and efficiently collect data, which has resulted in over three years of data collection for park sea turtle research.

Figure 1. A Turtle THIS volunteer team collects light data with equipment. During collection volunteers also learn about protecting sea turtles, such as how Turtle THIS only uses red light because red wavelengths are less likely to disorient sea turtles. Volunteers can then relay this information to stakeholders, decision makers, and members of the public they encounter in the field while collecting data. NPS Photo/Jeremy White.

Another objective of the program is to provide educational benefits. Turtle THIS helps volunteers grow into environmental stewards. By educating participants on sea turtles, conservation, and management, volunteers gain skills by providing this educational outreach to others (Figure 1). Additionally, Turtle THIS has set more prominent objectives for younger generations. The program allows youth to develop hands-on skill development in the fields of science, education, and management, and encourages participation through presentations, posters, and talks at regional and national scientific and interpretation conferences. Youth are also encouraged to attend community events or booth sessions to further their outreach skills in a professional setting. Additionally, Turtle THIS incorporates an internship program to serve as part of a career ladder into land management or education fields offering both year-long and summer internships to volunteers, which could grow to seasonal positions and eventually permanent positions.

Interns serve as important members of the team. Along with the skills and opportunities volunteers receive, interns are given other responsibilities such as helping with program management decisions, leading volunteers in the field, and using QA/QC procedures to ensure accuracy of data collection, recording, and data entry. A lead intern is employed to manage the overall data collection and volunteer program.

Program interns and volunteers are led by a team of scientists who provide oversight of lead interns who develop and teach protocol to achieve scientific goals. Turtle THIS was developed and is managed by a park biologist and the chief of resource education at Gulf Islands, a U. S. Geological Survey statistician, and a National Park Service Night Skies Team expert. While considering citizen science as the program's human resource base, these various backgrounds allow the program to utilize park resources, determine best equipment use, and create scientifically-informed project methods, thereby providing a scientific foundation for the program.

Developing project design

With hypotheses and the teams (e.g., scientists, interns, volunteers, etc.) in place, Turtle THIS identified a sampling design and methods to ensure robust scientific results. Turtle THIS encompasses a two-fold project design for understanding the effects of ambient light on sea turtles in the region; one study samples light at a fine scale and a second samples light at a large scale.

Fine scale light data are collected after two nesting events: when a sea turtle lays a nest and again when hatching occurs. The goal is to quantitatively measure the light conditions sea turtles experience during those events. Light data is collected each nesting season from May 1 to October 31. The fine scale data project began in 2014 and will continue annually through 2020 (Figure 2). The 2014 and 2015 seasons served largely as pilot studies to refine best practices for data collection and were necessary due to the novelty of the project questions, environmental complexities, and the expansive study area. Measurements were recorded within 20% of the lunar phase that occurred at the time of a nest event to maintain probable light conditions the sea turtles would have experienced. The 2016 nesting season procedure was refined to reduce variability in light conditions. Measurements are recorded within 72 hours of a nesting event.

At the larger scale, ambient light data is collected along the shoreline from the west end of Perdido Key to the east end of Santa Rosa Island (Figure 2). The goal is to create a light profile of the beach, which documents artificial light within the entire study area. Data are collected on transects spaced every 400 m (1312 ft). The light sensor has an approximate viewing range of 10 degrees in either direction, allowing for overlap between points so no light sources are missed. Light

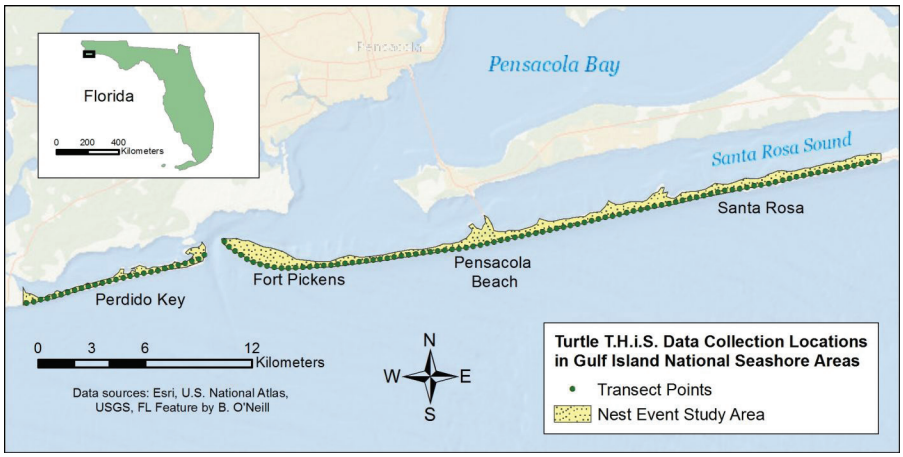

Figure 2. Data collection locations throughout Gulf Islands National Seashore and Pensacola Beach areas for Turtle THIS projects. Citizen science sampling activities are confined to the shoreline, where transect survey points have been marked by GPS, and where turtle nesting activity has been identified by Gulf Islands park biologists. Points on the figure represent transect line locations.

samples are recorded at three points along each transect: the mean high tide line, the toe of the dune, and the top of the dune. Because light conditions can change rapidly due to environmental conditions, sampling conditions are standardized. Sampling only occurs when the moon is absent and twice at each transect location when cloud cover is either greater than 20%, or equal to or less than 20% (cloud reflectivity strongly influences light measurements). Project samples consist of 121 transects, yielding a sample size of 242 when measured under two cloud conditions.

Sampling at both the fine scale and large scale utilize the same equipment, which includes a tripod and mount, two sky quality meters (SQM) for measuring light, and a laser pointer. The tripod and mount combination is adjustable in a circular horizontal plane and a vertical plane. The two SQMs, one of which measures white light and the other which measures blue light, attach to the mount in a fixed position. By systematically varying the altitude and azimuth of the mount, a hemispheric profile of white and blue light over the entire night sky is sampled. The laser pointer is used to determine the altitude of the horizon line. All measurements are standardized to true north to facilitate comparisons among sites. Equipment is easy to use and assemble. The overall equipment design was developed to quantify light visible at about 50 cm (20 in) above the surface of the sand to approximate a sea turtle's perspective, and from a scientific viewpoint not previously studied.

Preliminary project analysis

Turtle THIS has successfully collected 26.9% of beach transect data and completed three seasons of data collection at nest events. Transect data collection is an ongoing process and is in its third year with the bulk of the data collected during the 2016/2017 winter season. Thus far data have been collected at 52 transects during low cloud conditions and 13 transects during high cloud conditions yielding a total sample of 65 of the 242 transects (Figure 3). Turtle THIS will to continue data collection past the original 242 transects to document spatio-temporal variation in light conditions under a variety of environmental conditions.

Preliminary observations show that maximum vertical illuminance, the maximum amount of light striking a vertical surface, is greatest on the dune top and mean high tide and lowest at the dune toe. This suggests that a sea turtle will experience higher intensity light pollution when an adult exits the Gulf to nest or a hatchling enters the Gulf. This also suggests that dune structure may be

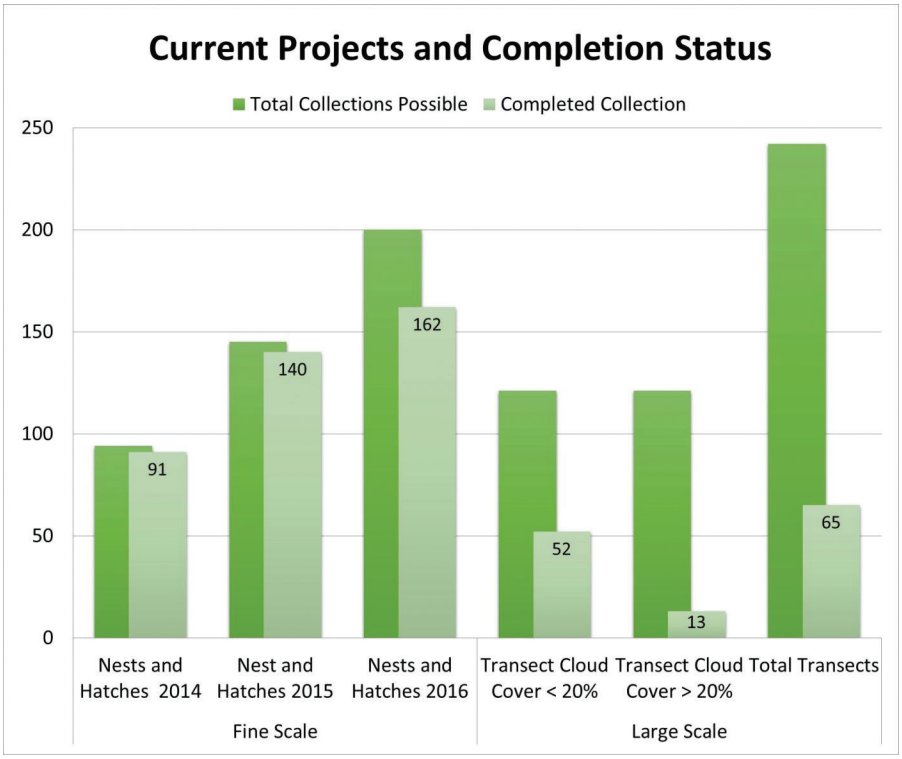

Figure 3. Current status of data collection for both fine scale and large scale projects. Fine scale project bars are organized annually, while large scale project bars are organized by cloud conditions and total transects collected. Last updated April 20, 2017.

an important factor in mitigating the effects of light pollution trespass into sea turtle habitat. Final results, with a higher, more refined sample size will provide more insight into this pattern.

Large scale beach profile results will allow Turtle THIS to create several products. This will include imagery to depict locations data were collected, analysis of the brightest and darkest light under different sky conditions and vertical illuminance analysis to depict light brightness at transect points.

Fine scale data collection and organization are complete for the 2014, 2015, and 2016 seasons. In 2014, there were a total of 94 nest events with data collection occurring at 91 of these sites. In 2015, nest events increased to 145, with a total of 140 samples collected (Figure 3). The total number of nest events does not include nests that failed to hatch a single individual. In 2016, the total of nest events increased to 200 resulting in data collection at 162 nests. Data not collected was due to limited available resources, timing of nest events, and environmental conditions.

These data subtly indicate that nests and number of hatches are increasing. However, when paired with disorientation and relocation data from park biologists, problems in survivability still exist. Preliminary observations of raw data and some initial analyses suggest light, specifically blue light, in Gulf Islands is influencing nest placement and continues to affect hatchling disorientation. However, more analysis is needed to confirm if and how light pollution significantly affects sea turtles in Gulf Islands.

Final analysis of light data collected at nest events will be used to decipher relationships between white light, blue light, horizon line, lunar phase, and other environmental data in comparison to locations of nesting and hatching occurrences.

Conclusion

Turtle THIS is a dynamic program which includes a core scientific component and invites youths and community members to assist with scientific research and promotes environmental stewardship for the national seashore and nature as a whole. The Turtle THIS program adapts as volunteers gain more skills and new volunteers join, interns transfer to permanent positions, new interns are hired, and seasons and conditions change. The program will continue to create new environmental stewards and future land managers, provide sound scientific findings to improve sea turtle management, and inform local populations of their role to help protect sea turtles and engage with Gulf Islands National Seashore.

Acknowledgements

Turtle THIS and this paper would not be successful if not for the help of countless other individuals. Special thanks to Brent Everitt, Cassidy Clements, and Steven Dubose for their dedication and contributions to the project. Extreme gratitude is also given to the Turtle THIS volunteers. Without our citizen scientists, this project would be incomplete, and for their help, the rest of the Turtle THIS team is grateful.

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3

Mapping Invasive Species to Efficiently Monitor Southwestern National Park Areas

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Introduction

Whether purposefully introduced or unintentionally transported, non-native plant species are a major problem across the United States. The excessive competition that pre-adapted invasive species bring to native landscapes has been categorized as the second largest catalyst of extinction and habitat destruction behind human development (Wilcove et al. 1998). This threat poses a serious challenge for the National Park Service. In the southwest, the accumulated impact of the reduction of native herbaceous vegetation and an influx of non-native seeds has increased the landscape's susceptibility to invasive species (Pellant 1996). To this end, NASA DEVELOP's Southwest US Ecological Forecasting team created invasive species distribution maps using Landsat 8 and Sentinel-2 multispectral imagery, in order to explore the feasibility of these data products to be used in locating invasives.

One of the most widespread and problematic invasive weeds that land managers must contend with in Valles Caldera National Preserve and Bandelier National Monument (both in New Mexico) is cheatgrass (*Bromus tectorum*). Cheatgrass has the ability to germinate in the fall or the spring and is usually dry by mid-July (Pellant 1996; Peterson 2005). This early phenology allows cheatgrass to plant its seeds earlier in the year than other perennial species, allowing it to quickly establish post-wildfire and crowd out native species. Additionally, its early dry season makes it is a significant fire hazard (Menakis, Osborne, and Miller 2002). These advantages allow cheatgrass to permanently alter entire ecosystems, posing threats to the preservation of the native and natural character of parks as well as the ecological functions of the landscape.

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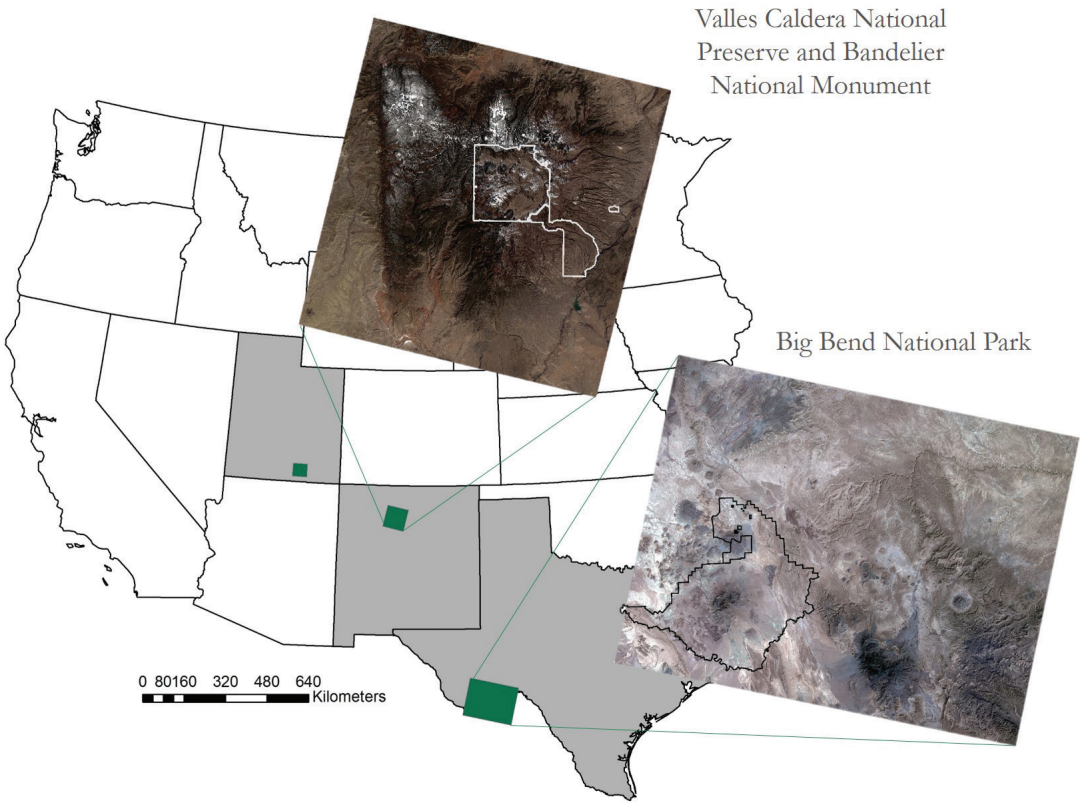
Another non-native weed in the southwest region that thrives on fire is giant reed (*Arundo donax*). Since its introduction to California as an erosion control agent in the 1820s, it has now established itself in monocultures along the stream banks of the Rio Grande. This perennial grass can grow up to 10 m (32 ft) in height and, like cheatgrass, giant reed is highly flammable and can propagate quickly after fire by being the first to grow after recent burns (Bell 1997; DiPietro 2002; Yang, Goolsby, and Everitt 2009). Aside from crowding out native species, giant reed does little to provide food or habitat for wildlife and consumes exceptional amounts of water (DiPietro 2002; Yang, Goolsby, and Everitt 2009). These characteristics make giant reed a threat to both the hydrology and ecosystem health of southwestern Texas.

The team examined three national parks in the southwestern United States and the land surrounding them: Big Bend National Park, Valles Caldera National Preserve, and Bandelier National Monument (Figure 1). The elevation of the Utah and New Mexico region ranges from about 1,000 to 3,400 m (3300 ft to 11,200 ft), whereas Big Bend's elevation ranges from about 500 to 2,300 m (1,640 to 7,500 ft). The average annual precipitation in the Southwest ranges from 127 to 500 mm (5 to 20 in; Sheppard et al. 2002). Data were acquired within the ranges of early March to mid-April and early June to mid-July for the years 2000 to 2016, based on the phenology of the invasive plants being studied as these correspond to the green-up and brown-down times of cheatgrass during the season.

Figure 1. The three national park area examined for this study: Valles Caldera National Preserve and Bandelier National Monument in New Mexico and Big Bend National Park in Texas.



Methods

The team obtained Landsat 5 Thematic Mapper (TM), Landsat 7 ETM+, and Landsat 8 Operational Land Imager (OLI) Surface Reflectance Level 1 imagery for the years 2000 through 2016 from the United States Geological Survey (USGS) Earth Explorer download client. Two images with the least amount of cloudiness were downloaded for each year, one in late April, early May and one in late June, early July, for the study region of each national park area. Images were selected in late April and in late June because of cheatgrass' unique phenology; it greens up before the surrounding vegetation in late April, early May and browns down before other vegetation in late June, early July. However, spatial variance also plays a factor into its phenology. According to our project partners, cheatgrass observations have also shown to green up in May within higher elevations in Valles Caldera National Preserve; therefore, we acquired Landsat scenes for May and July to classify scenes that represent different estimations of cheatgrass' phenological profile. The team also downloaded 10 m Sentinel-2, Level 3 images for the months of January through June for 2016 from the Copernicus download hub. Sentinel-2 is operated by the European Space Agency (ESA) and due to the constrained window of access that is placed on Sentinel-2 data within the US, only data from within a six month time period could be procured. Scenes were downloaded for the area surrounding Big Bend National Park and the Rio Grande River, and scenes with minimal cloud cover were selected for processing.

One-third arc-second void-filled digital elevation models (DEM) were procured for each study area from the USGS's TNM Download Client. We then derived slope and aspect from these models. The NPS provided the team with ESRI shapefiles of wildfire extent within the Valles Caldera and Bandelier park areas as well as with presence/absence data for cheatgrass, and coverage data of giant reed. In situ data were collected by the NPS from the year 2000 to 2016. Additionally, in situ data for cheatgrass were downloaded from SciNET. The team also utilized version two of the land cover data from the National Gap Analysis Program (GAP) supported by the USGS. GAP is a meso-scale land cover map, and the land cover data are based on spectro-physiographic zoning and uses 1999-2001 Landsat 7 ETM+ products as base maps, along with ecological categories through the NatureServe's Ecological System and other similar modeling techniques (Lowry et al. 2007). From the GAP dataset, the team extracted the introduced and semi-natural vegetation class, which is categorized by vegetation dominance, from the ecological systems layers in each NPS boundary. The ecological systems layer contains plants with similar ecological behaviors that grow within particular landscapes based on their phenological properties (Lowry et al. 2007).

Each Landsat scene's respective study area was processed to include only the national park, reduce edge artifacts of Landsat scenes, and to remove land cover types that cannot serve as invasive species habitat (such as urban cover). Additionally, the study area was also clipped to exclude areas above 3,000 m (9,800 ft) since cheatgrass typically does not grow in this elevation. For Big Bend National Park, two Landsat scenes taken in the same orbital path were mosaicked in order to capture a larger extent of the Rio Grande River. Additionally, NDVI images were made using the red and near infrared bands for every Landsat image and then the June NDVI image was subtracted from the April NDVI image for each year.

Our team made two classification maps for the years 2002 and 2016 in the area surrounding Bandelier and Valles Caldera using K-means clustering. This unsupervised classification method was chosen since this method does not require labeled training data. K-means was run several times with different combinations of variables used. In the end, using Landsat 7 bands 1-7 from the early green-up date, aspect, and an NDVI difference image between the early and late dates as

variables produced the best results for the year 2002. For 2016, Landsat 8 bands 2-7 from the early green-up date, aspect, and an NDVI difference image between the early and late start dates was computed. Once the classification maps were produced, the in situ points for each respective year were overlaid and the classes with the most in situ points within them were calculated. Because of the inconsistency of amount of in situ points for each year, in situ points for 2002 and 2003 were analyzed with the 2002 image, and in situ points from 2013–2016 were analyzed with the 2016 image. Classes with a significant amount of in situ points were visually inspected in Google Earth to determine if these areas showed likelihood for cheatgrass invasion.

Having more coverage information with the in situ polygons of giant reed around the Rio Grande, the team was able to perform supervised classifications in the area surrounding Big Bend. Two methods of supervised classification were run and compared. First, both Landsat bands and Sentinel-2 bands were classified using the Classification Tree Analysis method in TerrSet. Additionally, we used a Random Forest algorithm in R, where the classification tree process is iterated hundreds of times, using a different random sample of training data to validate and label each Classification Tree Analysis run. After all runs were computed, each pixel was labeled with the class that it was classified as most often out of all individual runs, to arrive at the final classification image. The team ran Random Forest with different spectral band combinations for both Landsat 8 and Sentinel-2. The training data included in situ shapefiles of giant reed monocultures and shapefiles of other classes (water, bare soil, shrubland, and other vegetation) that were visually identified by the team looking at a false color composite of Sentinel-2a and high resolution National Agriculture Imagery Program (NAIP) imagery. Random Forest was run several times, using different band combinations and number of training pixels sampled. Our best classification result with Landsat 8 used bands 2–7 and sampled 200 training pixels. Our best classification result with Sentinel-2 used bands 2, 4, 8, 11, and 12, and sampled 500 pixels. Because the shortwave infrared bands in Sentinel-2 (bands 11 and 12) are at 20 m (66 ft), all the other bands were resampled up to 20 m (66 ft) as well.

Results and discussion

The classification maps of Valles Caldera and Bandelier performed best when using bands 2–7 from either Landsat 7 or Landsat 8, an NDVI difference image computed using a March and June date, and aspect (Figure 2). Classification performance was qualitatively assessed by determining which classification captured the most in situ data points within the smallest number of classes. Classifications in 2016 were more thorough than 2002 in mapping grassland susceptible to cheatgrass as evidenced by the difference in coverage of grasslands within Valles Caldera.

The 2002 classification was also compared to GAP land cover classes to check if the validated classes matched up with larger class groups. The classifications are mainly on the East side of the study area and fall mostly on the Forest and Woodland class, most of that being within Pinyon-Juniper. Many of our classifications also fall within the recently burned areas. This is most likely due to cheatgrass' ability to regrow quickly after a fire. The 2002 classification does not, however, map potential invasion areas in the grassland classes; our 2016 classification explains this grassland invasion much better. This is likely due to the large amount of in situ data points within the period of 2013–2016 compared with 2002–2003.

We were not able to discern meaningful differences in the reflectance values of Landsat pixels where cheatgrass coverage was deemed present by field observations. This could be because Landsat's resolution is too coarse, the polygons did not represent 100% coverage of cheatgrass at

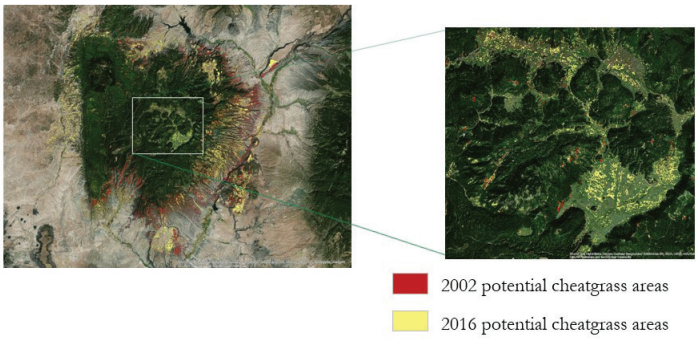


Figure 2. The 2002 and 2016 unsupervised classifications showing areas of potential cheatgrass in Valles Caldera and Bandelier National Monument.

high density, or that the cheatgrass had not experienced significant green-up or brown down relative to the surrounding vegetation at the time that the Landsat scenes were taken. It was difficult to obtain a cloud free Landsat image that fell within our time range and it was necessary to use in situ data outside the year of the remotely sensed data to validate the classification. The Valles Caldera National Preserve park staff acknowledge that cheatgrass experiences variability in phenology events from year to year and because of an elevation difference, the preserve's patches of cheatgrass experience these events later relative to Bandelier's patches. However, it was necessary to classify cheatgrass using Landsat imagery which covered Bandelier in order to have enough in situ points to validate a classification.

Sentinel-2 performs much better than Landsat 8 in correctly classifying most classes, especially the open water of the Rio Grande (Figure 3). Our error matrix for Sentinel-2 shows that giant reed was classified correctly about 90% of the time; however, we believe that this is because both results over classify areas along the river as giant reed when in reality those areas could be other types of riverside vegetation. This hypothesis is supported by the fact that our error matrix for our Random Forest Sentinel-2 classification shows that the other vegetation class was classified as giant reed about 5% of the time. Furthermore, from a visual inspection of our classified map overlaid with high resolution imagery from Google Earth, it is clear that the classifier labels multiple vegetation types as giant reed or other vegetation.

Additionally, the best Random Forest classified image classified a little over half the pixels that make up the entire class of giant reed with at least 75% certainty. The measure of certainty indicates, for a given pixel, that out of all classification trees generated by the Random forest algorithm, 75% or more agree that a given pixel is classified as giant reed. This is not a measure of accuracy and we still believe that the classifier over classifies riparian vegetation as giant reed. However, we are excited that the Sentinel-2 data are able to so finely separate these classes as it is and we expect that more training data and training shapefiles of vegetation classes other than giant reed.

Conclusions

NASA Earth observations have the potential to be an essential tool in mapping distributions of invasive species and forecasting their future spread. Important considerations from this study include the importance of the amount of in situ data in training a classification and the limitations of Landsat and other moderate resolution satellite imagery due to the mixed pixel effect. We determined after this study that there is opportunity to arrive at more accurate and representative landscape classifications if there were more in situ data to train our classifier to detect not just

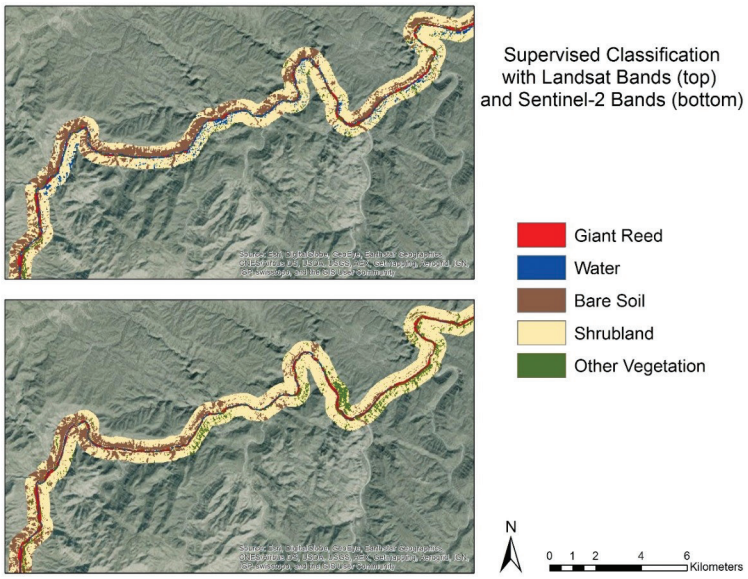


Figure 3. Random Forest classification of land cover type using Landsat (top) and Sentinel-2 (bottom) around the Rio Grande.

invasive coverage, but also other common vegetation types and soil types, since spectral properties can differ greatly between different species and substrates. We expect that in the future, with more in situ data and more opportunities to collect cloud-free imagery from Sentinel-2, image classifications can be a helpful tool for park managers in detecting and mitigating invasive species.

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4

Bringing Historical Perspectives on Climate into Current Adaptation Practice

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The National Park Service (NPS) has undergone many changes over the years. Parks have been added to the system and management priorities have been expanded to include natural resources, cultural resources, collections, and even ships.[1] More recently, many park managers are being challenged by the impacts of anthropogenic climate change on their parks. In some cases, the projected impacts of climate change may increase the frequency and intensity of existing climate and weathering impacts on parks. In other cases, climate change may present managers with new challenges, such as sea-level rise or other new conditions caused by multiplying or combining weather effects. Although the speed, intensity, or combination of climate effects may be new, people have coped with and adapted to erosion, accretion, storms, and flooding in highly changeable coastal environments for as long as people have inhabited coastal spaces.

Within the NPS, the Climate Change Response Program has published guidance documents to support and enhance park efforts to plan for climate change impacts. The Cultural Resource Climate Change Strategy, released in 2016, identifies ways in which climate change will impact cultural resources, as well as ways in which cultural resources can provide information and inspiration, from how past societies adapted to changing climates, to our current adaptation efforts.[2] Within this framework, my research looks to the historical record, starting with the sixteenth century Spanish and early seventeenth century English colonial presence in the modern United States, seeking information on how responses to past change can inform or critique modern climate change adaptation. This longer-term perspective on climate volatility and change may enhance the view, scope, or context of adaptation today.

To better understand climate change adaptation in a historical context, I ask two questions: how have managers' perceptions of the coastal environment and climate volatility

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changed overtime, and how can historical patterns of use inform climate change adaptation planning for cultural heritage resources? Perspectives on the environment encapsulate cultural views and understandings of our environment. From European settlers' views of nature as commodities to be incorporated into old world economic systems, to European expansion across the continent, to twentieth century conservation and preservation that led to the creation of the NPS, and to today, environmental views have translated to policies and actions.

Historical perspectives are important and relevant because these perspectives contribute to how policies are written and implemented. To address my research questions, I take a case-study approach, focusing on three sites: San Francisco Maritime National Historical Park, Gulf Islands National Seashore, and Colonial National Historical Park. I selected these parks to represent different regions of the United States, different coastal morphologies, and different historic resource types. To understand how climate change perspectives have changed overtime, my research draws on park management archival materials and interviews with current managers. By looking at how our past views, policies, and adaptations to climate volatility manifested in these parks, we may be able to advise or take a critical lens to modern adaptation actions.

Starting in Pensacola, the northern coast of the Gulf of Mexico has long been an important strategic location. Gulf Island National Seashore, along the Gulf Coast of Florida and Mississippi, interprets a range of coastal defenses dating from the late eighteenth through the mid-twentieth century, in addition to managing beaches, islands, live oak reserves, bayous, and other sites. The area within Gulf Islands National Seashore has a long and sporadic history of European settlement, with the Spanish settling briefly, leaving due to hurricane damage, returning when the French were claiming more territory in the area, then moving from the barrier islands to the mainland due to further hurricane damage. However, the importance of the area as a strategic military location, and later for shipping and tourism, overrode the hurricane risk and damages.

After repeated political turnover in West Florida, the history of Pensacola in the nineteenth century is dominated by American military and industrial expansion. The site was advertised and expanded as an industrial center in the twentieth century in anticipation of a Nicaraguan or Panamanian Canal. As Pensacola writers continued to encourage industrial development and migration to Pensacola, they emphasized the international trade potential of the area, as well as the natural beauty and healthful environment. Early tourism in the area focused on the "ruins" of early Spanish colonial sites. In 1828, amidst his excitement about the potential for government protection of live oak resources in the area for Naval purposes, Brackenridge mentions the ruins. Tourist pamphlets from the early twentieth century emphasize the remains of Fort McRee. Today the fort has disintegrated further, but still serves as a point of interest for boaters.

In the 1940s, the areas that now comprise Gulf Islands National Seashore were transitioned out of military use and into the care of state parks before coming under the management of the NPS. This transition from active military site to tourist heritage site, as one would expect, accompanied an ongoing change in perspectives of the environment, but also brought a change in expectation for the cultural resources. As military sites, the

forts in Gulf Islands were frequently altered by weather conditions, neglect, updating, and even the explosion of Bastion D.[3] The dry moat surrounding Fort Pickens was filled for air flow, arms storage was raised above flood levels, buildings were built at split levels to avoid earlier flood lines.

These examples of modifications could have applications today. The modification of these structures to improve airflow and hurricane resilience are authentic historic features with similar examples elsewhere in the historic record. These modifications suggest a flexibility to construct and change with environmental conditions. When the site was designated for its cultural heritage potential, and preservation work began, instead of being updated as needs arose, preservation goals instead became to maintain the historic character of these sites and their presentation at different periods of their military use. The recent plans for the acquisition of ferries to visit Fort Pickens represent an adaptation for the NPS, but also the return to an earlier situation, as the Army built and supplied Fort Pickens by boat, not road.

Moving north, Colonial National Historical Park encompasses Jamestown, Yorktown, and the scenic Colonial Parkway that serves to connect these historic capitals. A major theme in the ongoing history and change of Colonial National Historical Park is memorializing the American nation. This has contributed to physical changes to structures and landscapes, as well as much of the preservation work. The tercentennial (300th anniversary) exposition at Jamestown commemorated the landing of English settlers, but also defined the country by the naval, military, and industrial development that took place in the 300 years since through attaching these stories to a place of origin. The construction of Colonial Williamsburg in the early twentieth century, with the support of the Rockefellers, soon became an example for reconstruction and living history and during World War II was used to teach patriotism.[4]

Structure restoration has also been prompted by anniversaries relating to the birth of the nation. Moore House was restored before Colonial National Historical Park came under NPS purview for centennial celebrations. Slabtown was removed and relocated before bi-centennial celebrations. Until recently, James Fort was believed to be in the James River (due to erosion). James Fort may be threatened with inundation in the future through a combination of sea level rise and erosion.[5] The discovery of the fort on land has been a great opportunity for archaeological study and discovery. However, while the interpretation of erosion and changing environmental conditions was accepted before, now that James Fort has been discovered on the island, the conversation has changed to one of preservation.

Heading west, San Francisco also has a history of promotion and presentation through expositions, including the 1915 Panama-Pacific exhibition. The environmental history of American San Francisco starts during a period of technological expansion, which continued in the area into the twentieth century. The American history of San Francisco is one of massive environmental changes almost from the beginning, with the filling of waterfront lots beginning within a few years of the American take-over of the city in 1846. The poetic idea popular in the city now is that the places that were reclaimed will likely revert to bay with climate-change-induced sea level rise. Another key feature in the San

Francisco environment and landscape is the fog, which has transitioned from an annoying maintenance nuisance for the Spaniards, who were constantly challenged to maintain the adobe and roofing within the Presidio in the damp climate, to a navigational hazard that stalled entry into the bay. Today, cultural resource managers face the similar challenges from the salty, damp air. The maintenance of guns at Fort Cronkite, perhaps even more so than the firearm itself, may tell the legacy of the bay.

Another important aspect of the history of San Francisco is commercial fishing. The history of commercial fisheries in San Francisco Bay is almost more of a history of aquaculture than fishing. From as early as the 1860s oysters were shipped into the bay from Washington State and Mexico, as the native oysters were not to people's taste, and the native oyster population declined. Beginning more consistently in 1875 with train access, eastern oysters were shipped to San Francisco and planted in the bay.[6] Non-native fin fish species were also introduced to the bay. As the fisheries declined for various reasons, and the tourist economy saw an increase in the mid-twentieth century, the conservation and preservation ideals saw a transition from a focus on technological superiority over nature to the desire to protect human history alongside undeveloped space.

