National Park Service
U.S. Department of the Interior

State of the Park Report

Noatak National Preserve

Alaska

2017

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On the cover: A small alpine lake in the Baird Mountains near the boundary between Kobuk Valley National Park and Noatak National Preserve. NPS Photo.

Disclaimer. This State of the Park report summarizes the current condition of park resources, visitor experience, and park infrastructure as assessed by a combination of available factual information and the expert opinion and professional judgment of park staff and subject matter experts. The internet version of this report provides the associated workshop summary report and additional details and sources of information about the findings summarized in the report, including references, accounts on the origin and quality of the data, and the methods and analytic approaches used in data collection and assessments of condition. This report provides evaluations of status and trends based on interpretation by NPS scientists and managers of both quantitative and non-quantitative assessments and observations. Future condition ratings may differ from findings in this report as new data and knowledge become available. The park superintendent approved the publication of this report.

Executive Summary

The mission of the National Park Service is to preserve unimpaired the natural and cultural resources and values of national parks for the enjoyment, education, and inspiration of this and future generations. NPS Management Policies (2006) state that "The Service will also strive to ensure that park resources and values are passed on to future generations in a condition that is as good as, or better than, the conditions that exist today." As part of the stewardship of national parks for the American people, the NPS has begun to develop State of the Park reports to assess the overall status and trends of each park's resources. The NPS will use this information to improve park priority setting and to synthesize and communicate complex park condition information to the public in a clear and simple way.

The purpose of this State of the Park report is to:

- Provide to visitors and the American public a snapshot of the status and trend in the condition of a park's priority resources and values;
- Summarize and communicate complex scientific, scholarly, and park operations factual information and expert opinion using non-technical language and a visual format;
- Highlight park stewardship activities and accomplishments to maintain or improve the State of the Park;
- Identify key issues and challenges facing the park to help inform park management planning.

Noatak National Preserve (NOAT) is managed as a unit within the Western Arctic Parklands. The purpose of NOAT ("the park") is to protect an intact 6.7-million-acre, mountain-ringed river basin ecosystem for outstanding scientific research and wilderness opportunities within an arctic-subarctic environment.

The summary table, below, and the supporting information that follows, provide an overall assessment of the condition of priority resources and values at Noatak National Preserve based on scientific and scholarly studies and expert opinion. The internet version of this report, available at http://www.nps.gov/stateoftheparks/noat/, provides additional detail and sources of information about the resources summarized in this report, including references, accounts on the origin and quality of the data, and the methods and analytical approaches used in the assessments. Reference conditions that represent "healthy" ecosystem parameters, and regulatory standards (such as those related to air or water quality) provide the rationale to describe current resource status. In coming years, rapidly evolving information regarding climate change and associated effects will inform goals for managing park resources, and may alter how the park measures the trend in condition of resources. Thus, reference conditions, regulatory standards, and/or best judgment about resource status or trend may evolve as the rate of climate change accelerates and the park responds to novel conditions. In this context, the status and trends documented here provide a useful point-in-time baseline to inform understanding of emerging change, as well as a synthesis to share as the park builds broader climate change response strategies with partners.

The status and trend symbols used in the summary table below and throughout this report are summarized in the following key. The background color represents the current condition status, the direction of the arrow summarizes the trend in condition, and the thickness of the outside line represents the degree of confidence in the assessment. In some cases, the arrow is omitted because data are not sufficient for calculating a trend (e.g., data from a one-time inventory or insufficient sample size).

Condition Status		Trend in Condition		Confidence in Assessment	
	Warrants Significant Concern	⇧	**Condition is Improving**		**High**
	Warrants Moderate Concern	⇔	**Condition is Unchanging**		**Medium**
	Resource is in Good Condition	⇩	**Condition is Deteriorating**		**Low**

State of the Park Summary Table

Priority Resource or Value	Condition Status/Trend	Rationale
Natural Resources		web ▸
Air Quality		Air quality at NOAT is generally good. In a small northwest corner of the park, dust from the Red Dog Mine haul road that crosses the park has impacted air quality intermittently, and dispersed zinc, lead, and cadmium dust onto the surrounding tundra since 1989.
Geological Resources		Most of NOAT is underlain by frozen soil called permafrost. Permafrost average temperatures have warmed since 1950, and the thickness of the seasonally-thawed upper (or "active") layer has increased as a result of climate warming since 1950. While the extent of permafrost has changed little so far, continued warming is expected to impact the permafrost and tundra ecosystem. In addition to the Red Dog Mine currently in operation, there is mineral exploration and other small-scale mining nearby, outside the park boundary.
Paleontological Resources		NOAT has known fossil resources, but lacks a formal paleontological resources inventory. Non-permitted collecting in Western Arctic Parklands has been observed, but has not been officially documented. Fossils in river cut banks are at high risk of being eroded.
Water Resources		Increased drainage due to warming permafrost has decreased the surface area of lakes in the park. Sampling for water quality of lakes and streams is infrequent, but indicates that water quality is good. There are no stream gauges or long-term discharge measurements in NOAT.
Terrestrial Vegetation		Lichen diversity is relatively high in Noatak due to a diversity of habitats from lowland to alpine. NOAT has relatively high vascular plant diversity, with 506 species identified to date, of which 21 are classified as rare or imperiled. Vascular plant cover has been increasing across the Arctic in recent decades as shrubs and other plants increase in height and density, and this trend is expected to continue in the future. There are no known occurrences of non-native plant species in the park.
Birds		NOAT falls into nationally and internationally recognized bird conservation regions; however, population status information for landbird species in the park is incomplete. Information about the population status of breeding shorebirds in NOAT is also lacking. Loss of wetlands—particularly migratory stopover areas outside of Alaska that are important to those species breeding in Alaska—represents the greatest threat to shorebird populations worldwide.

Priority Resource or Value	Condition Status/Trend	Rationale
Terrestrial Mammals		Terrestrial mammals in the park include, but are not limited to, moose, brown bear, caribou, Dall's sheep, wolves, beavers, and wolverines. Distribution of moose in the Arctic is limited by winter range and winter access to shrubs over 1 meter tall. In the late 1980s and early 1990s, a decline was detected in NOAT; moose may have vanished from Noatak River tributaries in the central portion of the preserve. Though they have recovered, the population in eastern NOAT remains very low. Brown and black bears occur in and occupy suitable habitat in NOAT. Brown and black bear populations are not monitored by the NPS. According to residents of Unit 23, of which NOAT is a part, brown bear numbers have increased substantially since at least the 1940s or 1950s. The Western Arctic Caribou Herd is currently at the low end of its population cycle and has declined over 50% since 2003. In general, the health and success of the various caribou herds in this region is stable, with some natural fluctuation. Dall's sheep populations declined across Western Arctic Parklands by 70% from a peak in 2011 to 2014. All hunts are now closed across Western Arctic Parklands and the western Brooks Range. The few historical estimates of the wolf population size in northwest Alaska are varied and unreliable, but concern of their influence upon the Western Arctic Caribou Herd spurred predator control as early as the 1940s. The wolf population in NOAT has not been estimated in recent years, but many local residents report an increase in observations and a concern for the caribou and public safety.
Fish		Fish species in NOAT include whitefish, Dolly Varden, and chum salmon. Fish are an important subsistence resource. As a group, they represent the most accessible subsistence resource in the area, and are available from late spring through early winter. Generally, fish diversity and populations are presumed to be good based on their remote location and low levels of anthropogenic impact; however, there exists a lack of rigorous fish data. Anecdotal evidence indicates some species may be declining.
Unique Communities and Features **(Ultramafic Communities and the Noatak River)**		Mountains composed of ultramafic rocks are widespread in parts of NOAT. Ultramafic environments in NOAT are very remote and have been visited only briefly by botanists, and may contain very rare species of plant life. The Noatak River is a designated National Wild and Scenic River, and flows across both Gates of the Arctic National Preserve and NOAT. The entire watershed of the Noatak River, not just the river itself, lies within these two protected areas, and it is the largest undisturbed watershed in North America.
Landscape and Ecosystem Processes		Fire has been documented in NOAT for thousands of years, with a frequency similar to boreal forests (3.6 fires per year). The fire occurrence in NOAT has been variable over the past 65 years, yet with 68 fires reported in the park over the past 6 years (2010–2015), there appears to be an increasing trend of fire. Overall greenness of lowland tundra landscapes as measured by satellite has increased since records began in the 1980s.

Priority Resource or Value	Condition Status/Trend	Rationale
Dark Night Sky		A photic environment is described as the physical amount and character of light at a particular location, irrespective of human perception. The NPS Night Sky Program characterizes a park's photic environment by measuring both anthropogenic and natural light. While no ground based or modeled data are available for NOAT, 2012 visible infrared imaging radiometer (VIIRS) satellite data, which uses a broadband imaging detector with high sensitivity, indicates that there is no visible upward radiance within the park boundary, and small amounts of upward radiance within a 200-km radius surrounding the park. The largest sources of upward radiance emanate from the Red Dog Mine, adjacent to the park's northwest boundary, and from the town Kotzebue, AK just over 20 km from the park's southwest boundary.
Acoustic Environment		The mean acoustic impact level (L_{50} dBA), a measure of noise contributed to the existing acoustic environment by man-made sources, is 0.5 dBA in NOAT, meaning that the acoustic environment is in good condition. Overall, long-term projected increases in ground-based transportation and aircraft traffic indicate a downward trend in the quality of acoustic resources at this location, as does an increase in development and steady tourism pressure throughout the state of Alaska (McDowell 2014).
Cultural Resources		**web** ▸
Archeological Resources		Major themes/historic contexts in NOAT are moderately well developed, but it is very likely that a significant number of archeological sites have not yet been identified or professionally documented. A substantial amount of archeological inventory has been conducted in NOAT, but the preserve is large and archeological resources remain only moderately well understood. Few sites have been formally evaluated against anthropological and historic contexts.
Cultural Anthropology		Although anthropological research has been conducted in the region by scholars, local residents, and federal and state agencies, the park lacks formal baseline documentation to assess condition and adequately protect unknown or undocumented ethnographic resources. Each passing year marks the loss of knowledge bearers and elders who can contribute to the documentation process.
Cultural Landscapes		There are no inventoried cultural landscapes in NOAT. Three cultural landscapes have been identified as priorities for documentation in the next 5 years.
Historic Structures		Several historic structures have been identified in NOAT. These structures lack formal documentation including National Register evaluation. GIS data is lacking, and documentation of structure condition is lacking. The harsh arctic environment continues to erode the structures.
History		NOAT lacks a Historic Resource Study and an Administrative History. No National Register Nominations or Determination of Eligibility documents have been completed for historic resources in NOAT.
Museum Collections		The park currently has an adequate amount of research and reports to demonstrate the significance and context of the items in the museum collection; however, the park has the potential for both continued and expanded archeological, ethnological, historical, and natural history studies that would expand understanding. NOAT benefits from substantial support of the National Park Service's Alaska Regional Curatorial Center, located in Anchorage, AK.

Priority Resource or Value	Condition Status/Trend	Rationale
Visitor Experience		web ▸
Number of Visitors		The 10-year annual average of visitors for 2003–2012 was 6,024. The preserve is remote and has no public roads, entrance station, or facilities. Non-local and recreational visitors rely on concessionaires to get to the preserve in aircraft. Visitation numbers are estimates by staff who conduct field work in the park. Counts include outside visitors plus local area residents who travel through the park.
Visitor Satisfaction		Park staff does not conduct visitor satisfaction surveys because the park is remote and there is no ability to gather survey data. However, contact with visitors in the Northwest Arctic Heritage Center, community feedback, and social media suggest that people have significant appreciation for wilderness solitude and the effort it takes for a once in a lifetime trip in the park.
Interpretive and Education Programs – Talks, Tours, and Special Events		A small but robust interpretive team conducts many interpretive programs for community children and adults, as well as virtual visitors. The curriculum-based school program recently received the Freeman Tilden Award. Many local people attend the special events and listen to the weekly radio show. Increasing the numbers of general walk-in visitors is an ongoing effort—banners and a new Facebook page are planned solutions.
Interpretive Media – Brochures, Exhibits, Signs, and Website		Interpretive media exists only in the Northwest Arctic Heritage Center (NAHC), as there are no facilities in the park. Repairs to the aging exhibits are in progress. New audiovisual presentations are being created regularly. Maintaining the website is a challenge due to internet connectivity issues, but interpreters are spending an increasing amount of time to troubleshoot and create new content.
Accessibility		When the Northwest Arctic Heritage Center opened to the public in 2010, few accessibility features were put in place. Basic accommodations currently exist for mobility, visual, and auditory accommodations.
Safety		The safety of visitors and employees is a priority for the preserve. No visitor injuries have been reported in the Northwest Arctic Heritage Center and the number of accidents in the park is very low. A suite of safety courses are offered to permanent and temporary staff every year.
Partnerships		Volunteer efforts are critical to operation of NOAT. Many long-term community partnerships exist to enhance interpretive efforts for the public. Volunteers need to be skilled in specific disciplines in order to do projects in this remote area, so the numbers of individual volunteers are not high.
Recreational Opportunities		Wilderness covers a wide area of the park, so there are many opportunities for flightseeing, solitude, floating, and hiking. No signs or improved trails exist, so visitors have to navigate on their own and possess wilderness survival skills. Flightseeing tours enable people to view natural flowing rivers and unique permafrost features on the landscape. There are opportunities to see unique arctic wildlife such as large bird migrations, caribou herds, and even small animals like singing voles. With proper permits, non-local hunters may harvest wildlife in the park and fish with an Alaska State fishing license.
Scenic Resources		NOAT is notable for its pristine and natural character. Scenic resources at the preserve are in good condition, but development may result in scenic impairments. Primary risks to the scenic resource quality of the preserve are gravel mining on park borders.