In an environmental statement from 1977, the Army Corps suggested that "with improved conditions for the local cultural attraction, commercial fisherman at work, tourist activity would be enhanced."[7] This plan suggests there was an intent to preserve a human use of natural resources (fishing), but recommended doing so through development and construction along the shoreline. The shoreline use that is motivating planning, in this case, is tourism rather than fishing. To attract tourists, city managers restored fishing infrastructure, reconstructing a human use rather than a natural setting.[8] Residents started to become concerned about increasing the portion of the bay that was filled. Today, some of the recreational spaces that are popular, including along the maritime museum and trails in Golden Gate National Recreation Area, are at risk of coastal erosion and sea level rise.

Past social adaptations to climate volatility, and modern adaptation to climate change, are all a part of an ongoing historical legacy of people interacting with nature through alteration and creation. These brief examples suggest that managers of these spaces have taken adaptive action throughout the recent history of the sites. The examples I provided of adaptive actions at Gulf Islands National Seashore, changing interpretation at Colonial National Historical Park, and the now over 50-year history of shoreline conservation in San Francisco Maritime National Historical Park suggest that our views of these parks, including the effects of climate change, are part of a longer history of shifting interpretation. But what information can these adaptive actions provide?

Sites or structures that have a history of being moved, modified, repaired, or used for alternate purposes may present additional adaptation options and may need to be considered. Past alterations may inspire current preservation work and ideas. If sites have been altered in the past, such as the ongoing fog repairs in San Francisco or ongoing hurricane repairs in Gulf Islands, even before they were preserved as heritage sites, to withstand climatic conditions, site modification and change, as much as original material, are a part of the integrity of site structures and stories. Standards for site or structure authenticity and integrity may need to be updated to accommodate relocation or regular replacement due to climate change impacts.[9]

San Francisco Maritime, Gulf Islands, and Colonial National Parks all interpret climatic change for visitors. Gulf Islands displays flood lines from Hurricane Ivan and interprets the impacts of Hurricane Katrina on park resources through both interpretive panels and ranger talks. However, communicating climate change, climate science, landscape change overtime, and change in the resources overtime, is different than communicating modern actions, choices or decisions that parks are making or will be making about what to let go or protect. The management of cultural resources, given the reality of climate change, is currently framed as a decision point where managers will need to choose between protecting and preserving resources, as opposed to storms, erosion, repurposing, fire or other instances of past change. In addition to communicating observed and projected changes and economic processes that brought about those changes, cultural resources may serve as a focal point for discussing the creation of heritage through preservation choices that have and will be made.

Finally, the planned removal or adaptive alteration of structures in the historic past may provide instructive lessons on coping with loss. Sites without physical remains can tell stories—we've all heard them from relatives and likely we've told them ("When I was a kid this used to be…"). Cultural resource managers will need to consider research potential of sites as they prioritize the protection or recovery of archaeological artifacts and contexts. However, as resource loss takes place, we may need to recognize the importance of transitions, made visible through the gradual loss of historic sites, in our understanding of place. In conclusion, climate change adaptation may be incompatible with the current approach to cultural resource preservation. Climate change adaptation for historical resources and stories may require a re-framing of the idea of static structures and sites. It may demand a re-framing of the idea of any object or site as static and may require the explicit recognition that preservation choices are some in a long series of management decisions made in living landscapes.

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5

Utilizing NASA Earth Observations to Map Temporal and Spatial Patterns of Annual Bromes for Prairie Management and Invasive Species Control in the Northern Great Plains

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Introduction

Cheatgrass (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*) are Eurasian, annual grasses that have spread across the entire contiguous United States since their introduction to the western hemisphere in the late 1800s. In the west, these grasses have invaded a variety of ecosystems including steppe, pine woodlands, arid grasslands, and prairies (Grace et al. 2001). In the Northern Great Plains (NGP) cheatgrass and Japanese brome are displacing the native mixed perennial prairie grasses (Peterson, 2005). Common native grass species in the NGP include western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), needle-and-thread (*Hesperostipa comata*), and blue grama (*Bouteloua gracilis*; Ingram et al. 2014).

These invasive bromes are effective invaders due to their ability to "green up" in early April, before the native species, taking in water and nutrients and leaving the native grasses in a progressively stressed state (Grace et al. 2001). They are prolific seed producers that mature in the spring and disperse late in the fall and winter seasons (Ogle et al. 2003). The annual bromes also die off following seed set, earlier than the native grasses in mid-June, providing fuel and negatively impacting fire regimes, leading to more dangerous fires with a higher frequency (Ogle et al. 2003; Singh and Glenn, 2009).

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The Northern Great Plains Network (NGPN) is one of thirty-two NPS Inventory & Monitoring (I&M) Networks within the United States. The network is tasked with acquiring baseline inventories for a wide range of natural resources including air and water quality, geologic and soil resources, and plant and animal species occurrence and distribution. These inventories provide park managers the information necessary to effectively manage 13 park units throughout Wyoming, Nebraska, and South Dakota. The primary objective of this project was to create accurate distribution maps for cheatgrass and Japanese brome in Badlands (1030 km^2) and Wind Cave (140 km^2) national parks and Jewel Cave (5 km^2) National Monument (NM) in South Dakota (Figure 1). Understanding the behavior of these invasive species through space and time will aid managers in developing a successful annual brome adaptive management strategy for park units, and identify areas for targeted management efforts. Therefore, the goal of this feasibility project was to examine potential methods to regionally monitor invasive grasses by leveraging their unique phenology, in situ data, and satellite observations. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite, along with Landsat 8 Operational Land Imager (OLI), Landsat 5 Thematic Mapper (TM), and Sentinel-2 Multispectral instrument (MSI) provided the project with the spatial and temporal resolution necessary to create phenology-based maps of brome distribution.

NGPN in situ monitoring data

In situ vegetation monitoring data for Northern Great Plains (NGP) park units were col-

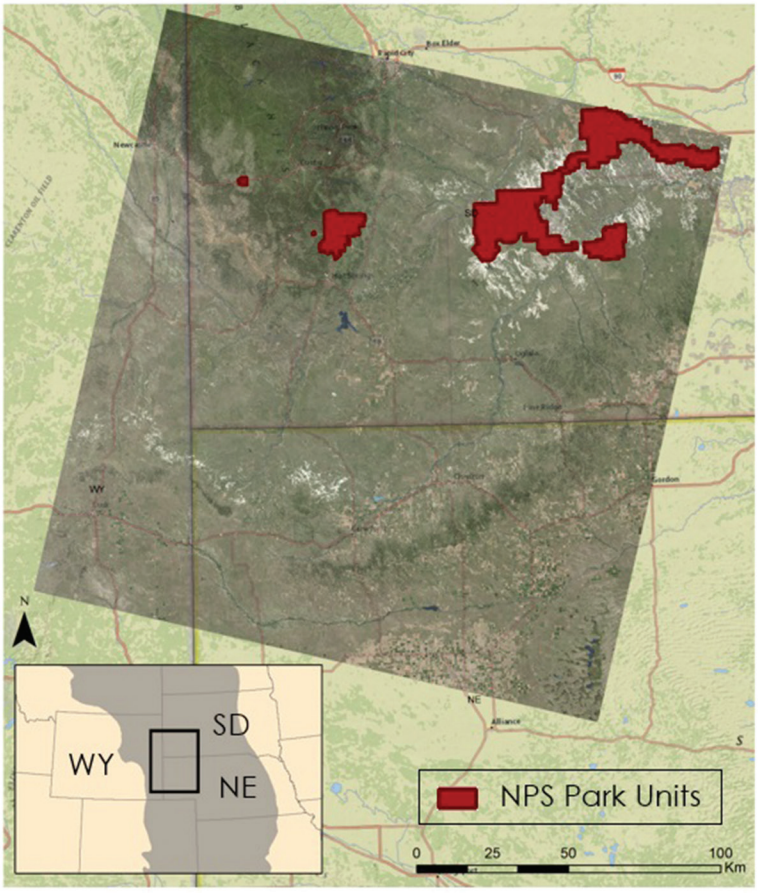

Figure 1. From left to right: Jewel Cave National Monument, Wind Cave National Park, and Badlands National Park (SD) within Landsat 8 OLI WRS-2 path 33 row 30.

lected by the NGPN and the Northern Great Plains Fire Effects program (NG-FEP) from 1998–2016. Vegetation sampling took place between May and August each year. The vegetation data contained 703 monitoring occurrences over 256 unique study plots for Badlands and Wind Cave NPs and Jewel Cave NM. Each data point contains measurements for absolute and relative percent of plant cover below 2 m, exotic species, and annual invasive brome grasses estimated for a 0.1 hectare (20 x 50 m) sample plot. These in situ data were used to validate the NDVI difference images and land cover classification.

Phenology estimation

Vegetation phenology data products were acquired through the United States Department of Agriculture (USDA) Forest Service's ForWarn System. These parameters, obtained from 2000-2014, are derived from Terra MODIS data at 250 m spatial resolution. Vegetation phenology was analyzed using a 15-year time series provided by the MODIS 8-day Normalized Difference Vegetation Index (NDVI) product. Utilizing this 8-day product, the team was able to take the average dates of green-up, maximum production, and senescence over the study area and calculate an average phenology for each year.

To identify the effect of cheatgrass and Japanese brome on local NDVI, NDVI values were extracted at each pixel containing an in situ data sample. Because bromes green up early in the growing season before the surrounding native vegetation, areas with higher relative abundance of brome grasses have high NDVI values. By July when bromes begin to senesce, an inverse relationship between brome grass abundance and NDVI is expected. Midseason, both native vegetation and invasive bromes have similar NDVI values. The expected local effects of bromes on greenness cannot be captured by the 250 m spatial resolution of Terra MODIS. However, 30 m Landsat data are able to identify the phenological differences between invasive bromes and the native vegetation.

NDVI differencing

Landsat 5 Thematic Mapper (TM) imagery from 2008-2011 and Landsat 8 Operational Land Imager (OLI) imagery from 2013–2016 were downloaded from the United States Geological Survey (USGS) EarthExplorer. Scenes from the months of March through August were chosen based on the examination of ForWarn phenological parameters to correspond with the brome growing season.

Utilizing the higher spatial resolution of the Landsat satellite (30 m, 98 ft), NDVI was calculated for all Landsat scenes with sufficient visibility of each park unit during the growing season. This provided a higher resolution reference to compare with ForWarn and MODIS data. The availability of cloud-free imagery limited number of scenes that could be used. The two scenes that were identified to be the most representative of the brome grass green-up and brown-down periods were compared to calculate the change in NDVI from early to late season in 2015. The result was visually analyzed in order to determine the validity of the output. Once this method was established, Google Earth Engine (GEE) was used to automate the calculation for each year from 2008 to 2016, excluding 2012. Classification for 2012 was excluded because of extreme drought (affecting vegetation regionally) and the lack of adequate Landsat data. For easy visualization, an orange-red color ramp displays only the NDVI difference above 0 (places greening up and senescing earlier than average), indicating where brome grass might be present (Figure 2).

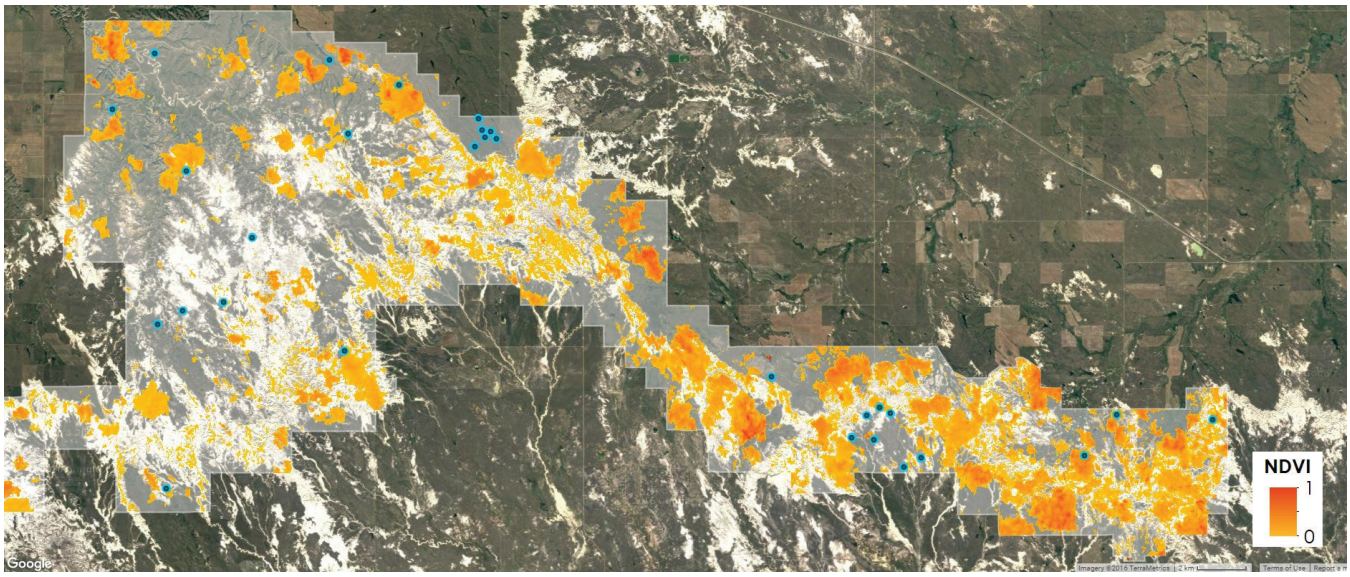

Figure 2. The difference between Landsat derived NDVI values between April 2016 and July 2016 within Badlands National Park; positive differences, shown in orange, represent areas with earlier vegetation phenology.

The NDVI difference maps from 2008 to 2016 showed annual variation in early phenological events which is characteristic of brome presence and abundance. When used alone, without the inclusion of other environmental factors, NDVI differencing was not capable of consistently and accurately identifying brome populations when compared to in situ measurements. For example, the difference image for 2010 showed high NDVI values in areas of all three park units. While 2010 had the highest relative percent of brome abundance measured by the NGPN, this was mostly attributed to measurements from Badlands NP. High NDVI difference values were unexpected in Jewel Cave NM and Wind Cave NP, where field measurements reported low brome abundance. In other years NDVI difference images identified areas of early phenology in both Jewel Cave NM and Wind Cave NP, where the actual ground data measured low or no brome abundance.

Generally, NDVI differencing for predicting potential areas for brome presence was more successful for Badlands NP than for the smaller Jewel Cave and Wind Cave park units. The level of accuracy of NDVI differencing between the three parks could be attributed to differing environmental conditions, such as variations in elevation or slight differences brome phenology. Additionally, while brome abundance has increased since monitoring began in 1998, the sample plots with the highest relative percent of brome abundance were recorded at less than 20% of the total vegetation. The 30 m spatial resolution of the Landsat imagery might not be able to detect areas where brome are present at low relative percentage.

Brome classification

Multiple different classification methods combined Landsat 5 TM, Landsat 8 OLI, in situ vegetation monitoring data as another technique to identify areas of brome grass abundance within the Badlands, Wind Cave, and Jewel cave park units. Both unsupervised

and supervised classification methods were run in an attempt to identify bromes more accurately than the NDVI differencing method was able to do. Basic unsupervised classification methods, where a software program uses an algorithm to group image pixels into clusters based on similar properties, were unsuccessful. When compared to NGPN monitoring data, these methods were unable to identify locations of higher relative brome abundance. Next, two supervised classification methods were run. These methods use training areas based off of known in situ brome presence data to classify the images.

Supervised classifications were performed for the entirety of the study area from 2008–2011 and 2013–2016. The resulting classified Landsat scenes were adjusted to remove areas outside the three park units, as well as specific land cover categories where bromes are unlikely to be found, including rock, cultivated crops, developed high intensity, emergent herbaceous wetlands, evergreen forest, and open water. The final images display classes of brome abundance as follows: 0–4%, 5–12%, 13–25%, 25–50%, and more than 50%.

The two lowest categories of brome abundance (0–4%, 5–12%) were the most widespread, covering almost all of Jewel Cave and Wind Cave park units. The medium (13–25%) and high (26–50%) abundance classes were found mostly within Badlands National Park. Areas with medium and high brome abundance, while not widespread in parks, threaten native species persistence, and can be combatted by our partners at NPS. Areas with extremely high brome cover (greater than 50%) were only located along roads and other places intensively disturbed by human activity.

Forecasting

Classified images from 2008 to 2016 were used to predict brome abundance for 2017. All classification images were stacked and clipped to the same extent for comparison. Using R (statistical software), a linear regression was calculated at each pixel in the time series to predict brome abundance in 2017 (Figure 3). The percent classifications were converted from labeled classes to numeric: 0–4% was assigned a value of 4, 5–12% was assigned a value of 12, 13–25% was assigned a value of 25, 26–50% was assigned 35% and values over 50% were uniformly assigned to be 70%. This conversion is expected to overestimate some values, and underestimate others versus the actual values observed. The resulting output was a map of predicted brome abundance for 2017. Due to the nature of regressions, all values were capped at 70%, fitting them into the extreme brome abundance class. Fewer than 1% of the pixels in parks were forecast to have this extreme brome cover.

Conclusion

This feasibility study examined methods for identifying, monitoring, and predicting the spatial and temporal patterns of cheatgrass and Japanese brome occurrence in three NGP national park units. Satellite data from Terra MODIS, Landsat 5 TM, and Landsat 8 OLI along with in situ data from the National Park Service's monitoring program provided a 15-year time series of brome grass distribution within Badlands National Park, Wind Cave National Park, and Jewel Cave National Monument in South Dakota. The NPS Northern Great Plains Network can incorporate remote sensing into inventory and monitoring protocols for invasive bromes and apply these methods to additional parks within the network. In the future, additional use of the European Space Agency's Senti-

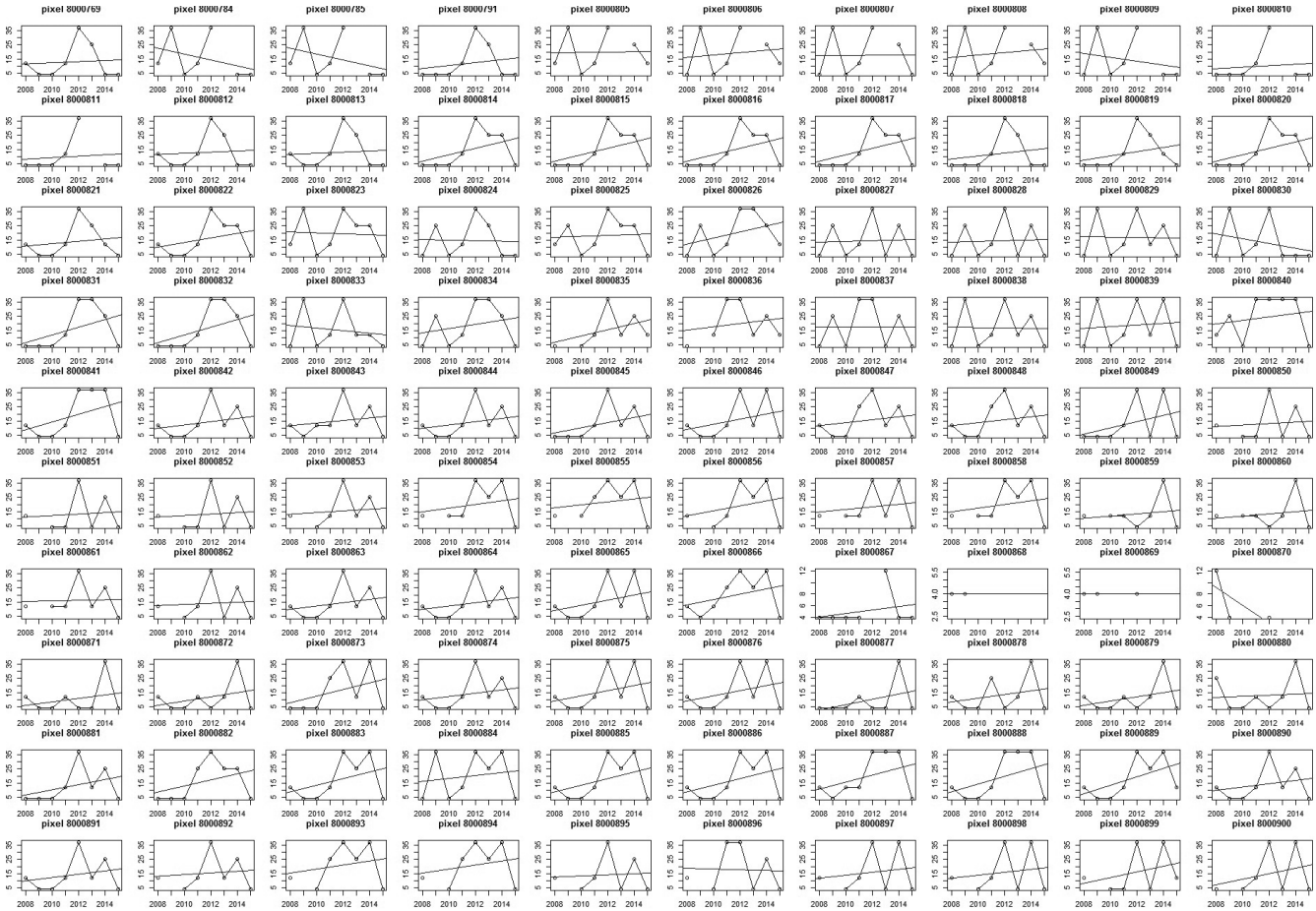

Figure 3. Pixel-based linear regression of classified Landsat imagery to estimate brome abundance in 2017.

nel-2's higher resolution imagery, Sentinel-2's red edge bands, and other ancillary data including slope and aspect, and bioclimatic variables including, annual temperature and precipitation could be added to improve the result of brome classification. The highest amounts of brome were only marked in places along spots of human disturbance making distance from roads and buildings another point to be examined.

The NPS Northern Great Plains Network can incorporate remote sensing into inventory and monitoring protocols for invasive bromes and apply these methods to additional parks within the network. While in situ field measurements are necessary create accurate classification maps from remotely sensed satellite data, the addition of NASA Earth observations to the network's current methods can contribute to timely regional monitoring efforts, potentially directing or limiting the need for time-intensive field work campaigns. Remotely-sensed classification methods provide an estimate of the current distribution of invasive annual bromes, which is needed to develop an adaptive management plan for invasive species control in the NGP.

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6

Creating Connections through Predictive Modeling and Cultural Resources Research

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This paper synthesizes research via two internship collaborations, focusing on predictive modeling of archeological site practices in two regions of the National Park Service (NPS). Lindsey Cochran's two internships were sponsored by National Center for Preservation Technology and Training (NCPTT), Natchitoches (LA) in 2015, and the George Melendez Wright Young Leaders in Climate Change program (YLCC) in Washington, DC, in 2016. Specifically, this paper highlights the intersection of these two internships while detailing the multi-spatial, multi-temporal, and multi-cultural connections the authors made through these two predictive modeling projects for the NPS.

As archeologists, we use material records of the past to interpret human history and link it to the present day using known site locational data and environmental factors. These diverse lines of evidence converge through our analysis, allowing us to better understand the environmental and cultural constraints that conditioned past human lives. Federal properties require that the managers create and maintain an inventory of resources within site boundaries; cultural resources use the Archaeological Sites Management Information System (ASMIS). The authors' participation in both programs was predicated on the implication of legacy and ASMIS archeological data into computer-based predictive modeling systems to model archaeological site type, location, and surrounding environment.

Our first project models known sites and probable locations of multi-temporal archaeological sites. The project incorporates the entire 3.6 million acres of Death Valley National

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Park (DVNP) into an ecological niche modeling approach. The second project analyzes the impact of rising sea levels on archeological sites, both above and below ground, in five national parks on the eastern seaboard. Both projects involve spatial predictive modeling using GIS, previously collected data, and statistical analyses to model past human behavior, and will provide management recommendations to parks.

Archeological site monitoring at Death Valley National Park

The initial premise and objective of the DVNP project was to develop a series of models as proof of concept for the applicability of ecological niche modeling to archaeological research. Our goal was to create these maps as tools for more effectively managing cultural resources, and to assist NPS resource managers in identifying ways to protect, preserve, and educate the public about archeological resources within DVNP boundaries. Using a database of various time periods and potentially significant environmental variables, we "mapped" the statistical outcome of the combination of such datasets. Outcomes of these tests will assist in determining the future trajectory of both "real-life" and digital cultural resource management of sites in the park. Output models are then shared with NPS archeologists to ultimately integrate them with improved maps of geomorphological and environmental characteristics of the park.

Archeological research has established that humans settle within identifiable spatial relationships relative to their environment. If humans from any time period settle in patterns constrained by their environment, then it is possible to create relational models to determine where unidentified habitation settlements may be located (Ruiz et al. 2014). Cochran and Britt combined grid-based geographic information systems (GIS) with statistical modeling to create three products to address these goals: create a series of maps that show the relative probability of locating unidentified sites, assess the accuracy of the location of current cultural resources used to "train" the model; and generate raw statistical outputs that can be exported and used in statistical software (like "R") for further analysis.

To create these predictive models, influenced by statistical patterning, Cochran and Britt collected data from over 2,600 known sites, assembled GIS layers that included landscape characteristics and other environmental data, assimilated geomorphological data, and developed models using a maximum entropy-based niche modeling approach called MaxEnt (Elith et al. 2011; Peterson 2006). This technique combines GIS imagery files, such as digital elevation model (DEM) and LiDAR (remote sensing) data, site file and type data, and other environmental variables. A series of statistics, chosen by the user, are then integrated into the maximum entropy model to run the final output.

We first identified a set of landscape features most likely to impact human habitation. These included: elevation, slope, aspect, water availability in soils, depth to water, depth to restrictive sediment layer, soil texture, geology, distance from intermittent and perennial streams, distance to playas, distance to ponds, distance to springs, and distance to faults (Ruiz et al. 2014). Then, a series of site types, identified through the ASMIS database, were classified as being prehistoric or historic, and then the functional uses of the site were further defined based on information recorded within ASMIS. As for the model, the better the contrast, the better we can define the location of undiscovered sites. Workflow

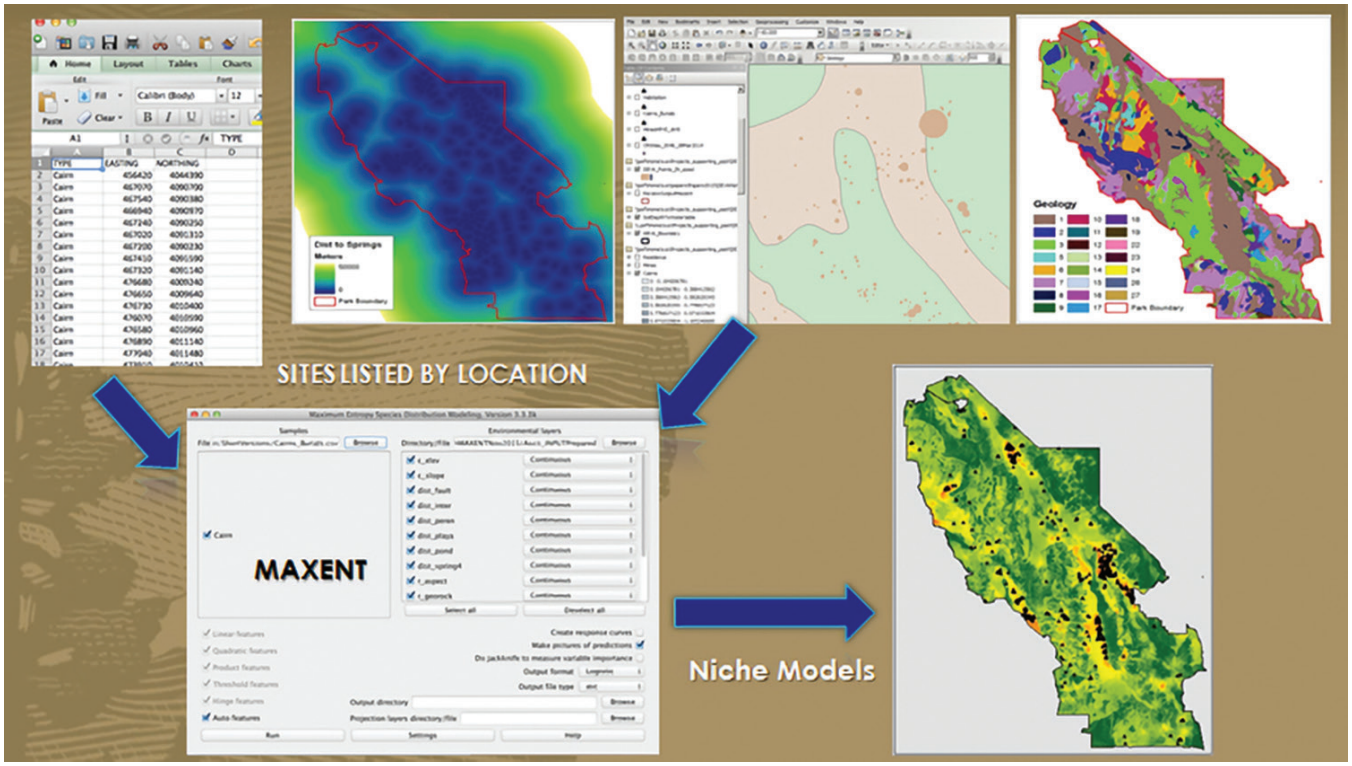
involves the integration of raw site locational data, environmental data, MaxEnt input, and the final output niche model product (Figure 1).

As with all statistics, no matter the breadth or complexity of the program, the results and model output are often solely contingent upon the quality of data input. We identified the primary sources of statistical bias from within the DVNP dataset through the output data in MaxEnt, and subsequently either eliminated the skewed data or used post-hoc statistical methods to analyze and subsequently minimize the impact of outlying data.

However, the archeological data present in the Death Valley database is biased in multiple and often unknown ways. Some sites are entered into the ASMIS database due to casual observations, others were part of specific undertakings, and for some sites the associated research design was not recorded or well defined. Some sites were recorded as early as the 1930s—these, of course, are not exactly up to geodata standards now. In addition, and for a variety of reasons, location data are not required in ASMIS. To bypass error inherent with inconsistent surveying techniques, we used a single northing/easting coordinate for each site location, rather than calculating the approximate area of each site. The tendency to collect site information differentially near roads or other easily accessible points also impacts the types of landscape features associated with sites in the model.

The ideal MaxEnt model will show spatial variation between high and low probability areas for habitation, but the variation between those places will be stark and easy-to-identify (Jaynes 1957). Eight models were run with a cumulative output (rather than a logistic re-

Figure 1. Modeling approach for DVNP.



gressive output) to emphasize variation between high and low probability areas after separating values for testing versus training of the model. Additionally, running the replicated MaxEnt string as a bootstrapped sample positively influenced the logistic regression variable measure of importance. Finally we used post-hoc jackknife testing to estimate the bias of each variable, essentially identifying the most and least influential environmental variables relative to the total inputs (Elith et al. 2011).

The interpretations of the models are preliminary, as they were developed as a starting point to facilitate NPS site identification and stewardship. The need to determine the reliability of the surveys and to develop a more nuanced metric for the site occurrence (or lack thereof) is an important area of future work (Ruiz et al. 2014). Current research seeks to identify at what scale this model no longer predicts site locations. In summary, Cochran and Britt find the ecological niche approach to development of cultural resource site models for DVNP was found to be informative, but not definitive. The results of these models can then be interpreted more completely, and used to develop maps that reflect management goals and plans, with the understanding that these models can be adjusted to focus on the changing priorities and requirements for sustainable site management.

Modeling effects of coastal climate change

The YLCC-sponsored internship focused on the potential to use existing archeological site data, as stored in the ASMIS for a new purpose: to understand the degree to which selected sites are vulnerable to the effects of climate change, such as increased erosion and sea level rise. ASMIS is a web-based application that allows users to access and enter data into NPS's official site inventory database, which stores basic site data as well as information on site condition, known threats and disturbances, site management efforts, and more. This system includes site location data, but as illustrated in the Death Valley project, their reliability and precision vary depending on the age of the record. While ASMIS has been in development for several decades, it incorporates some much older records, with observations dating, in a few cases, as far back as the nineteenth century.

NPS staff sought to understand the degree to which the data stored in ASMIS could be brought to bear on the problem of climate change adaptation for cultural resources, by isolating threats and disturbances for select coastal sites in five parks in the southeastern United States, and bringing those data into a GIS. Threatened coastal areas and the five sites used in this study included Cape Canaveral National Shoreline, Cumberland Island National Seashore, Timucuan Ecological & Historic Preserve, Cape Lookout National Shoreline, and Colonial National Park (Figure 2).

The primary goal of this project was to determine the applicability and accuracy of ASMIS data in addressing the impacts of climate change on archeological resources. If ASMIS data sources contain consistent information about the location, condition, and natural disturbances to sites within a national park, then it is possible to predict the effect of climate change on those cultural resources. A secondary goal of this project is to assess the quality and applicability of ASMIS data to understand short-term but accelerated climate change at archeological sites within national parks.

Cochran queried ASMIS to determine the degree to which records revealed that archeological sites were impacted by climate change, using criteria identified by Rockman and

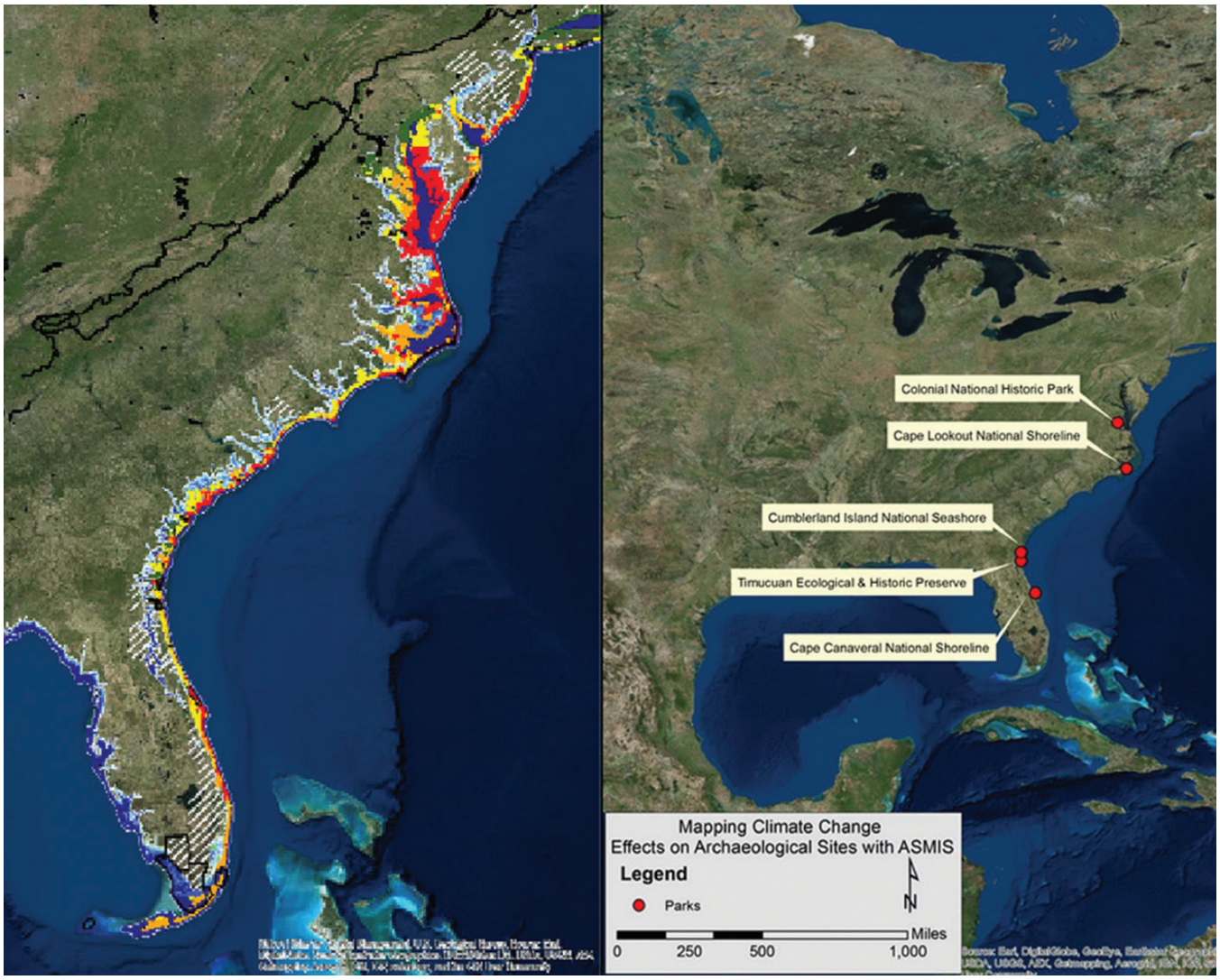


Figure 2. Threatened coastal areas displayed with data from NPS, USGS, and NOAA (left); national parks used in the YLCC study (right).

her colleagues (2016, 20–25). Cochran and Gadsby identified four variables, corresponding to ASMIS data fields, to represent impacts from climate change. These variables include condition of the archeological site, arch site disturbance levels, type of disturbance to the cultural resource, and effect of the disturbance type. Additional map and spatial projection layer sources include United States Geological Survey, Federal Emergency Management Agency, and National Oceanographic and Atmospheric Administration datasets that were corroborated with historical maps to assess the impact of storms dating back to the 1880s. Integrating these data sources, when possible, facilitates accurate estimates of the source and extent of damage to archeological sites from climate-change influenced processes.

In a 2015 assessment of impact of predicted sea level rise in coastal parks, Peek and her colleagues list most assets—such as roads and parking lots, buildings and structures, and historic and cultural resources—within the five national park units are listed as "high ex-

posure" in a recent report (Peek et al. 2015), however, threat assessments listed in ASMIS do not often correspond with this determination. This is likely due to the extended time interval between site recordings, but may also be partially explained by data collector bias regarding what constitutes a threat to a buried archeological site. Decreasing the time interval between surveys, and requiring location information would greatly increase the uses of ASMIS in identifying the impact of climate change on cultural resources.

As an example, the following are summary results from Canaveral National Seashore (CNS). CNS, situated on Florida's Atlantic coast, approximately 100 miles southeast of Jacksonville, and 30 miles west of Orlando, contains 206 archeological sites, 119 of which are determined to have been recently impacted by climate change. Of the known impacts to sites at CNS, two are associated with climate change: erosion–water (n = 93), and erosion–general (n = 26; NPS 2015a). Of the impacted sites, 104 are in good condition, 14 are in fair condition, and 1 is in poor condition (NPS 2015). These results (Figure 3) are somewhat at odds with the 2015 Coastal Assets Report, in which all modern assets in Cape Canaveral National Seashore are listed as being immediately and severely threatened (Peek et al. 2015, 126–128).

What should have been a fairly straightforward mapping exercise was rendered difficult by several factors, including the absence of location data for many of the sites in one park, and the peculiarity of how threat and disturbance and other data are stored in the ASMIS system. Overall, however, the results of this preliminary study suggest that ASMIS data can be useful in managing threats to archeological sites, as predicted by climate change.

Our analysis shows that ASMIS can be part of the tool kit that the NPS uses to manage sites in the face of changing long-term conditions. The use of existing data provides a low-cost planning tool for parks, and illustrates examples of the types of physical changes that sites have undergone over the past several decades. Further, we hope that the results of this study will assist with mitigation or adaptation responses as sea levels continue to rise, and the effect of changing climate on coastal sites intensifies.

Although the research undertaken at NCPTT and NPS-WASO through the YLCC internship were spatially disconnected, they relied on park-wide datasets, and both projects came to similar conclusions about the inherent spatial biases in the datasets. Both projects recommend decreasing on-ground survey intervals at parks to improve monitoring of impacts of common detriments to archeological sites, like receding shorelines and increased strength and frequency of storms.

The DVNP Predictive Modeling Project connected unknown prehistoric and historic cultural resources through a maximum entropy niche-based modeling system using regression-based Bayesian statistics in a GIS framework. The output, however, is created to give park managers and researchers new information about the probable location of archeological sites, and can be used to protect and preserve both known and unknown buried resources. At its core, this project represents a symbiotic relationship between humanities-driven questions and science-based methods.

Shoreline assessments of the Eastern Seaboard employed a larger-scale focus than the DVNP project by temporally connecting known archeological sites to modern endan-

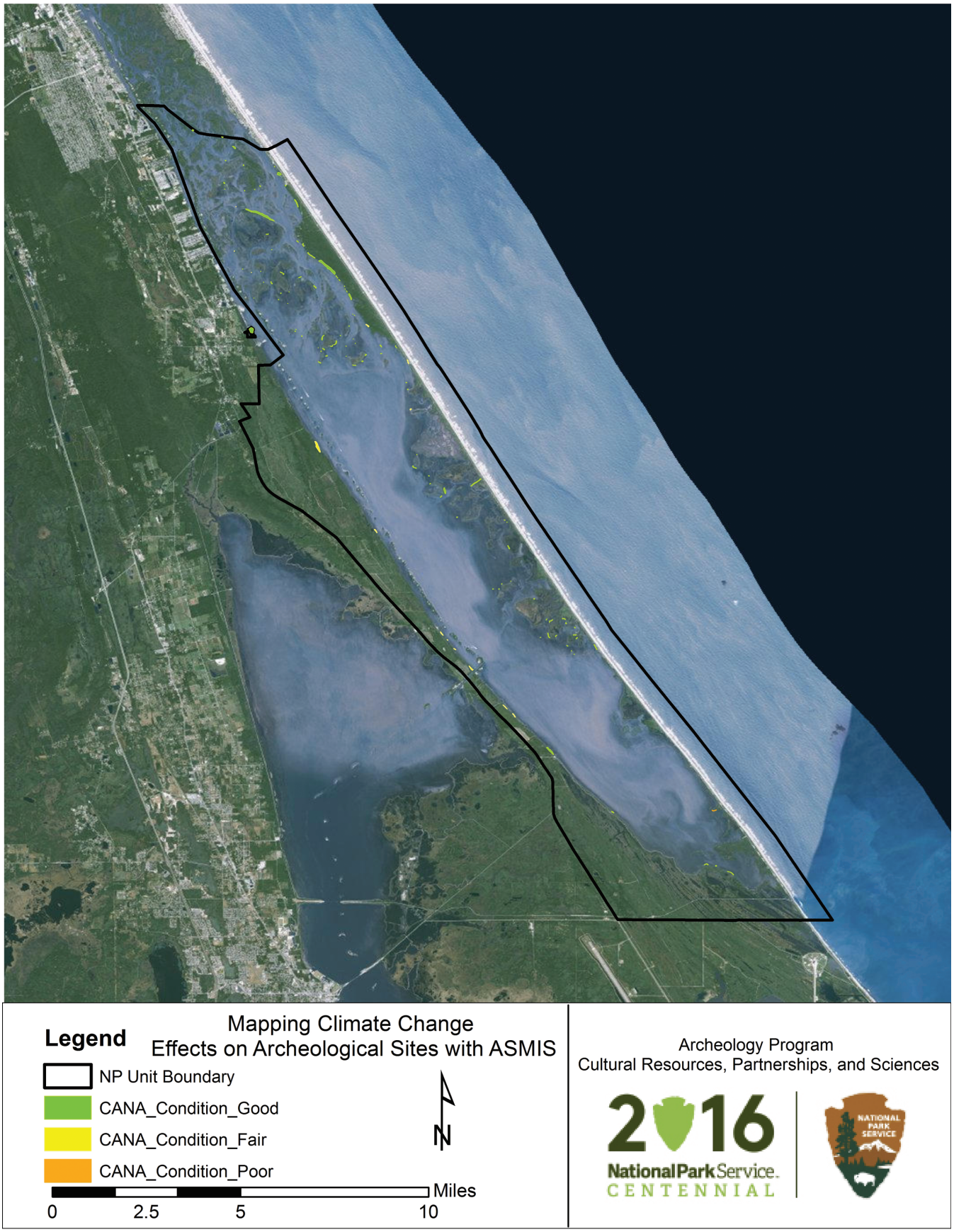


Figure 3. Canaveral National Seashore condition of impacted archeological sites.

germent and destruction. These models necessarily are built on multidisciplinary ideas, data, methods, and analytical techniques, encouraging increased communication and collaboration between many networks both internal and external to the NPS. These broad research trajectories created connections today that built on multidisciplinary data through federally funded research groups using previously collected multi-temporal and multi-spatial data to help managers understand broad scale mechanisms of past, modern, and future change.

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7

A Ten-Step Program that Links Monitoring to Management

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"When you've got a situation where there's not enough money to go around, you have to pick your highest priorities" (Former DOI Secretary Sally Jewell, July 19, 2013). When the U.S. Fish and Wildlife Service (USFWS) established a new policy in 2014 for population monitoring on the national wildlife refuges, it said that the scientific monitoring conducted on refuges should be linked to management issues on the refuge or broader landscapes. The policy described a process (Figure 1) by which surveys should be selected. It included a handbook with guidelines for the protocols used in conducting the surveys, and it promoted conducting surveys in coordination with partners that also had an interest in the results.

Selecting surveys has several straightforward steps that start with making a comprehensive list of all possible surveys—including those that are relevant to measuring the impact of climate change. The next step is to prioritize surveys by objective criteria that consider the purpose of the surveys. Surveys can then be selected by assigning a status that considers final priority scores along with the capacity (in personnel time and operational costs) of the refuge to conduct it. Future surveys

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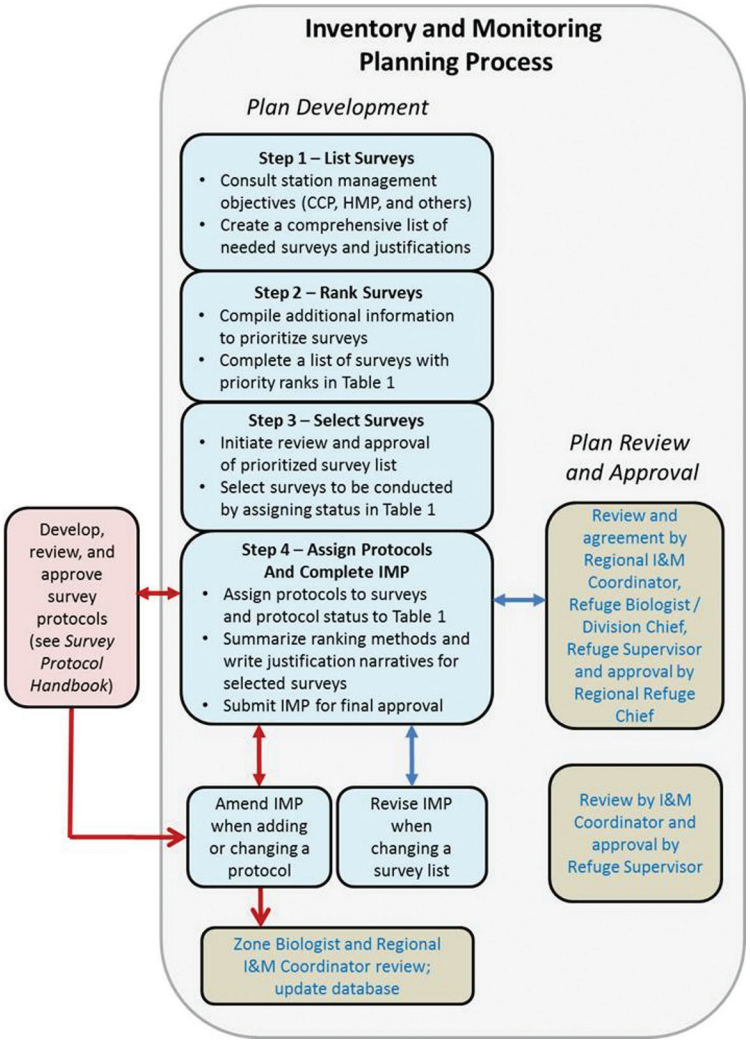


Figure 1. The process for developing inventory and monitoring plans and protocols in the USFWS inventory and monitoring policy.

are those that are low priority or would require lots of additional capacity. A refuge's inventory and monitoring plan defines the surveys that are or will be conducted over the life of the plan, usually 15 years. Once a refuge has a ranked list of surveys, attention can turn to ensuring the quality and relevance of the highest priority surveys.

In order to facilitate high quality biological monitoring, particularly on national wildlife refuges, members from different branches of the USFWS developed a road map for designing a monitoring survey. It starts with the assumption that monitoring is hard to sustain. Good survey design is essential because ecosystems can take a long time to respond to either stressors (e.g., drought, floods, fire) or management actions. Quick results are the exception. That means that time and resources spent on monitoring span multiple years, so detecting change in ecosystems usually is an expensive, long-term enterprise.

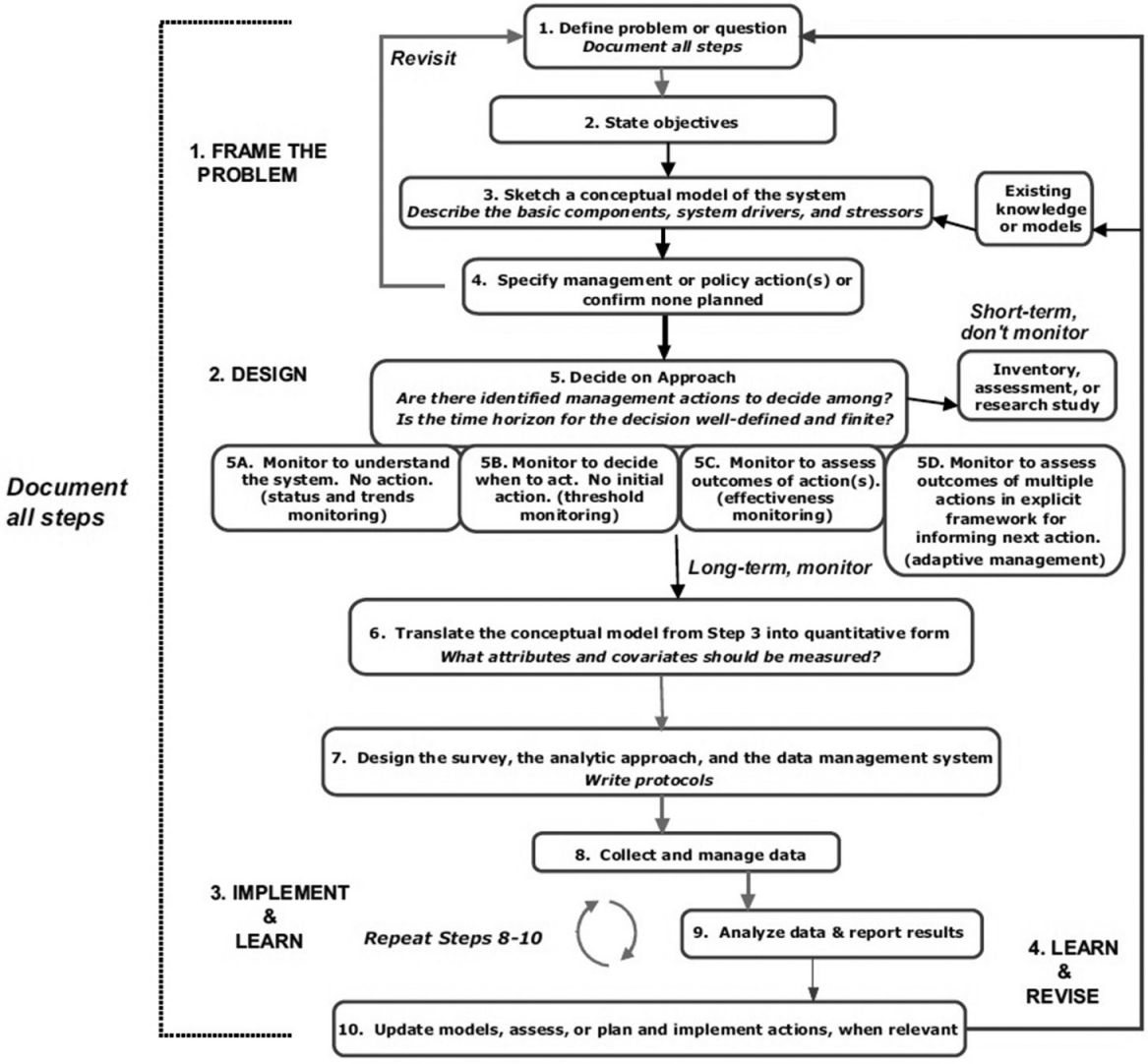
What are some of the attributes of inadequate monitoring design? A useful survey should address key questions facing resource managers. Too often, surveys are focused on the wrong management problem or the problem is too vague to guide the survey design. Secondly, flaws in sampling design or in the data collection methods can result in years of data that cannot be properly analyzed

using statistically rigorous methods. The time to subject your monitoring design to a biostatistician's review is prior to fieldwork. Also, because monitoring is so demanding and expensive, it is important to consider other approaches. Sometimes a research project will get you to the answer faster, and sometimes that research has already been conducted and is in the scientific literature.

If you think monitoring might be your best approach, we recommend a ten-step process, both to make sure that monitoring is necessary and to ensure it yields useful results (Figure 2). Borrowing from structured decision making, we start by defining the problem in a way that is agreed on by all those with a stake in the decision. It is important to document this problem definition, and all future steps in the process.

The purpose of Step 2 is to state your objectives. These are usually expressed as the desired future conditions in wildlife refuge comprehensive conservation plans, habitat management plans, or resource management plans.

Figure 2. The road map for designing a monitoring program.



Step 3 is to sketch a conceptual model. While many people do not think of monitoring as based on a conceptual model, almost all approaches to monitoring come out of some preconceived idea about how the system works. By writing down those ideas, we are in a better position to evaluate where the evidence is not strong and requires monitoring. One of the benefits of creating the conceptual model is to identify the key factors that may influence the attribute of interest and could confound the survey results. Moreover, all monitoring should in some way help update our conceptual model of how the ecosystem functions, and the more explicit this objective is beforehand the more likely it will meet with success.

Our Step 4 recalls why we said some monitoring fails. Now that the objectives are identified and there is a model of how the system functions, this step specifies the actions that are being taken to alter or maintain aspects of the system. It also identifies additional factors expected to influence the outcome of actions. Once those actions are identified, ask what role monitoring would play in informing those actions.

It is at Step 5 that we determine if monitoring is the best approach, and if so, what type of monitoring addresses the resource problem. Because monitoring generally requires a long-term commitment, it is important to consider alternative approaches. If monitoring is necessary, it is important to determine what type of monitoring will best address the problem. If you are primarily concerned with characterizing changes in the ecosystem over time, then status and trends monitoring would likely be most appropriate. If changes in a key component of the system might trigger you to act, then threshold monitoring might be the best approach. If assessing the consequences of an action is critical, then effectiveness monitoring should be considered. Finally, if there is considerable uncertainty about the expected responses to two or more actions, then adaptive management monitoring is probably the best approach.

Regardless of which type of monitoring you have selected, the following basic design steps apply. In Step 6, you further develop the conceptual model started in Step 3, transforming general or qualitative relationships into mathematical relationships. You make a series of decisions about what attributes are important, what variables reflect those attributes, and exactly how you plan to measure those variables. This is part of moving from broad objectives to SMART (specific, measureable, achievable, relevant, and time-specific) objectives.

With all of the preparatory work completed, you are ready to design the survey (Step 7). Sampling design comes in this phase as does a data analysis plan. It is in this step that you should write your monitoring protocols and have them reviewed by a biometrician and a data manager. All of the information gathered in the previous steps should at least be referenced in the protocol.

Step 8 puts you in the field, collecting the data, doing any initial quality control, and managing the data and including the necessary metadata so it can be used by others. At Step 9 you analyze data and report results. Reporting usually takes multiple forms, with the form often depending upon what is most important to the target audience. Managers need the take-home message up front, followed by the methods and analysis that support your conclusions.

The final step is to learn from your results, and to revise your model of the system if necessary. It is in Step 10 that management actions are implemented as warranted, and in the case of adaptive management, comparisons of the effects of alternative actions are made. For example, mowing

or burning are alternative actions for prairie restoration with uncertainty as to which is better; a well-designed monitoring program is yielding information that will reduce that uncertainty. In sustained monitoring, Step 10 is also when you intermittently revisit the survey design and sampling effort decisions in light of what you've learned about the system.

It is no accident that this ten-step program puts so much emphasis on forethought before going into the field to collect data. The initial seven steps aim to ensure that the resulting data will indeed be relevant and useful for guiding management decision making. In a time of rapid environmental change, scientific monitoring clearly presented will be ever more important to managers.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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8

Changing Climate, Changing Policy: Subsistence Use and Wilderness Values in Gates of the Arctic National Park

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Project summary

Gates of the Arctic National Park and Preserve (GANPP) is located entirely above the Arctic Circle in the U.S. state of Alaska. The park is directed by enabling legislation to "maintain the wild and undeveloped character of the area," as well as provide for subsistence use by local residents who continue a tradition of living off the land that has been present continuously for more than 10,000 years. Access for subsistence and wilderness values are priorities for park management, but the challenges wrought by climate change may necessitate re-evaluation of park policy in regards to these topics and their intersection. To this end, a study was conducted of residents' local ecological observations and experiences of subsistence use changes due to changing climate patterns (Figure 1). The results would inform park administration policy decisions.

The goal of this project was to gauge current and potential effects of climate change as experienced by community members of Anaktuvuk Pass, an Alaskan Native village wholly within the boundaries of GANPP. Information sought included local climate, ecology, and landscape use, with an emphasis on changing subsistence access. Project findings may be used to identify regulations and policies that are, or may become, outdated regarding subsistence practices within the park. Similar studies documenting local climate change observations have been conducted in other areas in northern Alaska, many taking subsistence uses into account, but none have been conducted in Anaktuvuk Pass. This study is thus a needed addition to this emerging literature.

Background

Anaktuvuk Pass is the site of a village in the Central Brooks Range of Arctic Alaska, and is home to about 325 Nunamiut Inupiat people. It was established as a permanent village

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Figure 1. Subsistence user in Gates of the Arctic National Park. Photo by Chris Dunn.

in 1949 in response to economic and ecological changes, as well as a desire for outside trade and services, like a school, post office, and airstrip. The Brooks Range has been the traditional homeland of the Nunamiut peoples for 4,000 years.[1] Prior to settlement they were primarily nomadic hunters who followed caribou throughout the range, while also occasionally migrating to the Arctic Coast. Much of the traditional Nunamiut homeland was subsumed into GANPP when it was created in 1980 with the passage of the Alaska National Interest Lands Conservation Act (ANILCA). ANILCA followed a series of laws, such as the Alaska Native Claims Settlement Act (ANCSA) of 1971, which largely served to create modern Alaska. ANCSA "extinguished all aboriginal claims to lands and … hunting and fishing rights"[2] while creating Native regional and village corporations that were given land rights and monetary compensation, but also the obligation to integrate into markets, and to seek profits, significantly altering the relationship that Alaska native peoples have with their traditional lands.

ANILCA, however, gave native and other rural Alaskans subsistence rights on most federal lands, defining subsistence as "the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft byproducts of fish and wildlife resources taken for personal or family consumption; and for customary trade."[3] Subsistence rights were extended to all "rural" residents, not just native, to ensure survival of physical, economic, and traditional existence (though specifically mentioning native *cultural* survival).[4] (See Figure 2.) GANPP has 10 resident zone

Figure 2. Caribou skin masks are a sought-after handicraft, a tradition that began in Anaktuvuk Pass in the early 1950s. Photo by Chris Dunn.

communities that have subsistence rights to hunt, trap, fish, and harvest plants in GANPP, including Anaktuvuk, where, of all 10, the Nunamiut depend most on the park, mainly on caribou.

ANCSA was largely passed in the context of the proposed oil developments at Prudhoe Bay, and the supporting oil pipeline which would cross the state, followed by ANILCA. The village of Anaktuvuk Pass was at first slated to be outside of the park, but locals wanted to be inside, finding "refuge in this white man's wilderness."[5] (See Figure 3.) This was largely in response to industrial developments like the Hickel Highway, a rough-shod bulldozed path built in 1969, which ran right through Anaktuvuk Pass, with the intent of blazing a trail for the Prudhoe pipeline. The pipeline and access road were completed in 1977, ultimately following a different route that did not pass through Anaktuvuk.

The residents of Anaktuvuk Pass Village continue to follow subsistence lifeways, though in a modern and changing context. Two of the greatest changes are the incorporation of the Nunamiut into regional native and village corporations, and the adoption of new technologies, including the all-terrain vehicle (ATV), and especially the Argo, first used by the Nunamiut in the 1970s. ATV use was initially restricted by the National Park Service (NPS) to specific corridors to minimize impacts and prevent the unregulated spread of motorized travel. Over time however ATVs began to be seen by locals as necessities for subsistence activities. This heightened tensions between the NPS and the village until 1996, when a land exchange between GANPP and the Nunamiut Village Corporation

Figure 3. Different user groups may have different conceptions of wilderness, such as these backpackers in the Arrigetch Peaks. Photo by Chris Dunn.

was implemented by Congress. Traditional hunting patterns, including those utilizing ATVs, could continue, in exchange for limiting development in the park and allowing recreational use.[6] This land exchange helped preserve prior conceptions of what wilderness is and should be, including allowed uses in wilderness, while meeting the needs and desires of the local community, healing many early tensions.

The issue however is complicated and ongoing. Alaska subsistence is understood in ANILCA to be a complex mix of traditional and modern practices. ANILCA allows nonconforming, pre-existing (prior to 1980) uses, specifically mentioning snow machines, motorboats, and planes (if traditionally employed), but not mentioning ATVs. "Traditional" use includes subsistence and access to homesites and inholdings. This is required "to assure adequate and feasible access for economic and other purposes." The issue becomes more complex when questions arise, such as what is "adequate" (could travel by foot, dogsled, or airplane be used instead) and "feasible" (is it both possible and consistent with purposes of ANILCA)? Is recreation a traditional activity? How does "traditional" apply to use versus technology?

This last question is answered in part by a Senate report on ANILCA, which states that "restriction of subsistence to customary and traditional uses shall 'in no way impede the use of new technology for subsistence purposes.'"[7] This could be read to apply to ATVs. However, ANILCA mandates preservation of "wilderness resource values." A 2002 request by a native resident asking for ATV access through GANPP wilderness to an allot-

ment historically accessed by plane and snow machine was denied by NPS after conducting an environmental assessment that concluded that ATV impacts can be severe, and that the Anaktuvuk Land Exchange of 1996 disallowed ATV use.[8]

Anaktuvuk Pass Village offers an alternate vision of wilderness: an inhabited homeland. This presents challenges to larger narratives defining parks and wilderness, but GANPP seems to have found a balance. On the one hand, the park is 80% designated wilderness, and they describe themselves as a premier (also flagship and black-belt) wilderness park. GANPP also acknowledges the prior and continuing human history: "People have been a part of the ecosystem here for over 13,000 years. Nomadic hunters and gatherers traveled between the mountains' forested southern slopes and the Arctic Coast. Now their descendants depend on and use park and preserve resources."[9]

Wilderness that includes subsistence use is not an altogether new idea. Mt. McKinley National Park (now Denali NP) was created in 1917 and initially allowed subsistence hunting by local miners. This did not last long, however, since the miners turned out to be poor stewards.[10] ANILCA institutionalized and greatly expanded this management challenge. Meanwhile, subsistence and alternative uses are allowed in several non-Alaskan parks, including Badlands National Park, Point Reyes National Seashore, Voyageurs National Park, Grand Canyon National Park, and Death Valley National Park.[11]

Subsistence is the primary arena where park management most directly affects Anaktuvuk residents. There seems to be a reasonably high degree of participatory management structured around subsistence. Subsistence Resource Commissions (SRCs) allow community recommendations to be factored into management decisions. Additionally, various park staff visit communities, and an Anaktuvuk-based park ranger attends city council meetings and acts as general liaison.

A crucial challenge for subsistence management could be the cultural and spiritual values that are deeply embedded in this traditional lifeway. Traditional native worldviews often include an understanding of nature as inspirited, a view traditionally shared by the Nunamiut.[12] This likely persists at some level, despite a widespread adoption of Christianity. Outside stakeholders, such as guides and some park staff, may not always fully appreciate this, which could at times lead to gaps in communication or differing management visions. In other words, epistemological barriers may exist that lead to institutional barriers. An example is that some Alaska natives object to collaring bears since it does not honor their spirit. The extent to which this applies to the Anaktuvuk case will, however, require further research to determine.

GANPP does not receive the volume of visitation of many lower 48, or more accessible Alaskan, parks. Visitation is nevertheless substantial and growing. The population of Anaktuvuk Pass Village and other rural arctic populations is also growing, if slowly.[13] Meanwhile technology that allows for both subsistence and recreational use, both mechanized and non-mechanized, is improving and allowing for greater and easier access into the park. Each user group may have a different vision of what wilderness is and a different set of expectations. The two groups do not typically collide, particularly since subsistence use from Anaktuvuk residents is primarily confined to areas surrounding the village. There nevertheless exists an increasing potential for conflict.

Perhaps the most significant challenge to wilderness and to the Nunamiut, and the relationship that they have with GANPP wilderness, comes from climate change. This presents unique challenges and amplifies prior concerns. Examples include changing weather patterns which affect temperature and snowfall. This can make snow machines less effective, and shorten their useful season. This in turn motivates locals to turn to greater ATV use, giving rise to many of the issues previously discussed. When the ground is not frozen, as is increasingly the case, ATVs have a greater impact. Another key issue is changing timing and location of animal presence and migration, especially caribou. The caribou are no longer coming through Anaktuvuk in the same way they did in the past, thus forcing local residents to travel further from town, increasingly butting up against the wilderness.

Alaska natives, including the Nunamiut of Anaktuvuk Pass, face many challenges, including their identity as it spans the worlds of corporate America and traditional subsistence culture. They must come to terms with modernity and the globalized connectivity posed by economics and technology. Climate change is affecting the Arctic more than any place on Earth and posing new, less predictable, and often detrimental realities that the people who reside there must face. Meanwhile, all of this must be done in the context of protected landscapes governed by bureaucratic structures: "Wilderness managers, advocates, and those living in and around wilderness must come to terms with the undeniable truth that humans are a part of the wilderness landscape in Alaska. Determining the appropriate context within which this relationship exists, however, remains to be determined."[14]

Summary of major themes

The following is a very brief synopsis of ethnographic fieldwork, including previously recorded interviews with Anaktuvuk Pass residents from the 2008 videos, *Voices of the Caribou People,*[15] which includes five interviewees who specifically mention observations of local changes including subsistence access. In one summer month in 2016, I conducted four complete, in-person interviews of seven people, and had many informal interactions, including through participant observation in Anaktuvuk Pass. All interviewees were active subsistence users, all above the age of 30, with a majority being elders over the age of 70. All of these interviewees had at least some experience with subsistence in the Anaktuvuk Pass area (at a young age) that they could draw upon as a point of comparison against current conditions, as well as relevant cultural memories. Additionally, I conducted one phone interview with a longtime active subsistence user and resident of Wiseman, as an additional source of information that may shed some light on the Anaktuvuk situation.

Snow machine access. "The summers grew longer where I can have my machine maybe eight months out of the year and you have only four months of good, hard snow … but global warming might be some changes in some of our seasons because I can go out longer with my eight-wheeler than before my uncles and my grandpas used to have."

- Snow machine season is impeded for about a month on either side (spring and fall); it *can* be extended but with more hazards (especially exposed rocks and open creeks), which may entail higher maintenance costs.
- True loss is about one week in both fall and spring ("That's quite a change.").

Animals.

- Caribou: last big migrations were in the late 1990s, early 2000s (or earlier)

- Reasons given: sport hunters, oil development, industrial noise, decrease in lichen, hunting habits of other villages or Anaktuvuk residents (not allowing the first "trail makers" to come through unimpeded), and perhaps also inadvertent encounters with hikers
- Changing habitats for other animals, including northward expansion of, for example, otter, beaver, and lynx

Weather. "No real for-sure anymore." "Never would have been like that before." "Things are getting more and more random."

- Warmer, drier summers; warmer, shorter winters
- Winter rain: notable rain events in October 2014 and December 2013 (or perhaps 2014)
- Negative effects on, for instance, caribou, trapping, and snow quality; for example, ice coating traps making them ineffective, or coating snow making lichen hard to access for caribou

Ice. "No way … you sure you're on the right river?… Huh, never used to be that way." There is thinner, less reliable river and lake ice. Permafrost effects are relatively minimal due to location, but some unusual ground ice formations reported.

Understandings of climate change as a scientific phenomenon. Belief in climate change is almost universal, but there are widely divergent conceptions of what exactly it entails:

- On multiple occasions, causation is attributed to shift in position of earth (sun higher in the horizon).
- On one occasion, a direct correlation with earthquakes was made.

Risk perception. There is a general lack of significant concern, along with a strong belief in people's ability to adapt.

Other. The 2007 tundra fire north of town was widely cited as, and understood to be, unusual.

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Wilderness Character Monitoring Continues on National Wildlife Refuges

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There are 74 wilderness areas on the 566 refuges of the U.S. Fish and Wildlife Service's (USFWS's) national wildlife refuge system. These comprise 18% of the designated wilderness areas in the country. Since 2011, the USFWS has been developing measures to conduct wilderness character monitoring on refuge wilderness areas. As the first of the four federal agencies managing wilderness to conduct this monitoring across all of its wilderness areas, our progress and findings provide a way forward toward our goal to preserve these unique areas.

As an introduction to wilderness character monitoring, it is important to understand the key events that led to these surveys. The Wilderness Act (1964) recognized these unique places found on public lands as legally designated wilderness. It established the national wilderness preservation system, which is made up of lands managed by the USFWS, the National Park Service, the U.S. Forest Service, and the Bureau of Land Management. It also mandates those agencies to preserve wilderness character for future generations. The four agencies realized they needed a way to monitor whether or not wilderness character was being preserved. *Keeping It Wild* (Landres et al. 2008) was published as the interagency strategy to develop wilderness monitoring. It took the wording directly from the Wilderness Act to define wilderness character, and how the agencies would monitor the status of wilderness character.

In 2011, the USFWS starting sending wilderness fellows to all refuge wildernesses to establish baseline reports based on the guidance provided in *Keeping It Wild*. These reports established the measures that a wilderness manager would use to address the key components of wilderness character. The first few years of wilderness character monitoring were a time to learn what was

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working and what needed to be changed. So, *Keeping It Wild* was updated with *Keeping It Wild 2* (Landres et al. 2015) to reflect the lessons learned, and improve our understanding of wilderness character.

Keeping It Wild 2 defined five qualities that make up wilderness character. The "untrammeled quality" looks at the intentional manipulations to the biotic and abiotic components of a wilderness, generally by management. The "natural quality" considers the threats to plant and animal species in wilderness, as well as abiotic components like air and water, and ecological processes. The "undeveloped quality" monitors the human-made structures and mechanized use in wilderness. The "opportunity for solitude and primitive or unconfined recreation quality" gets at the personal visitor experience in wilderness and the ability to be self-reliant. Lastly, the "other features of value quality" is an optional quality for those wilderness areas that have historical, cultural, or scientific resources.