Priority Resource or Value	Condition Status/Trend	Rationale
Wilderness Character and Stewardship		web ▸
Overall Wilderness Character		NOAT preserves wilderness including untrammeled, natural, and undeveloped characters as well as scientific, ecological, historical, and cultural components. Despite the remoteness and untouched appearance of Noatak National Preserve, pollutants affect air and water quality and are found in many of the plants and animals. In addition, erosion and degradation threaten the integrity of cultural sites and resource attrition occurs from visitor activity. Opportunities for primitive and unconfined recreation have remained essentially unchanged since 1980. With few changes to affect how people interact with this landscape, visitors are still able to explore the Noatak Wilderness in the same ways as they did 35 years ago.
Wilderness Stewardship		Although NOAT completed a Wilderness Narrative in 2015, no Wilderness Management Plan exists for NOAT and there is no Wilderness Character monitoring in NOAT. Without a Wilderness Management Plan to help provide guidance, the wilderness program has lacked consistency, direction, and focus for many years. There is no staff solely tasked with gathering and synthesizing information on wilderness. The compliance team for NOAT has waned with staffing, however, the park makes efforts to evaluate projects for impacts to natural resources, cultural resources, subsistence, and wilderness.
Subsistence		web ▸
Opportunity and Continuity for Subsistence Activities, Availability of Subsistence Resources		NOAT has three primary communities that are affiliated with the park and are heavily dependent on subsistence resources from the park: Kotzebue, Noatak, and Kivalina. Sharing of subsistence foods with relatives and friends is an important cultural practice that extends beyond the region. Opportunity to pursue key subsistence activities is decreasing. Key wildlife species of primary importance for subsistence use in the region are caribou, moose, Dall's sheep, and muskoxen. Sheep have drastically declined and caribou are declining. This is leading to a compounding situation where there is a decrease in availability of important wildlife resources and an increase in number of subsistence users.

Summary of Stewardship Activities and Key Accomplishments to Maintain or Improve Priority Resource Condition

The list below provides examples of stewardship activities and accomplishments by park staff and partners to maintain or improve the condition of priority park resources and values for this and future generations:

Natural Resources

- NPS's Arctic Network Inventory and Monitoring Program conducted monitoring in NOAT on vital signs including: Dall's sheep, brown bears, terrestrial vegetation (including lichen), terrestrial landscape patterns, permafrost, caribou, fire, large lakes, shallow lakes, streams, snowpack, muskoxen, moose, landbirds, air quality, and weather and climate.
- NOAT and Cape Krusenstern National Monument partnered with the Alaska Department of Fish and Game (ADF&G) to complete an expanded survey of the Cape Thompson muskox population. This interagency survey has the largest in spatial extent of any survey in the state.
- An aerial brown bear survey was conducted in the lower Noatak River within NOAT and Cape Krusenstern National Monument in 2016; this was the first reliable population estimate for the area in over 20 years. Results are not yet published.
- NOAT conducted a Dall's sheep survey in the DeLong and Baird Mountains in 2016. This was important due to the 70% decline in sheep this area. NPS worked with partners to close sheep hunting in NOAT to allow the population to recover.
- NOAT participated in a large scale study of persistent organic pollutants and other toxic substances (e.g., mercury) in fish, lake water, sediment, lichens, and vegetation. Results indicated generally low levels of contaminants, though thresholds would be exceeded by high consumption of several species of long-lived top predator fish by subsistence users and birds.

Cultural Resources

- NOAT's archival processing has been brought up-to-date. 205 linear feet of archives with a finding aid were produced for all northwest Arctic parks including Bering Land Bridge, Cape Krusenstern, Kobuk Valley, and Noatak.
- In the summer of 2015, the National Park Service collaborated with Alaska Geographic, Bering Straits Native Corporation, Kawerak Incorporated, Carrie McClain Museum, and UAF Northwest Campus to host Nome Archaeology Camp, an opportunity for Alaskan teens to learn more about the heritage of the Bering Straits region through archeological methods, oral history, and museum studies.
- Archeologists from the University of Alaska Museum and National Park Service recently conducted work on several sites in Noatak National Preserve that include large, rock-lined communal structures (qargit), and dozens of petroglyphs, which—taken together—are a completely unique set of prehistoric lakeside villages sites for Alaska.

Visitor Experience

- Technologically savvy interpreters and biologists are working hard to reach new visitors and help them learn about Arctic public lands through 6 new web videos, hundreds of twitter posts, 107 new Flickr images, 2 new blogs, 8 photo galleries, and an innovative Facebook page for the Northwest Arctic Heritage Center. These creative online features are a response to the new ways that people want to learn about national parks.

Wilderness

- NOAT completed the mapping of current wilderness boundaries and calculation of current wilderness acreage.
- The Western Arctic Parklands compiled the legislative history of Wilderness in Kobuk Valley National Park, Noatak National Preserve, and Cape Krusenstern National Monument.

Subsistence

- NPS released new regulation changes allowing customary and traditional uses of horns, antlers, and plant materials collected from parklands (Federal Register 2017).
- NPS continues to work within a regulatory framework to balance subsistence uses with conservation of wildlife populations. The NPS manages one muskox hunt in and four sheep hunts in and adjacent to NOAT and coordinates with the State of Alaska.

Key Issues and Challenges for Consideration in Management Planning

Many of the major management challenges facing NOAT are common to all Arctic parks, including: adapting to landscape and ecosystem change driven by climate change, managing for subsistence and wildlife populations, mitigating current and potential impacts from development outside park boundaries, addressing logistical challenges unique to remote parks, and adapting to the increase in shipping in the Arctic. While recognizing that preventing many of these changes is beyond park control, the NPS may consider a suite of adaptations.

Climate-driven Challenges

The Arctic has been warming at twice the rate of the temperate latitudes, which has led to several observed physical and ecological changes with many more anticipated. Models predict that the Western Arctic Parklands are expected to experience warming of up to 10 °F mean annual temperature over the next 60 years. Sea ice has retreated to historic lows in both extent and thickness, and researchers predict an ice-free summer Arctic Ocean by 2035. With a changing climate comes a host of current and potential issues requiring adaptation in terrestrial and aquatic environments.

Terrestrial: The most dramatic of changes predicted to occur in terrestrial ecosystems in NOAT in the coming decades include: tall shrub increase and the movement of forest into open dwarf and low shrub tundra; loss of ungulate lichen winter range and open tundra currently hosting abundant lichen cover types; permafrost thaw and degradation of ice wedge polygons; increased fire frequency leading to more of the landscape being in an early successional state with fewer lichens; increases in winter icing events leading to wildlife winter forage difficulties; changes in the composition of wildlife and bird communities with declines in tundra-adapted species and increases in boreal species; habitat decline for the Western Arctic Caribou Herd; reduction in the availability of and access to key wildlife species hunted for subsistence by local residents, including caribou and moose; and mismatch of migration, forage, and pollination timing because of earlier green-up and longer snow-free season.

Aquatic: As temperatures warm, shallow lakes and ponds have shown a modest decrease in number and size, a trend expected to intensify, reducing aquatic habitat. Rivers will warm and become more filled with sediment seasonally, presenting challenges to Arctic fisheries important to subsistence (including chum salmon, and several other species of whitefish). As peat decomposes, it is expected to release nitrogen and mercury into surface waters.

Subsistence Opportunity: NOAT was established in part to provide for subsistence opportunity. Subsistence opportunity for caribou is likely to face increasing hardship because the Western Arctic Caribou Herd has declined over 50% since 2003; changes in vegetation due to climate change may alter habitat suitability.

Wildlife-related Challenges

ANILCA mandates protection of habitat for and populations of fish and wildlife, resources related to subsistence needs, and subsistence use by local residents in NOAT. As per ANILCA, wildlife management in the parks as it relates to subsistence includes involvement of local residents and Native Alaskans through Regional Advisory Councils and Subsistence Resource Commissions.

Wildlife Management Challenges: Challenges to wildlife management in NOAT include the park's lack of data on wildlife populations that are critical to meeting ANILCA's mandates of protecting habitat for and populations of fish and wildlife, providing for subsistence, protecting resources related to subsistence needs, and providing for non-consumptive uses. This lack of data leaves NOAT unable to appropriately respond to regulatory proposals that affect park wildlife resources, including the management of predators. The NPS lacks critical wildlife data primarily because of the lack of funding for wildlife studies.

Additional challenges stem from divergent park uses including: subsistence hunting and gathering, recreational boating, wildlife watching, and sport hunting. Some of these uses can be at odds with others, which presents the management challenges of mitigating the effects of these activities on park resources as well as mitigating impacts to other user groups' activities. It is an

ongoing challenge to provide appropriate staffing to manage logistics of permitting and enforcing wildlife regulations over the extensive area that comprises NOAT.

Key species-specific challenges: Species-specific challenges include the fact that the Dall's sheep populations in Western Arctic Parklands declined by 70% between 2011 and 2014 and the populations still appear to be in decline. The decline is related to cold springs, deep snow, and icing events; the decline is likely exacerbated by hunting pressure. The NPS manages sheep hunts and relies on data from NPS surveys to inform harvest management; providing opportunities for subsistence hunting while conserving the population is a significant challenge.

For brown bears and wolves, NOAT lacks population estimates, movement, demographic, and habitat use data for the last 20 years. Meanwhile, wildlife proposals are routinely submitted to State and Federal bodies to increase harvest of brown bears and wolves.

Although western science and traditional knowledge concur that caribou naturally cycle in abundance, the Western Arctic Caribou Herd is currently at the low end of its population cycle and has declined over 50% since 2003.

Moose calf recruitment and population numbers are low in NOAT. The NPS relies on data from cooperative surveys with Alaska Department of Fish and Game to inform population and harvest management.

Wildlife Conflicts: In addition to being important resources for subsistence, wildlife can be the source of conflicts with local residents. For example: some muskoxen tip over grave markers and stomp on graves, some people feel intimidated by muskoxen near berry-picking locations, and some bears break into cabins or take fish from fish racks or nets. Addressing wildlife conflicts in a non-lethal way is a management challenge for all Western Arctic Parklands.

External Challenges

There are many challenges associated with increased commercial shipping and development. Emerging external challenges include proposed mining and mining access roads, likely increase in regional pollution, increased potential for invasive species introduction, and ongoing illegal activity including looting of archeological and paleontological resources, poaching, and wanton waste.

Logistical Challenges

Working in the Arctic presents unique logistical challenges. Fieldwork in these remote, roadless parks requires access by boat or plane and is hampered by high costs of supplies, poor weather, and lack of infrastructure. The Western Arctic Parklands are understaffed and struggle with high staff turnover, difficulty hiring local residents (due to low federal wages compared to the high cost of living in Kotzebue), lack of housing, and slow telecommunications.

Chapter 1. Introduction

Noatak National Preserve (NOAT) is managed as a unit within the Western Arctic Parklands in northwest Alaska. The purpose of this State of the Park report for NOAT ("the park") is to assess the overall condition of the park's priority resources and values, to communicate complex park condition information to visitors and the American public in a clear and simple way, and to inform visitors and other stakeholders about stewardship actions being taken by park staff to maintain or improve the condition of priority park resources for future generations. The State of the Park report uses a standardized approach to focus attention on the priority resources and values of the park based on the park's purpose and significance, as described in the park's Foundation Document or General Management Plan. The report:

- Provides to visitors and the American public a snapshot of the status and trend in the condition of a park's priority resources and values.
- Summarizes and communicates complex scientific, scholarly, and park operations factual information and expert opinion using non-technical language and a visual format.
- Highlights park stewardship activities and accomplishments to maintain or improve the state of the park.
- Identifies key issues and challenges facing the park to inform park management planning.

The process of identifying priority park resources by park staff and partners, tracking their condition, organizing and synthesizing data and information, and communicating the results will be closely coordinated with the park planning process, including natural and cultural resource condition assessments and Resource Stewardship Strategy development. The term "priority resources" is used to identify the fundamental and other important resources and values for the park, based on a park's purpose and significance within the National Park System, as documented in the park's foundation document and other planning documents. This report summarizes and communicates the overall condition of priority park resources and values based on the available scientific and scholarly information and expert opinion, irrespective of the ability of the park superintendent or the National Park Service to influence it.

Most of the national park units in Alaska, including NOAT, were established or expanded under the Alaska National Interest Lands Conservation Act (ANILCA), adopted on December 2, 1980. ANILCA's passage culminated more than 20 years of deliberation on federal land claims after Alaska statehood.

In 1971, Native claims were resolved by passage of the Alaska Native Claims Settlement Act (ANCSA). This act, in addition to Native land claims, also provided for withdrawal of 80 million acres for possible designation as national parks, fish and wildlife refuges, national forests, and wild and scenic rivers. NOAT is among those park areas first established in 1978 by Presidential Proclamation by President Carter when he withdrew over 100 million acres of federal land, including 56 million acres as national monuments.

The purpose of Noatak National Preserve is to protect an intact 6.7-million-acre, mountain-ringed river basin ecosystem for outstanding scientific research and wilderness opportunities within an arctic-subarctic environment. Specifically, Section 201 of ANILCA states that the preserve shall be managed for the following purposes, among others:

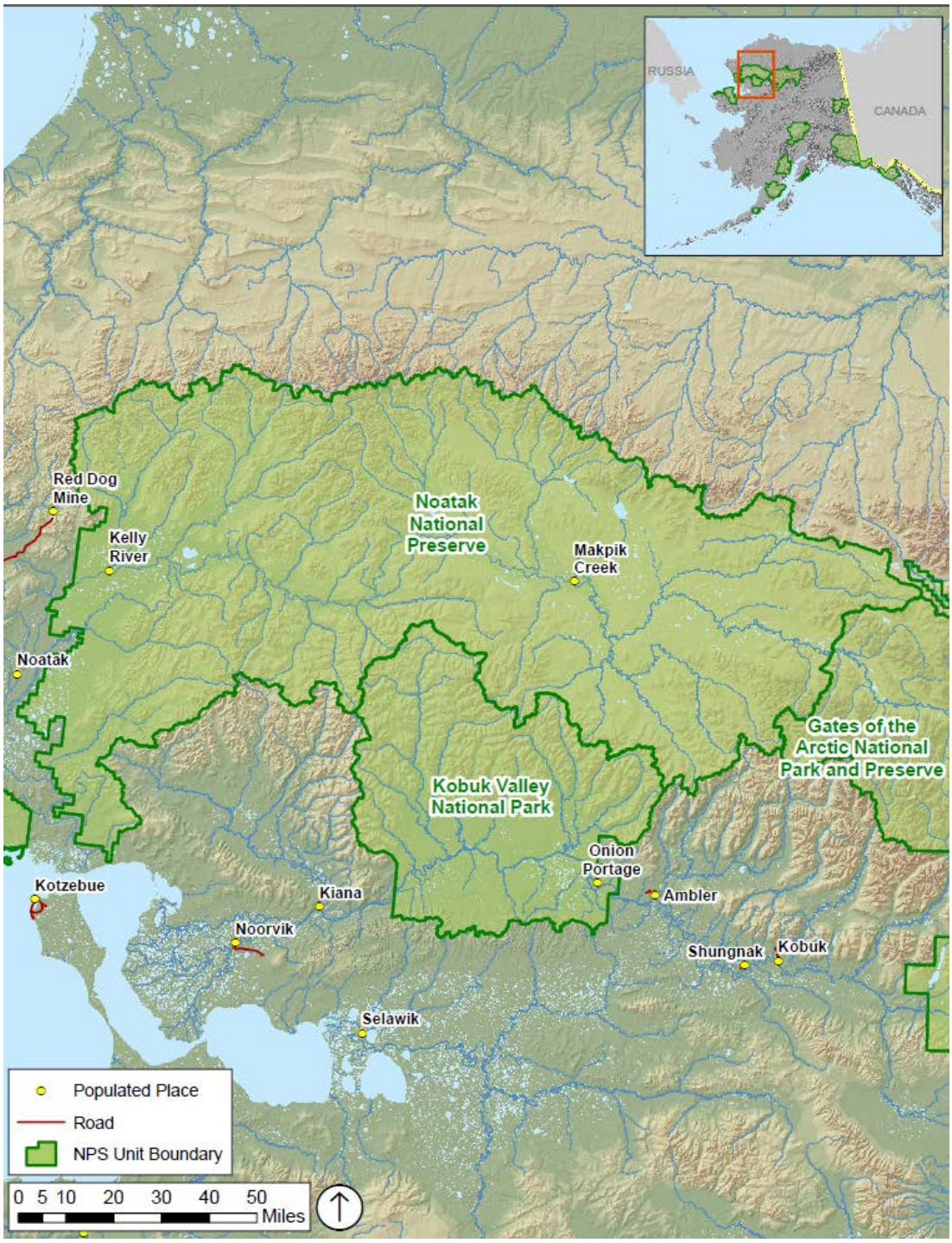
- to maintain the environmental integrity of the Noatak River and adjacent uplands within the preserve in such a manner as to assure the continuation of geological and biological processes unimpaired by adverse human activity
- to protect habitat for and populations of fish and wildlife, including but not limited to caribou, grizzly bears, Dall's sheep, moose, wolves, waterfowl, raptors, and other species of birds
- to protect archeological resources
- to provide opportunities for scientific research

Guided by legislation and the knowledge acquired through management, research, and civic engagement; statements of significance define what is most important about the preserve's natural and cultural resources and values. The significance statements are used to guide planning and management decisions to ensure that priority resources and values are preserved. Significance statements for NOAT are:

1. Noatak National Preserve, largely unaffected by adverse human activity, protects a nationally significant, intact, and biologically diverse arctic-subarctic river basin ecosystem.
2. Noatak National Preserve fosters exceptional opportunities for scientific research of unaltered arctic-subarctic ecosystems.
3. Noatak National Preserve protects natural resources and native habitats that provide the opportunity for local rural Alaska residents to engage in customary and traditional subsistence uses.
4. The Noatak Wilderness constitutes the western half of a 13-million-acre designated arctic wilderness that limits development and protects the nation's largest unaltered river basin and free-flowing wild river.

Noatak is located northeast of Kotzebue and above the Arctic Circle, at the western end of the Brooks Range and in the Baird Mountains. The preserve contains more than 6.5 million acres of land and water, including boreal forest and vast tundra. Park headquarters are at the Northwest Arctic Heritage Center in Kotzebue, west of the park on the Bering Sea coast. Access to the area is available by commercial jet flights to Kotzebue, the largest community in the region. Access to parklands is by small charter aircraft, and in winter by snow machine, ATV, and dogsled. Travel along the Noatak River is possible by boat from Gates of the Arctic National Park.

The Noatak River system is considered the last remaining complete river system in the United States that has not been altered by human activities. Noatak National Preserve shares its southern border with Kobuk Valley National Park and its eastern border with Gates of the Arctic National Park. Cape Krusenstern National Monument is west of the park, on the opposite side of the Kobuk River.



Map of the Preserve

Chapter 2. State of the Park

The State of the Park is summarized below for five categories—Natural Resources, Cultural Resources, Visitor Experience, Wilderness Character, and Subsistence Use —based on a synthesis of the park's monitoring, evaluation, management, and information programs, and expert opinion. Brief resource summaries are provided below for a selection of the priority resources and values of the park. Clicking on the web ▸ symbol found in the tables and resource briefs below will take you to the internet site that contains content associated with specific topics in the report.

The scientific and scholarly reports, publications, datasets, methodologies, and other information that were used as the basis for the assessments of resource condition are referenced and linked throughout the report and through the internet version of this report that is linked to the NPS IRMA data system (Integrated Resource Management Applications). The internet version of each report provides additional detail and sources of information about the findings summarized in the report, including references, accounts on the origin and quality of the data, and the methods and analytical approaches used in data collection and the assessments of condition. Resource condition assessments reported in this State of the Park report involve expert opinion and the professional judgment of park staff and subject matter experts involved in developing the report. This expert opinion and professional judgment derive from the in-depth knowledge and expertise of park and regional staff gained from their being involved in the day-to-day practice of all aspects of park stewardship and from the professional experience of the participating subject matter experts. This expert opinion and professional judgment utilized available factual information for the analyses and conclusions presented in this report. This State of the Park report was developed in a park-convened workshop.

The status and trends documented in Chapter 2 provide a useful point-in-time baseline measured against reference conditions that represent "healthy" ecosystem parameters, or regulatory standards (such as those related to air or water quality). Note that climate change adaptation requires park managers to continue to learn from the past, but attempting to manage for conditions based on an understanding of the historical "natural" range of variation will be increasingly futile in many locations. Thus, these reference conditions, and/or judgment about resource condition or trend may evolve as the rate of climate change accelerates and park managers respond to novel conditions. Management must be even more "forward looking," to anticipate plausible but unprecedented conditions, also recognizing there will be surprises. In this context, the NPS strives to incorporate climate considerations in decision-making processes and management planning and consider adaptation options that may deviate from traditional practices.

Climate impacts many aspects of park management, from ecological systems to park infrastructure. The climate is changing and human influence is now detectable in nearly all major components of the climate system, including the atmosphere and oceans, snow and ice, and various aspects of the water cycle (IPCC 2013). Global patterns of change demonstrate the human effects on climate are even more pronounced in high latitudes and polar regions (Larsen et al. 2014). As a region, Alaska has warmed more than twice as rapidly as the rest of the United States over the past 60 years, with average annual air temperature increasing by 3 °F and average winter temperature by 6 °F (Chapin et al. 2014). The observed impacts of a warming climate in Alaska include declining sea ice, shrinking glaciers, thawing permafrost, changing ocean temperatures and chemistry, increased coastal erosion, and more extensive insect outbreaks and wildfire (e.g., Larsen et al. 2014, Chapin et al. 2014, Markon et al. 2012).

Even with multiple lines of evidence that Alaska is warming, interpreting temperature trends and other climatic indicators is complicated. Climate in Alaska is dynamic and nonlinear, with strong linkages to atmospheric and oceanic processes, such as the position of the polar jet stream or the frequency of El Niño events (Papineau 2001). An important climate pattern, evident in the relatively few long-term climate stations located in parks, is the Pacific Decadal Oscillation (PDO). Much of the warming that has occurred since the middle of the 20th century occurred in 1976 as a stepwise shift, attributed to a climatic transition from a cool to a warm phase in the PDO (Chapin et al. 2014, Bieniek et al. 2014). In the early 2000s, the PDO shifted back to a cooler phase resulting in statewide temperatures that were cooler than the previous decades (Bieniek et al. 2014). The most recent years have seen yet another shift back to a warm phase that may or may not persist, but has resulted in two of the warmest years on record for Alaska in 2014 and 2015 (NOAA 2016). The north slope of Alaska has continued to warm despite changes in the PDO. Nonlinear responses and regional variations are expected to continue to occur as the planet adjusts to global scale change (IPCC 2013, Larsen et al. 2014). Recent studies suggest that warming Arctic temperatures weaken the temperature gradient between the poles and lower latitudes leading to a wavier jet stream, which results in more persistent weather patterns and extreme conditions such as cold spells, heat waves, droughts, and flooding (Francis and Vavrus 2015). The data and information gathered from national parks provide an important piece of the puzzle in understanding both the drivers and effects of climate change.

2.1. Natural Resources

Air Quality

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Ozone	Ozone Annual 4th-Highest 8-Hour Concentration		No condition data are available for ozone. However, given the paucity of ozone sources, it is likely that concentrations fall well below advisory thresholds.
Deposition	Nitrogen and Sulfur Wet Deposition		Data from the Bettles National Atmospheric Deposition Program (NADP) monitoring station (200 miles distant) and adjacent areas suggest that wet nitrogen deposition (ammonium, nitrates) is likely to be in the range of 0.2–0.5 kg/ha/yr level (NADP Monitor ID: AK06, NPS-ARD 2015, Brumbaugh et al. 2016). National and Arctic nitrogen critical loads assessments (Pardo et al. 2011, Linder et al. 2013) rated arctic tundra as extremely sensitive with a critical load of 1 kg/ha/yr of nitrogen deposition. While nitrogen levels in park rivers are currently low (O'Donnell et al. 2015), permafrost thaw may eventually contribute nitrogen to surface waters (Ewing et al. 2015, Sullivan et al. 2011d, Sullivan et al. 2011b). Ecosystems in Noatak were rated as having high sensitivity to nitrogen and sulfur acidification effects relative to other parks (Sullivan et al. 2011b) and moderate sensitivity to nutrient nitrogen effects (Sullivan et al. 2011c). Ecosystems and vegetation types such as the park's remote lakes, tundra lichen communities, and herbaceous communities are sensitive to the effects of both nitrogen nutrient enrichment and acidification. Acidification effects can include changes in water and soil chemistry that impact ecosystem health, lichens, fish, invertebrates, and phytoplankton (Sullivan et al. 2011a, Sullivan et al. 2011c). The degree of confidence in the nitrogen and sulfur deposition status is low because of the large distance to the monitoring sites. No trend data is available due to insufficient monitoring timespan. Regional pollution is likely to increase due to increased shipping traffic through the Chukchi Sea and oil development in the National Petroleum Reserve – Alaska.

Air Quality (continued)

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Deposition (continued)	Dry Deposition		Unpublished data on moss tissue suggests that a small area in northwest NOAT (approximately 6 miles from Red Dog Mine) has been exposed to levels of zinc, lead, and cadmium slightly above the proposed threshold levels for effects on lichens (Neitlich et al. 2017a, b, c; Exponent 2007a, b). The vast majority of NOAT is likely to be below proposed threshold levels for zinc, lead, and cadmium. Heavy metals are at or near arctic baseline levels based on moss monitoring (Neitlich et al. 2017a, Hasselbach et al. 2005). No trend data is available due to insufficient monitoring timespan.
Contaminants	Mercury and Persistent Organic Pollutants		Mercury deposition warrants moderate concern, based on estimated wet mercury deposition and predicted levels of methylmercury in surface waters in Gates of the Arctic and Noatak. The 2011–2013 average wet mercury deposition is very low at the adjacent monitoring station in Bettles at 2.1 micrograms per square meter (NADP MDN Monitor ID: AK06) and predicted methylmercury concentrations in surface waters are very low, estimated to be 0.02 nanogram per liter (USGS 2015). While much lower than NPS Air Resource Division benchmarks, there is concern because mercury concentrations in some fish in Gates of the Arctic and Noatak exceeded thresholds for both subsistence users and wildlife health (Landers et al. 2008, NPS-ARD 2015). Persistent organic pollutants are low in water, air, snow, lake sediment, and vegetation of Noatak. However, concentrations of historically-used pesticides were generally mid-range along the spectrum of western U.S. National Parks. The banned pesticide Dieldrin in long-lived fish such as lake trout exceeded the health advisory threshold for subsistence users while Chlordanes approached the advisory threshold for fish-eating birds (Landers et al. 2008).
Visibility	Haze Index		Data from the Bettles monitoring site indicates that visibility is in good condition. This status is based on NPS Air Resource Division benchmarks and the 2009–2013 estimated visibility on mid-range days of 1.8 deciviews (dv) above estimated natural conditions of 4.1 dv. The degree of confidence is low due to the distance between the park and the visibility monitor. No trend information is available because the monitor has an insufficient number of years of data (IMPROVE Site ID: GAAR1, AK; NPS-ARD 2015). While haze is generally low, the park has also experienced intermittent periods of high particulate haze from local or regional summer fires.

Resource Brief: Historical and Projected Changes in Climate for Noatak National Preserve

Climate, by determining the temperature and precipitation regimes for any ecosystem, is widely recognized as one of the most fundamental drivers of ecological condition. The climate patterns of Alaska are primarily influenced by latitude, continentality, and elevation. The high latitude drives the seasonal pendulum of available solar radiation; areas farther north have limited incoming solar warmth in the winter and an abundance of available light in the summer. Major mountain ranges act as barriers to the moisture from surrounding ocean waters. Large-scale atmospheric and oceanic circulation patterns influence seasonal and annual weather patterns in the parks, like the repositioning of the polar jet stream and the Aleutian low pressure system or the frequency of La Niñas and El Niño (Papineau 2001). Each of these can affect the regional patterns of storm tracks, prevailing winds, snowfall amounts, and the extent of sea ice (ACIA 2004).

Noatak National Preserve encompasses strong climate gradients, from the arctic maritime climates in the western region of the preserve in close proximity to the Chukchi Sea to the strongly continental climate found in the eastern region of Noatak. Noatak National Preserve includes portions of the North Slope, Central Interior, and West Coast climate divisions as defined by Bieniek et al. (2012). A transitional climate region lies between the coast and the interior influenced by major mountain ranges which act not only as the environmental controls to drive climate but also contribute to the highly localized micro climates found in complex mountain terrain. Temperature inversions are common through much of the year as a result of low water vapor content, extended periods of snow cover, and low solar radiation.

There are two long-term climate stations that anchor the preserve's major climate zones. Kotzebue provides context for the West Coast climate division and Bettles for the Central Interior in the southeastern region of Noatak. These sites provide insight on long-term climate trends that affect the parklands. Average seasonal and annual temperatures from these sites are shown in the graphs below. Temperature and precipitation projections over the next century have been calculated on a monthly time scale for all three locations as well. The projections are based on the PRISM model historical baseline projected at a 2km resolution using the mid-range emissions scenario (representative concentration pathway RCP 6.0). These graphs are useful in looking at overall trends in temperature increases versus specific values due to the uncertainty in models and natural climate variability (SNAP 2016).