Some of the changes in *Keeping It Wild 2* include refined focus for the qualities, and reorganized indicators that address those qualities. It also provided additional tools to help those tasked with selecting measures for wilderness character monitoring.

Because wilderness fellows completed baseline reports for refuges before *Keeping It Wild 2* was published, the USFWS was prepared to start the process of updating measures for those reports. The USFWS is doing this with wilderness character monitoring update summaries, which act as an addendum to the baseline report for each refuge wilderness. Within this report, changes are made to the selected measures to be consistent with the new interagency strategy. Interim data are also collected since the year of the baseline report, which sets a wilderness steward up for data entry later.

An example of a modified measure from a completed update summary is from Okefenokee Wilderness, under the untrammeled quality. The old measure, acres of herbicide application within wilderness boundaries, was a common measure selected in baseline reports because many refuges employ this type of management for invasive species. *Keeping It Wild 2* refined the untrammeled quality by stating the focus should be on the intent to manipulate the environment, and not the magnitude of those manipulations. The new measure, number of actions taken to manage plant species, moves away from magnitude by counting each action, or the opportunity to make a decision to perform an action. The measure is also improved because the scope of management actions on plant species was broadened. Even though herbicide application may be the predominant management action today, this measure must be robust well into the future, and that may mean counting new types of management action(s) down the line.

Similar to how *Keeping It Wild 2* provided improved tools, the USFWS is also providing improved tools to help wilderness stewards calculate data values for measures in the update summaries. Adapted from the U.S. Forest Service technical guide (Landres et al. 2009), the USFWS provides specific examples of actions that could be taken to manage plant species, and how each example would be weighted toward the data value for this modified measure (Table 1). This means 50 years from now a wilderness steward will be able to count actions the same way a wilderness steward does today.

Once an update summary is completed for a refuge wilderness, the USFWS uploads these reports to the USFWS Service Catalog so they are publicly available. At this time, the data collected in the

Counting the number of actions to manipulate plant species in the Okefenokee Wilderness (adapted from the Forest Service Wilderness Character Technical Guide)		
Type of action	Example	Counting rule
Single action at a single location	Herbicide applied at a single location to treat a single species	Count as one action
Single action at multiple locations	Herbicide applied at multiple locations to treat a single species	Count as one action for the single species regardless of the number of locations
Multiple actions at a single location	Both herbicide and mechanical manipulation is used to manage a single species at single location, or herbicide is used to treat two species at a single location	Count as multiple actions, in the first case two (one for each action type), and in the second case two (one for each species)
Multiple actions at multiple locations	Both herbicide and mechanical manipulation is used to manage a single species at multiple locations, or herbicide is used to treat two species at a multiple locations	Count as multiple actions, in the first case two (one for each action type), and in the second case two (one for each species)
How the time frame of actions affects counting		
Time frame of action	Counting rule	
Action occurs within a single fiscal year	Count as one action regardless of the number of times the action is undertaken within the same fiscal year	
Action spans multiple fiscal years	Count as multiple actions, one for each different fiscal year in which the action occurs	

Table 1. Counting protocol for the measure number of actions taken to manage plant species.

update summaries are also entered in the interagency Wilderness Character Monitoring Database. This database houses the data for all wilderness areas in the national wilderness preservation system. Update summaries have been completed for 30% of national wildlife refuge wilderness areas, and the USFWS plans to have the remainder completed in the next two years.

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10

Historical and Ecological Considerations in the Establishment of National Parks and Monuments

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Congress declared in the national park system General Authorities Act of 1970 that areas comprising the national park system are cumulative expressions of a single national heritage. Yet the national park system is not representative of the range of natural resources that our nation has been blessed with. While many localities and communities strive very hard to have the places they love become part of the national park system, other communities fiercely oppose the idea. Redesignating federal lands as national monuments by a sitting president under the Antiquities Act is always controversial, and so too were the recent designations by President Obama in the last months of his presidency under this Act.

The Antiquities Act was first exercised by Republican President Theodore Roosevelt in 1906 to designate Devils Tower National Monument in Wyoming. Sixteen presidents since 1906 have used the act to protect some of America's most inspiring natural and historic features, including the Grand Canyon and the Statue of Liberty. Under the act, presidents of the United States are authorized to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the government of the United States to be national monuments. Nearly a quarter of all national park units originated in whole or part from the Antiquities Act.

One of the most recent designations was the Katahdin Woods and Waters National Monument. A donation of land by Roxanne Quimby, former owner of Burt's Bees, was made to the National Park Service (NPS) for the purposes of establishing a national park in Elliotsville Plantation in the State of Maine. As most all designations under the Antiquities Act are, this was very controversial.

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The 87,000 acre property, located next to Baxter State Park, home to Mount Katahdin and the northern terminus of the Appalachian Trail, was donated to the federal government in late August 2016 and quickly designated as the Katahdin Woods and Waters National Monument. As with Bears Ears National Monument in Southern Utah and some other designations, the loss of local control is a great issue. With the sharp decline of the logging industry in the Northeast there was also a concern that moving 87,000 acres from active logging to conservation land would spell the end of this industry in Maine. However, with 17.5 million acres of forest in Maine, 95% held privately, Quimby's property represents a small fraction of the timberlands that once supported a major wood products industry.

With an estimate of one percent of the state in federal ownership, Maine is under-represented in the national system of national parks. Thus the Quimby property would provide the opportunity to include an unrepresented ecoregion without foreclosing on future forestry options. The donation of land is valued at $60 million, with Roxanne Quimby providing $20 million to fund park operations with a commitment to raise another $20 million.

Another issue expressed by many which will be addressed here is whether the proposed national monument lands were worthy of national park status. Although the question of local control over the management of federal lands continues, whether they be national forests, national wildlife refuges, national parks or national monuments, the conflict over appropriate management will persist. However, the question of the appropriateness of the land in question for national park status is one that needs to be addressed and perhaps dispelled.

Besides re-designations of federally-owned land that occur under the Antiquities Act, only Congress can establish a national park. The NPS is often requested by the U.S. Congress to consider certain properties for inclusion into the national park system. With both processes, the first step is to consider several criteria and make recommendations to the secretary of the interior. Potential additions to the national park system should present an outstanding representation of the broad spectrum of natural and cultural resources that characterize this national heritage.

NPS Management Policies of 2006 state that to receive a favorable recommendation from the NPS, a proposed addition to the national park system must be "an outstanding example of a particular type of resource. It possesses exceptional value or quality in illustrating or interpreting the natural or cultural themes of our nation's heritage. It offers superlative opportunities for public enjoyment or for scientific study. It retains a high degree of integrity as a true, accurate, and relatively unspoiled example of a resource." So it is appropriate to consider the Quimby property in light of these criteria and in light of similar historical examples within the current national park system.

In terms of adding an important element to the national park system there seems to be little doubt that the Quimby property possesses exceptional value as an example of a northeastern conifer-hardwood forested ecosystem. Distinct ecoregional boundaries have been suggested by numerous ecologists, but there seems to be a consensus that forests of central northern Maine are a part of the Laurentian mixed forest ecoregion described as a transition zone between the boreal spruce-fir forest to the north and the deciduous forest to the south. Acadia National Park, more heavily influenced by the Atlantic Ocean, belongs to the eastern broadleaf forest (oceanic) province more to the south.

The land includes spectacular views of Mount Katahdin (Figure 1), several mountain peaks, about 25 miles of the East Branch of the Penobscot River, including four spectacular rapids and falls, and the lower reaches of Wassataquoik Stream, which flows out of Baxter State Park. It is home to moose, deer, bear, lynx, and many bird species.

So, too, is there little doubt of the superlative opportunities for public enjoyment and scientific study. The recreation values of this area were well acknowledged as far back as the late 1880s. In 1895 the Maine Proprietors Association urged the state to turn this area of the Maine woods into a state park to attract tourists. In 1911 a bill was introduced to turn the region into a national park but none of these efforts was successful. Maine has increasingly become a tourist destination since the Civil War and the tourism contribution to the state economy expanded rapidly into the twentieth century, spurred by the robust promotional efforts by the railroads and others as many attempted to capitalize on the growing demand for outdoor experiences by eastern urbanites.

The opportunities for advancing scientific understanding of northern forested ecosystems, wildlife habitats, lakes and mountains environments abound. Most recently the concerns about the potential impacts from projected climate change on wildlife and plant populations, timber production, and insect and disease outbreaks have accelerated research activities in Maine.

Figure 1. View of Mount Katahdin from Katahdin Woods and Waters National Monument.

Does the proposed park property retain a high degree of integrity as a true, accurate, and relatively unspoiled example of a resource? Most authors who have written about the Quimby property have rightly noted that it has been heavily logged over the many decades. The previous proprietors, the Great Northern Paper Company, sold the property to Quimby with commercially valuable assets largely removed. This is not unusual as by the 1900s most of the land in and adjacent to the Quimby property was harvested. In fact, most of the timber of New England had by this time had been harvested whenever it became profitable. White pine was the first species targeted but spruce and other species followed as the pulp and paper industries expanded. It may be difficult to conclude that the plantation in question retains a high degree of integrity as a true, accurate, and relatively unspoiled example of a northern forest ecosystem.

Although an important if not critical attribute, how important is it for the property to possess a very high level of integrity now? Although the forests cannot be described as "old growth" or original, primeval, ancient or virgin, not ever having been logged or otherwise affected by humans, they can be described in ecological terms as a forest that was cut long ago but is in ecological recovery on a trajectory to become old growth in our lifetime. There are precedents for establishing national parks from areas that have been highly impacted. Let's examine two other examples of national parks with extensive land use challenges from the time of inclusion into the national park system and how these properties appear today.

The story of the Great Smoky Mountains

In the early part of the 1920s, with recreation trips to the western USA increasing, an interest developed in establishing a national park in the eastern USA. With funds committed (via philanthropy and even pennies collected by school children), 1929 was spent trying to get landowners to sell their properties in order to establish the Great Smoky Mountains National Park. This was a daunting task, because even though timber companies were the largest landowners, there were many other owners with very small tracts to obtain—over 6,000 in all. Many were descendants of original settlers, some simply loved their homes and didn't want to move under any circumstances, and a few were big business interests such as the Little River Lumber Company and the Champion Fiber Company (the single largest owner), who held out for as much as they could (Figure 2). It wasn't until 1931 that the Champion and the Little River Lumber Company sold their property but continued to cut timber for 15 more years.

The larger question that remains is whether a national park's past land use is important ecologically over time. Had the logging history permanently damaged the Great Smoky Mountains in perpetuity?

The scientific literature is replete with examples of studies documenting the local impacts of logging and other land uses on forested ecosystems, from changes in temperature, nitrogen cycling, carbon storage capabilities, etc. The Great Smoky Mountains is an excellent example of a national park area if left alone can recover from early land use practices to become one of the most ecologically rich and diverse protected areas in the world. An all-taxa biological inventory has documented over 1,300 native vascular plant species, including 105 native tree species, plus nearly 500 species of non-vascular plants—a level of floristic diversity that rivals or exceeds other temperate zone protected areas of similar size (Figure 3). The park is also home to the world's greatest diversity of salamander species (31)—an important indicator of overall ecosystem health—and is the center of diversity for lungless salamanders, with 24 species. It is also a designated World Heritage site as a place of "outstanding universal value."

Figure 2. Logging in Great Smoky Mountains in 1920 (photo: George Masa).

One could conclude that although the Quimby property has been heavily logged, this should not have presented an obstacle to national park designation. As stated previously, the 87,000 acre gift to the nation has numerous natural attributes with the logged areas providing the promise of a northern conifer-hardwood ecological recovery for the enjoyment of all.

The story of Grand Teton National Park

As early as 1897, Colonel S.B.M. Young, acting superintendent of Yellowstone, proposed to expand Yellowstone's boundaries southward to encompass portions of northern Jackson Hole to protect migrating elk herds. Neither the Department of the Interior nor Congress acted on this proposal. In 1916, a new bureau called the National Park Service was created within the Department of Interior. Stephen Mather as the first director was committed to expanding the number and sizes of parks. In a report to then Secretary of the Interior, Frank Lane, it was stated that adding part of the Tetons, Jackson Lake, and headwaters of the Snake River to Yellowstone National Park is "one of seven urgent needs facing the Park Service." Over fears expressed by the state of Idaho over the loss of sheep grazing permits with federal jurisdiction, the effort failed. In addition to Idaho sheep ranchers, other groups opposed park extension; these included Jackson Hole businessmen, area ranchers and the regional U.S. Forest Service personnel who feared the loss of jurisdiction on previously managed forest areas.

Proposals soon emerged to dam outlets of Jenny Lake and Emma Matilda and Two Ocean Lakes in 1919. Alarmed businessmen and ranchers felt that some form of protection by the NPS might be their only salvation from commercialization and natural resource destruction. John D. Rockefeller purchased 35,000 acres but attempts by Rockefeller to give these properties to the NPS met resistance.

Difficulties of park-making define Grand Teton National Park and emphasize the visionary ideology of Horace Albright, John D. Rockefeller, Jr., and several pro-park residents. Legislation for the new park contained significant compromises: protection of existing grazing rights and stock

Figure 3. Great Smoky Mountains National Park today is among the most biologically diverse natural areas in the world.

driveways; reimbursement to Teton County for lost tax revenues; provision for the controlled reduction of elk within park boundaries; agreement that in the future presidential proclamation could not be used to create a national monument in Wyoming; and allowance for continuation of certain existing uses and access rights to forest lands and inholder properties.

Cliff Hansen, a powerful rancher and Senator, was strongly opposed to designation of a national park. At one point drove a herd of cattle through downtown Jackson Hole in protest of the proposed federal presence. Later he was to write that that was one fight he was glad he had lost.

Each new national park has its own particular enabling legislation that shapes the activities allowed in that park. While all must be compatible with maintaining an unimpaired natural system, examples exist of national parks being established with lands being used extensively for human uses. Grazing and hunting are but just two land uses that were maintained in areas slated to be included into the national park system. So the inclusion of the Quimby property, although heavily logged and with intense local interest in recreational access, may not exclude it from inclusion. Numerous examples of compromises similar to the Grand Tetons exist, from continuing to allow the commercial harvest of shellfish by the towns at Cape Cod National Seashore, Massachusetts, to Big Thicket National Preserve, Texas, where oil and gas exploration and extraction continues in and around the park, authorized by Congress. So, in closing, we think you should take the opportunity to visit a rare occurrence, the establishment of a new unit of the national park system in a part of the country where private property rules.

11

Reflections on the Past, Present, and Future of Civic Engagement in National Parks

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This paper discusses the past, present, and future of the National Park Service (NPS) Civic Engagement initiative launched in a national workshop in New York City on December 6–8, 2001. What were the origins of the initiative? What has it accomplished in the past 16 years? What might its future be?

Origins of the civic engagement initiative

The Civic Engagement initiative came out of the Northeast region, one of seven NPS regions nationwide. Just as the earliest NPS strategies for resource protection and interpretation were developed in the nature parks of the West, the Civic Engagement initiative reflects its origins in historic sites of the East, and several phenomena not unique to the Northeast region but especially present there.

One phenomenon, perhaps underlying all, is a demographic change over the past 50 years in the ethnic, religious, and regional backgrounds of NPS employees. Paralleling the larger historical profession in this same period, as the diversity of NPS employees increased, so too did the histories that they wanted to interpret to the public. One principal organizer of the Civic Engagement workshop in New York City in 2001 was Chief of Cultural Resources for Boston National Historical Park Marty Blatt, born and raised in Brooklyn, who had come to NPS from the Massachusetts Department of Labor. Many who attended the Civic Engagement workshop, including Marty, had previously worked on national historic landmark theme studies on women's history, labor history, and Civil Rights sites designed to expand the range of places that NPS recognizes and interprets.

Of course, the greater diversity of NPS employees and the historic sites they designated and interpreted to the public did not just happen; efforts to broaden the interpretive context at NPS had

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been especially encouraged since 1995 by Chief Historian Dwight Pitcaithley. Pitcaithley had gained a lot of attention (read "criticism") for his directive that all Civil War sites must mention slavery as a cause of the war rather than simply stating "both sides fought for what they believed in," then immersing visitors in the details of army life and battle strategies. Beginning in 1997, he received a lot of support from his new boss, another long-time career NPS employee, Director Robert Stanton (1997–2001), who is African American. Another prominent African American, historian John Hope Franklin, chaired the 12-person NPS Advisory Board in the late 1990s. So the Civic Engagement initiative, as it sought to broaden the interpretation of history at NPS sites, was the culmination of at least two decades of many NPS employees' efforts to "be more inclusive," look for the "untold stories," and not shy away from controversial historical issues.

A second factor influencing the Civic Engagement initiative—also with origins in the particular circumstances of the Northeast region—was the growing presence since the 1970s of heritage areas and other sites "affiliated" with the NPS, where the protection and interpretation of significant natural and cultural resources is achieved not by outright federal purchase, but rather by entering into partnerships with state and local government and private non-profit organizations. In 2001, there were approximately two dozen (today there are four dozen) national heritage areas, each with federal recognition and some level of access to NPS technical assistance and funding; a disproportionate number in 2001 were in the Northeast.[1]

Several individuals planning the Civic Engagement workshop had entered NPS through this "external" side when the NPS reincorporated the programs that had been under the Heritage Conservation and Recreation Service in 1981. Rolf Diamant had planned Blackstone River Heritage Corridor through central Massachusetts and Rhode Island, and was superintendent at Olmsted NHS in Massachusetts before leading Marsh Billings Rockefeller NHP in Vermont, a park with stewardship conservation as its principal theme. Of necessity, these NPS employees were sensitive to the particular challenges of heritage areas: conserving nature and culture in peopled landscapes that change with time, establishing management goals across multiple jurisdictions, and looking at historical and recreational sites through lens of local as well as natural significance. It was not surprising, then, that the Civic Engagement workshop in 2001 addressed not only issues of historical interpretation, but also park planning and how NPS engages with neighboring land-owners.

A third factor that pushed the NPS toward greater engagement with external constituencies in the 1980s and 1990s was the passage of the Native American Graves Protection and Repatriation Act in 1990. The NPS relationship with native peoples is central to its history, since the earliest national parks in the West had been carved out of recently conquered native lands, and the structures and artifacts that the federal government sought to protect through the Antiquities Act of 1906 were of native origin. NAGPRA compelled the NPS to consult with tribal entities concerning the ownership and disposition of these artifacts as never before.

A fourth factor that contributed to the development of the Civic Engagement initiative in 2001 was historians outside the NPS examining the politics of public memory and commemoration. In 1991, historian Edward T. Linenthal published a study of NPS management of battlefield sites, and in 1995 Linenthal and other scholars explored the political controversy surrounding the National Air and Space Museum's exhibit about the dropping of the atomic bomb.[2] Linenthal attended the Civic Engagement workshop and challenged the NPS not to shy away from interpreting controversial historical events.

In considering techniques for how the NPS might share multiple and often conflicting interpretations of history with the public, NPS Northeast Regional Director Marie Rust found an ally in Ruth Abram, director of the NYC Tenement Museum. In 1999, Abram founded the International Coalition of Sites of Conscience, an organization that also included the Gulag Museum in Russia, District Six Museum in South Africa, Terrezin Memorial in the Czech Republic, and the Slave House in Senegal. The immediate impetus for the Northeast Region's Civic Engagement Workshop in 2001 was to identify NPS "sites of conscience," where the superintendents of these sites could meet and discuss common issues. These sites would include Manzanar, Little Big Horn, and Wounded Knee, Southern plantations—places that John Hope Franklin, chair of the NPS Advisory Board, had called the nation's "sites of sorrow."[3]

As planning for the workshop proceeded, a major change occurred—from identifying the current or potential "sites of conscience" within the NPS, to an insistence that every NPS unit had the potential to be such a site. By this point the name of the workshop had changed from "sites of conscience" to sites of "civic responsibility," and would soon change again to sites of "civic dialogue." Civic dialogue was the name under which the workshop was held on December 6–8, 2001, but those present decided by the end of the three days that "civic engagement" captured more of what they meant the initiative to be. The size of the workshop grew—50 NPS superintendents and other personnel attended in all—and the group was not limited only to superintendents from "controversial" sites. Superintendent Connie Rudd from Shenandoah NP related how the park discussed acid rain with its visitors.

The events of 9/11 affected planning for the workshop, and indirectly were responsible for the workshop being in New York City. Participants met in lower Manhattan, at the Museum of the American Indian, less than one half mile from the World Trade Center site. Regional Director Rust wanted to give the hotels and restaurants in NYC some business, to be sure, but her principal goal for the meeting was to prompt participants to think about the ways that their individual NPS site could affirm American values and be of use to their communities. At the opening session of the workshop, Rust noted the increases in attendance at all NPS sites in the wake of 9/11 (Shenandoah near Washington, DC experienced a 130% increase), and asserted that NPS sites and staff can be there "when visitors ask for help in making sense of their lives."[4]

The workshop itself opened with a discussion of 9/11, then went on to discuss interpretation, collaboration with partners, and the desirability of new historic sites entering the NPS system—such as Stonewall, in New York City, the site of an early gay rights protest, and Beaufort, South Caroline, a center for Reconstruction-era activities. The workshop sought to introduce "civic dialogue" as a technique for engaging with stakeholders, with the local community, with visitors and school groups, and heard from several professional facilitators with expertise in these methods.

Discussing controversial issues with visitors was clearly unfamiliar territory to most NPS employees, and the conversation soon turned to a key question—should the NPS be in dialogue with visitors and the surrounding community about issues that directly affect the park (like Shenandoah NP and acid rain) or was the NPS role primarily as a facilitator of other groups' dialogues, offering a safe and secure neutral space for discussion? Participants noted that contemporary political issues provoke a strong emotional response—were park rangers trained to handle this? Judy Hart from Rosie the Riveter/World War II Homefront NHP in California posed an intriguing question: "Is Congress giving sites such as M.L. King and Manzanar to NPS because it is genuinely inter-

ested in civic dialogue and controversy, or because it assumes that NPS will make them, and their interpretation, safe?"[5]

This, then, was the discussion in December 2001, and the principal topics in the final report: Interpreting diverse histories, enabling community collaboration, and fostering civic dialogue about contemporary issues of public concern.[6] Two years after the workshop, NPS Director Fran Minella issued a Director's Order making civic engagement part of NPS policy servicewide.[7] In the interest of time and space, I am skipping over how the Civic Engagement initiative was implemented in its early years, and refer readers to overviews by Edward Linenthal, who led a series of "Preserving Memory" seminars for the NPS between 2002 and 2005, and Barbara Little, who brought Civic Engagement into the NPS archaeology program.[8]

Civic engagement in national parks today: how well is NPS meeting the goals it set for itself in 2001?

The greatest success of the Civic Engagement initiative has been the NPS steadily increasing its commitment to diverse and inclusive histories. Last year the NPS produced theme studies identifying sites of significance for lesbian, gay, bisexual, and transgender history, Asian American Pacific Islander history, Latino history. New historic sites like Stonewall and Reconstruction, envisioned in 2001, have joined the NPS system as national monuments.[9]

The NPS can also count partnering with academic institutions among the initiative's successes. Many of the new theme studies were carried out by academic historians, and the Organization of American Historians' "Imperiled Promise" Report points to specific ways that the NPS history program can take advantage of academic scholarship.[10]

NPS efforts to partner with state and local government and private landowners has been less successful. On the one hand, the number of national heritage areas has doubled since 2001, and many more NPS sites follow Lowell NHP's example by developing cooperative management agreements with neighboring entities. The NPS Conservation Study Institute, which played a central role in planning the 2001 Civic Engagement workshop, is now called Stewardship Institute and is focusing on partnerships in urban areas under a new NPS Urban Initiative.[11] On the other hand, the concept of federal cooperative land management has met with considerable political resistance in Congress, which has not passed general heritage area legislation and threatens to zero out federal money for heritage areas in its FY2018 budget.[12]

NPS efforts to introduce more facilitated dialogue have also met with mixed success. More park superintendents are sending staff to specialized training in facilitated dialogue techniques for interpretation by organizations such as International Sites of Conscience. However, staff reductions, coupled with increased visitation, have made it more difficult for the NPS to employ this labor intensive way of communicating with the public. Social media allows the NPS a different kind of dialogue and engagement, but also requires staff time for moderating on-line discussions.

The future of civic engagement in national parks: the promises and pitfalls of the new federalism

The Civic Engagement initiative builds on more than a century of NPS efforts to become more than "islands of protection" for natural and cultural resources. In the nineteenth century, the NPS protected scenic western lands from commercial exploitation by private developers while developing heavily regulated tourist facilities of its own. In the 1930s, the NPS brought historic sites into the system and, through New Deal programs, provided technical assistance and additional

labor to state and local government recreation and historic preservation efforts. The system expanded dramatically after World War II, along with the reach of other federal government agencies. This expansion of federal programs peaked domestically during the 1960s and 1970s, but then, during an economic downturn, met a well-funded political counter-reaction.

Since the 1980s, bi-partisan political support for expansion or even maintenance of federal domestic programs, especially environmental regulation, civil rights laws, public arts and humanities agencies, and even the NPS, has broken down. The NPS developed national heritage areas and other partnership strategies since the 1980s as a creative and sustainable way to maintain influence as its budgets fell.

Most of the long-term trends that led to civic engagement initiative in 2001—demographic change in NPS and audiences, reaching out to academics and state and local partners—are likely to continue even with reduced federal funding. But dialogic interpretation by NPS staff about contemporary social, cultural, and environmental issues, because it is so labor-intensive, even on-line, is endangered by budget cuts and by a polarized political environment.

The promise of the New Federalism is it could enable the NPS to engage with the public more fully in areas of the USA where its partners are relatively well funded and supported. The pitfall is that in areas of the USA where its partners have less capacity, NPS units could return to "island" status. In the 1940s, Secretary of the Interior Harold Ickes desegregated visitor facilities at Shenandoah and other Southern parks, despite his concern that they would become "islands of jurisdiction." If Shenandoah had been cooperatively managed at the time, and Ickes compelled to rely on local partners, it would not have happened. Will NPS sites in some areas of the USA become "islands of truth" about climate science, history, and tolerance, without the supportive local partnerships necessary to carry out the Civic Engagement vision?

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Charting a Path: A Critical History and Analysis of Social Science in America's National Parks

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Today, social science is a common activity in national parks. In its usual form, the visitor survey, it documents the characteristics, behaviors, and perceptions of park visitors. But few people know the origins of social science in the parks. Who conducted the first survey? How has park social science evolved? Where should it be heading? This paper begins to address these questions.

In 1893, Lieutenant Hiram Chittenden, an army engineer working on the road system in Yellowstone National Park, mailed a questionnaire to a sample of guests who had stayed at the park's hotel at Mammoth Hot Springs. This is the first recorded social science in an American national park. Chittenden's survey was motivated by his opposition to a proposal by businessmen in Washington state to build an electric railway to transport visitors between Yellowstone's major attractions. Electricity for the train was to be generated from dams constructed on streams and waterfalls in the park. At the time, travel in Yellowstone was mostly by stagecoach, and dusty roads were a constant problem. During the summer of 1893, the concessioner at Mammoth—working with the Washington state group—had collected signatures from hotel guests on a petition supporting the railroad. Because Chittenden believed that the petition did not represent the "actual opinion upon the subject," he drew one name from the hotel's guest register for each day of the season, attempting to represent geographic diversity, and mailed a questionnaire to each person in his sample. Of 120 questionnaires sent out, 100 were returned. As reported by Chittenden, the survey included three questions: "(1) What was the principal drawback to the enjoyment of your tour of the park? (2) From the experience of your own tour would you advise your friends to visit the park? (3) Assuming that there were a complete system of thoroughly macadamized or graveled roads in the park, so constructed as largely to eliminate the mud and dust nuisance, and in which there should be no hills so steep that teams could not ascend them at a trot; and assuming also that there were a well-equipped electric railway covering substantially the same route, by which

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method would you prefer to make a tour of the park: by coach or by car?"[1] On the issue of travel, Chittenden reported that respondents overwhelmingly favored stagecoaches, 147 to 29. (The 176 responses exceeded the sample size because other members of the respondents' travel groups volunteered answers, which Chittenden included in his tally.)

Bills authorizing the railway were introduced in Congress in 1894 and 1895, but died in committee.[2] The House report included adverse comments from the secretary of the interior and from Captain George Anderson, Yellowstone's military superintendent and Chittenden's commanding officer. Anderson called the railway "unneeded, undesirable, vicious."[3] Given the command structure in Yellowstone during its military years, it's almost certain that Anderson knew of Chittenden's results, and these informed his response to Congress, along with his staunch opposition to other railroad proposals for the park.

As with Chittenden's survey, most social science information collected by the fledgling National Park Service (NPS) (after its creation in 1916) described park visitors. Initially, the major source of this information at Yellowstone and other parks was a detailed form filled out for each group passing through park check stations. For example, on July 26, 1920, Mr. R. Floodas of Pocatello, Idaho arrived at Yellowstone's west entrance in an Oakland (a make of car). Two passengers and one Airedale accompanied him. He carried a firearm and paid an entrance fee of $7.50.[4]

Statistics such as these had applied value. They documented the growing popularity of national parks, and they illustrated the diversity of national park visitation, underscoring the patriotic value of parks in encouraging all citizens to "see America first." As well, they justified public investment in roads, hotels, and auto-accessible campgrounds.

At times, NPS summaries of check station data displayed a childlike wonderment at the transformation in vacation patterns caused by the private auto. In 1922, as his park approached the 100,000-annual-visit milestone, Yellowstone Superintendent Horace Albright enthused that the park's visitors presented a "more comprehensive 'automobile show' than has ever been staged under auditorium or show-room roof," with 123 vehicle models and "innumerable adaptations of modern touring cars into houses on wheels…."[5] (Behind the scenes, the NPS fretted over the safety of automobiles in parks, as well as conflicts with horse-powered travel.) But as visitation increased, detailed record-keeping at park entrances became impractical. It was replaced by today's traffic-counting systems that record visitor numbers (but not characteristics) and by sporadic surveys, usually covering periods of two weeks or less.

Lemuel (Lon) Garrison transferred to Yosemite National Park in California in 1935 from nearby Sequoia. At Yosemite, he found a park crowded with people and vehicles. Private cars were first admitted to the park in 1914, and by 1929 annual visitation approached half a million, most of it concentrated in Yosemite Valley. Park planners dubbed the five auto campgrounds in the valley the "Yosemite slums." In the 1930s, with camper counts reaching 20,000 on Fourth of July weekends, the campgrounds reportedly had a settlement density twice that of Pittsburgh, Pennsylvania. To park staff, the clear result was a negative visitor experience.[6]

Garrison held a psychology degree from Stanford University, and in 1937 and 1938 he surveyed more than 2,000 campers in Yosemite Valley. Garrison hoped to discover information about their motives and perceptions that could be used to encourage greater use of campgrounds outside of the valley. As he planned his research, Garrison consulted with his former professors at Stanford.

This was an early example, perhaps the first, of university involvement in national park social science.

In contrast to park planners, Garrison's report noted that many visitors felt that the Yosemite Valley encampments provided an enjoyable experience. Half of the campers said they preferred campgrounds that were "near the center of things" with many things to do. Although the other half said they preferred a quiet and isolated campground, they still chose to camp in Yosemite Valley. Garrison concluded that "those who prefer a quiet campground don't know what they mean." But, he added, "It might be possible to increase the quality of use by a well thought out and aggressive educational campaign." To Garrison's disappointment, his study was disregarded by the park. He later wrote that his report quickly disappeared "like a hard-boiled egg dropped into a bowl of soft mashed potatoes."[7]

Economic research also played a key role in early park social science. When Yellowstone National Park was established in 1872, supporters argued it would pay for itself through income from concession leases, at least after roads and other infrastructure were completed. In effect, the economic value of the park would be measured by its operational surplus. Some national parks did report surpluses, including Yosemite in 1907 and Yellowstone in 1915 and 1916.[8] Whether military costs were included in the parks' balance sheets is unknown. But from the 1920s onward, federal appropriations outstripped park earnings and deficits grew dramatically. By this accounting yardstick, the national parks had no value. Perhaps as a result, the discussion of the parks' economic importance shifted from their revenue generation to the income and employment realized in communities whose financial lifeblood flowed from having a popular destination on their doorsteps. As early as the 1940s, a study at Yellowstone National Park calculated the contribution of park employment and visitor spending to the economy of the surrounding region.[9]

The methods employed in the national parks' first social science have been greatly refined since Chittenden's pioneering survey. However, some aspects endure. Visitor surveys remain a key social science tool, and early topics, such as transportation, crowding, and economic contributions, continue to be relevant. Tabulations of visitor numbers and characteristics are still strategically important. Universities and other partners continue to contribute to park social science through cooperative ecosystem studies units. As Garrison found, visitors' and managers' perceptions of experience quality can differ. And finally, as Garrison also discovered, social science may inform management, but it doesn't necessarily determine it.

However, other things have changed in the 125 years since Chittenden's original inquiry. These changes are producing new social science needs in the national parks. One need is for social science informed by historical and contextual depth. A second is for more social science that examines issues transcending park boundaries.

A feature of much contemporary park social science is its cross-sectional design. Visitor surveys represent a snapshot at one brief point in time. Typically, this cross-sectional approach seeks explanations for what visitors think and do in present conditions. Common "proximate" explanatory variables include age, race, income, and attitudes. But this is like trying to understand a tree by its foliage, while ignoring the roots and the soil from which it grows.

"Distal" causes are more distant in time and broader in social context. They represent the cumulative impact of historical forces and social conditions on the present. Understanding distal

causes can improve understanding of a current problem, just as understanding a tree is improved by knowledge of its soil and roots. Historical depth and social context can also suggest additional actions to address a problem.

Consider the relatively low visitation by African Americans to national parks. Commonly cited proximate causes are inequities in income and knowledge about parks. But this disregards the roots of the problem by ignoring who participated in the conversation about national parks when the idea first appeared in the nineteenth century, and—more to the point—who was excluded from that conversation. A reasonable hypothesis is that the historical legacy of African American exclusion is reflected in visitation patterns today.

Fee-free days and information campaigns respond to proximate causes. They are important in many ways but don't represent a comprehensive approach to the problem. Distal causes also must be addressed. One approach to overcoming the weight of historical exclusion is to work with African American groups to support their own grass-roots efforts to reverse exclusion by creating a culture of inclusion. Cultural peers are more likely to understand the full effects of exclusion and how to overcome it. These peers include the many passionate participants in organizations such as the Outdoor Afro movement.

Regarding trans-boundary issues, more questions than answers exist; thus, the need for additional social science is clear. The problem is how to protect national parks when their borders are porous, and every day the conditions outside parks become less like the desired conditions inside. A related problem is the increase in partnership parks and attempts to build protected-area collaboration on a landscape scale across many geographic and institutional boundaries.

Human population growth fragments natural systems, but it also fragments social systems. As human populations increase, they become more complex, more diverse, and segregated into specialized functions. One effect is multiple jurisdictions and interests with differing and often incompatible goals for a landscape. This leads to a loss of common ground as a basis for collaboration.

An important barrier to collaboration is differences in stakeholders' core values. A second is distrust. Core value differences include: conflicting symbolic values shaping community identity, for example, the Old West vs. the New West; differences in economic values shaping land-use decisions, such as more development vs. limited development; and disagreements over ecosystem values driving park management, such as in priorities attached to wilderness character or wildlife habitat.[10]

Distrust is multidimensional. One form of distrust is a general predisposition to not trust specific entities, such as the federal government, independent of context. Another is distrust of specific processes, such as environmental assessments or social surveying, independent of participants. A third is distrust based on personal incompatibilities between potential participants in a collaborative process.[11] Many other collaboration barriers exist, but research on how to overcome value differences and distrust is particularly important if national parks are to successfully partner across boundaries in fragmented social systems.