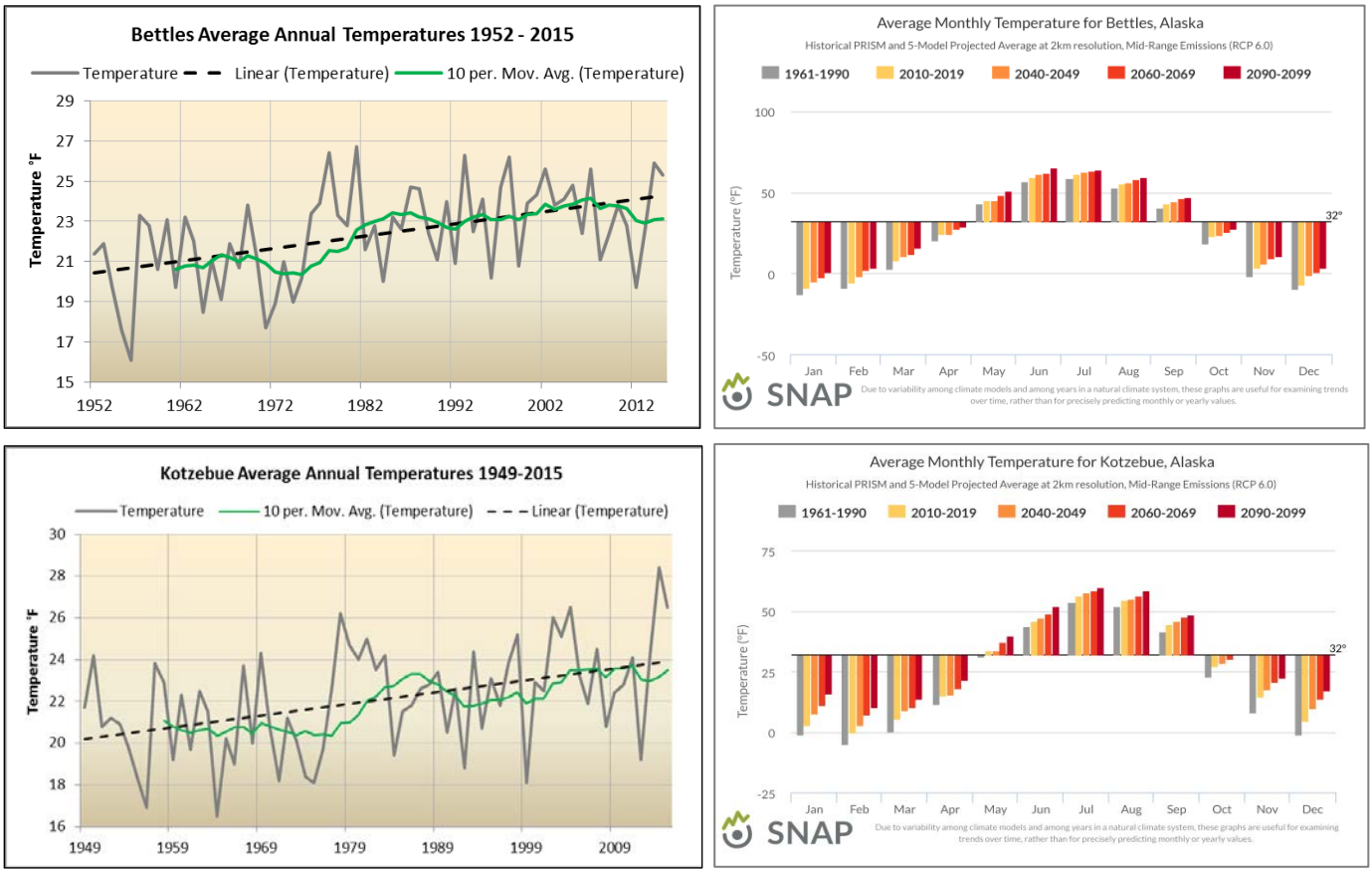
Historical trends and future projection for temperature

The observed temperature trend is non-linear with multi-decadal variations (graph below left). The increase in the mean annual temperatures is significant with temperatures warming ≈3.9 °F at both locations when a simple linear regression is applied to the long-term records. Considering just a linear trend masks important variability in the time series; this record spans the phase shift of the Pacific Decadal Oscillation (PDO) in 1976 where annual temperatures at this location, and at most locations around the state, abruptly shifted up by ≈2.5 °F in a single year and then persisted in this warmer phase for the next several decades. The ecological consequences of an abrupt shift in temperatures versus a steady increase in temperatures need further investigation. The trend in annual temperatures since 1977 has been relatively stable. However, over the past several years the PDO index has had the highest, most persistent positive values since the 1980s, coinciding with a strong El Niño pattern, resulting in two of the warmest years on record for the state of Alaska in 2014 and 2015.

Seasonally, winter temperatures show the most significant increase at both locations. Summer temperatures have also increased significantly over the period of record for Kotzebue and Bettles. Spring temperatures in Bettles show significant warming as well. Temperatures are projected to increase for all seasons by mid-century, with the greatest increases likely in winter (graphs below right). There is general agreement among individual climate models in the direction and magnitude of warming over the coming decades. Warming temperatures pose serious threats to park resources when the average annual temperatures are near freezing.

Persistent warm periods and temperatures that reach above freezing in winter can pose problems to an ecosystem that is dominated by snowcover for a good portion of the year: snow turns to rain, which leads to icing, which makes foraging difficult; plants are subject to desiccation because of low or no snow cover; and subnivean fauna are left unprotected. Extremes in spring temperatures, especially in late spring can have repercussions related to the timing of many phenological events that are triggered by the return of warmer temperatures in May. An increase in summer temperatures can lead to many scenarios that fall out of the "normal" range of expectations including impacts to the fire season, insect outbreaks, wildlife migrations, aquatic ecosystems, active layer thawing, etc. Changes in early fall season temperatures can once again impact the timing of many phenological events that are triggered by cooler temperatures and decreasing daylight.

Resource Brief: Historical and Projected Changes in Climate for Noatak National Preserve (continued)



Average annual temperatures at Bettles (top left) and Kotzebue (bottom left). The green lines show the 10-year moving averages. The dotted lines show a simple linear regression trend. The Scenarios Network for Alaska and Arctic Planning (SNAP) monthly temperature projections for the next century are shown for Bettles (top right) and Kotzebue (bottom right)(SNAP 2016).

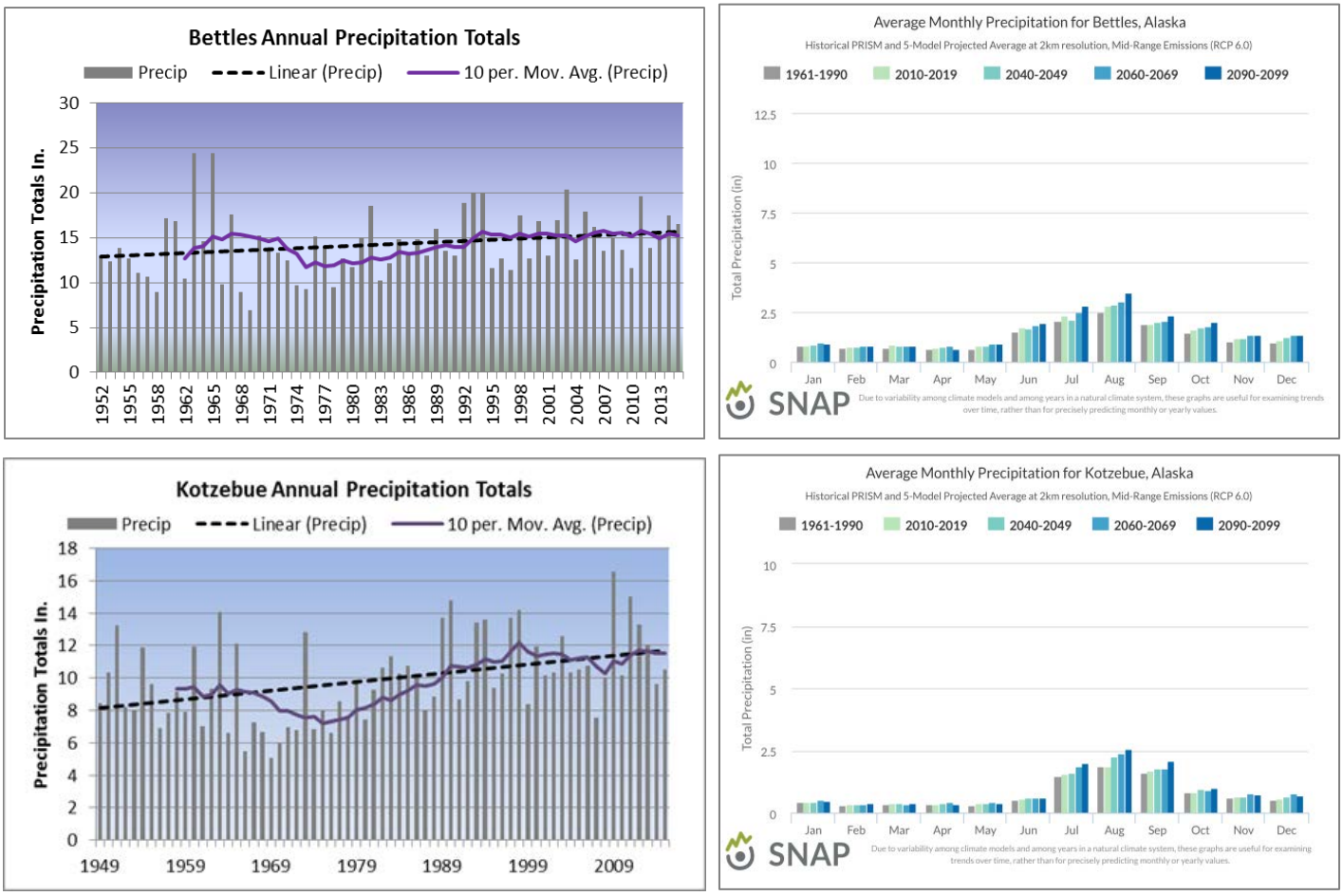
Historical trends and future projection for precipitation

Observed annual precipitation totals have increased significantly at Kotzebue, with most of the increase apparent in the winter and spring seasons. In Bettles, the precipitation totals have increased over the period of record, but not significantly, with the largest increases occurring during the summer and winter season (graphs below left). Annual snowfall totals at both locations show a significant increasing trend. Total annual precipitation is projected to increase throughout the next century, particularly in the summer season (graph below right) (SNAP 2016). Precipitation variability is likely to remain large over the coming decades (larger uncertainty in precipitation than in temperature projections) (Stewart et al. 2013).

Seasonal trends show the extreme variability in precipitation between seasons and among seasons, and can also be used to highlight extreme events that have large ecological implications for humans (i.e., floods, droughts) and wildlife (i.e., high or low snowfall, rain on snow events).

Increasing winter temperatures can lead to an increase in the number or intensity of rain-on-snow events that could potentially disrupt the path to the food supply for wildlife. The precipitation projections indicate that late spring may see an increase in precipitation amounts. Late spring snowfall events can interfere with the timing of bird migrations, wildlife health, green-up, and other ecological processes that begin once the snow has melted. The precipitation projections show that precipitation will increase the most during the summer months in Bettles and Kotzebue; more rain and more intense rain events can lead to flooding, erosion, and soil instability.

Resource Brief: Historical and Projected Changes in Climate for Noatak National Preserve (continued)



Total annual precipitation at Bettles (upper left) and Kotzebue (lower left). The purple lines show the 10-year moving average. The dotted lines show a simple linear regression trend. The Scenarios Network for Alaska and Arctic Planning (SNAP) monthly precipitation projections for the next century are shown for Bettles (top left) and Kotzebue (bottom right) (SNAP 2016).

Other projections

In addition to warmer mean temperatures and changes in annual precipitation, climate change will exhibit itself in many other ways. Permafrost, which is present throughout the Preserve, is projected to thaw across large portions of Alaska by 2100 under both low and high emissions scenarios, altering local hydrology and potentially impacting roads, buildings, and other infrastructure (Stewart et al. 2013). The growing season is projected to increase 15–25 days by mid-century, and warmer spring temperatures already are linked to increased wildfire activity in Alaska (Stewart et al. 2013). Global climate change will interact with regional phenomena, such as the Pacific Decadal Oscillation (PDO). The phase of the PDO (negative or positive) may modify observed climate trends, with the negative phase dampening and the positive phase exacerbating overall climate change trends. Significantly, warmer temperatures and a more variable precipitation regime may lead to both droughts that are more frequent and more severe flooding and erosion.

Geological Resources

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Permafrost	Extent of Permafrost, Permafrost Temperature, Thickness of Active Layer		Most of NOAT is underlain by permafrost. Modeling by University of Alaska Scientists (Panda et al. 2014, 2016) and ground temperature observations by NPS (Swanson 2016a) show that permafrost has warmed and the thickness of the seasonally-thawed upper (or "active") layer has increased as a result of climate warming since 1950, but the extent of permafrost has changed little so far. Recent warming has raised permafrost temperatures above -3 °C across much of NOAT. This has reduced the margin of safety protecting permafrost from thaw in the future, and widespread thaw of permafrost is expected in the latter half of the current century if warming continues.
	Stability of Permafrost Terrain		Climatic warming since 1950 has locally caused ground ice near the surface to melt. Some degradation of ice wedges has been documented in southern Kobuk Valley National Park (to the west) and far western NOAT (Swanson 2016b). Unusual weather in 2004 produced a large number of small landslides due to permafrost thaw in NOAT (Swanson 2014, Balser 2015). Most of these landslides have since stabilized and revegetated, though a few have continued to grow. A large thaw slump on the Noatak River continues to shed sediment, but elsewhere current levels of sedimentation due to thaw slumping appear close to historical levels.
External Development	External Development Threats		In addition to the Red Dog Mine currently in operation west of the park, there is mineral exploration and other small-scale mining outside the boundary. The Omar prospect is a deposit of copper and iron sulfides approximately 7 miles south of Noatak. In 2006, NovaGold staked a large block of claims, and acquired the Omar property (Tintina Gold). In the succeeding years, the company has done a considerable amount of field work emphasizing geologic mapping, geochemical sampling, and drill coring. Development of this mine could bring some potential impacts to water and air quality in NOAT including: sulfur and nitrogen emissions, heavy metal-bearing fugitive dusts, and water-borne contaminants. Industry and local communities interested in generating infrastructure may propose additional road corridors that run near or through the park. A geodatabase has been developed to allow resource managers to track current and proposed development activity in and around NOAT.
	Inventory of Abandoned Mine Lands and Formerly Used Defense Sites (FUDS)		A handful of mining claim blocks were staked in NOAT during the 1970s; however, no known work other than geologic sampling was conducted. Over the past 20 years, a large number of barrels (most containing only water or small amounts of gasoline) have been removed from NOAT.