In sum, when the future of park social science is examined against an ever-encroaching and more diverse world, we see new needs added to the science already in place. We need social science informed by history. We need more qualitative case studies of collaboration and what can be learned

from success and failure. We need long-term monitoring of social change in and around parks, including changes in who park visitors are, and in levels of trust and distrust. And, because the NPS can't do this alone, we need more healthy partnerships to extend the capacity of park social science.

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13

National Colonial Farm in Piscataway Park: Green History, Farming, and the Quest for Relevance

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A place of wild fruit
Where land and people are one
Our journey begins.

Accokeek is an Algonquian word that means "place of wild fruit." The haiku I just shared was written by participants in a gathering that we had this spring—a Dialogue on Race, Agriculture and Living History. A new strategic plan developed three years ago by Accokeek Foundation board and staff prioritized uniting all of the Foundation's work under the interpretive message of sustainability to better focus how we engage visitors on the acres we steward in this national park on the Potomac River. Everything came under scrutiny, including our "main attraction," the National Colonial Farm. Our living history scenario's inclusion of an enslaved character was cutting edge twenty years ago, but now? Now we had an interpreter telling us that current events had made it too uncomfortable for her to play an enslaved character, and a high school agricultural intern hiding any time visitors came on to the colonial farm for fear they would think he was "playing a slave."

This year the Accokeek Foundation celebrates sixty years of stewardship. Stewardship and sustainability—two words I spend a lot of time contemplating as leader of this non-profit partner of the National Park Service (NPS). When Congresswoman Frances Bolton created the Foundation sixty years ago, donating a farm she had purchased to save the land from development and preserve the view from George Washington's Mount Vernon across the Potomac River, she effectively launched one of the country's first public-private land preservation projects. In the end, nearly 5,000 acres would be permanently protected as a national park of which the Foundation stewards 200.

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Sixty years has seen a lot of change in the world. In order for any organization to be sustainable, it must remain relevant. Today I want to share the story of the Accokeek Foundation's quest to ensure the relevance of its work on this landscape. By sharing some of our story, I hope you will come away with new insights on your own work as we all "look to the past to chart a path forward."

From the very beginning, innovation has been a core value for the Accokeek Foundation. Recognizing that responsible stewardship of protected land required a vision for that stewardship, the Foundation created the National Colonial Farm in 1958, one of the first living history farms in the country. Building on this landscape's centuries of agricultural history, the colonial farm started out as a demonstration space for colonial agriculture with preservation of genetic diversity an important focus. Eventually a historic farmhouse and tobacco barn were moved from nearby counties, creating a farmstead and providing an approximation of an ordinary colonial farm family's life, easily contrasted against the story told at George Washington's Mount Vernon across the river. The interpretive scenario, based on ground-breaking scholarship by top historians in the early 1990s, continues to anchor the living history interpretation at the colonial farm.

Twenty-five years ago we broadened our approach to engaging the public in agriculture with a bold experiment. We took an eight-acre piece of land depleted by centuries of mono-cropping tobacco and corn, and created the Ecosystem Farm. Could we rebuild the soil through sustainable agriculture? The Ecosystem Farm became one of the first organic vegetable farms in the region, with one of the first farmer training programs and one of the first Community Supported Agriculture programs.

Fast forward twenty years. In the process of working with a consultant to examine the feasibility of expanding the Foundation's sustainable agriculture work to land outside of the park, several things became evident. Once on the cutting edge, the Accokeek Foundation was no longer a leader in sustainable agriculture in the region. Organic vegetable farms had proliferated, and many programs now existed to help train new farmers. Though our local community enjoyed having a Community Supported Agriculture program just down the road, providing weekly shares of vegetables had never been the goal of our program—producing more farmers had been the goal. With the many new learning opportunities for aspiring farmers, our twenty-year-old model was no longer innovative. Expanding beyond the boundaries of the park was beyond our institutional capacity. How could we most effectively use our limited resources to engage the public in sustainable agriculture in Piscataway Park?

You know how when you begin tugging on a loose thread, a sweater starts to unravel? In this case, eliminating our farmer training program was that loose thread. It was our shifting of the Ecosystem Farm from a production-oriented farmer training program to a space for engaging students and the general public in sustainable agriculture that started our unraveling of "what had been" and beginning to knit "what could be." Nothing was off the table. "Nothing" included the National Colonial Farm and its interpretation.

With new strategic priorities of unifying all of our work under the umbrella of sustainability and creating programs that are thought-provoking, participatory, and inclusive of different perspectives, the first big change was in our school programs. We eliminated our three field trips focused on colonial farm life on the eve of the American Revolution, and created one new interactive experience called "Eco Explorer: Colonial Time Warp." As members of an eco-explorer team, students embark on a mission to save the earth and change the course of history. A well-meaning

time traveler has recently transported back to the year 1770 to give our colonial farm family several modern objects that will make their lives easier. But, if left on the farm, these objects could set in motion a chain of events that destroys the environment for future generations. Students "travel back" to 1770, find the objects, weigh the positive and negative effects of these modern conveniences and decide whether to confiscate the objects and replace them with colonial objects that fill the same function. Along the way they encounter characters who humanize the impact of these decisions, including the enslaved character of Cate whose discovery of insecticide promises to make her life in the tobacco fields much easier and perhaps enable her to visit her young son who had been sold to another planter (Figure 1).

This new program represented a big change for our staff, and one not universally embraced. We lost most of our part-time interpreters and one full-time staff member. In the beginning, it also took a toll on our bookings, as teachers accustomed to ticking off the "colonial history" box had to rethink where and how they connected this field trip to their curriculum. But the tour went on to earn the American Alliance of Museum's Innovation in Museum Education Award, and has been growing in popularity with Maryland teachers. The field trip provides a "Meaningful Watershed Experience" in the Chesapeake, which is now a part of our state's environmental literacy graduation requirements.

This new school program helped us begin to reframe our approach to engaging all visitors to the site as "green history." Green history connects a contemporary sustainability issue to its colonial

Figure 1. Students meet enslaved character Cate on their journey to save the planet in EcoExplorer: Colonial Time Warp field trip (photo credit: Accokeek Foundation).

equivalent, making it more relevant to today's visitors. Designed and curated on the themes of soil, water, energy, and food waste, our green history uses simple exhibits and interactive theatrical experiences to transform visitors into informed decision-makers regarding today's environmental issues. For example, "Underspace: The Science of Soil" provides visitors with an immersive, glow-in-the-dark exploration of the difference between healthy and unhealthy soil. Then they are encouraged to visit the colonial farm and learn about the challenges of life as a tobacco planter.

The next new program we launched was the Agriculture Conservation Corps, a seven-week paid summer internship for county high school students during which they learn about all aspects of the Foundation's agricultural work—colonial, sustainable, and heritage breed livestock. As we prepare for our third summer with these interns, the ACC represents a strong partnership between the Accokeek Foundation, the public school system, and our county's summer youth employment program. It has also led to a spin-off called AgLab that engages both high school and college students in individual projects during the school year, and has led to new partnerships with individual high schools, as well as Prince George's Community College, the University of Maryland, and the Maryland Institute College of Art.

I began this paper mentioning our recent "Dialogue on Race, Agriculture, and Living History." The idea for this conversation evolved out of our desire to "de-colonize" the colonial farm. Were we inadvertently perpetuating stereotypes through our interpretation at the National Colonial Farm? Like most living history sites that address slavery, the white family is the center of our story. What other stories should we or could we tell against the backdrop of our colonial farmstead? And, given that Piscataway Park encompasses the sacred homeland of the Piscataway people, how do we ensure that visitors learn about this important and continuing story of the landscape? We are just beginning to analyze the material that we gathered during the dialogue and to formulate possible next steps in how we approach interpretation at the National Colonial Farm.

But we have begun formulating a very exciting new initiative that is transforming how we approach our stewardship of this landscape. Our vision is to showcase the future of sustainability with the world's largest permaculture food forest. Drawing on both ancestral knowledge and modern innovation, our goal is to find a true path to sustainability that is centered on patterns of nature and ecologically-oriented agriculture. In the tradition of Piscataway Park's original and enduring inhabitants, our goal is to transform these invasive-choked woodlands into a forest of food that will serve as a living case study in a different kind of working farm-scape. We see this as an opportunity to engage local, regional, and national communities in hands-on learning to create and manage permaculture landscapes. Unique elements of this national food forest include the following:

- agricultural systems that build an edible landscape, layers of native trees and perennials, into the existing forest;
- heritage livestock and plants bred to excel with minimal intervention in the native ecosystem;
- extensive use of silvopasture, combining forestry and grazing of domesticated animals in a mutually beneficial way that enhances soil protection; and
- a national park landscape that serves both as a recreational, leisure, educational, and conservation asset and as a working farm.

It is an ambitious undertaking. With the NPS, we are currently working through the development of a management plan for the 200 acres of the park that we steward. The NPS is learning about

food forests and permaculture, and we are learning about the federal rules and regulations that must be navigated on this archaeologically significant landscape. I am excited about the possibilities. Not only does this food forest approach to agriculture and land stewardship build on everything that the Accokeek Foundation has done for the last sixty years, it also honors the park's significance as indigenous cultural landscape of the Piscataway people. I welcome your thoughts, ideas, and suggestions.

A place of wild fruit
Where land and people are one
Our journey begins.

14

Fulfilling the Promise: Improving Collaboration between Cultural Resources and Interpretation and Education in the U.S. National Park Service

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In 2011, the Organization of American Historians' report, *Imperiled Promise: The State of History in the National Park Service*, made a compelling argument that history is vital to the identity and function of the U.S. National Park Service (NPS), but divisions between the work of cultural resources and interpretation diminish its power and reach (Whisnant et al. 2011). Every uniformed park ranger becomes a public historian regardless of background, yet scholars who produce research on the parks rarely interact with those who are the public face of the agency.

Seeking to apply the insights of *Imperiled Promise*, the workshop leaders sought insight into best practices, needs, and suggestions for bridging the divide. Herrin and Button Kambic met with chiefs of interpretation and cultural resource program managers at twelve parks in the National Capital Region. Crawford-Lackey worked on pilot projects in the national Cultural Resources Office of Interpretation and Education, which aims to promote relevance, diversity and inclusion in interpretation and education about cultural resources. At the George Wright Society workshop, she demonstrated an interdisciplinary approach to place-based exploration and interpretation from a workbook in development called "Discovery journal: Giving voice to America's places." All three authors facilitated discussion during the workshop, and Acting Associate Director of Interpretation, Education, and Volunteers Tom Medema joined as a guest discussant. Participants

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ranged from graduate students and seasonal employees to national park and program leaders from the United States to Australia.

The challenge

Cultural resources are at the core of the visitor experience at most national parks. Approximately two-thirds of today's 417 national park units were established to recognize places of cultural and historical significance to the USA (Whisnant et al. 2011, 5). Interpretive rangers, educators, and volunteers are the NPS's ambassadors to the past, while anthropologists, archeologists, archivists, architects, historians, landscape architects, and museum curators work to document and preserve cultural resources according to federal and state historic preservation law. The shared responsibility of stewardship shapes all of their work.

Despite this common mission, 544 NPS employees who responded to a survey for *Imperiled Promise* said that today "history is generally practiced in NPS as an adjunct to administration," while "interpreters are left to do much of the research for interpretive programs." Over 52% of survey respondents recognized a divide between resource management and interpretation that has a negative effect on the practice of history in the parks. Only 3% answered that the divide has had a positive effect, and 26% responded that it has had no effect, or there is no divide (Whisnant et al. 2011, 54–55).

The functional division between cultural resources and interpretation in the NPS has historical and organizational roots. At the park, federal and regional levels, cultural resources have been within a separate directorate from interpretation since 1965. The passage of the National Historic Preservation Act in 1966 fostered the growth of today's extensive private-public network of historic preservation practitioners. The act's mandates to identify, recognize, and preserve cultural resources helped create the professional field of cultural resource management, but it also shifted the purpose and audience of National Park Service research from public consumption to professional preservation. Rather than exhibits and waysides, cultural resource professionals today primarily focus on section 106/110 compliance, National Register of Historic Places nominations, and other planning and management responsibilities (Whisnant et al. 2011, 22–24). They produce numerous baseline management documents such as archeological overviews and assessments, administrative histories, cultural landscape inventories and reports, historic resource studies, special history studies, cultural landscape inventories and reports, and ethnographic assessments (NPS 1998).

Collaboration between interpretation and resource management exists at all levels of the service, but it is often voluntary, decentralized, and dependent on staff initiative and park creativity. Workshop participants and National Capital Region discussants identified two major barriers to collaboration: a lack of organizational structures and processes to support communication across divisions, and limitations on staff time that make it difficult to develop these processes anew. This means that when cultural resource professionals produce research on park resources, there is no standard method for communicating results to interpreters, educators, and volunteers. Similarly, there are no common processes for making sure that front-line staff who talk to the public about cultural resources know about and have access to their park's resources, or have opportunities to share their site-based knowledge with researchers.

Why collaborate?

Workshop discussions centered on how and why cultural resource knowledge and interpreta-

tion are mutually dependent, and how greater collaboration can strengthen agency efforts in both stewardship and civic engagement. Collaboration is vital to the service's preservation mission because interpreters serve as the voice of resource management, transmitting information about park resources to visitors, students, volunteers, and online audiences. They have the platform to share important messages from and about resource management issues and foster the ethic of stewardship. On a day-to-day level, interpreters with a strong understanding of cultural resources can integrate the history and management of the park into the park's larger story, helping make connections between the park's founding resources and values, the importance of continued stewardship, and the NPS's role in shaping park histories. Close communication with cultural resource managers can help to ensure that interpretive programs align with research goals and reflect the latest scholarship. In turn, interpreters are uniquely positioned to address and deconstruct negative stereotypes and common misconceptions using accurate historical information.

Interpreters can directly contribute to resource management goals because of their direct role in community engagement. Their knowledge of communities and audiences can inform resource managers about which groups have connections to parks that could inform ethnographic studies, how audience interests relate to research projects, and what their success stories for transferring knowledge look like. They may have insights on culturally appropriate outreach techniques to share these stories with more diverse audiences. They can also bring their experience with interpretive techniques and relationships with communities to help frame messaging around highly charged topics or controversial management decisions.

In turn, interpreters need accurate, up-to-date knowledge to tell their parks' stories effectively and maintain public trust, and resource managers can and should help provide that. NPS research has the advantage of drawing explicit connections between park lands and their broader historical and cultural contexts, providing content that can be easily tailored to a park's resources and stories.

First, baseline documentation for cultural resources can help compile and verify anecdotal evidence about the origins and history of a park, creating reliable sources of information to share with the public. For instance, interpreters should be aware of their park's management history, as documented in administrative histories, and why it is worthy of being preserved as a national park, as noted in founding legislation and National Register of Historic Places and National Historic Landmark nomination forms. Second, strong lines of communication about research and compliance activities ensure that park staff are well informed about park operations, projects, and important questions in scholarship.

This communication can also help interpreters understand and share how knowledge is produced and used, presenting history as an unfinished process that visitors can help create. Tom Medema discussed the important role cultural resources can play in the turn toward "audience-centered experiences," which draws on ideas and techniques from *The Participatory Museum* (Simon 2010), museum hack, and research on how and why audiences engage with content (see NPS 2017). Medema explained that for audiences to connect, they need to participate in dialogue and co-creation. Cultural resources can be at the heart of those experiences in places where people expect to be challenged and talk about difficult topics, such as slavery, segregation, and war. Workshop participants noted that strong interpretation and education requires high levels of both content knowledge and skill in interpersonal and emotional engagement, especially in a participatory model. Research is one tool that equips interpreters to do this in a culturally sensitive and

historically informed way. Cultural resource managers can support interpreters by connecting the information they can provide with the day-to-day challenges of interpreting difficult topics.

Finally, collaboration between interpretation, resource management, and other divisions contributes to the "One NPS" goal of the Urban Agenda (NPS 2015, 14). Partners in the workshop noted that divisions of responsibility are not transparent to those outside the agency, and ensuring that staff across divisions are knowledgeable about each other's work can make it easier for partners to navigate communications.

Action items for parks and programs

Drawing on the expertise of workshop participants, National Capital Region chiefs of interpretation and cultural resources, and *Imperiled Promise* we identify five major areas in which parks and programs could work toward greater collaboration.

Communication as process: the simplest step is to expand and add cross-divisional communication to routine processes and distribution lists, which already happens in some parks. Suggestions include the following:

- Invite a park or program's chief of interpretation to kick off meetings for cultural resource projects, or invite a cultural resource manager to major interpretive meetings.
- Create, share, and update spreadsheets of current projects so staff in different divisions can identify overlapping topics and share their knowledge.
- Include interpretive supervisors or staff on email lists for announcements of public comment periods, new reports, or cultural resource related accomplishments, with clear guidance about what information is appropriate to share with visitors.
- Inform interpretive supervisors of site visits for research or technical assistance so that interpreters can learn about cultural resource projects through brown bag lunches, shadowing, or participation.
- Plan outreach and cross-training for interpreters with their schedules in mind, for example, by scheduling at least two weeks ahead, avoiding the busiest times in the park, or planning for after work events.

Training and documentation: workshop participants ranging from early career interpreters to senior cultural resource managers noted that interpreters need better training resources and program documentation, especially given the high turnover of seasonal interpretive staff at many parks. Ideas for improving training related to cultural resources include the following:

- Create libraries of well-vetted, accurate interpretive programs and baseline cultural resource documents for new employees to learn from.
- Create processes for collecting and organizing documentation, and succession plans for how they will be maintained through staff turnover.
- Provide training opportunities for interpretive staff to learn from resource managers and researchers, such as presentations to staff during seasonal training or at the end of studies, webinars on resource issues that can be stored and archived for future use, or guest lectures and workshops with scholarly experts.
- Frame training around issues interpreters face directly in their jobs, such as how historical knowledge or cultural competency can help with difficult conversations.

Making research accessible: echoing the *Imperiled Promise* call for interpretive deliverables for cultural resource management projects (Whisnant et al. 2011, 57), interpreters called for research products that are more accessible in content, format, and location. Most report types are constrained by the need to answer specific questions necessary to resource management, but there are ways to make them navigable, create supplementary products, and raise awareness of these resources for all staff. These include the following:

- Add summaries, tables of content, and indices to reports.
- Write reports for popular publication, for example, Joan Zenzen's Battling for Manassas (2010), commissioned as an administrative history.
- Require contractors to write a document for the general public as well as a technical document, for example, a public archaeology report that is narrative and omits sensitive information.
- Stay up to date on uploading non-sensitive documents to the integrated research management application (irma.nps.gov).
- Train all staff on where to find cultural resource documents online, on park shared drives, and in physical libraries.
- Create summaries or briefs aimed at interpretive uses, for example, highlight the new sources or discoveries in a report, provide narrative summaries identifying big themes and interesting stories (in contrast to executive summaries that focus on methods and accomplishments), or communicate key points through a fact sheet like the example for the LGBTQ heritage theme study (NPS 2016).
- Work with interpreters to define and include specific interpretive deliverables such as narratives, web content, or brochures in scopes of work for cultural resource projects, as part of the required plan for transfer of knowledge beyond a report.

Improved digital content: every park's website can have a history and culture section, and developing digital content is one area where interpretation and cultural resources should be natural partners. Simple suggestions for improving park websites includes the following:

- Call on cultural resource managers to review history and culture articles written by park web coordinators.
- Partner with park interpreters to create new digital content.
- Include specifications for web content (article text, images, maps, video, or story maps) in scopes of work for cultural resource projects completed by contractors and outside researchers.

Collaborative projects and programs: more ambitious projects can bring together staff from both cultural resources and interpretation to share knowledge and expertise in either research or public programs. There are many innovative examples across the agency, some of which are detailed in *Imperiled Promise*, but a few examples that participants are experimenting with include the following:

- The NPS's pilot edition of the discovery journal workbook, meant to facilitate brainstorming, research, and design for interdisciplinary interpretive projects; core questions included in the workbook can also be found online (www.nps.gov/articles/taas-consider-a-place.htm)
- Designing the transfer of knowledge element of a cultural resource study to provide fund-

ing and opportunity to create public or internal outreach products, such as workshops or symposia bringing interpretive staff together with expert researchers
- Planning public programs that directly involve cultural resource staff, or draw on cultural resource research to help honestly and accurately address big questions with the latest sound science and scholarship

Conclusion

Experienced personnel from both the workshop and the National Capital Region advised that the most important single factor in expanding collaboration is management support. From superintendents to front-line supervisors in parks, to regional and national leaders, managers have the responsibility of setting priorities and making time for what is important. They have the power to make cross-divisional collaboration part of their staff's regular workflow, and to provide the resources necessary for success.

There are also excellent examples to learn from and build on across the service. These best practices can be as simple and low-cost as interpretive supervisors inviting their parks' cultural resource managers to quarterly meetings, resource managers adding interpreters to their distribution lists for new reports and announcements, and scheduling individual interpreters to shadow researchers visiting their parks. They can be as ambitious and visible as Harpers Ferry National Historical Park's seasonal public programming featuring cultural resource staff, facilitated dialogues about the histories of segregation and conservation at LeConte Memorial Lodge at Yosemite (now Yosemite Conservation Heritage Center), or the development of digital interpretive products for the National Historic Landmark Program's LGBTQ Heritage Theme study (Springate 2016). Rather than starting from scratch, expanding collaboration to better fulfill the NPS mission is a matter of building on the agency's strengths.

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15

Using Digital Point-Intercept and Sub-meter Navigation to Assess Vegetation Recovery in Fire Island's Wilderness

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Introduction

After disturbance, ecological assessments are essential to quantify ecosystem impacts and resilience, which usually dictate implementation of treatments and allocation of resources to maximize recovery potential (Miller, Chambers, and Pellant 2015). Rapid assessment methods typically compliment or extend long-term studies, or refine landscape-scale assessments from aerial imagery, and they provide reliable information about the status of the disturbed area (Fennessy, Jacobs, and Kentula 2004). Rapid assessment methods should be simple and reproducible, and should reduce the cost and time spent assessing resource status (Medeiros and Torenzn 2013). We used and validated a rapid assessment method for coastal vegetation recovery after a dune overwash event.

Traditional point intercept methods (TPI) consist of locating plots and manually quantifying vegetation present. Windy conditions make identifying the natural orientation of vegetation in a plot difficult, herein referred to as wind bias (Cagney, Cox, and Booth 2011). In coastal environments, wind bias may be considerable owing to presence of onshore and offshore breezes. Digital point intercept methods (DPI) use a mounted camera to take nadir photographs of plots, which are analyzed using image software (Booth, Cox, and Johnson 2005). DPI is less susceptible to wind bias

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due to camera shutter control (Booth, Cox, and Johnson 2005), and allows for vegetation cover and species frequency quantification using GIS-based tools (Gobbett and Zerger 2014). Other advantages to DPI include increased sample size due to less time invested per plot, and the ability to reanalyze original plot images from digital archives (Chen et al. 2010). We combined DPI with sub-meter GPS navigation to eliminate the need for permanent plot markers and to facilitate rapid movement between plot locations. Because plot locations are georeferenced, both temporal and spatial analyses of vegetation recovery are possible (Legendre and Legendre 1998).

The purpose of this study was to adapt a rangeland vegetation assessment method for recovering coastal vegetation. Our objectives were to explore DPI for rapid assessment of vegetation cover, test sub-meter GPS navigation as an alternative to conventional plot layout procedures, and compare TPI and DPI estimates of vegetation cover among permanent vegetation plots.

Study area

Fire Island is a barrier island located off the south shore of Long Island, New York, USA (40.6476° N, 73.1459° W). Fire Island National Seashore consists of a mosaic of natural areas, managed by the United States National Park Service (NPS), and 17 private residential communities. Within the National Seashore exists the only federally-designated wilderness area in New York State, the Otis Pike Fire Island High Dune Wilderness (OPWA).

Barrier island physiognomy is characterized by strong ocean to bay stratification of vegetation (Ehrenfeld 1990), and the beach is highly vulnerable to inundation from coastal storm surge and sea-level rise. Before Superstorm Sandy made landfall in October 2012, the primary dune system in the OPWA was 4–15 m high and relatively intact (Hapke et al. 2010). Superstorm Sandy produced an unprecedented storm surge that obliterated sections of the primary dune at more than 10 locations on Fire Island, which carried sand inland and buried existing vegetation (Hapke et al. 2013). Plant species such as American beachgrass (*Ammophila breviligulata*) and beach pea (*Lathyrus japonicus*) will initiate succession in overwashes over time (Ehrenfeld 1990).

Materials and methods

Using ArcGIS and aerial imagery, we delineated boundaries of nine post-Sandy overwashes. Paired fenced and unfenced permanent plots were randomly placed within each overwash using Carsonite posts. Fenced plots were enclosed using welded wire fence material (2 x 4 in), twelve inches of which were buried to increase stability. All permanent plots were surveyed using TPI and DPI.

We used the *Create Fishnet* tool in ArcGIS (Version 10.1, http://arcscripts.esri.com/, accessed 10 October 2014) to overlay a 10 x 10 m grid within each overwash to identify additional plots for DPI sampling. Optimal grid size was determined using inter-patch distances measured from aerial imagery (Legendre and Legendre 1998).

Permanent plots were surveyed September 22 through 24, 2015 using TPI. A map was used to locate the permanent plots, at which a 1 m^2 quadrat was oriented with the post in the southeast corner. The 1 m^2 quadrat contained 50 points with a 10 cm north-south interval and 20 cm east-west interval. At each point, a pin flag was lowered vertically to the ground and species presence was recorded if vegetation contacted the pin. The sampling protocol was executed with two people: a vegetation identifier and a recorder. Species presence was entered into a digital database, verified, and used to estimate percent species cover for each plot.

DPI surveys were conducted from September 11–14, 2015. A Canon T3i digital single-lens reflex camera with 18–55 mm zoom lens was mounted 2 m above the ground on an adjustable, aluminum frame with a 1 m^2 base (Booth et al. 2004). The camera was placed in the nadir position. Survey date and plot number were written on a dry-erase board, which was placed within the camera extent but outside the quadrat. The camera zoom was adjusted to capture the frame base and dry-erase board (Figure 1). Camera shutter speed was set to 1/2000th of a second to minimize blurring of windblown vegetation, and the shutter was released using a Bluetooth remote. Photographs of each plot were stored for later processing. The protocol was executed with two people: a navigator and a camera frame carrier.

Plot locations were downloaded into a sub-meter, handheld Trimble GeoXT 2008 Series GPS unit with TerraSync. Navigation to plot locations was accomplished by using the realtime, satellite-based augmentation system available through the TerraSync application. Accuracies to less than 60 cm were verified in the field by repeatedly navigating to a known fixed location from approximately 50 m away using the Trimble GPS. A pin flag was inserted into the ground at the plot location, and with the aid of a mounted compass, the camera frame was oriented due north with the pin flag in the southeast corner (Figure 1). A twin-sized bed sheet attached to two 122 cm wooden dowels was used to shade the plot from direct sunlight, which reduced glare and shadows (Cox and Booth 2009).

Post-processing photographs required three main steps: label with survey date and plot number, crop to within the quadrat, and analyze for vegetation cover. A grid of 100 points, twice the number surveyed with TPI, was created using Geospatial Modelling Environment software (Version 0.7.3.0). The grid was placed inside a 5 cm buffer of each image to minimize edge effects. The 100-grid-point file was used as input to PointSampler, an ArcGIS extension that sequentially prompts the user to identify cover at each point using user-defined categories. PointSampler created a tabulated file containing the identified cover category for each point, which was used to compute percent species cover.

We assessed vegetation cover for 30 sets of 100 random points and one set of 100 systematic points on the same photograph to validate the use of systematic points for future analyses. The mean percent cover and 95% confidence interval were computed by species for the 30 sets of 100 random point placements and compared to percent cover derived from the single set of 100 systematic points. For TPI and DPI methods, percent cover was calculated by dividing the total number of contacts of each species by the total number of points and multiplying by 100.

Logistics of DPI and TPI were compared using measured field and data processing times. For TPI, field time included locating permanent plots, aligning the quadrat, removing vegetation from beneath the frame, collecting species contacts, and securing fenced plots before departure. Processing time included transferring species contacts from data sheets to a digital database and verifying each entry. For DPI, field time included navigating to plots, aligning the quadrat, removing vegetation from beneath the frame, and taking a photograph. Processing included renaming photographs, clipping images, identifying species contacts using PointSampler, and extracting the resultant table to a digital database.

Accuracy of TPI and DPI estimates were assessed using a third, independent cover estimation. We selected 30 images containing various amount of beach grass cover, classified images using maximum likelihood classification in ArcGIS into three classes of cover (bare sand, senescent/

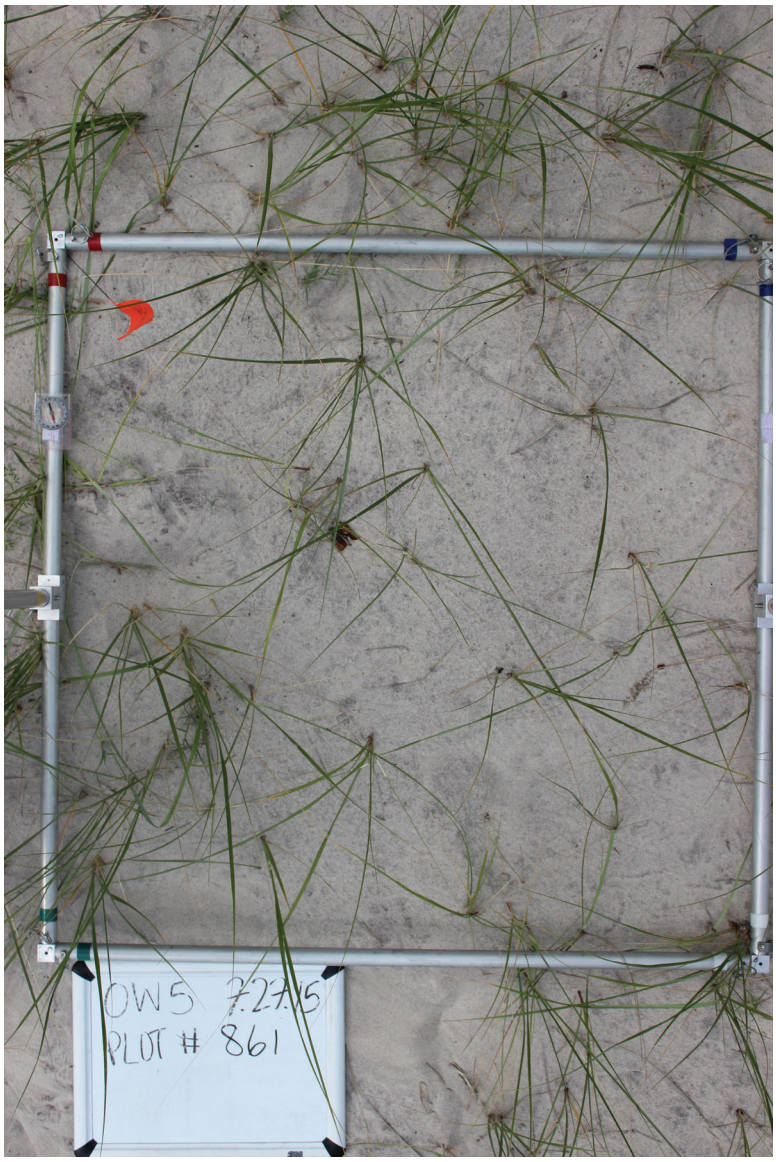

Figure 1. An overwash vegetation plot photographed on July 27, 2015. The orange pin flag located in the top-left (southeast) corner was located using sub-meter navigation and the frame was oriented north using a mounted compass.

brown beach grass, and young/green beach grass), and assessed stratified accuracy of classified images (Stehman and Czaplewski 1998). To calculate accuracy, we isolated pixels of each class, created 50 random points in each class (n = 150), identified true and classified cover at each point, calculated confusion matrices for each image (Congalton 2007), removed plots with class-level accuracies less than 60%, and calculated overall accuracy for remaining plots (Stehman and Czaplewski 1998). We used classified images with overall accuracies more than 80% as our basis for truth. Classified images were clipped by 5 cm inside the quadrat perimeter, congruent with the DPI point grid, to test for edge effects. All comparisons were made using standard linear regression.

Results

Fifty-two permanent plots (19 fenced, 33 unfenced) were surveyed using TPI and DPI. An additional 624 plots were surveyed using DPI. Systematic sampling resulted in cover estimates with-

in the 95% confidence intervals obtained from random sampling (Table 1), therefore systematic points were used to assess vegetation cover for remaining images.

TPI required 2,160 person-minutes in the field and 360 person-minutes for processing, which amounts to 48.4 minutes per plot. DPI required 2,220 person-minutes in the field and 216 person-minutes for processing, which amounts to 3.6 (SE 0.16) minutes per plot. Plot images with class accuracies less than 60% were removed from further analyses. Classified images (n = 25) were, on average, 88% accurate for bare sand and 91% accurate for green *A. breviligulata*. Senescent *A. breviligulata* was occasionally misclassified as bare sand, but 82% of pixels containing senescent *A. breviligulata* were accurately classified.

TPI resulted in higher percent beach grass cover estimation at most cover values compared to DPI (Figure 2a). Percent beach grass cover from classified images showed a strong, positive linear relationship with DPI estimates (Intercept 3.32 (SE 1.97), Grass 0.85 (SE 0.04), Figure 2b). Regression of percent *A. breviligulata* cover from clipped, classified images on DPI estimates (Figure 2c) revealed an intercept not different from zero and slope not different from unity (Intercept 1.30 (SE 1.59), Grass 0.94 (SE 0.03)), indicating removal of a significant edge effect.

Discussion

We documented an order of magnitude difference in time required to collect and process vegetation cover between DPI and TPI methods. Consequently, we were able to incorporate substantially more spatial replicates and achieve greater coverage of each overwash using DPI. Like Booth et al. (2005) and Cagney, Cox and Booth (2011), digital methods required significantly less processing time than traditional methods. We demonstrated wind bias in TPI estimates of cover relative to DPI, which was ameliorated in DPI estimates by use of camera shutter priority (Booth et al. 2004).

Although DPI surveys preceded TPI surveys by ten days (less than 200 GDD), we discount the elapsed time as a significant source of bias in cover estimates. Experience in the OPWA shows that peak vegetation biomass occurs in July and senescence is only substantial after mid-October (Dilustro and Day 1997). Other potential sources of bias for DPI include inaccurate vegetation identification due to fuzzy edges or shadows, lack of ability to assess multi-layer vegetation, edge effects, and observer bias (Chen et al. 2010).

We minimized inaccurate identification from fuzzy vegetation edges by using high-resolution images (18 mega-pixel quality). Shadow attenuation using multiple high-dynamic-range (HDR) images was problematic; high winds make perfect alignment of multiple images difficult (Cox and Booth 2009), increasing the presence of fuzzy edges. We chose instead to shade the plot in the field (Booth et al. 2004), which eliminated glares from direct sunlight and lessened extreme contrasts.

Table 1. Average percent cover of bare sand, *A. breviligulata* (AMBR), and litter, including 95% confidence limits, for the same vegetation plot derived from 30 replicates of 100 random points compared to a single replicate of 100 systematic points.