Paleontological Resources

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Paleontological Resources	Inventory and Understanding		Fossils are non-renewable resources that are irreplaceable windows into the past. Once a fossil is gone, it is gone forever. Paleontological resources provide educational and scientific opportunities for visitors and paleontologists. The Public Land Management Act of 2009 directs the parks to implement a comprehensive paleontological resource management program on federal lands. The act requires increased protection, enhanced management tools, and greater scientific and public understanding of NPS fossil resources. A paleontological inventory was completed by Elder et al. (2009). A database of all known paleontological resources is under development and expected to be completed in 2017. NOAT contains fossils in two contexts: 1) Paleozoic to Mesozoic (542–65 million years ago) marine sedimentary rock units of the mountains and uplands; and 2) Pleistocene and Holocene (2.6 million years ago to present) fossils within unconsolidated deposits found along river gravel bars. The marine fossils of the park are generally common invertebrate fossils; however, one site has a vertebrate ichthyolith (fish). Pleistocene bone fragments are found isolated and out-of-context along river gravel bars. One mammoth tusk resides in park collections from NOAT.
	Percentage of Known Sites in Good Condition		A paleontological resources inventory and field-based site assessment to establish baseline resource monitoring needs has not been done. Non-permitted collecting in WEAR parks has been observed, but has not been officially documented. Fossils in sea bluff exposures and river cut banks are at high risk of being eroded.

Water Resources

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Lake Communities and Ecosystems	Surface Area and Number of Lakes		Analyses of lake area change by remote sensing (Swanson 2013) indicate that in recent decades the area of lakes and ponds has been stable or decreasing in NOAT. The decreases have been due to decadal-scale climate variations that could persist into the future. Areas with the most substantial declines in lake area in recent decades are the lowlands of central NOAT, due to shrinkage of stable lake basins due to a change in the water balance. The declines of 10% to 20% in recent decades have likely reduced habitat for aquatic wildlife; if this continues, it could be cause for significant concern in the future.
	Water Quality (chemistry, temperature, concentration of organics, turbidity)		Large lakes in NOAT have very low concentrations of inorganic nitrogen, phosphorus, and organic matter (O'Donnell et al. 2015) needed to support life. The chemistry of shallow lakes varies with parent material and ground ice content (Larsen et al. *in prep*), but in general, shallow lakes are in good condition with respect to surface water chemistry. There are no long-term records for lake chemistry in NOAT; thus, large uncertainties exist for long-term trends and trajectories.
Stream Communities and Ecosystems	Water Quality (chemistry, temperature)		Arctic stream chemistry is sensitive to the effects of climate change and disturbance (e.g., permafrost thaw; Vonk et al. 2015). Between 2013 and 2015, 33 streams and rivers were sampled in NOAT as part of a pilot study to characterize stream chemistry (O'Donnell et al. 2015). Nearly all streams were in good condition, with very low nitrogen, phosphorus, and organic matter concentrations. Most NOAT watersheds are underlain by ice-poor permafrost and near-surface bedrock, which strongly governs watershed hydrology and stream chemistry. Some watersheds are underlain by glaciolacustrine deposits with moderate ice-content (e.g., Cutler, Eli, and Makpik Rivers), which function to convey higher amounts of organic matter to streams relative to the ice-poor bedrock catchments (O'Donnell et al. 2016). Few long-term records exist in NOAT; however, researchers have been studying stream chemistry and watershed biogeochemistry in Asik Creek in the Agashashok Watershed for over three decades now (e.g., Stottlemyer 2013). Observations indicate a significant long-term decline in stream nitrate concentration in Asik Creek (Stottlemyer 2013). This finding coincides with a long-term increase in active layer thickness. However, it's unclear how generalizable this finding is across other watersheds in NOAT.

Water Resources (continued)

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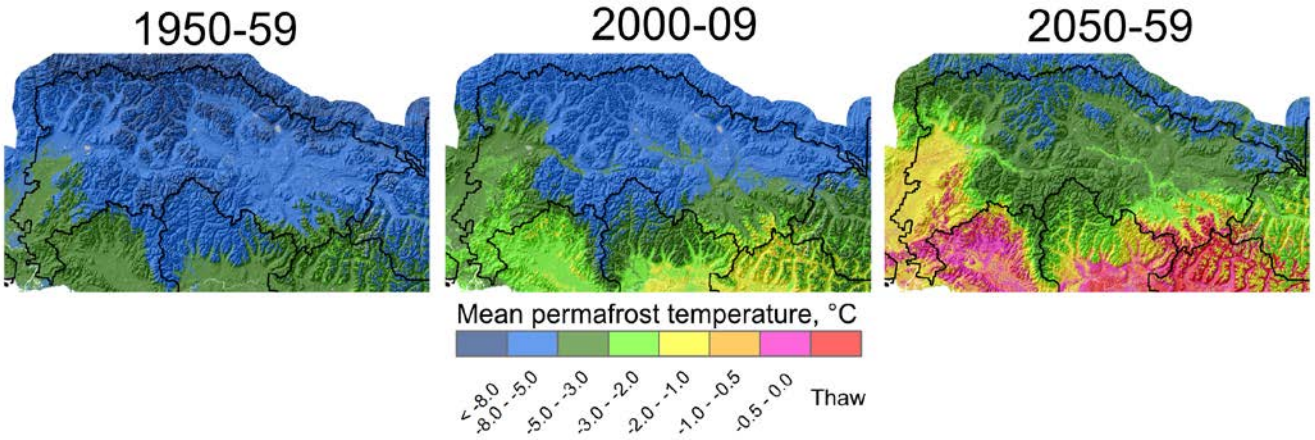
Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Stream Communities and Ecosystems (continued)	Flow (Magnitude and Timing)		There are no stream gauges or long-term discharge measurements in NOAT. Stream discharge has been reported for Asik Creek, where researchers have examined treeline biogeochemistry over the past three decades (Stottlemyer 2001). However, discharge measurements have not always been continuous, which limits the ability to detect a trend. More generally, the magnitude and seasonality of discharge is changing in many arctic streams and rivers, and is likely changing within park boundaries. Annual river discharge is generally increasing across the Arctic (e.g., Peterson et al. 2002), and is primarily due to increased net precipitation. In many watersheds regionally, spring snowmelt is occurring earlier, including in the nearby Kobuk and Wulik Rivers (Tape et al. 2016b). Groundwater discharge to streamflow is increasing in the discontinuous permafrost zone of Alaska (Walvoord and Striegl 2007), but little is known about continuous permafrost regions, such as NOAT.

Resource Brief: Permafrost Temperature

Permafrost underlies most of NOAT and affects nearly everything in the ecosystem, from soils and vegetation to water and wildlife. Permafrost is ground that doesn't thaw in the summer due to a cold climate. Permafrost perches water near the surface, making soils wet. The striking polygonal patterned ground so characteristic of the Arctic is due to permafrost. Ice can build up in the ground and then thaw, producing pits, ponds, lakes, and landslides. Permafrost thaw in a warming climate could have far-reaching effects on arctic ecosystems. Ground temperature measurements and computer modeling by University of Alaska scientists and NPS show that warming since the 1950s has caused the permafrost in NOAT to warm, but most is still safely frozen and has temperatures below -2 °C. With the continued warming expected in the future, permafrost in NOAT is expected to warm so that by the year 2050 southern parts of the Preserve will be near the thaw point and vulnerable to major changes with warming after 2050.



Mean permafrost temperature. Maps courtesy of Santosh Panda, University of Alaska Fairbanks.

Terrestrial Vegetation

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Native Plants	Terrestrial Lichen Cover, Caribou Lichen Winter Range	↓	It is likely that terrestrial lichen cover has declined slightly due to shrub increase in tundra habitats (Swanson 2015), and this trend is expected to continue. Lichen cover is still on the moderate end of potential spectrum in Noatak with approximately 7% cover within lichen-rich plant communities—such as dwarf shrub tundras, sparse vegetation alpine communities and forests (Holt and Neitlich 2010). Lichen cover has the potential to increase with the decline of the Western Arctic Caribou Herd (Joly et al. 2010). Increasing forest cover in the future is likely to promote higher cover by epiphytic lichens (i.e., lichens growing on trees). If NOAT experiences increases in fire frequency and area burned due to the continued warming and the increase in lightning strikes, this will impact late successional lichen cover. Landscape units burned in the past 60 years had only one quarter of the lichen abundance of unburned units in the Western Arctic Caribou Herd's historic winter range (Joly et al. 2010). A greater presence of fire on the landscape is likely to place more of the landscape into earlier successional states with less lichen abundance (Joly et al. 2009, Racine et al. 2006).

Resource Brief: Lichen

Lichens are a conspicuous and abundant component of the flora in Arctic parklands. Lichens are fragile, slow-growing, and sensitive to air pollutants. Forage lichens—i.e., the dominant lichens of the low shrub and alpine tundra—form the bulk of the winter diet for caribou and domesticated reindeer, and are also consumed by muskoxen. Over the past decade, NPS studies have documented 491 species of macrolichens in the Arctic parklands (Holt and Neitlich 2010). Scientists have estimated the presence of a similarly large number of crustose lichens. NPS cooperators recently described 3 new lichen species of *Hypogymnia* (or Tube Lichens) from Beringia, based in part on specimens gathered on the Seward Peninsula (McCune 2008).

Reindeer lichens can frequently form a co-dominant landcover in the Western Arctic Parklands and are a preferred caribou winter forage. NPS Photo by Peter Neitlich.

One expected impact of climate change is increased shrub dominance and spread of forest into tundra habitats (Swanson 2015). In the long term, this may turn lichen-rich dwarf and low shrub tundra into denser shrub thickets and woodlands. These communities tend to smother terrestrial lichens with litter fall and therefore have lower biomass of the forage lichens needed to sustain large ungulate herds (Joly et al. 2010). Such a pattern has been demonstrated on the Seward Peninsula, with black spruce encroachment (Lloyd et al. 2003). The future state of northern Alaska lichen communities may more closely resemble the lower lichen biomass mixed forest-alpine communities of southern or interior Alaska. These climate driven changes, in combination with a decreased fire-return interval, may result in substantial declines in lichen biomass. While lichen biomass may eventually decline, lichen diversity may actually increase with greater tree and shrub cover.

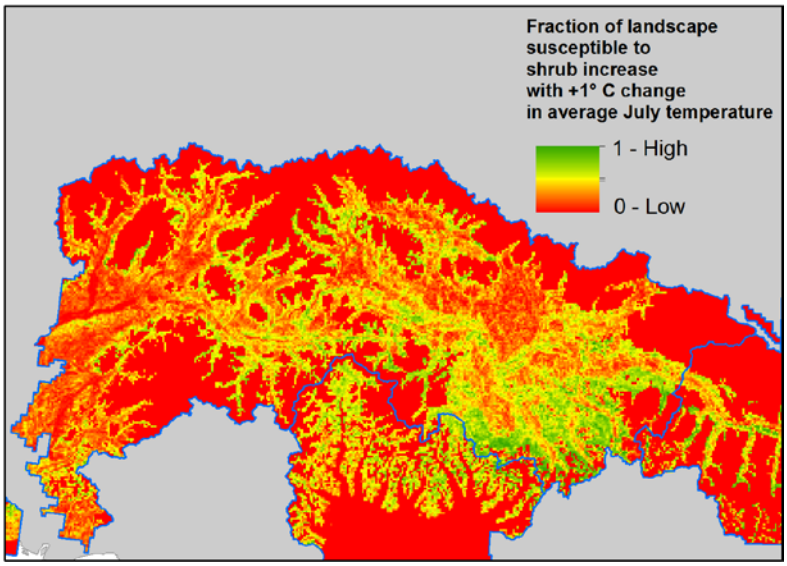
Terrestrial Vegetation (continued)

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Native Plants (continued)	Lichen Species Diversity		Lichen diversity is relatively high in Noatak due to a diversity of habitats from lowland to alpine (Holt and Neitlich 2010). 203 macrolichen species have been documented with a mean of 26 species per acre. Diversity may change with climate change due to an influx of lichen species associated with more southerly forests along with the shrinkage of arctic tundra habitat. NOAT currently has no trend data on lichen diversity but has no basis to suspect changes.
	Vascular Plant Diversity		NOAT has relatively high vascular plant diversity, with 506 species identified to date, of which 21 are classified as rare or imperiled at the State of Alaska level by the Alaska Natural Heritage Program (AKNHP 2016, Parker 2006). At present, these plants are naturally rare and are not threatened with extinction by human actions. Climate change and associated changes in ecological disturbance regimes such as fire and flooding are expected to alter the abundance of many plant species, but significant changes in overall diversity of vascular plants are not expected to occur in the next few decades.

Resource Brief: Shrub Extent and Expansion into the Tundra

Shrubs have grown taller and expanded into new areas of arctic tundra in recent decades (Tape et al. 2006). This shrub expansion is due mainly to climate warming, and it has far-reaching consequences. Shrubs provide forage for browsing species (moose, hares, and ptarmigan); they also can: reduce erosion by vegetating bare areas along streams, increase snow depth by capturing windblown snow, and shade out plants of lower stature (such as lichens). Shrubs react quickly to climate warming because they are relatively fast-growing and already present across the arctic tundra and adjacent boreal forests—though often stunted by wind and cold.



Landscape susceptible to shrub increase. Map from Swanson (2015).

Shrub expansion can be detected by comparing aerial photographs from the 1950s or 1980s with more recent photos or satellite images. These comparisons have shown that, while shrub expansion is clearly visible, it has covered modest total areas as yet and has occurred mainly in the tundra areas with the warmest summers. July average temperatures above 10 °C (50 °F). Multiple tall shrub species can grow on well-drained soils with neutral pH, while only a few tolerate the cold-wet, acid soils common in the Arctic. Thus in the future shrub expansion is expected to be most apparent on well-drained soils in places with tundra vegetation where, as a result of warming, the July average temperatures have risen above 10 °C. The uplands of eastern Noatak Valley contain the land in the Preserve most susceptible to future shrub expansion with climate warming.