Cover	Random Sample			Systematic Sample
	Average Estimate	LCL	UCL	Estimate
Sand	73.9	71.9	76.0	76
AMBR (young/green)	19.7	17.8	21.5	18
AMBR (senescent/brown)	5.9	4.9	6.9	6
Litter	0.1	0	0.2	0

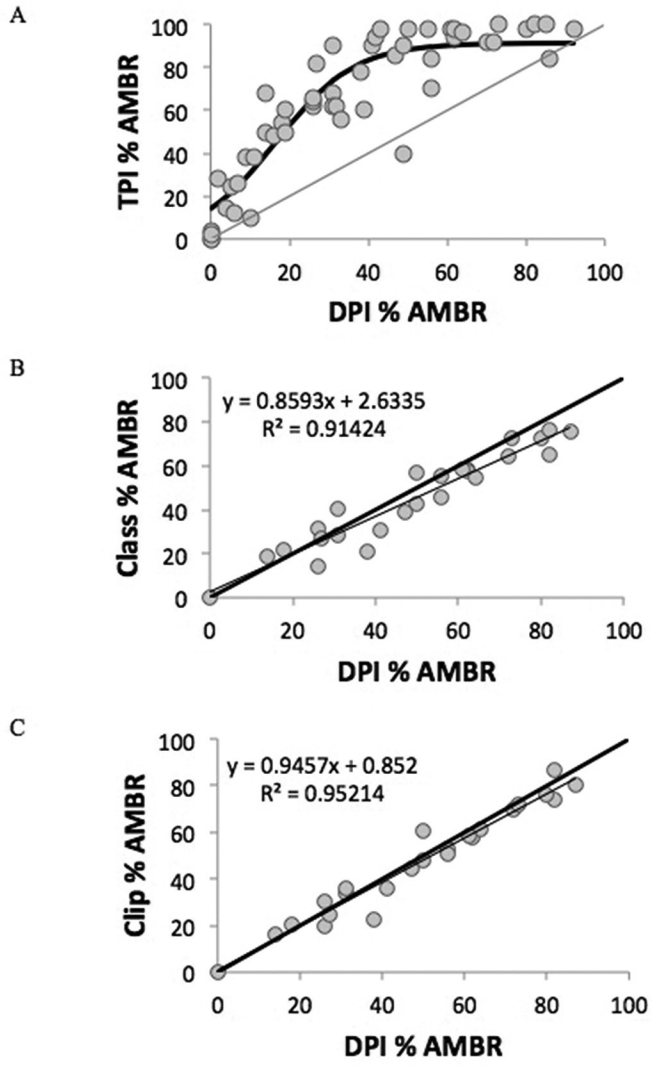

Figure 2. Regression of *A. breviligulata* cover estimated from traditional point intercept methods on cover estimated from digital point intercept methods (A), classified *A. breviligulata* cover on digital point intercept cover (B), and cover of *A. breviligulata* estimated from clipped, classified images on digital point intercept cover (C). The thin, grey line indicates a 1:1 relationship. The ordinary, non-linear least-squares curve-fit is shown in A and simple linear regression equations are shown in B and C.

DPI methods are only accurate for single-layer vegetation as some plants near the ground could be obscured from view in the nadir image. The vegetation we assessed was predominantly present in one layer due to prostrate growth forms of many coastal plants (Stuckey and Gould 2000) and the sparsely populated nature of recovering overwashes. In a few instances, particularly along the edges of overwashes, grasses, forbs and shrubs overlapped, creating multi-layered vegetation. In these cases, obscured vegetation was identified in the field and recorded as present in the plot. As we do not expect rapid shrub encroachment into overwashes, we believe DPI is suitable for future monitoring.

Edge effects were revealed in the classification of the plot photographs. Dislodging beach grass from under the camera frame reduced estimated cover inside the 5 cm buffer along the quadrat perimeter, especially in plots with substantial cover. The effect measured was not a removal of grass within the frame, but rather a redistribution of leaves in such a way that created a greater chance for missed contacts (i.e., clumping). Edge effects were potentially present in TPI estimates, but

were not quantifiable due to a lack of archival data. Observer bias was minimized by using a well-trained team with clearly defined roles (e.g., navigator and facilitator). Species identification was verified by at least two additional qualified specialists to ensure accuracy, and image classification was conducted by one observer.

In conclusion, TPI is useful for temporal analyses of relative vegetation cover, particularly where multiple layers of vegetation are present. TPI estimates may be easily corrected for wind bias using an equation derived from another method, such as DPI. DPI requires less post-processing for accuracy, saves time in the field, allows for larger sample sizes, reduces wind bias, minimizes edge effects, and allows for future and comparative analyses of archived plot images. We recommend the use of DPI methods in coastal and windy environments where single-layer vegetation predominates. Sub-meter navigation was sufficient, but finer-scale research questions may require permanent plot markers to ensure precision and accuracy of cover estimation at a particular location. An extension of DPI using unmanned aerial vehicles for locations with accessibility concerns is ripe for investigation.

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16

Western Highways Transportation Corridor: Adaptation and Challenges for Preserving a Cultural Landscape Today

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The intent of this paper is to introduce what Parks Canada has initiated to identify and preserve cultural landscapes within five western national parks, which are currently facing major investment projects for the highways that traverse these national parks (Figure 1). It is important to know that before highways were built, these national parks had a long history of scenic road building which allowed visitors to experience the "spirit of the beauty" of the place.

In November 2014, the government announced the largest infrastructure investment in Parks Canada's 104-year history. Starting April 2015, Parks Canada was allocated up to $3.4 billion over five years to maintain and upgrade its assets, including cultural resources. This investment program addresses deferred work and should improve the condition of Parks Canada assets, including the highways through the national parks. For the highways, the main reason for the proposed changes is to improve traffic safety. For the western highways, the scope of work will involve widening the highway from 2 lanes to 4, and recontouring the slope where necessary to bring the road to the current Canadian roadway design and construction standards, where possible. For Glacier National Park more specifically, it will involve improving the avalanche mitigation systems.

Brief introduction to the history[1] of the highways within western national parks in Canada
Highway 16 (Yellowhead Highway, Jasper National Park), also known as 'the Yellowhead,' is a through highway that extends east-west across Jasper National Park. The highway follows an ancient travel and trade route crossing the Rocky Mountains via Yellowhead Pass.

Highway 93N (Icefields Parkway, Banff-Jasper National Parks), a scenic highway, runs north-south through Banff and Jasper national parks through spectacular mountain scenery including the Columbia Icefields. Linking Jasper and Banff with a tourist road was discussed as early as

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Figure 1. Parks Canada Mountain Guide, highways within the Mountain Parks, 2010/2011.

1914. The route of the highway crosses a number of important east-west travel and trade routes to and through the mountains that have very long histories of use by human cultures; these include Howse Pass and Athabasca Pass.

Highway 93S (Banff-Windemere Highway, Banff and Kootenay national parks), the Banff-Windermere Highway is a scenic road stretching from Castle Mountain in Banff National Park, to Radium, in Kootenay National Park. For most of its route, the road is in Kootenay Park. The history of the park and road are directly connected. The road opened in 1923. It was designed to stimulate tourist travel, as it was an important link to routes that American tourists could follow up from the western states to Canada's western parks. Its construction was seen by the National Parks Branch as a key element in its plan to intensively develop auto tourism.

Highway 1, the Trans Canada Highway, or the TCH (Banff, Yoho and Glacier national parks) is identified as one of the longest national highways in the world, with 7,821 km coast to coast. It is

a through highway that extends east-west across Banff, Yoho and Glacier national parks (NPs). From the Banff East Gate to Lake Louise the highway follows the Bow River. At Lake Louise it continues west through the Kicking Horse Pass National Historic Site (NHS). At Glacier NP/ Rogers Pass NHS, it is a through road that uses Rogers Pass to cross the Selkirk Mountains. In the parks, the highway follows the route of the Canadian Pacific Railway, Canada's first national railway link which was completed in 1885.

In summary, the Federal Infrastructure Investment projects for major highways involve the following national parks: Glacier, Jasper, Banff, Yoho and Kootenay. Some projects are more intrusive than others because they directly impact the transportation corridor cultural landscapes within these national parks. The following are three examples of major highway infrastructure projects.

First, the widening of the existing Trans-Canada Highway in Kicking Horse Pass National Historic Site to a 4-lane highway. A significant consideration[2] with this stretch will be addressing is some of the less tangible cultural landscape values that have been identified in the Commemorative Integrity Statement for Kicking Horse Pass NHS. These heritage values are under threat as a result of the cumulative impact of the road work, rock scaling and borrow pitting. Unfortunately, this may be unavoidable. It is suggested that the heritage value that may be lost can be communicated through interpretive measures or through recording the current condition of the highway before it is widened.

Second, the Icefield Trail project[3] route will roughly parallel the existing Icefields Parkway, or Highway 93N. It passes through Banff and Jasper National Parks. Key features that will be impacted by the project include the old road grades and associated features. There are archaeological sites and cultural landscape features present. Depending on how the cultural resources are impacted by this project, there may be a net negative impact, a net positive gain, or a mix. If these cultural resources are affected in a way that preserves their physical integrity and/or restores and protects the character defining elements, then it could be seen as a major plus for the resource. Additionally, it will be a positive intervention if the public has the opportunity to appreciate the heritage value associated with these resources. Implementation of this opportunity is still to be discussed at the time this paper is being written.

Third, is the widening of the existing Trans-Canada Highway in the Rogers Pass National Historic Site at the Summit and Illecillewaet Curve areas from 2 lanes to 4 lanes. This project is explained in more detail as a case study below.

The first phase of understanding the major highway corridors through the mountain parks was the development of a framework: the matrix of historical themes and values and their key features, a working document (Figure 2). The matrix was developed to respond to the need to analyze the potential impact of the mountain parks highway projects on cultural resources. As a cultural resource management advisor, it was important for me to collect information to adequately understand the heritage value of the transportation corridors' cultural landscapes. A formal analysis of its potential values and character-defining elements must be undertaken before a formal evaluation is completed.

This analysis had not yet been conducted, although a tentative analysis and evaluation of the potential cultural components of the highways within national parks was initiated by Christina Cameron, former Parks Canada Director General, National Historic Sites directorate, in 1991.[4]

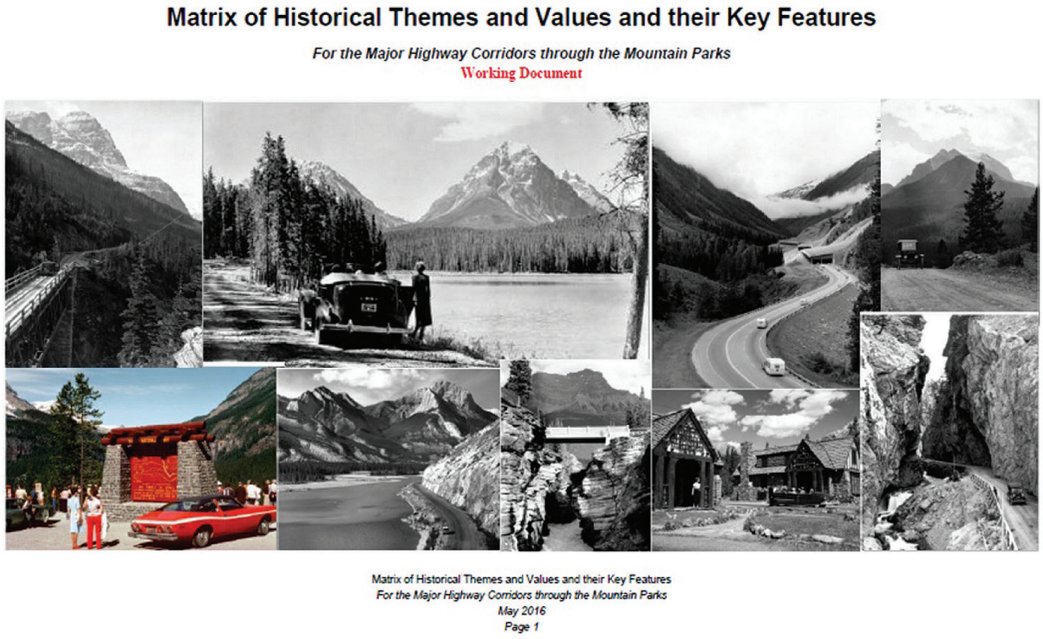

Figure 2. The matrix of historical themes and values and their key features, a working document, cover page, May 2016, Parks Canada Agency.

This was associated with the possibility of transferring[5] the highways within all national parks to Transport Canada. Since the transfer was put on hold, the analysis was never completed and the evaluation never occurred. Ironically, 25 years later, the opportunity to evaluate the cultural components of the highways through the mountain parks is back under cultural resource management's consideration due to the major infrastructure investment program.

The first step taken was to create a multidisciplinary team which was familiar with both the project location and the conservation approach for cultural landscapes. This multidisciplinary team[6] included a historian, national office cultural resource management advisors, archaeologists, and field unit cultural resource management advisors working directly with the mountain parks. All were involved in the production of the matrix of historical themes and values and their key features. Although all members contributed to the understanding phase, and played a key role in the identification of heritage values and key features, historical research played a fundamental role in this process by providing the history of road construction,[7] a detailed chronology, and an overview presentation that drew on the historical literature on twentieth century highways and engineering, travel, aesthetics and Canadian park history.

A conservation approach that followed the principles of the *Standards and Guidelines for the Conservation of Historic Places in Canada (S&G)* was developed to guide the group's discussion during the analysis, which followed the first step of a conservation approach, the understanding phase. To achieve this, an evaluation criteria document[8] was written as a framework for the workshop to outline the proposed steps for the "understanding" exercise of the major highway corridors landscape. Finally, in order to support the discussions, a template was proposed for a matrix which identified the main sectors and provided the sections to be completed by the

multidisciplinary team. The intent of the matrix was to develop a document that would be used by cultural resource management advisors and any person who has to deal with changes through the major highway corridors, to support decision making, evaluate impacts and identify mitigation strategies for cultural resources impacted by federal infrastructure expenditures along these transportation routes.

A case study: the 4-lane project at Rogers Pass National Historic Site, in Glacier National Park

As proposed, the 4-lane project was intrusive to the landscape because it was located in an area with significant heritage value related to the landscape, which is the Illecillewaet Curve. The cultural resource management team analyzed the impacts using the matrix to identify which features would be impacted by the project. This is part of the cultural resource impact analysis process, which is always done by a multidisciplinary team. For this specific project, the team included an archaeologist, a historian, the field unit cultural resource management advisor and myself, as a national office cultural resource management (CRM) advisor. Some archaeological sites were impacted, which included the former remains of a wood snowshed on an 1885 grade, former rail grades, sidings, structures, and refuse deposits associated with the original Trans Canada Highway construction as well as changes in the original design of the highway, which modified historic scenic views.

In order to record the changes that are happening in this significant area of the Trans Canada Highway transportation corridor cultural landscape, the CRM team suggested that the field unit management team carry out a viewscape heritage recording, as a mitigation measure for cultural resources (Figure 3). The field unit agreed to follow this recommendation. Consequently, a viewscape heritage recording is being undertaken in response to the 4-lane Illecillewaet project in Rogers Pass National Historic Site. This document records the landscape through Rogers Pass, but it is not limited to this specific area. The field unit made the decision to be proactive and do this exercise for the whole Trans Canada Highway transportation corridor cultural landscape within Glacier National Park**.** The rationale to extend the scope of work was to provide a reference document that will help the field unit in the future with other infrastructure projects for the highway within this transportation corridor cultural landscape.

The document[9] includes the following:

- an essay[10] to provide a history of Glacier National Park and Rogers Pass National Historic Site viewscapes on the Trans-Canada Highway;
- historic pictures, where existing, of key viewpoints (the intent is to show the evolution of the landscape and related viewscapes since the beginning of the late nineteenth century;
- a heritage value statement to make the link between the features and values that they embody, such as historical, scientific, aesthetic, scenic, cultural and spiritual values; and
- current views of the corridor that include key features such as views, buildings, engineering works, vegetation, etc. (a list of character defining elements was identified and provided in advance to the photographer in order to ensure that the most significant features were captured).

This document records what exists today as well as the evolution of the landscape since the late nineteenth century. It will help especially to manage the future proposed highway work in this area.

Figure 3. Leaving the summit at Rogers Pass National Historic Site on the eastbound, September 2015, photo by Gwénaëlle Le Parlouër.

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Evaluating Diverse Trail Projects Using Standardized Assessment Tools: Conservation Corps Example

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Conservation corps trail assessment background

Service learning corps focused on youth and young adults make significant contributions to the maintenance and management of parks and public lands in the United States. These groups perform activities such as trail maintenance and building, habitat restoration, and other community activities such as disaster response. The effects of conservation corps programs on participants are well documented, with service-learning involvement leading to increased community engagement, positive attitudes toward public lands, and broad social, health, and economic benefits. A study commissioned by the Public Lands Service Coalition, for example, found that youth conservation corps participants experienced growth in areas such as community engagement, teamwork, and self-responsibility after completing the service learning programs. Participants were also more likely than a comparison group to pursue education and careers in natural resource management (Duerden, Edwards, and Lizzo, n.d.). Additionally, maintenance in national parks conducted by conservation corps resulted in significant savings to the agency, up to 87%, on project labor costs (NPS 2012).

Less is known about corps' impacts on environmental outcomes, however, due to the diversity of projects, habitats, and agency partners, and the challenge of measuring this effort. Evaluation of corps' activities contributes to national-level assessments of ecosystem health, increased accessi-

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bility and public lands usage, enhanced visitor experiences, and promotion of human health outcomes. The result is the contribution of a standardized, national-level assessment of conservation corps work, focused on environmental outcomes.

As part of a collaboration with 14 conservation corps working across the USA, this project developed standard assessment protocols for trail maintenance and construction projects on public lands. As part of a three-year evaluation study, data collection focuses on trail activities during 2016 and 2017, and habitat activities during 2017 and 2018. This paper provides an overview of a multi-corps and research institution collaboration, a description of protocol development and associated training materials, and results, highlighting the environmental changes associated with corps work. Tangible outputs also include how these protocols could contribute to other programs or nature conservation goals.

Creation of parallel eco-logic model from best practices

Developing an effective measurement tool involved a review of the best practices using a three-part approach: literature review, surveys with corps partners, and interviews with public land managers. The result, a "parallel eco-logic model," mirrors a traditional logic model; it evaluates effectiveness by measuring environmental change. The eco-logic model addresses both short-term outcomes, such as reduced erosion on and alongside trails, as well as longer-term impacts, such as increased visitor safety. By establishing baseline measurements of environmental change, these short-term outcomes can be quantified in a meaningful way, while paving the way for longitudinal studies.

Development of standard assessment protocols

To standardize measures across a wide range of conservation corps, ecosystems, and project activities, a set of common, useful indicators were identified during the best practices review. Crews addressing these common problems contributed to overall environmental health, such as through the mitigation of forest fuels by removing natural debris. Nine indicators of trail condition and ecosystem health were identified as likely to occur across multiple environments:

- natural hazard or debris (e.g., NPS 2007)
- drainage feature damage (e.g., Ballantyne and Pickering 2015)
- structural damage (e.g., USFS 2011)
- erosional features (e.g., Cole 1983)
- increased tread width (e.g., Leung and Marion 1999a)
- root exposure or damage (e.g., Marion & Leung 2001)
- bedrock exposure
- muddiness or standing water (e.g., Applied Trails Research 2012)
- running water on tread (e.g., Leung & Marion 1999b)

An effort was made to ensure objectivity rather than subjectivity of measurements, considering that the crews were evaluating their own work. For example, rather than using a descriptive scale (i.e., good, fair, poor) of the severity of a trail maintenance concern, an alternative scoring system was adopted that used major, moderate, and minor to describe the extent of the issue. In addition, to accommodate the amount of time, equipment, and expertise available to crews in the field, while still capturing valid data, a rapid, visual assessment approach, based on percent cover, was used in the data collection protocols. Data were collected at the overall project level, as well as at the activity-specific, or plot, level. Plots were set based on the occurrence of a trail event, or feature

that triggered at least one hour of work on behalf of the crew (for example, repair of a damaged drainage feature). To capture the magnitude of environmental change, measurements were made pre-work and post-work at the same locations.

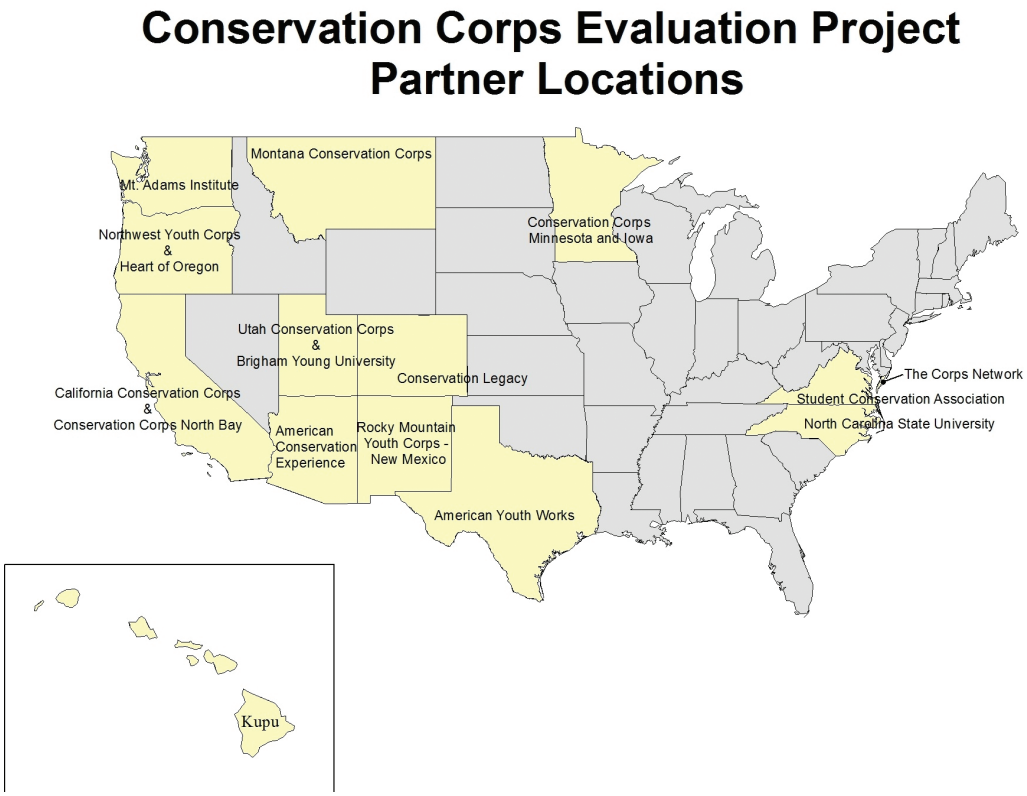
All of these considerations addressed the diversity of corps size, location, project type, and other variables, to ensure measurement applicability across different programs. Furthermore, to engage the corps with the research process, prepare them to collect data in the field, and integrate the evaluation into their operations, tools and training opportunities were provided in the form of an online and interactive training website, ongoing conference calls and communication with corps leaders, and in-person presentation of the trail assessment protocols at The Corps Network Conference, held annually in Washington, DC.

Trail study results

The first season of data collection was conducted from April through August, 2016. In that time, data for 163 trail work projects were submitted by ten participating corps, representing 118,119 crew hours, 773 trail miles, and 1,214 crew members (Figures 1 and 2).

A total of 2,586 trail indicator assessments across 803 plots were submitted over the data collection period. Plots were assigned categories of minimal, moderate, and major, depending on the severity of the problem. These categories correspond to ordinal values of 1, 2, and 3, respectively,

Figure 1. Location of corps that participated in trails data collection.



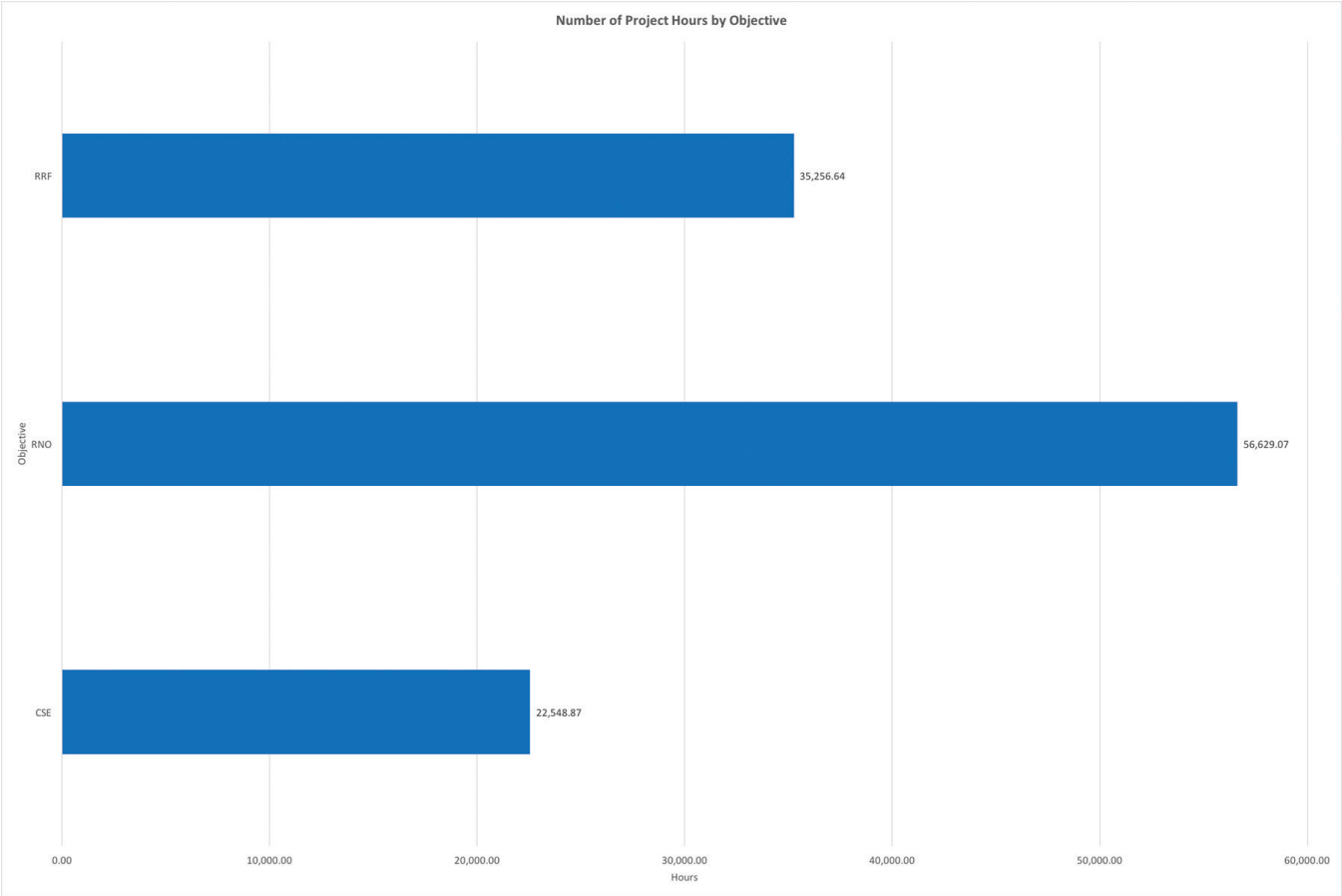


Figure 2. Trail project hours by objective (158 projects reported objective data). CSE = controlling soil erosion, RNO = reducing natural obstructions and hazards, RRF = restoring recreation function.

so that a reduction in value indicates a move toward desired conditions (Table 1). Analysis was based on the ordinal categories.

Implications and next steps

Following the initial season of trail data collection and analysis, findings were shared with participating conservation corps in the form of an overall report, as well as individual reports for each organization. Participant feedback was largely positive, with one site manager noting how they "really liked the content, in that they were able to record more and measure the impact on the trail."

In year two of the study, the focus will shift more toward measuring impacts on habitat restoration activities, primarily involving invasive species removal and forest fuels reduction. A similar approach will be used as for the trails data collection, which will continue in year two. Future research endeavors based on this data and findings may be used to determine larger-scale impacts on communities, economic implications, and ecosystem health. By adopting a standardized approach to measure conservation corps' work on public lands, the value and impact of these efforts can be better understood within a larger and more meaningful context.

Indicator	Number of plots	Average Pre-Score	Average Post-Score	p-value[1]	Effect size[2]
Natural Hazards/Debris	595	2.15	0.84	< 0.001	-0.78589
Erosional Features	469	1.95	0.90	< 0.001	-0.72911
Increased Tread Width	387	1.66	0.90	< 0.001	-0.61355
Drainage Feature Damage	306	2	0.91	< 0.001	-0.73344
Structural Damage	239	1.90	0.92	< 0.001	-0.65461
Root Exposure or Damage	236	1.53	0.89	< 0.001	-0.5826
Running Water on Tread	148	2.32	0.89	< 0.001	-0.77761
Muddiness	105	2	0.74	< 0.001	-0.73973
Bedrock Exposure	101	1.58	1.06	< 0.001	-0.54329

Table 1. Pre-work and post-work plot indicator measurements. Plot scores for each indicator were assigned categories of minimal, moderate, and major, which correspond to ordinal values of 1, 2, and 3, respectively.

Notes on statistical results in Table 1:

1. The p-values came from the Wilcoxon signed rank test for paired samples. This test was chosen as these data did not follow a normal distribution and included two paired dependent variables for which the means were examined. The p-value helps determine the statistical significance of the results. It is a measure of the likelihood of concluding that there is a statistically significant finding when one does not exist. A value of less than or equal to 0.05 is commonly used as a threshold for determining statistical significance.

2. Measures of effect size are standardized measures (between -1.0 and 1.0) that assess the magnitude of this difference. Effect size is often used to determine whether a statistically significant difference is meaningful in practice with effect sizes further from zero, either positive or negative, suggesting greater practical importance. For this statistical test, the criteria for interpreting the absolute value of the r value (or the effect size) are: small ≥ .10, medium ≥ .30, large ≥ .50.

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The Goldilocks Syndrome

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Across protected lands, cutting-edge research is underway. The findings are vital to habitat protection and make for compelling stories and opportunities for STEM (science, technology, engineering and mathematics) learning and civic participation. This conference session aimed to showcase strategies that insure that both staff and visitors benefit from the park-based research. Like Goldilocks, those of us who work in or with parks tend to encounter expectations of scientists that are too big and too small. At times scientists' expectations of what parks can do are too ambitious, and other times they are unnecessarily limited. Presenters asked themselves and each other: what are the questions we can pose as brokers between parks and researchers to get it just right?

Session presenters shared their perspectives, including Jim Pfeiffenberger, Education Coordinator at Ocean Alaska Science Learning Center, Paul E. Super, Education Coordinator at the Appalachian Highlands Science Learning Center at Purchase Knob, Great Smoky Mountains National Park, Brent Everitt, representing the Gulf Islands National Seashore, and Martha Merson from the Interpreters and Scientists Working on Our Parks (iSWOOP). Martha Merson and Brent Everitt

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facilitated the session, asking participants to share ideas and challenges they are confronting. This discussion set the stage for presenters' vignettes of more and less successful efforts. The session concluded with small groups listing tips for park staff to advise scientists for outreach to different audiences.

The challenges in communicating science to the public are many. Participants mentioned several, including the following:

- Research might not result in clear solutions to communicate.
- Managers want guidance.
- One research study involved 12 parks, findings vary, and there's much complexity.
- Climate change plays a role, and that can add a political element.
- Competing priorities for research and other projects mean there are challenges to sustaining momentum. Turnover in administration (at the local or federal level) could also mean waning interest in supporting particular research projects.
- Adverse stakeholder groups could seek to undermine the research, or events where research is discussed.
- Limited staffing: no one person is designated for outreach.

The goal presenters embrace is not only to come up with realistic projects, but to make outreach a routine, standard part of scientists' experience in parks, with options that fit the park's needs as well as scientists' varied skills and interests. Given demands on scientists such as funding research in the field, training assistants, and managing the analysis process, as well as reporting and permitting, well-planned outreach and education can easily get lost in a long list of competing priorities. Park staff are also pulled in multiple directions, but with a protocol to guide conversations early on, education coordinators have found that they can shape outreach and education opportunities that are rewarding for participants and scientists.

Pfeiffenberger's advice to researchers is to find an educator to collaborate with early on. If the same care that's given to a research plan is given to an outreach and education plan, meaningful connections between various audiences can result. In a pinch, yes, if the data have already been collected and even analyzed, parks can probably still help connect researchers with an audience, but if the outreach plan is designed early on, there is time to plan targeted events and create appropriate products.

An example, from a recently funded research project on marine invertebrates, makes the point. With Pfeiffenberger's help, the researchers realized that the significance of their study went far beyond the mussels and clams in the marine environment. Giving the study more context, the proposers related the health of the invertebrates to bear nutrition. The funder awarded nearly $100,000 for outreach (of a grant totaling $800,000), which the project has used in a number of ways: to fund summer interns dedicated to raising awareness of the research; to produce a film that is traveling to Alaska communities, letting adults and youth know about the research in their park; and to produce fact sheets or research briefs that are designed with commercial boat operators in mind, since their livelihoods are intricately tied to the scenic marine habitats where researchers have set up their study. Project leaders have also contracted with an educational designer of virtual field trips, expanding opportunities for teachers and students to connect classroom learning with park-based science.

Paul Super shared details from several citizen science projects that grew out of conversations with researchers about their needs, and opportunities for visitor engagement. Citizen science can take many forms, such as water monitoring, or bird counts. Typically, several elements make citizen science distinct from other education and research projects. Ideally, citizen science results in meaningful, useful data that advance scientific understanding, and may be applied to real-world problems. Objectives include education about specific organisms or systems, the scientific process, or conservation and natural resource management.

A project that uses citizen volunteers to collect data but does not include an educational component is taking advantage of unpaid labor. It might advance science, but doesn't advance science education, or scientific literacy. Paul Super considers the balance. A bird banding station that welcomes in the public and allows visitors to assist with banding sounds more like education for visitors than useful for scientists. However, a project where volunteers are trained in pollinator ecology, and then help with a bumble bee inventory, collecting data at sites that the principle investigator can't (because of time or limited resources), that hits the sweet spot—the project is both educational for volunteers and useful for scientists.

Another example brings together several points. Dr. Chris Carlton planned to collect a certain beetle that lives in fungi in Great Smoky Mountains National Park. After several weeks, he had failed to find the fungus or the beetles he wanted to study. Mr. Super wondered if Dr. Carlton's research would be a good match for a citizen science project.

Before long, Super arranged to have Dr. Carlton give a talk to the Asheville Mushroom Club, which held a fungal foray (Figure 1), and collecting a large bag of stinkhorns, Dr. Carlton's target fungus. Then Super arranged to have a camp group of middle school students paw through the fungi, locating the beetles (Figure 2). In a matter of hours, Dr. Carlton had achieved his data collection goals, Mushroom Club members and middle-school students had learned about an inter-species relationship between fungi and beetles, and both groups had the satisfaction of helping a researcher. Last, the park had a better grasp of the beetle population. In this case, however, the broader public still went about its park visits none the wiser about the research inquiries into the beetles which are fond of stinkhorn fungus.

If citizen science isn't the complete answer, what is? Merson explained that a collection of visuals can be a springboard to building science and visual literacy in parks and other protected lands. The iSWOOP project, piloted at Carlsbad Caverns in New Mexico, brought scientists and park rangers into direct contact. Through field- and classroom-based experiences, the park rangers became conversant in studies of the Brazilian free-tailed bat, led by Nickolay Hristov and Louise Allen. Visitors to the Caverns tend to ask questions about the bats. With information on the park-relevant and park-based research, park rangers could answer questions, but because the scientists shared a library of visual images (animation, video from thermal and high-speed cameras, and 3D models), park rangers could do more. They could reveal something about a natural resource that visitors might not otherwise see. They could invite visitors to observe, predict, and speculate. The visual library served multiple purposes. Park rangers commented on how running a video could act as a hook, captivating attention in the visitor's center. Hristov and Allen have footage of bats flying at sunset, startlingly beautiful. One ranger loved to show a dense cluster of very young bats, prompting visitors to observe differences between infant bats and mature bats. In addition to eliciting surprise and inquiry, scientists' visuals can also function as a springboard for conversations

Figure 1. The Asheville Mushroom Club with the findings of their fungal foray. NPS photo.