Terrestrial Vegetation (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Native Plants (continued)	Area of Open Tundra		Vascular plant cover has been increasing across the Arctic in recent decades, as shrubs and other plants increase in height and density, and this trend is expected to continue in the future (Tape et al. 2006, Verbyla 2008). Local declines in plant cover due to fires are short-lived, as vascular vegetation cover is quickly re-established. The cover, density, and height of shrubs have increased in tundra areas of NOAT, as has occurred elsewhere in the Arctic. Comparison of aerial photographs from 1980 and 2010 across 5 NPS units in northern Alaska showed that about 14% of the area of tall shrub thickets in 2010 was new since 1980, but shrub thickets still cover only about 6% of the total area (Swanson 2013). Most of the increase in shrubs is occurring in the relatively warm and well-vegetated portions of the tundra lowlands or near current treeline. This shrub increase is expected to continue with climate warming. While shrub increase will benefit certain species such as moose and willow ptarmigan, it will alter the iconic open arctic tundra landscape and harm some of the species that depend on it (Marcot et al. 2015). Expansion of trees onto arctic tundra has also been documented in the National Parks of northern Alaska (Suarez et al. 1999, Swanson 2013). Tree expansion has been slower and less widespread than shrub expansion. NOAT hosts both forested terrain that follow river drainages (where permafrost is diminished) and arctic tundra. Boreal forest is expected to expand into arctic tundra gradually over the coming century. In coming decades it is likely that white spruce (*Picea glauca*) will expand out very gradually from existing stands. Cottonwoods (*Populus balsamifera*) should continue to grow taller and expand in areas along the river valleys of NOAT.
Invasive Plants	Presence/Absence		There are no known occurrences of non-native plant species in the park. Terrestrial invasive plant species have been recorded at airports in Nome, Quartz Creek, Kotzebue, Dahl Creek, and Bettles. These airports are frequently used to access the park, and NOAT's greatest concern is that plants could be inadvertently transported from these locations into the park. Future monitoring of the floatplane landing areas for aquatic invasive species is warranted. The main aquatic plant of concern is *Elodea*, a freshwater aquatic plant that has become established in southern and interior Alaska. It is unknown whether *Elodea* can survive in the brackish water of the Kotzebue floatplane lagoon.

Birds

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Landbirds	Populations		NOAT falls into nationally and internationally recognized bird conservation regions (Conservation Region 2, BPIF 1999 and the Arctic Avifaunal Biome, Rich et al. 2004). However, population status information for landbird species in NOAT is incomplete. Ninety-six species of montane-nesting birds were detected during a 2001–2003 inventory of national parks in the Arctic. River-based surveys of riparian passerine assemblages were conducted along the Noatak River in Gates of the Arctic National Park and Preserve and NOAT in 2010. The following are species of high conservation concern because most, if not all, of their Western Hemisphere populations breed in Alaska: short-eared owl, McKay's bunting, Smith's longspur, snowy owl, snow bunting, hoary redpoll, and Lapland longspur. Species associated with shrub habitat may be vulnerable to climate-induced expansion of woody vegetation into open landscapes. For example, in a study of passerine assemblages in Denali National Park from 1995–2013, Mizel et al. (2016) documented pervasive upslope shifts in the distributions of shrub-associated passerine species. In particular, species associated with high elevation, open shrub habitats, including Arctic warbler, savannah sparrow, and golden-crowned sparrow, showed relatively large upward shifts in their optimum elevation.
Shorebirds	Populations		Information about the population status of breeding shorebirds in NOAT is lacking. Loss of wetlands, particularly migratory stopover areas outside of Alaska that are important to those species breeding in Alaska, represents the greatest threat to shorebird populations worldwide. Wetland habitats are threatened by climate change through rising sea level, drying interior wetlands, and increased storm frequency and intensity (Thorne et al. 2015). Priority species of high conservation concern that are experiencing population declines and thought to breed or migrate through the park include: American golden-plover, solitary sandpiper, whimbrel, black turnstone, surfbird, western sandpiper, dunlin, red knot, and red-necked phalaropes (ASG 2008, Andres 2012).

Terrestrial Mammals

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Moose	Distribution		Moose in the Arctic are limited by winter range, defined by access to shrubs in excess of 1 meter in height (Tape et al. 2016b). Available habitat has changed over time concurrently with climate and fire regimes that favor the succession of woody browse over lichens (Joly et al. 2012). Moose have been found in the archeological record in arctic Alaska, but were absent from this region prior to recolonization in the 20th century (Westing 2012). Moose inhabited NOAT by the 1960s (LeResche 1974, Tape et al. 2016b) and primarily utilize habitat along riparian areas adjacent to the Noatak River and its tributaries.
	Abundance		In the late 1980s and early 1990s, a decline was detected in the preserve; during this time, moose may have vanished from Noatak River tributaries in the central portion of the preserve. Though they have recovered, the population in eastern NOAT remains very low. The most recent (2013) population estimate for moose in the lower Noatak River drainage was 1,478 animals at a density of 0.23 moose per square mile. In 2010, a survey was conducted east of the Nimiuktuk River and yielded a population estimate of only 153 animals, or 0.03 moose per square mile. Recent observations by biologists confirm low moose densities. In addition, the Alaska Department of Fish and Game is currently not recommending reauthorization of an antlerless moose (i.e., cow moose) harvest in Game Management Unit 23, of which NOAT is a part (B. Saito, personal communication).
Caribou	Migration		Climate change is anticipated to affect mammals in myriad ways, including the timing of migration. Caribou in northwest Alaska have crossed the Kobuk River for thousands of years. There does not appear to be a change in the average timing of this fall crossing, though there is some indication that the first collared caribou has been coming later and later (Joly and Cameron 2015).
	Population		The Western Arctic Caribou Herd is currently at the low end of its population cycle. In 2016, the population was estimated at 201,000, down from 490,000 in 2003 (Parrett 2016). In general, the health and success of the various herds in this region is stable, with some natural fluctuation.

Terrestrial Mammals (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Bears	Abundance and Harvest		A study conducted in 1986–1988 found brown bear densities in a 1,862 km^2 area just northwest of NOAT (around the Kelly River, Wrench Creek, and Wulik River) to be 1 bear per 66 km^2 for independent bears (i.e., bears without cubs) and 1 bear per 51 km^2 for total bears (Ballard et al. 1990). Estimated annual harvest rates in this area range between 8% and 16% (Ballard et al. 1990), which exceed maximum allowable harvest and the conservative exploitation rates of 2–4% recommended for northern latitudes (Reynolds 1976, Sidorowicz and Gilbert 1981). The observed harvest rate also exceeds the suggested maximum sustainable annual hunting mortality of 5.7% (Miller 1990). A 1984 study of brown bears in the western Brooks range that overlapped a northwestern portion of NOAT found brown bear densities to be 1 bear per 42–44 km^2 for bears of all ages (Reynolds 1984). Studies in the eastern Brooks Range where study areas overlapped northeastern portions of NOAT found brown bear densities to be 1 bear per 83–304 km^2 for bears of all ages (Ballard et al. 1990). Aerial surveys were conducted in the upper Noatak drainage in NOAT and Gates of the Arctic in 2005 and 2007. The 2005, survey estimates for densities of independent bears and total bears were 1 bear per 119 km^2 and 1 bear per 80 km^2, respectively. In 2007, survey estimates for densities of independent bears and total bears were 1 bear per 94 km^2 and 1 bear per 62 km^2, respectively (B. Shults, unpub. data). In the lower Noatak drainage (including NOAT and Cape Krusenstern in 2008), estimated densities of independent bears and total bears were 1 bear per 57 km^2 and 1 bear per 36 km^2, respectively (B. Shults, unpub. data). A trend is not assigned to this measure because recent survey estimates are not directly comparable with estimates from the 1980s, due to the different study areas. In addition, the 2005, 2007, and 2008 survey methods had some design flaws; the method has since been improved to generate more accurate estimates and a survey employing the improved method was conducted in lower NOAT and Cape Krusenstern in May 2016. Results are forthcoming. Local residents believe that there are numerous bears in Game Management Unit 23 (of which NOAT is a part). Local residents have reported bear-related damage to cabins and nets, taking of fish from fish drying racks, and a general concern for human safety.

Terrestrial Mammals (continued)

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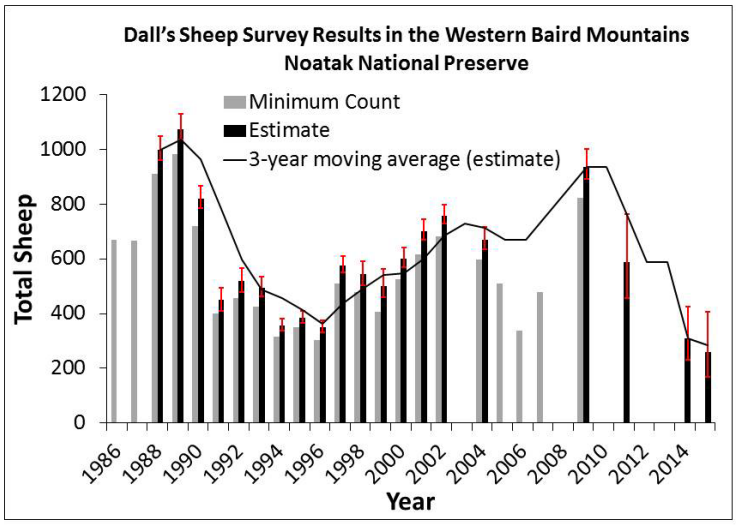
Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Bears (continued)	Distribution		In the last 20 years, bear distribution has changed in response to changes in habitat prompted by climate, human commerce, and the impacts of development. More salmon reach spawning areas far inland in NOAT due to decreased commercial fishing locally, while berry shrubs have proliferated. Meanwhile, impacts from Red Dog Mine have caused den abandonment and mortality (Ayres 1991). Variability in marine mammal carcass availability may also have shifted bear distribution.
Wolves	Abundance and Distribution		The few historical estimates of the wolf population size in northwest Alaska are varied and unreliable, but the concern of their influence upon the Western Arctic Caribou Herd spurred predator control by means of poison and aerial shooting as early as the 1940s (Kelly 1954) and liberal harvest quotas since. From 1987–1992, wolves were radio-collared to study their demographics and predation rates; it was determined that hunting, trapping, and rabies were the most significant sources of mortality (Ballard and Krausman 1997). The wolf population in NOAT has not been estimated in recent years, but many local residents report an increase in observations and a concern for the caribou and public safety.
Dall's Sheep	Abundance		Dall's sheep declined by more than 70% across NOAT between 2011 and 2014, prompting emergency closures to both state and federally-managed hunts in the western Brooks Range (Schmidt and Rattenbury 2013, Rattenbury and Lawler 2010). The current decline involves all age categories and both ewes and rams. Populations fluctuate naturally as sheep are a relatively non-migratory and alpine-adapted species sensitive to local environmental change. Large declines have been linked to severe winter weather (Nichols and Bunnell 1999, Shults 2004).
	Distribution		Dall's sheep populations in NOAT are at the northwestern edge of the species range and relatively isolated from the much larger sheep population in Gates of the Arctic National Park and Preserve. Within NOAT, sheep in the Baird Mountains south of the Noatak River likely do not mingle with those in the DeLong Mountains north of the river based on collar data (Ayres 1986, Shults 2004). The recent decline and marginal habitat in NOAT may have resulted in contraction of the Baird and DeLong sheep populations. Local observations have indicated that a contraction has occurred.

Resource Brief: Dall's Sheep

Two Dall's sheep rams. NPS Photo.

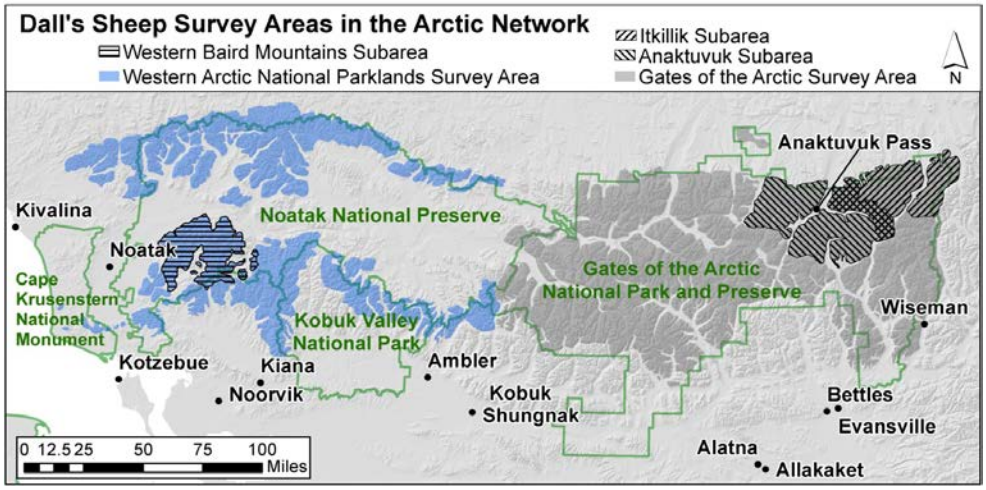
Dall's sheep (*Ovis dalli dalli*) sheep in Noatak National Preserve are at the northwestern edge of the species range and relatively isolated from the much larger sheep population in Gates of the Arctic National Park and Preserve. They are an important subsistence species for local residents—particularly when caribou are scarce—and are highly valued by hunters. Dall's sheep are also one of the most visible large mammals for wildlife viewing in northern Alaska. The NPS conducts aerial distance sampling surveys for Dall's sheep on an annual basis in the western Baird Mountains and every four years across Noatak National Preserve. There are over 27,000 square miles of potential sheep habitat in Alaska's national parklands, so monitoring the animals is an enormous task. Scientists fly transect surveys in the mountains and analyze the data using statistical modeling to estimate the sex and age composition and population of sheep in the parks. In addition, NPS scientists are monitoring the diet and forage quality and composition for sheep in two harvest management areas in the Brooks Range.

Sheep numbers declined by more than 70% across NOAT between 2011 (2,825 sheep) and 2014 (785 sheep), prompting emergency closures to both state and federally-managed hunts in the western Brooks Range (Schmidt and Rattenbury 2013, Rattenbury and Schmidt 2017). Preliminary estimates from the 2015 survey in the western Baird Mountains subarea in southern NOAT indicate continued decline and poor lamb recruitment. The number of adult sheep in the subarea was at least 50% lower in 2015 (309 adult sheep) than the average of surveys conducted from 1988 to 2014 (see graph below; Rattenbury and Schmidt 2017, Shults 2004). The current decline involves all age categories and both ewes and rams, and there were likely 3–4 years of poor lamb recruitment from 2012–2015 based on observations in other areas of Alaska and Canada.



Results from aerial Dall's sheep surveys in the western Baird Mountains, 1986–2015. Estimates are from sightability model analysis of minimum count data from 1988 to 2009 (with 95% confidence intervals; Udevitz et al. 2006, Debevec and Udevitz 2008) and distance sampling in 2011, 2014 and 2015 (with 95% credible intervals; Schmidt and Rattenbury 2013). The area was partially surveyed in 1986, 1987 and 2005–2007.

Populations fluctuate naturally as sheep are a relatively non-migratory and alpine-adapted species sensitive to local environmental change. Large declines have been linked to severe winter weather, such as the cold spring in 2013, deep snow in the early 1990s, and icing events that may reduce nutritional condition and increase vulnerability to predation (Nichols and Bunnell 1999, Shults 2004). Climate change impacts—increases in winter weather variability, changes in vegetation phenology, and changes in species composition—may affect Dall's sheep populations in NOAT.



Map showing Dall's sheep survey areas in Noatak National Preserve and Gates of the Arctic National Park and Preserve, including subareas that are surveyed annually.

Terrestrial Mammals (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Muskoxen	Abundance and Distribution		NPS and the Alaska Department of Fish and Game (ADF&G) collaborate on muskox population estimation and composition surveys of the Cape Thompson (CT) muskox population. Since 1988, population estimates and composition surveys have been conducted on the CT population in what is called the “core area” in and adjacent to Cape Krusenstern. Since 2004, the CT population has declined in the core area and/or is shifting eastward into what has been called the “expanded area” in NOAT (Schmidt and Westing 2011, J. Lawler, pers. comm., J. Dau, pers. comm.). The 2016 point estimate for whole population in the expanded area was 556.

Resource Brief: Muskoxen

The muskox is an iconic species of the Arctic and is native to Alaska. Once common in Alaska, muskoxen were heavily hunted and extirpated from Alaska by the mid- to late-1800s (Lent 1988, Allen 1912). Muskoxen were reintroduced to Alaska in 1935; 34 animals were captured in eastern Greenland and translocated to Nunivak Island (Gunn and Forchhammer 2008, ADF&G 2016b). The population on Nunivak Island thrived and in 1970 and 1977, 70 muskoxen were reintroduced from Nunivak Island to Cape Thompson (Gunn and Forchhammer 2008, ADF&G 2016b).

Muskoxen in snow. NPS Photo.

NPS and the Alaska Department of Fish and Game (ADF&G) collaborate on muskox population estimation and composition surveys of the Cape Thompson (CT) muskox population. Since 1988, population estimates and composition surveys have been conducted on the CT population in what is called the “core area” in and adjacent to Cape Krusenstern. The core area consists of an area within 30 km of the shore from the mouth of the Noatak River northwest to Cape Lisburne. Since 2004, the CT population has declined in the core area and/or is shifting eastward into what has been called the “expanded area” in NOAT (Schmidt and Westing 2011, J. Lawler, pers. comm., J. Dau, pers. comm.).

In 2011, the suspected shift in the population’s distribution prompted the NPS and ADF&G to survey and generate a population estimate for the CT population in both the core and expanded areas. The results showed that at least half of the CT population resided in the expanded area. There is increased interest to expand subsistence hunting of the CT population. Recent concern about the overharvest of adult bulls and subsequent declines in muskox populations (Schmidt and Gorn 2013) has led to the need for more frequent and precise estimates of sex and age composition and abundance of the population. To this end, in March 2016 the NPS and ADF&G again collaborated on population and composition surveys of the CT population in both the core and expanded areas.

The 2016 point estimate for whole population in the expanded area was 556, which was not significantly different from the 2011 estimate of 576. However, when looking at the data from 1988 to present, the core area subset of the population declined from a high of about 370 animals in 2005 to around 220–230 animals in 2011, and has stabilized at the 2011 level. The bull:cow ratio in the expanded area was 42:100, which is reasonable for muskox; however, it is concerning that the bull:cow ratio in the core area declined from 37:100 in 2015 to 34:100 in 2016. Once populations exhibit a bull:cow ratio of 20:100, harvest is not recommended (Schmidt and Gorn 2013). This gives managers pause to think about the impact of the harvest of bulls, especially those bulls that are closer to and more accessible from communities.

Terrestrial Mammals (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Wolverines	Abundance and Distribution		Wolverine are distributed throughout northwestern Alaska. In general, most of what is known about both wolverine distribution and abundance is based on anecdotal observation from local hunters and trappers as well as trapping records. Currently, there is an effort underway to quantify wolverine populations to the north and east of the park using a systematic survey of wolverine tracks in the snow and an occupancy modeling approach (Wildlife Conservation Society 2015). Within Game Management Unit 23, which includes NOAT, the Alaska Department of Fish and Game reports that wolverine populations were thought to be low during the period of last reporting (Westing 2013). Wolverines naturally occur at low population densities and have low reproductive rates. Wolverine populations have been shown to be very sensitive to harvest. An investigation of radio-collared wolverines (including 2 in Alaska) concluded that populations in these areas would decrease without immigration from untrapped populations (Krebs et al. 2004). In NOAT, wolverine are available for harvest under hunting regulation from 1 September–31 March. Trapping season goes from 1 November–15 April. Although local hunters intensively pursue wolverine for their fur, the cost of gasoline in recent years may have reduced local effort to take wolverine (Westing 2013). Although it does not capture all of the harvest, sealing (hunting) records from 1988–2011 (Unit 23) indicate an average wolverine take of 24 per year. More than half of sealed wolverines were taken in the Kobuk drainage, and the Noatak drainage accounted for 31% of the sealed wolverines. Community harvest surveys from 2011–2012 indicate that villages in Game Management Unit 23 harvested 46 wolverines per year.

Fish

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Whitefish	Abundance		Five species of anadromous whitefish (not including sheefish) inhabit the waters of the Western Arctic Parklands. As a group, they represent the most accessible subsistence resource in the area, and are available from late spring through early winter. Traditionally, whitefish were harvested to feed both people and sled dogs. As dog teams are used less, the demand for dog food has decreased substantially. Both eggs (roe) and meat are still prized by people (Georgette and Shiedt 2005). Whitefish do not die after spawning, reproduce several times over their lifetime, and can live more than 20 years. Their movements between nearshore marine waters, brackish waters, and the rivers, streams and lakes of the region are very complex and dependent on life stages. Robust abundance data on whitefish are scarce. In a traditional ecological knowledge survey in Kotzebue and nearby villages, elders generally agreed whitefish were abundant and could not recall a time they were not (Georgette and Shiedt 2005). There was less agreement on whether abundance was increasing, decreasing or stable, though they did indicate whitefish were more consistent annually than salmon. Escapement data are not available, but limited Alaska Department of Fish & Game observations and fishermen interviews also do not indicate declining populations (Menard et al. 2015). Estimated subsistence harvests from the villages of Noorvik, Kiana, Ambler, Shungnak, Kobuk and Noatak from 1997–2003 ranged from 39,754 to 84,851 fish and averaged 54,407 (Georgette et al. 2004 in Georgette and Shiedt 2005). Importantly, subsistence harvests seem to be influenced more by weather and water conditions than fish abundance (Georgette and Shiedt 2005). Narvagruk (Lake Narvakrak) is an important summer habitat for whitefish in Noatak (Georgette and Shiedt 2005).

Fish (continued)

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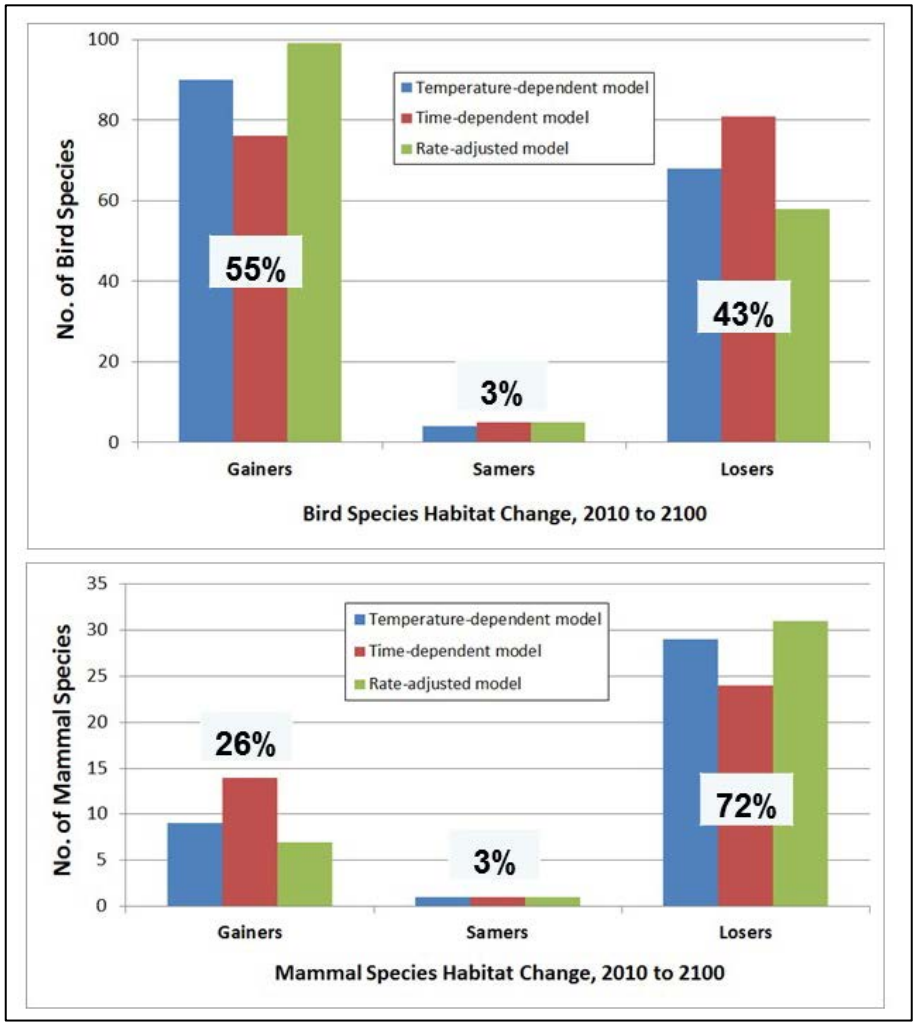
Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Chum Salmon	Abundance		Chum salmon are the most abundant salmon species in the region, and the Noatak River supports a significant annual run. Chum represent the bulk of the commercial fishery in the Kotzebue Sound area. Since no fish processors operate in the area, commercial catch is heavily influenced by cargo space on commercial flights and demand from commercial buyers (Menard et al. 2015). Catch data are therefore a poor indication of run strength or abundance. Chum are also an important subsistence fishery, forming a substantial portion of the total subsistence catch for villages along the Noatak and Kobuk Rivers, as well as Kotzebue and the surrounding area (Whiting 2006, Menard et al. 2015). Chum runs vary greatly from year to year. Alaska Department of Fish and Game aerial surveys on the Noatak River between 1990 and 2014 (except 2010–2012) varied from 26,670 in 1990 to a record 483,939 in 2014 (Menard et al. 2015). Commercial harvests suggest chum runs the last six years have been strong (Scanlon 2015). Subsistence harvests from the village of Noatak averaged 4,540 chum from 1990–2004 and 2012–2013. The harvest in 2013 was 5,655 chum (Menard et al. 2015).
Dolly Varden	Abundance		Dolly Varden (known locally as “trout”) are members of the salmon family that feed in the ocean and spawn in rivers and streams (Scanlon 2015). They inhabit most coastal streams and large rivers in the Kotzebue Sound area. Dolly Varden are important subsistence fish in many villages after chum and other whitefish (Whiting 2006), though in some villages they outrank other fish (Menard et al. 2015). Known for their large size in the area, Dolly Varden are also targeted by sport fishermen, though subsistence harvests are much greater. However, very few data are available on escapement, spawning or abundance (Scanlon 2015). Aerial surveys from the mid-1990s indicate about 9,000–12,000 Dolly Varden spawned annually in the Noatak drainage (Scanlon 2015). Partial surveys from 2002–2005 and angler reports suggest that spawner abundance in the Noatak River had declined to some degree; however, based on anecdotal subsistence reports, it appears that fishing has been good and subsistence needs are being met in northwest Alaska (Scanlon 2015). Since 1991, subsistence harvest of Dolly Varden in the Village of Noatak has been estimated between 3,000 and 11,000 fish. These estimates are considered minimal because of survey timing (Menard et al. 2015).

Resource Brief: *Wildcast*

The NPS Wildcast project modeled the likely effects of climate warming in northwest Alaska on the extent of 60 habitat types for 162 bird and 39 mammal species known (or expected to occur regularly) in the region. The project was a partnership with cooperators including U.S. Forest Service, U.S. Fish and Wildlife Service, and several universities. The project developed three models based on studies of historic changes in vegetation, mean annual air temperature, and influences of 23 biophysical drivers (such as permafrost melt and tundra fire). Researchers project that shrub, woodland, and forest habitats of 53% of the 201 wildlife species will increase, habitats of 3% will have no change, and lowland shrub, meadow, grassland tundra and other habitats of 44% will decrease (Marcot et al. 2015). In addition, habitat for 86 species of birds (43% of total bird species) and 28 species of mammals (72% of total mammal species) is likely to decline (Marcot et al. 2015). Changes in wildlife habitats will likely affect the composition and function of the ecosystem; of particular significance are the predicted declines in habitats of most small mammals, as these form the prey base for mid-sized carnivores and raptors and serve ecosystem engineering functions of burrowing and soil and nutrient turnover. Habitat is also likely to decline for 25 of the 50 bird and mammal species harvested for subsistence (including greater white-fronted goose, tundra swan, rock and willow ptarmigan, caribou, muskoxen, Arctic fox, muskrat, American beaver, and northern river otter), with habitat increases for grouse, some waterfowl, cranes, moose, black bear, and American marten.