Figure 2. Dr. Carlton overseeing the middle school students digging through the stinkhorn fungus to find beetles. NPS photo.

about the role and relevance of research. One ranger used thermal video footage from the roost to reveal the bats' activity level during daylight hours. She concluded by asking visitors how the use of technology might change their park experience. Did it make it better? Different?

Park rangers have attested to the impact of their iSWOOP experiences. For some, access to the visual library was the most valuable component (compared to opportunities to gain new strategies for interaction; Char 2015). Collecting scientists' images is a concrete step toward making research a more prominent and interactive part of visitors' experiences (Table 1); iSWOOP has paired the visual library with direct contact with scientists. Whether or not the latter kind of professional development can be arranged, having an image collection can prompt substantive conversations about the science underway on-site. Establishing a visual library should include agreement on these four elements:

- guidelines for fair use and a credit line (list funder, affiliated university, etc.);
- preferred ways to direct people to more information (e.g., an online researcher biography of the researcher, a website citing published work, or social media);
- where the image library will be located and accessible to those who need it; and
- strategies for promoting the collaboration, if this is of interest to the park and researcher.

Gulf Islands National Park has been proactive about giving visibility to its park-based research projects. Susan Teel, Chief of Resource Education, advises, "Find out about research on charismatic species or resources that need protection. Make the project famous! Use as many outreach strategies as possible." At Gulf Islands, they are serious about using every vehicle at their disposal, including actual vehicles. Researchers are given large signs to attach to their vehicles, indicating they are "Park Researchers." This strategy increases awareness of the park as a site for research,

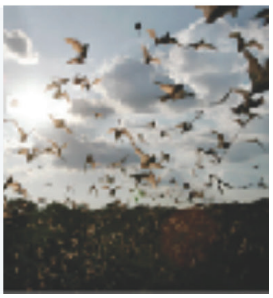
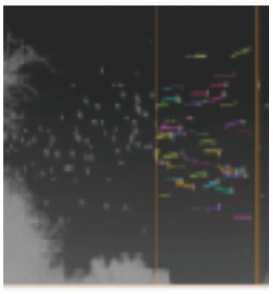
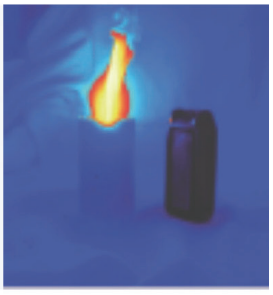
TYPE	PURPOSE	EXAMPLE	MEDIA
High-resolution images of the resource	Make aspects of the resource visible; inspire stewardship	Bottomland hardwood forest	
High-resolution images of the research instrument	Visual reference for scientists' tools; illustrate an innovation	Low-tech artificial nest boxes	
Visual of the researcher in action	Illustrate the science process; put a human face to scientific research	Field assistant removing a bird from the net	
Visual of human interaction with the resource	Model how to handle the resource; get across scale	A migratory songbird whose weight is equal to a car key	
Visual that documents the focus of study	Illustrate what was investigated	Emergence of 1000s of bats from roost	
Video or audio of the phenomenon	Help viewers imagine themselves in the scene	Group dynamics in a dense flight formation	
Image that precedes a graph or visualization	Show the process of data analysis; what the instruments pick up that is then analyzed	Analysis of bat emergence with computer vision	
Graphs, spectrographs or visualization	Show the data and other results of the research activity; illustrate evidence	Each colorful trail shows the trajectory of a bat	
Tutorial visual that demonstrates the technology	Scaffold understanding by showing technology in use with familiar objects	Thermal image of candle and ice pack	
Juxtaposition of any kind	Help viewers imagine themselves in the scene	Hot flame versus a frozen ice pack	

Table 1. Elements of a visual library.

and the signs fuel curiosity and spark conversations. But this is just one of many ways staff try to make the research famous. Their goals are to increase visibility of park-based science and to increase stewardship.

To create a visible, effective campaign, park staff ask themselves these questions:

- Who needs to care?
- What is cute or appealing about this?
- How will caring change visitor behavior?
- Is there an action for visitors to take at the park and at home?
- What message could a magnet or other souvenir carry (e.g., "I slow down for chicks.")?
- How could the research lead to an annual event?
- How can teens be involved?

Known for Turtle THIS (Teens Helping in the Seashore), Gulf Islands interpretation and education division leaders have found ways to highlight research to build public awareness of challenges facing wildlife, for example, light pollution decreasing infant turtle survival, to establish career paths for youth (from intern opportunities to programs in bio-tech, with paid positions), and, perhaps most gratifying, to spark behavior change among visitors.

Applying ideas from Turtle THIS, the park staff came up with simple strategies to build interest in chicks and awareness of humans' impact on their mortality. Publishing a daily count of chick births on a white board in the visitor center leverages interest in baby animals, offers something new all the time, and invites questions about the park's seabird research and management. A magnet souvenir reminds visitors of the action they can take while in the park—"slow down for chicks."

Participants of the session left on a hopeful note with a list of reasons to make park research visible. We have a powerful rationale. Research in parks (and refuges) is federally-mandated, fun, vital to connection with surrounding community, vital to inspire people to live in harmony with nature, and vital to managing resources and making decisions. Nearly any research topic, from stinkhorns to mussels, can find an appreciative audience. Topics like dinosaurs, the plight of young chicks, and the challenges facing turtle hatchlings, are a gateway, an opening to more science learning. Interested readers can obtain a questionnaire with hints for planning and brokering productive outreach and education partnerships by contacting the lead author.

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19

Letting the Landscape Speak: Values and Challenges of "Historic Abandonment" Design and Management at Fort Bowie National Historic Site

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> This Ill-fated Pass, the name of which has long been a terror to the hapless white man who must make his way through. It was no less an object of dread and bloody memory to the Apaches themselves, for in its treacherous windings, many a brave has met his death.[1]

Introduction

Set in the exposed heartland of Chiricahua Apache territory, Fort Bowie played a major role in the Indian Wars (Figure 1). Abandoned in 1894, Fort structures were dismantled by scavenging neighbors and the remaining adobe walls began to crumble, returning slowly to the soil. Congress authorized acquisition of 1,000 acres in 1964 to preserve the fort's ruins and the landscape of Apache Pass. Mission 66 plans for a road, picnic area, parking lot, visitor center—and even an aerial tramway—came and went. Because of landscape challenges and politics, development funds did not materialize until decades later. Without funding, planners instead proposed what was, at that time, an original development philosophy called "historic abandonment." They would leave the landscape untouched and unobstructed by the usual park facilities. This philosophical decision still protects one of the most unusual historic parks. Today, visitors discover the landscape's ongoing influence and the ruined fort on their own as they hike the dreaded Apache Pass. Yet that decision has in the past and still presents significant ecological and management challenges to park managers who strive to preserve viewsheds and ruins and provide minimal facilities for visitors and staff.

Apache Pass is a narrow valley squeezed between north and south components of the Chiricahua Range (Figure 2). It offered a tiny opening to westward travelers during the California gold rush.

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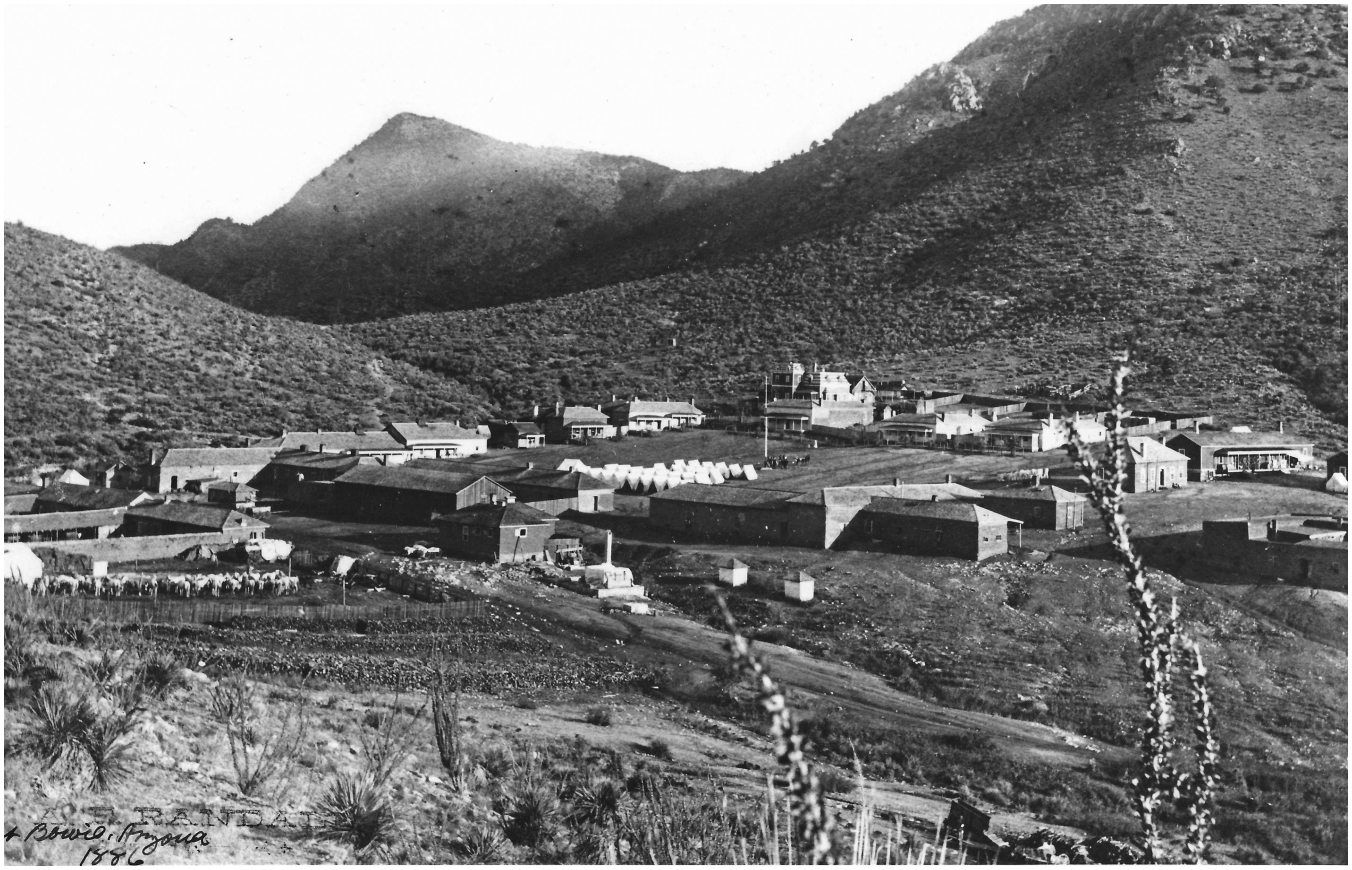

Figure 1. Fort Bowie as seen from Overlook Ridge was located at the eastern end of Apache Pass. Until 1886, Fort Bowie played a central role in the execution and conclusion of the Indian Wars. Image by A.F. Randall, September 1886, at the conclusion of the Geronimo Campaign. View looking southeast. Fort Bowie National Historic Site Photo Collection

Apache Pass's most important feature, however, is Apache Spring, a rare perennial water source in the southeastern Arizona desert.[2] Possession and control of that water and surrounding landscape were critical for both Chiricahua Apache who regularly camped at Apache Pass and for the U.S. Army who recognized its strategic military value during the Civil and, later, Indian Wars.

History

This landscape was acquired with the Gadsden Purchase in 1854. John Butterfield proposed a stagecoach line across the Southwest and through the pass to carry mail and passengers between Saint Louis and San Francisco. Cochise, the Apache leader of the Chokonen band, allowed Butterfield to build a stage station near Apache Spring and to transit unmolested.

In 1861, that agreement fell apart when a young lieutenant from Fort Buchanan falsely accused and deeply offended Cochise of abducting a young boy. The confrontation at the stage station rapidly escalated into seized hostages on both sides; both sets of hostages were murdered later in retribution. The confrontation and murders aroused a 12-year conflict between Cochise and the U.S. military and all Americans who passed through or settled in the Chiricahua territory.[3]

Shortly thereafter, southern states declared war on the North, and all military troops departed from the region. In 1862, California Volunteers marched eastward to defend Arizona and New

Figure 2. Apache Pass is a narrow defile squeezed between north and south components of the Chiricahua Mountain Range. The Spanish Army called it "El Puerto Del Dado" or the Gate of Chance. It offered a tiny opening to westward travelers during the California gold rush. This western approach to Apache Pass illustrates the wildness of the park landscape. View looking east. Arrow points to location of historic Fort Bowie as seen in Figure 1. Photograph by R.L. Pinto, 2017.

Mexico from incursions by Confederate troops. After a long trek across a waterless plain, 300 Volunteers with their animals approached the stage station and spring. Cochise's band supported by other Apache reinforcements were ensconced in the surrounding hills; they attacked, firing down upon the men from behind constructed stone breastworks. Finally, with the aid of two mountain howitzers and a daring assault up the nearby ridge, the troops routed the Apaches and gained access to that critical water. Those killed at the Battle of Apache Pass became the first of many interred in Fort Bowie's cemetery.[4]

Commander Carleton, recognizing the importance of Apache Pass as a transportation route and a vital source of water, ordered establishment of a permanent fort to secure its location. Fort Bowie played a central role in the execution and conclusion of those Indian Wars through 1886. From the summit of Bowie Mountain, heliograph messages were transmitted to those troops who trailed and finally captured Geronimo and the last of the Chiricahua Apaches.[5]

Development

Fort Bowie was originally proposed as a national monument in 1937. World War II and the Korean War, however, intervened before the proposal could receive serious attention. Finally, in 1964, Congress passed legislation authorizing NPS to acquire private lands in Apache Pass. The legisla-

tion limited the park to 1,000 acres and allocated $500,000 for purchase and development of the site. The incipient unit would be administered by Chiricahua National Monument, 30 miles away.

The job of transforming Fort Bowie from paper to reality was handed to a young and energetic acting regional historian, Bill Brown. Bill, who recently passed away, was a wonderful, highly opinionated, and brilliant philosopher. A significant player at many historical sites in the Southwest, he became a key man during the early years of the Alaska parks. He also wrote for the George Wright Society journal, *The George Wright Forum,* in the guise of "Letters from Gustavus."

Brown was captivated by the prospect of creating a park in this unaltered, windswept landscape. Before a planning team was assembled, he penned a philosophy for Fort Bowie that is positively lyrical among NPS documents. His words, besides being powerful, have defined this most unusual park ever since.

> Long before the master plan is completed, decisions will be made affecting the ultimate development of Fort Bowie. Some decisions have already been made—in the form of commitments to Congress, landowners, and the Bureau of Land Management. Before the fate of the site is further sealed, the warp fully strung on the loom, it seems to me that a statement of doctrine is needed to establish a governing philosophy of development at Fort Bowie.
>
> The eroded adobe ruins of the first and second forts, the ruins of the stage station, the Apache Spring, and the ruts in the soil by which emigrant and stagecoach may be followed, all set against a natural backdrop nearly untouched by the hand of man, afford a unique opportunity to visualize the drama and meaning of an important segment of frontier history.
>
> The overriding fact about Fort Bowie is its impact on the emotions of the visitor. To be alone at Fort Bowie is to be frightened. The complex of looming mountains and rough terrain, of heat and hostile vegetation, of rattlesnakes and forsaken ruins in the setting of awful isolation produces an overwhelming unseen dread.… In short, Fort Bowie is haunted.
>
> Fort Bowie and Apache Pass do cast a spell—a spell compounded of isolated, wild atmosphere and sinister mood. This is a fragile thing.… Here, at no other historic site in the system, the factors of isolation and covering topography make possible complete exclusion of intrusive developments from core historical sectors of the site.
>
> To the extent possible, Fort Bowie should be left in its wild state. The ruins should not be cleaned up and manicured. Granted the central ruins of the Fort must be accessible, they must be stabilized, and bona fide trash and junk removed. But let our touch be subtle. Let us not desecrate the forsaken, lonely mood that smites today's visitor.[6]

Despite Brown's exhortations, this was still the era of Mission 66 when even basic development plans included access roads, visitor centers, parking lots, paved trails, and picnic areas. The challenge for developing Fort Bowie was, again, the landscape. Limited by the topography of the sur-

rounding hills and mountains, crossed by three separate washes that during summer storms became raging torrents, the property was already crowded with historic sites. Little room remained for the typical park facilities.

Planners did try, however. With expectations of hundreds of thousands, planners designed a road that would pass by every site and ruin. Visitors would be transported in a replica stagecoach or lifted to the Fort via an aerial tramway that would have been visible throughout the park.

Fortunately, fiscal tightening during the Vietnam War eliminated development funds and Fort Bowie went into a deep freeze. Nonetheless, the curious and the historically minded continued to venture down a primitive trail to find Fort Bowie's hidden ruins and its stories. With almost universal acclaim, these hikers loved the challenge of discovery and thrilled to this landscape of historic abandonment.

In 1971, Brown offered a second proposal. "Why not view Fort Bowie's primitive condition as an asset for those visitors who like the primitive? Why not open it up on purpose to those sweat-it, hiking sons-of-guns who are always trying to get out of the crowd anyway?"[7]

The framework for management of Fort Bowie would be as a primitive historical area to preserve the atmosphere of wildness and the sense of historic abandonment. Subsequent planning abandoned Mission 66 concepts and embraced the notion of a light touch. Access would be restricted to a 1.5 mile trail leading from the county road to the spring and fort; the only non-historic structure would be a 10 x 10 ft homegrown, adobe brick contact station built near the ruins.[8]

Consequences

NPS administrators embraced the primitive framework in all its manifestations. Many assumed that a primitive site required only primitive funding. For years, the lone park ranger lived in a trailer off-site. Though frequently proposed, Fort Bowie never acquired its own superintendent, instead remaining an administrative subunit beneath Chiricahua National Monument. Plans for a legitimate visitor center were postponed for 20 years. The present one, built by the park ranger and maintenance man, is set on the hill overlooking the ruins and contains one small office and museum to display historic artifacts from the site and information.[9]

A second challenge arose from a 1960s belief that cattle were a historic component of the region and therefore should be part of the historic scene. During early negotiations, planners agreed to allow cattle grazing outside of the adobe ruins. The hike from road to fort exposed visitors to roaming animals including bulls. Many unfamiliar with western tradition were frightened by the large, and sometimes, aggressive animals. While the Park Service erected fences to protect the ruins, livestock often broke down those restraints and trampled fragile adobe remains. NPS was fearful of challenging the local ranchers, until, in 1997, a Department of the Interior solicitor's legal opinion confirmed NPS authority to exclude those cattle.[10]

The significance of Apache Pass rests in its visual impact; the landscape with its short and long views still inspires those same emotions of fear and impending dread as it did for historic travelers. By the mid-1980s, 120 years of cattle grazing, climate change, and fire exclusion had caused a significant shift in vegetation type and structure. Where once had been open grasslands, there are now valleys filled with mesquite forest. Visitors could not see the ruins for the thickets of shrubs and trees. Those visual impacts had been severely reduced. In the early 1990s, rangers began a

mesquite-cutting program and cleared 32 acres by hand to restore important viewsheds along the trail and around the Fort.[11]

Preservation of the adobe ruins was a major directive from establishment legislation and the most difficult problem confronting park managers. Once exposed to the elements, torrential summer thunderstorms removed increasing percentages of adobe material. For over 20 years, material specialists tested quick-fixes to stop adobe loss including preservatives, water repellants, soil cement caps, and sacrificial mud caps. Finally, in 1988, rangers encapsulated the ruins with a mud coating covered by lime plaster (Figure 3). They colored the lime plaster to match the local soil and replaced the coating every 10 to 12 years. So far, the encapsulation provides 100% protection of historic materials.[12]

Conclusion

The concept of historic abandonment has always been the guiding light for planning and development of facilities and interpretation. But the devil is always in the details. The management balancing act has not always been successful. Development is still primitive but the administrative attention paid to larger protection issues at the historic site also remains primitive.[13]

Figure 3. Lime-plaster encapsulated ruins of the historic corral wall at Fort Bowie NHS. Rangers colored the plaster to match the local soil; the lime coating is beginning to wear away exposing the uncolored plaster. View looking southeast. Photograph by R.L. Pinto, 2017.

Do we have before us the untouched landscape that Bill Brown embraced 50 years ago? No. There have been trade-offs necessary to accommodate other park management needs. Yet to a significant degree, the landscape of Apache Pass appears much as it was 60 years ago.

Cultural landscapes and resources need protection and oversight; the present visitor center should be located within view of the ruins. Hikers need a safe environment during their journey of discovery and should be rewarded with appropriate learning opportunities once they have achieved that end. No one likes the lime plaster coating; it clearly does not add to the sense of Historic Abandonment. At present, the coating is the only option that preserves the remaining adobe resources, a legislation stipulation.[14] Without the coating, specialists estimate the ruins would disintegrate within the next 20 years.[15]

Some experts have argued that the adobe ruins should be exposed and allowed to return naturally to the earth, perhaps a fitting conclusion within the concept of historic abandonment. Yet that perspective could also be interpreted as selfish for those who have already experienced the ruins. Cultural resources are unique and once eliminated are not reversible. Fort Bowie's historic site will only continue to tell its tales to those future hiking sons-of-guns as long as we preserve all of the character-defining elements within that landscape.

Endnotes

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20

Stakeholder Sentiments about Adaptation Strategies for Historic Buildings at Cape Lookout National Seashore

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Introduction

The National Park Service (NPS) is charged with minimizing the loss of culturally significant material which the National Historic Preservation Act of 1966 defines as historic districts, historic sites, historic buildings, structures and objects (NPS 1998). These cultural resources can hold and portray multiple values, including research and discovery, introspection, conserving cultural memories, and ancestral connections (Schupp et al. 2016). Moreover, cultural resources can serve as primary data sources for human responses to environmental change (NPS 2014). However, cultural resources are vulnerable to threats posed by climate change.

In a recent study, Peek et al. (2015) documented that over $40 billion worth of assets (infrastructure and cultural resources) are at "high risk" from climate change impacts by 2100 under 1 m of sea level rise, given vulnerabilities to submersion, saturation, dissolution, inundation, and erosion. The NPS Climate Change Response Program has dedicated efforts to determine appropriate adaptation strategies for cultural resources in response to Policy Memo 14-02, which suggests managers prioritize adaptation actions for the most vulnerable and most significant cultural resources (NPS 2014). Current adaptation strategies being considered include one or a combination of the following: leave things as they are, take off-site actions, manage the change, improve resilience, relocate, document and prepare for loss, and interpret the change (Rockman et al. 2016). Although vulnerability assessments can help managers determine the resources most at risk from such coastal impacts as storm-related flooding and erosion or sea level rise, currently there are no strategies for distinguishing significance among cultural resources listed on the National Register of Historic Places (NRHP). For example, buildings listed within a historic district on the NRHP are currently considered to hold the same cultural significance.

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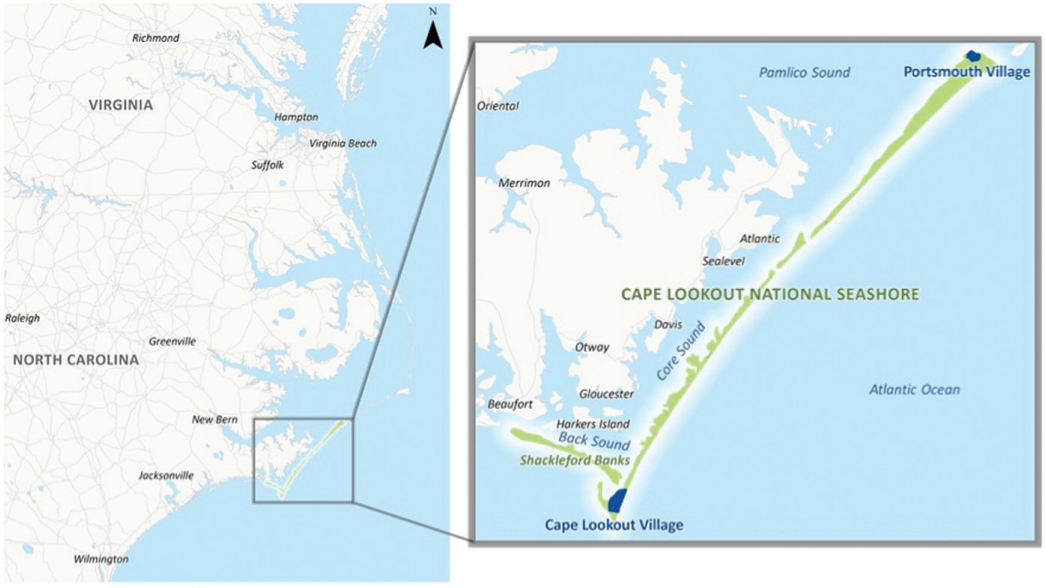
As cultural resources may hold different meanings to diverse stakeholders, there is a need to assess stakeholders' place connections, their preferences for adaptation strategies, and how adaptation strategies may alter stakeholders' place connections. Theoretically, place connections are described in the literature on sense of place (the symbolic meanings of landscapes; Stedman 2003), place attachment (the role of personal and familial identities and personal dependence on a place to form connections; Low and Altman 1992) and place meanings (the instrumental, utilitarian and intangible values that are contingent on relationships with a place; Davenport and Anderson 2005). Research on place connections has been common within natural resource planning and management for several decades (see review by Farnum, Hall, and Kruger 2005); however, such applications are largely absent within cultural resource planning and management. This paper presents a brief overview of stakeholders place connections to the two historic districts (Portsmouth Village and Cape Lookout Village) at Cape Lookout National Seashore (Figure 1), as well as their preferences for adaptation strategies, and perceived impacts to their place connections from adaptation strategies.

Historic accounts of the villages reveal stories of human resilience and relationships to the land and the sea, which began with ties to maritime commerce and federal maritime administration. The communities that emerged were challenged with living in isolation in a harsh environment, and many of the buildings were adapted to changing conditions (and changing occupational purposes). The NPS acquired the lands and buildings in 1966 and instituted either 25-year leases or life estates for buildings with ownership documents. In 1971, the last permanent residents left Portsmouth Village, and it was listed on the NRHP in 1976. In 1972, the Cape Lookout Light Station Complex was listed on the NRHP, followed by the Cape Lookout Coast Guard Station Complex in 1988. In 2000, the two complexes, along with 14 of the residential buildings, were designated as a historic district. Although all leases and life estates have expired, many families who used the buildings as vacation houses still reside in nearby communities. All of the buildings, with the exception of the Coast Guard Station Complex in Cape Lookout Village, have been assessed as having "high" vulnerability to climate change impacts (Peek et al. 2015).

Figure 1. Cape Lookout National Seashore (map created by K. Bitsura-Meszaros).



Methods

Separate efforts were implemented between 2015 and 2017 to collect the opinions of three distinct stakeholder groups: semi-interviews with individuals known to have direct or indirect connections to the buildings ("community members"); on-site structured interviews with visitors ("visitors"); and online survey research with members of partner organizations ("partners"). Community members (n = 18) were identified through strategic sampling (lists provided by NPS managers and the director of one partner organization), chain-referral sampling, and interviews (open-ended questions) were audio-recorded, transcribed verbatim, and analyzed using thematic coding techniques with peer debriefing sessions to enhance data quality. Visitors (n = 145; 85% response rate) were intercepted within each district on randomly selected days, and interviews were audio-recorded, transcribed verbatim, and coded using content analysis for statistical analysis. Some questions were open-ended and others included Likert-type scale response options. Partners (n = 274) were emailed a pre-study notification, an initial request, and two reminder requests, each with a link to a survey questionnaire (all members of both organizations with valid email addresses were asked to participate). Data were downloaded from the survey administration software for statistical analysis. Although an accurate response rate cannot be determined for the partner survey because one partner organization administered the survey and did not share their membership list, a 53% response rate was calculated based on responses to membership affiliation for the other partner organization that shared their membership list.

Results

Community members interviewed included individuals who were born on the island or descendants of former residents, had previously owned homes in one of the villages, were raised in the area who frequently visited or vacationed within one or both districts, and nearby residents who volunteered or temporarily worked for the NPS within the districts. For these individuals, Cape Lookout National Seashore and the historic districts, particularly the Cape Lookout Lighthouse, are symbols of "home" steeped within intangible cultural resource values that connect them to traditional way of life on the "Banks" (the islands). The place meanings that emerged through their narratives align with the constructs of personal identity, family identity, community identity, and place dependence, all of which are linked to sets of cultural resource values. For example, our participants identify with the history of Cape Lookout National Seashore, and the symbolism of the lighthouse, which stir deep emotions and yield strong sentiments of what it is like to grow up near and with the sea. Such identity represents a strong sense of place that is not necessarily dependent on the physical remains, as exemplified in such statements as "To me the greatest resource is the connection our crowd still has.… It's not tangible.… I think it's within the people really, the cultural resources" and "If all the buildings went away and the lighthouse fell down … I'd be sad, but I'd still have the same feeling about the area whether those resources were there or not."

With such strong intangible place connections (with the exception of the connections to the lighthouse), it follows that community members expressed a preference for maintenance of the historic buildings, robust documentation, and increased interpretation. Moreover, there was a general acceptance of the inevitability of loss to climate impacts and the limited potential of off-site engineered solutions like beach nourishment: "There's nothing they can do… I don't think there are any solutions except to let nature take its course." Yet, community members were concerned about deferred maintenance (what they called "neglect") and would prefer strategies that focus on enhancing the structural integrity of the buildings: "I think it's vulnerable to neglect. I think neglect is the biggest deal.… It's a battle of corrosion, it's a battle of salt and sun and all sorts of

stuff." Additionally, community members were not in favor of substantial structural (moving or elevating), as they feared it would change the meanings instilled in the buildings: "I'm not sure it would help to raise 'em or move 'em … I'm not sure what the value is in trying to raise a house 'cause … you gain saving everything above that level, but you lose how it is people used to live. You don't know what it really looked like."

The majority of visitors intercepted were first time visitors (56%), and 48% were 50 years of age or older (16% were younger than 40). Visitors' place connections (measured from 1, strongly disagree, to 5, strongly agree) were strongest in terms of perceived importance of the history and culture to the nation, and for future generations (Table 1). Mean responses to personal identity, fami-

Table 1. Visitor and partner organization member place connections.

Questionnaire items*				Frequencies				
	N	Mean	SD	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Visitor Interviews								
I feel that Cape Lookout is an important part of our nation's history.	138	4.46	0.664	0.7	0	5.1	40.6	53.6
I have a personal attachment to the history and culture here at Cape Lookout.	137	3.14	1.346	14.6	19.7	23.4	21.9	20.4
There are important family memories tied to the history and culture associated with Cape Lookout.	136	2.92	1.521	24	22.8	8.8	22.1	21.3
It is important that the historical and culture resources at Cape Lookout is preserved and protected is important for future generations.	136	4.65	0.538	0	0.7	0.7	31.6	66.9
I believe that the history and culture associated with Cape Lookout are unique and unlike others in the region.	138	4.22	0.774	0	1.4	16.7	39.9	42
I get more satisfaction from visiting Cape Lookout than from other outer banks historic/cultural sites.	126	3.53	0.961	0.8	9.5	46.8	21.4	21.4
Partner Survey								
Cape Lookout is an important part of our nation's history.	262	4.52	0.653	0.4	1.1	3.1	37.4	58.0
I identify strongly with Cape Lookout.	262	4.13	0.916	2.3	2.3	15.6	40.1	39.7
Many important family memories are tied to Cape Lookout.	262	3.48	1.386	13.4	13.0	15.6	27.9	30.2
Preserving the history and culture associated with cultural resources at Cape Lookout is important for future generations.	262	4.69	0.613	0.8	0.4	2.3	22.1	74.4
The history and culture associated with Cape Lookout is unique and unlike other historic barrier island communities in the region.	262	4.33	0.793	0.5	1.5	13.4	34.0	50.8
No other place can compare to Cape Lookout.	262	3.95	0.985	1.5	6.1	23.7	33.6	35.1

*Measured on 5-point Likert-type scale where 1 = strongly disagree and 5 = strongly agree.

ly identity, and place dependence measures were still favorable but reflect greater variation among respondents. Visitors were asked to describe how three specific adaptation strategies (removing, moving, and elevating buildings) would affect their experience. The majority of visitors indicated that their experiences would be most negatively affected if buildings were removed (79%), while elevating (59%) would have no impact on their experience. Visitors were more divided in their perception of how moving buildings would impact their experience (48% negative impact and 33% no impact). Interestingly, few respondents felt that they wouldn't like but would understand the need to remove (3%), move (10%), or elevate (10%) buildings.

Of the partners surveyed, the average age was 65 years and 85% had never owned or held a lease on one of buildings. Similar to visitor place connections, partners felt strongest about the importance of history and culture to the nation, and preserving them for future generations (Table 1); however, partner responses to place identity (personal and family) and place dependence items were more favorable than visitor responses. In terms of adaptation strategies, partners perceived managing change (e.g., through planting vegetation to reduce erosion, or building boardwalks to access buildings) and interpreting the change as most desirable (Figure 2). Additionally, these strategies were perceived as slightly enhancing partner place connections. Moving buildings, taking off-site action, leaving buildings as they are, and documenting to prepare for loss were the least desirable adaptation strategies, and the ones that were perceived to detract from partner's place meanings.

Discussion

The goals of this research were to document different stakeholder groups place connections to vulnerable coastal cultural resources, preferences for adapting the resources to pending climate change threats, and perceptions of how adaptation strategies would affect place connections, using the two historic districts at Cape Lookout National Seashore as the case study. Results highlight deep place connections among individuals with known ties to the buildings located within Cape Lookout National Seashore's two historic districts, and that those connections are primar-

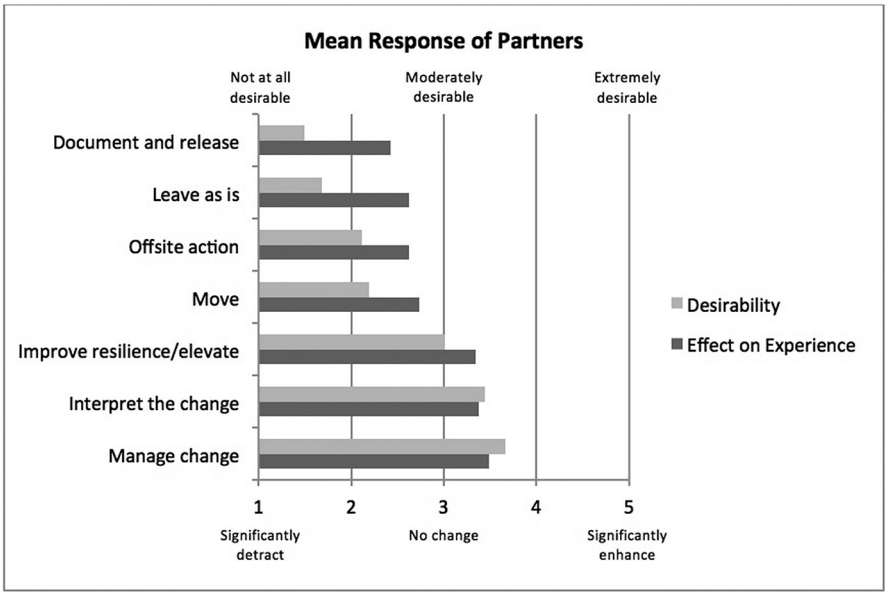


Figure 2. Partners perceptions of adaptation strategies and associated impacts on place connections (n = 264).

ily manifested within intangible meanings and values. While both visitors and partners perceive that the physical cultural resources are important to the nation's history and should be preserved for future generations, visitor place meanings (personal identity, family identity, and place dependence) were generally weaker than partner's. However, results illustrate that both stakeholder groups typically held the weakest connections in terms of family identity. This is likely due to the fact that the last permanent residents occupied buildings over 40 years ago and that all life estates and leases have expired, which suggests that direct familial connections to the resources may be declining and that the NPS should consider expediting efforts to document descendant stories.

Community members and partners preferred keeping the buildings in their current condition, which includes regular maintenance and stabilization, as well as small landscape changes, like planting vegetation to reduce erosion and constructing boardwalks to access buildings. These preferences likely reflect an acceptance of the inevitability of loss from climate change impacts, as well as the importance of maintaining the historic integrity of the buildings. Although visitors were not explicitly asked about these specific strategies, their preference for elevation may suggest a similar preference for strategies that result in the least change. Future research is needed to explore visitor preferences of a fuller range of adaptation strategies. Regardless, the consistency in preferences among two of the stakeholder groups suggests that management decisions may be not be controversial, provided that perceptions of blind neglect from deferred maintenance are remedied first. It will be important to explore stakeholder perceptions of when a building should no longer be maintained and released to the forces of nature.

Study results showed that the preferred management strategies will be those that affect place connections the least. For community members, the intangible values will remain even after the buildings are lost to the sea. However, the symbolic meanings held within the lighthouse suggest that efforts should be made to prioritize actions that retain the structure on the landscape. Although many visitors felt that actively removing buildings from the landscape would negatively impact their experience, the majority of visitors were intercepted near the lighthouse and were mostly unaware of the existence of the other buildings in Cape Lookout Village or Portsmouth Village. This may also explain why moving and elevating buildings were most frequently perceived to have no impact on visitors' experiences. For partners, managing and interpreting changes associated with climate-related impacts were perceived to have a slight positive impact. Again, this may suggest the need to expedite documentation and communication efforts to enhance the telling of the human stories associated with the districts. Regardless, these findings suggest that some adaptation strategies deemed appropriate for addressing climate change (Rockman et al. 2016) may not change and can even enhance stakeholders' connections to vulnerable cultural resources.

Conclusions

Impacts from climate change on cultural resources present significant challenges to the NPS' ability to minimize losses of culturally significant material. In exploring stakeholder place connections, preferences for adaptation strategies, and perceptions of how adaptation strategies might alter place connections, this paper highlights a general acceptance of the inevitable losses to tangible resources from climate change, and a preference for strategies that least impact the historic integrity of those resources. Moreover, such strategies may enhance place connections, at least in the short-term. However, given the realities of insufficient funding (evidenced by the deferred maintenance backlog within the NPS), additional decision guidance will be necessary, such as determining the point at which investment in maintenance and stabilization should be stopped, assessing key criteria for prioritizing such actions when funding becomes available, and optimiz-

ing longer-term planning efforts aimed at retaining as much historical significance within the landscape as possible.

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21

Connecting People, Nature, and Culture through Metropolitan Conservation Alliances

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This is about three powerful ideas and how they can be brought together in synergetic ways. The first of these is a movement to encourage urban people to get out into nature. The second is metropolitan conservation alliances. The third is a renewed effort to integrate the protection and interpretation of cultural heritage and natural heritage.

Getting urban people out into nature near where they live

The first powerful idea is that people need nature: Direct exposure to nature is critical for healthy childhood development and the physical and mental health and wellbeing of both children and adults. This is backed up by a solid body of scientific evidence, which Richard Louv drew upon for his influential 2008 book, *Last Child in the Woods,*2 and it is the basis for the Healthy Parks Healthy People movement, which started in Parks Victoria in Australia and has influenced many other conservation agencies, including the United States National Park Service.

Health benefits are only one side of the coin, however, and the one that gets a lot of attention. The other side of the coin is political: Nature conservation locally and globally depends on urban voters, donors, and communicators. Urban people are more likely to support conservation everywhere when they appreciate nature where they live. In a fast-urbanizing world, nature is being squeezed and people are losing contact with it. Spending a lot of time on digital screens doesn't help.

Metropolitan conservation alliances

The second powerful idea is metropolitan conservation alliances, which promote cooperation among organizations that work to conserve their region's natural assets and educate people about them. The best-known of these alliances, which has served as a model for others, is Chicago Wilderness, a coalition of some 200 organizations that grew out of efforts that started

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in the 1960s and was officially launched in 1996. Its region covers part of four states—Illinois, Indiana, Michigan, and Wisconsin—which has more than 10 million people and over 545,000 acres (220,000 hectares) of protected areas.

Chicago Wilderness is broad-based. Its members include national, state, and local government conservation agencies, municipal and county governments, conservation and natural history associations, zoos, aquariums, botanic gardens, universities, and private companies.

It is also broadly focused. Currently, its emphasis is on oak ecosystems (oaks are keystone species in the region), a dozen other "priority species," water as a resource, applying technology and data to accelerate collaboration, working with landowners to undertake conservation actions, and "Beyond the Choir." The latter has to do with "actively engaging the cultural, generational, economic, and geographic diversity of our region … We reach beyond the choir to create and sustain a strong conservation constituency."[3] There is also a cross-cutting theme on climate change.

Other metropolitan conservation alliances in the United States have similar membership profiles, but often with somewhat different purposes and activities. In other countries, metropolitan conservation alliances tend to have narrower structures or purposes.

What I found missing

Before I get to the cultural side of the nature-culture equation, I want to relate what I found when I went to cities in different parts of the world and visited organizations responsible for protecting and interpreting nature.

As the project leader and author of an IUCN publication, *Urban Protected Areas* (2014),[4] I visited museums, zoos, aquariums, botanic gardens, science centers, museums of regions and cities, and protected areas in several U.S. cities, as well as London, Paris, Beijing, Shanghai, Hong Kong, Sydney, and Melbourne. I was struck by a general lack of systematic cooperation among these organizations. I was also struck by the failure of most museums and similar institutions to show visitors where to go to experience nature where they live, a lack of exhibits about local nature, and the failure in many such institutions to sell books on nature in their regions. Let me describe these one by one.

Museums should encourage their visitors to go to local natural areas to experience the "real thing." This is where almost all the institutions visited fail, although little cost need be involved. Once visitors become interested in what they have seen in a museum, garden, or zoo, they could be directed to natural areas close to where they live to see the "real thing."

There are fine exceptions. For example, an initiative in Chicago could easily be replicated widely. On summer weekends, rangers from nearby Indiana Dunes National Lakeshore are posted at the entrance to the Field Museum of Natural History to show visitors what they will find at the Lakeshore, as well as in natural areas close to their homes.

More and better exhibits about local and regional nature are needed. Exhibits often focus on the exotic, giving visitors the impression that nature is someplace else. Also, most zoos and many botanic gardens are organized by kinds of animals and plants, rather than by habitat, biome, region, or country. In some cases, there is virtually nothing focused on the natural environment of the region.

There are good examples of what can be done. For instance, the Oakland Zoo is building a California Trail, which will focus on the state's natural environments and hold living exhibits of large mammals and birds found in the state. The American Museum of Natural History in New York City has a Hall of New York State Environments focusing on Stissing Mountain and the farming village of Pine Plains, 90 miles (145 km) from the city.

Museums should sell books about nature in their city and region. Selling books in museum stores may seem a minor thing, but if even a very small fraction of the visitors to a major museum are interested in natural history guides and other books about nature in their localities, they are certain to include people whose lives will be changed by reading and using those books. Digital media supplement print publications and may replace some of them, but there is no digital substitute for holding a beautifully illustrated guide to local birds or trees.

Unfortunately, few stores at natural history museums or similar institutions sell more than a token selection, if that, of books about local and regional nature, even when many such titles are in print. Good examples can be found of what can be done, but they are few and far between.

The movement to bring nature and culture together

The third powerful idea is integrating natural and cultural heritage. In the conservation field, this has a long history in efforts to understand and protect cultural landscapes, that is, landscapes that have been influenced or shaped by human involvement.

World Heritage. The World Heritage Convention, adopted in 1972, provides for designation of cultural, natural, and mixed World Heritage Sites. Although both nature and culture fall under this single international instrument, they have usually been treated separately, with the exception of mixed sites, as well as cultural landscapes, which were recognized for inclusion in the World Heritage List in 1992. (As of now, there are 814 cultural, 207 natural, and 35 mixed sites inscribed, of which 88 are cultural landscapes.)

In recent years, there has been growing interest in bridging this divide, both in conceptual and management terms. Kishore Rao, then Director of the World Heritage Center, wrote in 2015 that "the immediate impact of a cultural site on visitors hinges upon the way it fits into its natural setting. This goes hand in hand with the realization that natural sites are frequently marked by longstanding cultural connections and biocultural heritage."[5]

The three official Advisory Bodies named in the World Heritage Convention are working with UNESCO to mesh nature and culture in the World Heritage System. These are IUCN (International Union for Conservation of Nature), ICOMOS (International Council on Monuments and Sites), and ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property).

More specifically, IUCN and ICOMOS are leading on connecting practice, IUCN and ICCROM are responsible for a World Heritage leadership development program integrating nature and culture, and IUCN and ICOMOS are featuring nature-culture integration at their respective major conferences.

United States National Park Service. A similar movement has been taking place in the U.S. National Park Service (USNPS). In 2012, at the request of then Director Jonathan Jarvis, the

Science Committee of the USNPS Advisory Board reviewed the goals and policies of resource management in the USNPS. The Committee's report noted that since the last such broad policy review in the 1960s, additions to the System have included "significant cultural, recreational, and urban resources. The cultural values and interests held by the American people have greatly broadened, generating pressing demands for diversity in the National Park Service and for relevancy of the National Park System to new generations of citizens."

The report pointed out that, "Many if not most parks include both natural and cultural resources, and many park resources feature natural and cultural attributes — Yellowstone bison are both ecologically important and culturally significant. Parks exist as coupled natural-human systems. Natural and cultural resource management must occur simultaneously and, in general, interdependently.… Artificial division of the National Park System into 'natural parks' and 'cultural parks' is ineffective and a detriment to successful resource management."[6]

Late in 2016, in response to the Advisory Board's recommendations and further consultations, Jarvis issued Director's Order 100, "Resource Stewardship for the 21st Century."[7] Section 4 of the Order sets out policies for integrating natural and resource stewardship, including creating incentives for funding projects that integrate nature and culture; requiring nature-culture integration in stewardship strategies; and collocating natural and cultural resource operations where possible.

Metropolitan alliances. In metropolitan conservation alliances, the movement to bring nature and culture together hasn't yet penetrated very far, even though some of their key partners are agencies such as the U.S. National Park Service that have given priority to integrating nature and culture.

In some cities, metropolitan conservation alliances have counterparts in metropolitan *cultural* alliances, at least in the United States. These tend to concentrate on the visual and performance arts and sometimes literature, but rarely include history or other cultural heritage.

Natural Neighbors

These findings led to our launching the Natural Neighbors initiative, which aims to introduce greatly increased numbers of people to the natural and cultural heritage of the regions where they live. It does this by promoting alliances within metropolitan areas among conservation and historic preservation agencies on one hand, and museums and similar organizations on the other.

Natural Neighbors is a concept as much as an initiative. There is no template; it is not a kind of franchise operation.

Originally, the rationale behind Natural Neighbors focused on nature. But to those of us who were organizing a pilot Natural Neighbors project in Los Angeles, it soon became clear that urban people are more likely to have a sense of belonging and of civic responsibility when they appreciate their region's history and culture, as well as its natural environment.

Although Natural Neighbors is still evolving as a concept and in practice, its rationale remains the same: In most metropolitan areas, several kinds of institutions, along with agencies responsible for nature conservation and cultural heritage, work to interpret and sensitize people to nature and human history, but systematic cooperation among them is uncommon.

Natural Neighbors encourages museums of natural history and history and similar institutions (these include zoos, aquariums, botanic gardens, science centers, museums of cities and regions, and so forth) to do the following:

- Create more and better exhibits about local and regional nature and history.
- Direct visitors to natural areas and historic sites nearby.
- Carry a good selection of guides to local and regional natural and human history.

Natural Neighbors encourages conservation areas and historic sites to do the following:

- Direct visitors to nearby museums and similar institutions where they can learn about what they have experienced.

Natural Neighbors encourages all such organizations to do the following:

- Cooperate in engaging with the underserved.
- Have exhibits and activities linking nature, history, literature, and the arts.
- Cooperate with schools and universities.
- Include exhibits and activities about nature conservation, historic preservation, climate change, and benefits of outdoor exercise and contact with nature.

In Los Angeles, 20 agencies and institutions have agreed to participate in Natural Neighbors Southern California. Themes under discussion include engaging with underserved local communities, and increasing public awareness of the region's distinctive Mediterranean-type ecosystem.

In addition to its involvement in the Los Angeles project, the U.S. National Park Service has proposed using the Natural Neighbors concept in several other U.S. cities that have national parks or are near them.[8]

Going deeper

I've outlined the rationale for metropolitan alliances that bring together people, nature, and culture, discussed basic structures and functions, and given a few examples. There is much more to consider. Here are a few things being discussed in informal networks that have started to form around them, as well as in forums such as IUCN and the George Wright Society:

- Defining culture in ways that include contemporary and intangible culture, as well as historic and prehistoric sites.
- Recognizing that different people and social groups have different perspectives on history, usually for very good reasons.
- Finding ways of welcoming people who are uncomfortable entering natural places and museums where they don't see people like themselves.
- Finding local symbols that capture the public imagination, such as an animal or plant species or an historic trail.
- Being flexible about the "catchment areas" of conservation alliances, considering other kinds of regions, as well as metropolitan areas.
- Finding ways of focusing on the local and regional without distracting attention from the global, and drawing attention to the interconnections.
- Drawing on social thought, social and behavioral science, and concepts from the design professions, including, for instance, spirit of place, sense of belonging, and the regionalist ideas of Patrick Geddes and Lewis Mumford.
- Realizing that lateral thinkers are important.

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Endnotes

1. Ted Trzyna: President, InterEnvironment Institute; Chair, IUCN WCPA Urban Conservation Strategies Specialist Group; Chair, Natural Neighbors. www.Trzyna.info. I appreciate comments from Tim Badman, Stacie Beute, Mark Bouman, and David Goldstein on a draft, but they bear no responsibility for the result.
2. Richard Louv, *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder* (Chapel Hill, NC: Algonquin Books, 2005.)
3. Chicago Wilderness, "Beyond the Choir," http://www.chicagowilderness.org/?page=ourworknew.
4. Ted Trzyna, *Urban Protected Areas: Profiles and Best Practice Guidelines*, Best Practice Protected Area Guidelines Series No. 22. (Gland, Switzerland: IUCN, 2014).
5. Kishore Rao, editorial, "Culture-Nature Links," *World Heritage* 75 (April 2015), 1, http://whc.unesco.org/en/review/75/.
6. Rita Colwell, Susan Avery, Joel Berger, Gary E. Davis, Healy Hamilton, Thomas Lovejoy, Shirley Malcom, Ann Mcmullen, Michael Novacek, Richard J. Roberts, Richard Tapia, and Gary Machlis, "Revisiting Leopold: Resource Stewardship in the National Parks," *Parks* 20.2 (2014): 15–24, http://doi.org/10.2305/IUCN.CH.2014.PARKS-20-2.DRC.en.
7. USNPS Director's Order 100, 20 December 2016, "Resource Stewardship for the 21st Century", www.nps.gov/policy/DOrders/DO_100.htm.
8. For background and details, visit www.NaturalNeighbors.org.

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Breakthroughs in Bison Conservation Bring Recovery a Bit Closer

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Session overview

If we want wild wildlife in the Anthropocene, then we will have to go about it with intention. A prime example of this challenge is the case of the plains bison, an iconic American animal that we will have to work hard to keep wild.

Plains bison have gone through distinct demographic phases over three centuries. In the nineteenth century the population estimated at 30 million covering much of North America was decimated to about 1,000. Early in the twentieth century, the American Bison Society was started and its members built back the population from five remnant herds. By the end of the century, you could watch herds in parks and on wildlife refuges and you could buy the lean meat in grocery stores. In the twenty-first century, advances in genetics and animal breeding are likely to further domesticate our buffalo. The question is whether we will take comparable steps to let our wild bison continue to adapt and develop under natural selection.

Why is maintaining and expanding wild bison such an ambitious goal? Nine out of every ten of the 400,000 or more bison in this country are managed as livestock. In many states they are classified as livestock, and their health and management is the responsibility of the state agricultural agency. Domestic bison producers provide a valuable product and, represented by the National Bison Association, helped get the species recognized as the national mammal in the United States. Nonetheless, wild bison continue to face significant challenges in the twenty-first century.

Most of the plains bison that are in conservation herds are also behind fences, at least in the United States. In Canada, many are free-ranging. The challenge for us in this century is what actions we should take to develop more herds where bison are treated as wildlife.

Citation: Weber, Samantha, ed. 2017. *Connections Across People, Place, and Time: Proceedings of the 2017 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites*. Hancock, Michigan: George Wright Society.

The following group of four papers (Hartway and Hardy, Barfield, Garvoille, and Jones and Dratch) focused on work being done in four disparate fields of the natural and social sciences, with the common goal of expanding the recovery range and bringing about the ecological restoration of these bison.

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Informing Bison Conservation Strategies Using Population Viability Analyses for Department of the Interior Bison Herds

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The Department of the Interior (DOI) is the primary conservation steward of North American plains bison. Currently 19 herds, totaling around 12,000 bison, live on DOI lands. The National Park Service (NPS) manages 10 of these herds, the Fish and Wildlife Service (FWS) manages seven, and the Bureau of Land Management (BLM) manages two. Together, these 19 herds are crucial to the long term preservation of the species. Yet only one of these herds has over 1000 animals, 12 are kept behind fences, and almost all are culled to maintain low population densities. Given these circumstance, concerns have been raised about the long term genetic viability of the DOI herds. Compounding these concerns is the fact that in recent years the DOI herds have primarily been managed in isolation from one another, with each herd treated as an independent population (DOI 2014). The ecological restoration of bison is a priority for the Wildlife Conservation Society (WCS), making WCS a natural partner in the development of shared management strategies for these conservation herds.

The objective of this joint NPS/WCS project is to use the best available science to build a meta-population viability model of plains bison on DOI lands, and to use this model as a guide for developing a management strategy to maintain or increase genetic variation of bison across all herds. Specifically, we are working with the FWS, BLM, the International Union for the Conservation of Nature Conservation Breeding Specialist Group, the University of California Davis Veterinary Genetics laboratory, and state agencies from Alaska, Arizona and Utah to gather and analyze up-to-date genetic and demographic data for all 19 DOI herds. We will use these data to establish a common, standardized baseline of genetic information across all herds, develop a population viability analysis (PVA) for each individual herd under current management, and explore the outcome of proposed metapopulation management scenarios across all herds (Lacy 2000).

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The management scenarios we explore include determining optimal augmentation strategies to maintain or increase the genetic diversity of small herds. For example, what data should be monitored to determine whether an augmentation is needed to increase the genetic diversity of a herd? How many bison need to be moved, which herd or herds should be the source of the transplanted bison, and does the age or sex ratio of the transplants matter? The ultimate goal of this project is a continent-wide conservation strategy for the long-term viability of plains bison in North America. This management strategy will utilize well-established scientific methods in analysis and modeling, will eventually encompass the entire existing range of plains bison, and will be based on the collaborative efforts and shared stewardship of federal agencies, state agencies and tribal nations.

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Using Assisted Reproductive Technologies to Mitigate Disease and Preserve Genetic Variation in Bison

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Assisted reproductive technologies (ART) refers to interventions into the reproductive process of a person or animal intended to result in pregnancy or to preserve fertility. They include procedures such as in vitro fertilization, artificial insemination, and embryo transfer. For decades these techniques have been used to promote reproduction in livestock, wildlife, and humans. What has this to do with bison, an animal whose annual natural breeding rates can exceed 80% in healthy herds (Fuller et al. 2007)? Bison are not endangered, but when it comes to disease management or movement of valuable genetics, reproductive technologies provide some clear potential benefits.

Reproductive techniques currently applied to bison have been modeled after routine procedures used in cattle worldwide. Embryo transfer, the collection of an embryo from the uterus of one female prior to implantation and placement of that embryo into the uterus of another female, is done in hundreds of thousands of cattle annually. Embryos may be collected and transferred to another female immediately or frozen for transfer at a later date. Semen can be collected from live males or even post-mortem and preserved for use in artificial insemination or production of embryos in vitro. Eggs from females are typically used to make embryos that are frozen and stored. Once they are frozen, reproductive cells and embryos can theoretically remain viable if kept in liquid nitrogen for hundreds of years, providing some genetic insurance for the species.

The direct relevance of these techniques for bison conservation is in the movement of genetics between herds, especially when there are associated disease risks. The best example of this is brucellosis in bison from Yellowstone National Park. Accessing the genomes of these animals, which have no cattle genes and are highly desired by many bison herd managers has been difficult because of the fear of bringing brucellosis along. This is where reproductive technologies may prove to be a valuable tool in the conservation story of bison.

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The assisted reproductive technologies described above can be performed on bison that have brucellosis. The embryos collected from brucellosis positive females can be washed to prevent the transfer of the bacterium that causes the disease to the female that will receive the embryo and give birth to the offspring. This washing technique is not novel; it is required for all cattle embryos that cross international borders (Stringfellow 2010). Additionally, semen can be "cleaned" by separating the sperm cells from the fluid portion of an ejaculate via centrifugation and collection through a device called a ProInsert (Nidacon). Following this wash procedure, sperm can be frozen using standard cattle semen freezing protocols. Disease-free bison calves have been produced in our laboratory from washed embryos and washed semen.

This is an exciting time in bison conservation with the establishment of new herds and a more concerted effort to manage herds for genetic variation. Many of the challenges associated with building or augmenting herds can be addressed by these assisted reproductive technologies. For example, even though one may know which genetics they want to augment their herd, locating and obtaining animals with those genetics may be difficult for a variety of reasons. The animals may be in very distant locations so that transport is difficult or the owner of the desired animals may not be willing to move any of their animals. While owners may not be willing to part with a bull, they may be amenable to collecting semen from that bull to be used for artificial insemination of females in another herd.

Just as the shipping of semen may provide solutions to moving genetics, so can movement of embryos. It is far easier to send a small tank with frozen semen or embryos across the country or across borders (though this can be complicated by customs and international regulations), than to ship live animals. Anytime a bison is put on a trailer, there is the risk of injury to the animal or to personnel moving the animal. Long hauls are stressful for bison as bison are not easily loaded and off loaded from trailers for overnight stops for rest and feeding/watering. Depending on time of year, weather during transport can also be a significant concern.

When moving bison from herd to herd, there is also the risk of exposing animals to new diseases. If a bison is coming from a herd known to be potentially exposed to a specific disease or is from a region where a disease is prevalent, it can be difficult to ensure that the bison being shipped is not a carrier without extensive testing or quarantine, which is costly, time consuming, and laborious for managers. Shipping embryos and semen that have been treated as described above can minimize or eliminate those concerns.

Lastly, one complication that has been expressed anecdotally by a number of bison managers is failure of a new animal to integrate into a herd. Even if you do find the bison with the genetics you want, there is no guarantee that that animal will breed in your herd. Moving young bison (one- or two-year-olds) seems to prevent some of these dynamics but does not guarantee acceptance of new animals. When you artificially inseminate a female or transfer an embryo with the genetics that you desire, that offspring will grow up as a member of the herd, even though genetically it may be unrelated, avoiding the acceptance problem.

Reproductive technologies can play an important role in bison conservation from the perspective of genetic preservation, genetic movement, and disease mitigation. While these techniques may not be appropriate for all herds and in all situations, they are valuable tools that can be integrated into management strategies that previously posed significant challenges, particularly when it comes to disease management. At the least, preservation of genetics from all herds in the form of

frozen semen and embryos could protect against unpredicted loss of animals to environmental conditions or unexpected disease outbreaks. Bison have already survived one population bottleneck. Assisted reproductive technologies can be a safety net preventing another.

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American Icons in Metropolitan Grasslands: People, Place and Bison Recovery along Colorado's Front Range

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In November 2015, ten bison with Yellowstone genetics galloped out onto the sun-swept shortgrass prairie of northern Colorado. The return of these bison was heralded as hopeful for the Colorado community and important for science. The Laramie Foothills Conservation Herd would facilitate important breakthroughs in animal health science and advances in grassland ecology by bringing back a disease-free keystone species to the shortgrass prairie ecosystem after a prolonged absence of megafauna. However, the Laramie Foothills bison reintroduction was also a key socio-cultural event at a protected area already rich with human history and meaning. The bison were brought back to Soapstone Prairie Natural Area, a vibrant 18,000-acre recreational, cultural, and working landscape, frequented by hikers and mountain bikers from Colorado's rapidly urbanizing Front Range, and a place integral to the livelihoods of local cattle ranchers as summer pasture for their cow-calf operations.

This talk draws on social science research conducted with Soapstone Prairie visitors as part of the Laramie Foothills Bison Project in northern Colorado. It argues that in order to successfully establish new and resilient conservation bison herds on North American landscapes—and fulfill the Vermejo Vision of large-scale, long-term and inclusive bison recovery (Sanderson et al. 2008)—scientists and conservationists need to understand and manage bison recovery as a place-based social and ecological process (Figure 1).

The concept of "place" is a useful heuristic, or conceptual framework, for developing an integrative understanding of bison recovery. As Cheng, Kruger and Daniels (2003) explain, place is the meaning-filled social, spatial, and temporal context for natural resource management that emerges at the intersection of socio-political processes, sociocultural meanings, and biophysical processes. Place describes the ways that meanings and values emerge for people and human communities

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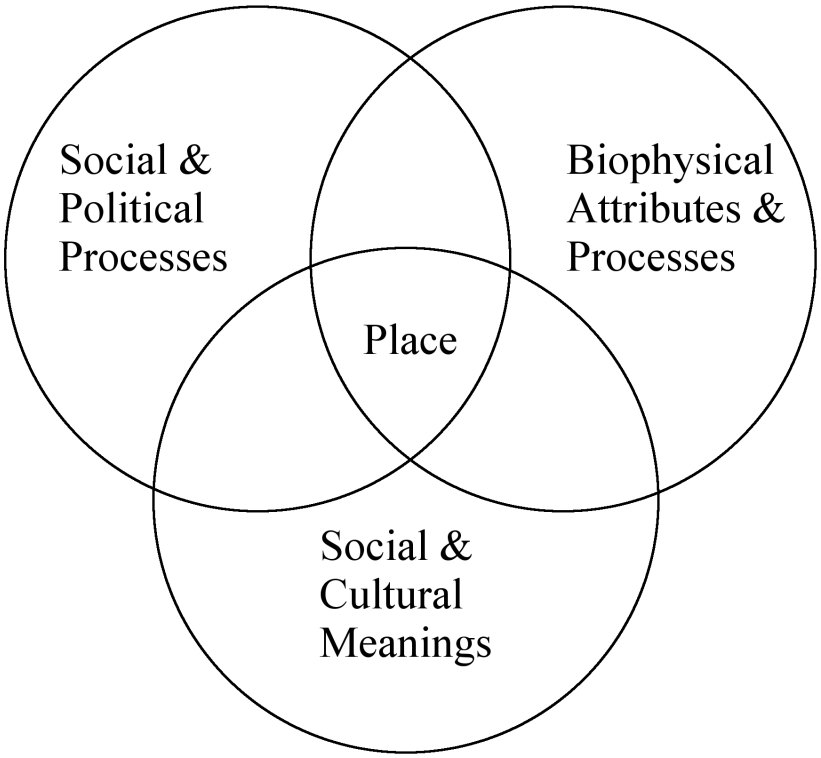

Figure 1. The concept of "place" is a conceptual framework in understanding bison recovery (credits: Cheng, Kruger and Daniels 2003).

from landscapes they come to know and frequent, while also attending to the broader political context in which those landscapes are defined and managed. As Williams and Patterson (1996) have noted, "recognizing and understanding this [meaning-filled] context is the principal contribution of social science to ecosystem management." Moreover, sense of place is a social variable often affected by key natural resource management events such as bison reintroduction.

The Denver Zoo Department of Conservation and Research collaborated with the Laramie Foothills Bison Project's science and management team to conduct over 700 visitor-intercept interviews before and after the bison reintroduction to Soapstone Prairie Natural Area. The purpose of these interviews was to capture how the Laramie Foothills bison reintroduction was reshaping visitor place attachment and sense of place (how visitors were experiencing Soapstone) in a peri-urban grassland located in one of the fastest growing regions in the country, the Colorado Front Range. The Front Range, the corridor between Colorado Springs, Colorado, and Cheyenne, Wyoming, is rapidly developing. As such, it is a landscape caught between the push and pull of traditional ranching lifestyles and an influx of new economy amenity migrants seeking outdoor adventures.

Visitor interviews were strategically conducted at the Soapstone Prairie Natural Area entrance gate, the only access point to the protected area, and typically lasted five to ten minutes. Researchers used a 44-item questionnaire containing open and close-ended questions, and conducted interviews using iPads and the cloud-based data collection software, iSurvey. The researchers pre-tested the interview guide and refined it accordingly. Interview data were collected from July through September 2015 (pre-bison reintroduction) and from July through September 2016 (post-bison reintroduction). The study employed multi-stage random sampling across weekend

days and times to ensure that those visitors interviewed were as representative of the visitor population as possible.

More than six in 10 visitors agreed to be interviewed about their experiences at Soapstone Prairie Natural Area by the research team. Soapstone recreationists tended to be white, well-educated and originate from the Fort Collins, Colorado, region and metropolitan Denver. The interview data revealed three key findings. First, bison were a primary motivation for park visitation. In fact, one in four visitors explained that bison were a main reason for their 2016 visit to Soapstone Prairie Natural Area. Soapstone visitors also overwhelmingly agreed that bison were an important part of their experience and enhanced their sense of connection to Soapstone in 2016. Finally, as measured by a four-item place attachment scale based on Folmer, Haartsen, and Huigen (2013), researchers found that levels of visitor place attachment in 2016 were significantly higher than the levels of visitor place attachment in 2015 ($p=0.01$). These findings demonstrate that the return of bison—a highly visible charismatic species—to the northern Colorado prairie was a socially meaningful event that had an immediate positive effect on visitor place attachment and sense of place at Soapstone Prairie Natural Area. Research into how the presence of the Laramie Foothills bison has qualitatively shaped visitor sense of place is ongoing with an analysis of the narrative data collected through the Soapstone visitor interviews underway (Wilkins et al. 2017).

Sense of place shapes the ways in which communities and people experience, and understand bison recovery landscapes. These landscapes are already meaningful to people with different North American worldviews, cultures, histories and livelihoods. As this talk has shown, creating inclusive and resilient bison recovery projects requires recognizing sense of place as a key emergent social variable in bison recovery. Project managers and scientists would benefit from more thoughtfully considering and managing for sense of place across different communities as part of bison recovery, and attending to how it broadens and deepens the definition of an effective long-term and large-scale bison recovery project.

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Transforming Department of Interior Bison from Livestock to Wildlife

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In the last 200 years, North American plains bison have moved across a spectrum of species recovery and restoration. From the brink extinction with only 1,000 remaining, bison were managed in captivity as zoo exhibit animals or livestock, then progressed to intensively managed wildlife to lightly managed and monitored wildlife, and finally in a few places to free-ranging animals (Figure 1). Captive and intensive management is essential in the early phases of species recovery, but when compared to elk, deer or wild sheep, it's clear that bison have been left behind.

When considering the pathway of a species from extinction to restoration, it's worth noting that extinction can occur in two ways. Demographic death of a species occurs when the last individuals of a species are gone. Genomic extinction occurs when the genetic makeup of a species changes substantially. Bison have progressed beyond the first hurdle thanks to the diligent efforts of early conservationists such as Hornaday (1889), but we now face the challenge to prevent genomic extinction through domestication of plains bison in conservation herds.

Molecular markers are powerful methods of ever-increasing resolution that can be used to learn more about genetic variation and the results of early hybridization experiments with cattle. The primary methods used are DNA marker microsatellites, powerful tools used for population differentiation and detection of introgression; mitochondrial DNA haplotyping, subject to selection, commonly used for maternal lineage diversity, also providing additional information on introgression; and single nucleotide polymorphism (or SNPs) that have the most resolution across the

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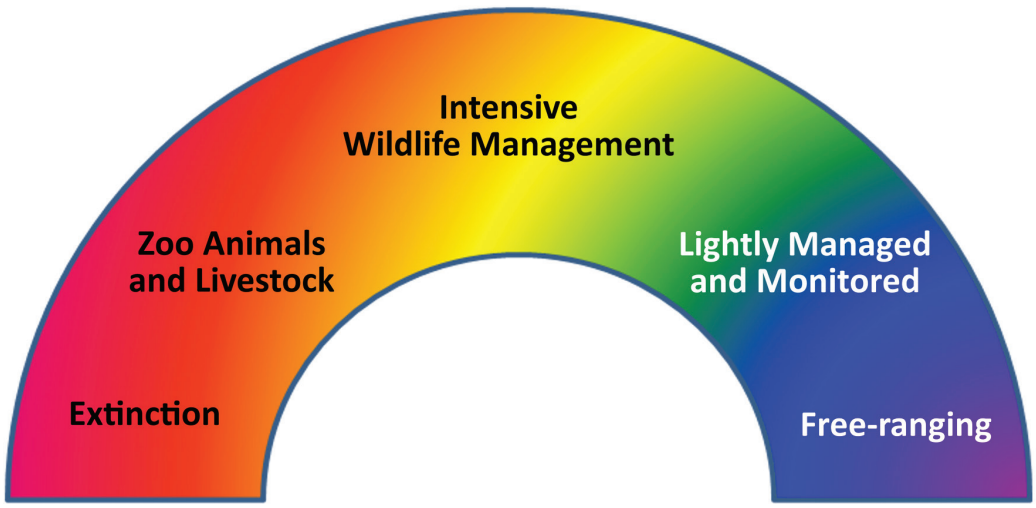

Figure 1. Restoration efforts for wildlife species, including North American plains bison, have generally moved through this spectrum of management. Plains bison currently exist across this spectrum.

genome. These methods are commonly used in livestock production for genetic trait selection in domestic animals, but can also be employed to conserve genetic diversity within herds (Giglio et al. 2016).

In DOI conservation herds the goal is to preserve wild bison. A wild bison is a member of a herd with a large enough population size to prevent loss of genetic variation and with low levels of cattle or subspecies introgression, and subject to some of the forces of natural selection, including breeding competition (Dratch and Gogan 2010).

In the past decade, we have made significant progress towards improving Interior conservation of wild bison, and we elaborate on seven steps forward in managing plains bison conservation herds as wildlife:

- Minimize round-ups and handling, as injury or mortality can impact an animal's fitness.
- Continue to let animals die of disease to allow for the development of natural disease resistance.
- Introduce predators where possible, as an important component of natural selection.
- Explore alternative genetic sampling techniques as needed, such as using remotely delivered biopsy darts.
- Augment herds as warranted to restore gene flow across large, fragmented landscapes; and increase the size of the wild plains bison metapopulation.
- Donate surplus bison to support the wildlife value of bison for conservation and cultural purposes, including developing alternative funding mechanisms to support management of conservation herds.

- Restore bison to their former ecological role on large landscapes.

With continued expansion of human-altered landscapes and increasing effects of climate change, restoration efforts will have to consider historic population patterns and future conditions. Moving bison restoration forward will take conscious effort and commitment, and incorporating these seven steps into conservation herd management will conserve the wild character of DOI bison.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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