The Wildcast project will help NPS managers design better adaptation strategies by projecting the future composition of the ecosystem. Tomorrow's ecosystem will more closely resemble that of the subarctic coast and the boreal forest, with tundra restricted to the alpine. Caribou, in particular, are expected to lose a significant portion of their lichen winter range to shrub and forest communities. This will have profound influences on the ecosystem and subsistence hunting opportunity.



Winners and losers with changing habitat. Adapted from Marcot et al. 2015.

Projected Habitat Losers. Adapted from Marcot et al. 2015.

Unique Communities and Features
(Ultramafic Communities and the Noatak River)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Ultramafic Community Features	Condition of Unique Community		Mountains composed of ultramafic rocks are widespread in parts of NOAT. Ultramafic rocks are very high in calcium, magnesium, and iron, and result in unusual soils and unique vegetation. Ultramafic environments in NOAT are very remote and have been visited only briefly by botanists. They are very sparsely vegetated. No ultramafic endemic species have been identified in NOAT, but several rare species have been identified in ultramafic areas (Jorgenson et al. 2009). The only known agent for ecological changes in these areas is climate change, which is expected to have minor effects on these cold, barren environments in coming decades (Jorgenson et al. 2015).
Noatak River	Condition of Unique Community		The Noatak River is a designated National Wild and Scenic River, and flows across both Gates of the Arctic National Preserve and NOAT. The entire watershed of the Noatak River, not just the river itself, lies within these two protected areas; it is the largest undisturbed watershed in North America. The Noatak River flows 531 km from the central Brooks Range westward to Kotzebue Sound. The river is in good condition with respect to water quality. Nutrient concentrations are at or near analytical detection limits (O'Donnell et al. 2015). Permafrost is actively thawing in parts of the Noatak basin (Swanson 2014). In some instances, the formation of thaw slumps (i.e., mudslides) has resulted in high rates of erosion and sedimentation into the main stem of the Noatak River (Balser 2015). Thaw slumps can increase suspended sediment loads, which can affect a river's turbidity, chemistry, productivity, and habitat characteristics (Kokelj et al. 2013). The effects of thaw slumps on aquatic ecosystems are transient, and do not appear to have affected downstream drinking water quality for the village of Noatak.

Resource Brief: Noatak River

The Noatak River flows over 300 miles from the central Brooks Range to the Bering Sea, draining a remote Arctic landscape in northwest Alaska. On December 2, 1980, the 330 miles (530 km) of the Noatak—from its source in Gates of the Arctic National Park to the Kelly River in NOAT—became part of the National Wild and Scenic Rivers System. The Noatak watershed is largely uninhabited by humans, with the exception of the village of Noatak on the lower river. Consequently, NOAT makes an ideal location to study the impacts of climate change on terrestrial and aquatic ecosystems in the absence of direct anthropogenic disturbances. The Arctic is warming at nearly twice the rate as temperate regions, and as a result, ecosystems in the Noatak River basin may be particularly vulnerable to the effects of climate change.

Recent evidence indicates that warming air temperatures in the Noatak River basin have contributed to localized permafrost thaw (Swanson 2014). Thermokarst features (subsidence of ground surface due melting of ground ice), such as retrogressive thaw slumps and active layer detachment slides, have developed across the upper Noatak River basin. Thaw slumps that occur along the Noatak River can transfer large volumes of soil to the river through erosion and sedimentation processes, which can impact habitat for aquatic organisms and water quality. Near-surface permafrost thaw is expected to continue across a large fraction of the Noatak River basin (Panda et al. 2016). Still, large uncertainties exist about how permafrost thaw and associated landscape change will impact the ecology of the Noatak River.

Environmental monitoring protocols have been designed for the Noatak River to detect long-term changes in the chemical composition of river water, with particular focus on dissolved organic matter, nutrients, and suspended solids. Long-term river chemistry data can be useful for detecting permafrost thaw at the watershed scale (O'Donnell et al. 2014). At present, water quality in the Noatak River is largely in good condition with respect to nitrogen and phosphorous concentrations (O'Donnell et al. 2015). The U.S. Geological Survey has joined with the NPS for a newly funded "Changing Arctic Ecosystems" project to examine the effects of permafrost thaw on aquatic food webs in the Noatak River basin. Researchers are using a variety of techniques to track thaw impacts on river chemistry, hydrology, and biota, including resident fish species Arctic Grayling and Dolly Varden.

Measuring Dolly Varden as part of environmental monitoring of the Noatak river. NPS Photo.

Landscape and Ecosystem Processes

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Fire	Frequency		Fire is a natural part of Noatak. Fire has been documented in NOAT for thousands of years, with a frequency similar to boreal forests (Higuera et al.2011, Hu et. al. 2010). The average number of fires per year is 3.6, using data from 1955–2015 (WFMI data). The fire occurrence in NOAT has been variable over the past 65 years, yet with 68 fires reported in the park over the past 6 years (2010–2015), fire frequency warrants moderate concern. The greatest number of fires occurred in Noatak during 2010, when 37 fires affected the park. Repetitive burning can potentially increase the release of older stored carbon in organic soils (Hu et al. 2015).
	Total Area Burned		An average of 9,202 acres in NOAT burned per year between 1950 and 2015 (WFMI data). Since 2010, the average area burned was 28,765 acres per year. The average fire size has not increased. Increased area burned results in younger successional phase of plant communities and reduced late successional non-vascular plants (lichens and mosses) (Racine et. al. 2006). High severity fires can remove insulating moss and lichen layers and potentially organic soil layers that can influence permafrost thaw.
Landcover	Match of Seasons to Historic Norms (snow-free season, green-up, peak greenness, senescence)		Overall greenness of lowland tundra landscapes as measured by satellite has increased since records began in the 1980s. This is probably due to climate warming that occurred in the late 1900s, which involved both longer and warmer summers. More detailed satellite records since 2000 provide specific information on the timing of snow cover loss, spring green-up, and fall. This shorter time period is dominated by year-to-year fluctuations. Higher greenness indicates higher shrub cover, which implies a decrease in caribou winter range lichen habitat; the earlier dates of snow melt has the potential to bring mismatches in the timing of wildlife migration and foraging.

Dark Night Sky

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Anthropogenic Light	Anthropogenic Light Ratio (ALR) — Average Anthropogenic Sky Glow: Average Natural Sky Luminance		A photic environment is described as the physical amount and character of light at a particular location, irrespective of human perception. The NPS Night Sky Program characterizes a park's photic environment by measuring both anthropogenic and natural light. While no ground based or modeled data are available for NOAT, 2012 visible infrared imaging radiometer (VIIRS) satellite data, which uses a broadband imaging detector with high sensitivity, indicates that there is no visible upward radiance within the park boundary, and small amounts of upward radiance within a 200-km radius surrounding the park. The largest sources of upward radiance emanate from the Red Dog Mine, adjacent to the park's northwest boundary, and from the town Kotzebue, AK just over 20 km from the park's southwest boundary. With no visible upward radiance originating within the park boundary and low to moderate upward radiance within 200 km of the park, Noatak National Preserve serves as a harbor of dark skies.

Resource Brief: Night Sky Resources at Noatak National Preserve

The night sky has been a source of wonder, inspiration, and knowledge for thousands of years. Unfettered night skies with naturally occurring cycles of light and dark are integral to ecosystem function as evidenced by the fact that nearly half the species on earth are nocturnal. The quality of the nighttime environment is relevant to nearly every unit of the NPS system as the nighttime photic environment and its perception of it by humans (the lightscape) are both a natural and a cultural resource and are critical aspects of scenery, visitor enjoyment, and wilderness character.

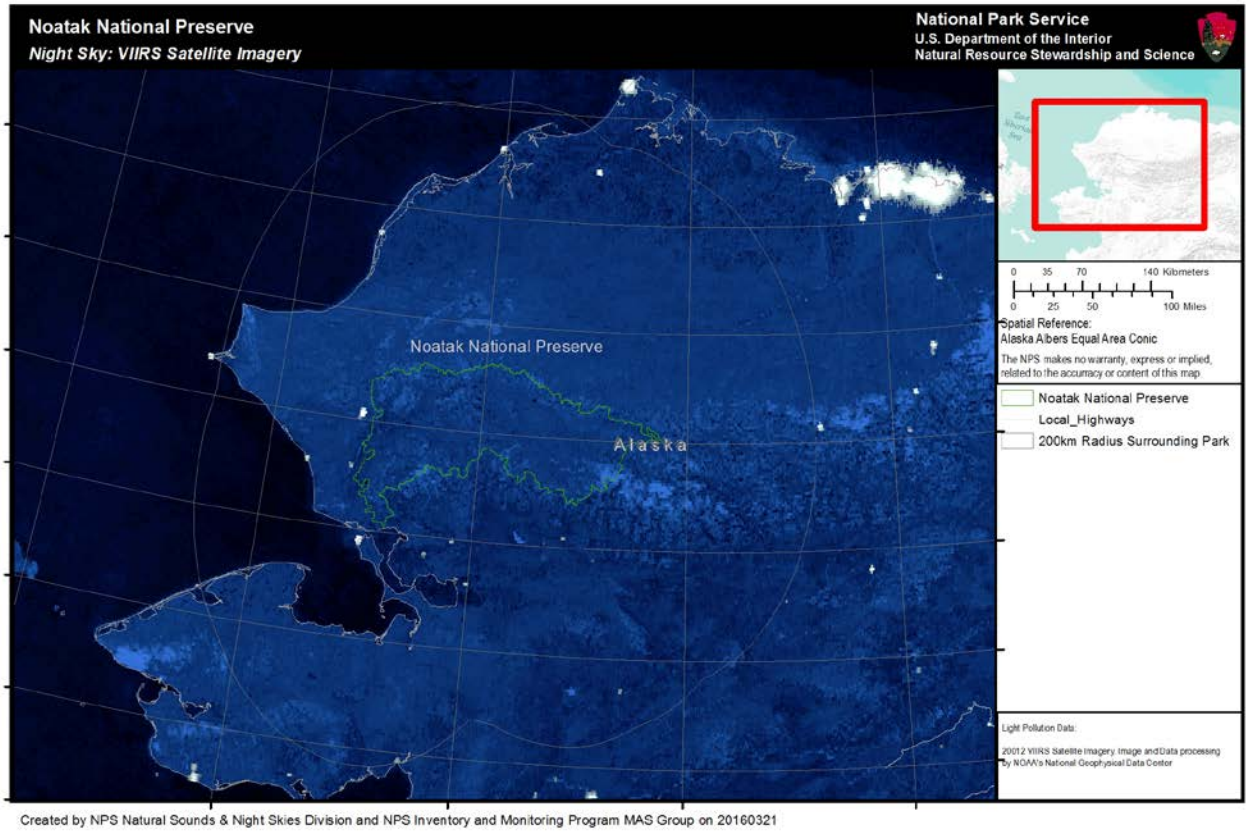
Condition and Functional Consequences
Night sky quality at NOAT is in good condition. 2012 visible infrared imaging radiometer (VIIRS) satellite data, which uses a broadband imaging detector with high sensitivity, suitable for detecting anthropogenic sources of light on the earth's surface, reveals no upward light within the park. Further, very little anthropogenic light is detected in an area within a 200-km radius surrounding the park except for a small amount of upward radiance from the Red Dog Mine, adjacent to the park's northwest boundary, and from the town of Kotzebue, AK just over 20 km from the park's southwest boundary. Given the absence of anthropogenic light originating within the park boundaries, and low to moderate upward radiance within 200 km of the park, the photic environment of NOAT is subject to the natural regime of dark/light patterns allowing visitors to the park to experience pristine night sky resources. At these light levels, most observers feel they are in a natural environment. The Milky Way is visible from horizon to horizon and may show great detail, with fine details such as the Prancing Horse. Zodiacal light (or "false dawn" which is faint glow at the horizon just before dawn or just after dusk) can be seen under favorable conditions, and there is negligible impact to dark adaptation looking in any direction.

Assessment
No ground based or modeled data are available for NOAT. However 2012 visible infrared imaging radiometer (VIIRS) satellite data, which uses a broadband imaging detector with high sensitivity is suitable for detecting direct or reflected sources of upward radiance of anthropogenic sources of light on the earth's surface. These data are qualitative and are not calibrated to known thresholds or reference conditions.

Criteria for Impact
Two impact criteria were established to address the issue of urban and non-urban park night sky resources. Parks outside of designated urban areas are considered more sensitive to the impact of anthropogenic light and are assessed using lower thresholds of impact.

Resource Brief: Night Sky Resources at Noatak National Preserve (Continued)

According to the U.S. Census Bureau, NOAT is categorized as non-urban, or more sensitive (U.S. Census Bureau 2010). Learn more in the document Recommended Indicators of Night Sky Quality, and the NPS Natural Sounds & Night Skies Division website.



Regional view of anthropogenic light near NOAT. White and red represents more environmental influence from artificial lights while blues and black represent natural conditions. This scale shows regional context and how far reaching the impacts of artificial lighting can be. With no visible upward radiance originating within the park boundary and low to moderate upward radiance within 200km of the park, NOAT serves as a harbor of dark skies.

Acoustic Environment

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Acoustic Impact Level	A modeled measure of the noise (in dBA) contributed to the acoustic environment by man-made sources		The mean acoustic impact level (L_{50} dBA) in NOAT, calculated as the difference between nationwide models of existing and natural ambient, is 0.5 dBA. This indicates that the acoustic environment is in good condition. Acoustic conditions in national parks are largely driven by transportation activity, and overall, nationwide increases in ground-based (Federal Highway Administration 2013) and aircraft traffic in recent decades (Federal Aviation Administration 2010) indicate a downward trend in acoustic conditions. State-wide increases in development and steady tourism pressure throughout the state of Alaska (McDowell 2014) also indicate a downward trend in acoustic conditions.

Resource Brief: Acoustic Environment at Noatak National Preserve

To characterize the acoustic environment, the National Park Service has developed a national model of noise pollution (Mennitt et al. 2014). This model predicts the increase in sound level due to human activity on an average summer day. The model is based on measured sound levels from hundreds of national park sites and approximately 100 additional variables such as location, climate, vegetation, hydrology, wind speed, and proximity to noise sources such as roads, railroads, and airports. The model reveals how much quieter parks would be in the absence of human activities. The quality of the acoustic environment affects visitor experience and ecological health. Acoustic resource condition, both natural and cultural, should be evaluated in relation to visitor enjoyment, wilderness character, ecosystem health, and wildlife interactions. Learn more in the document Recommended indicators and thresholds of acoustic resources quality for NPS State of the Park Reports, the figures above and below, and the NPS Natural Sounds & Night Skies Division website.

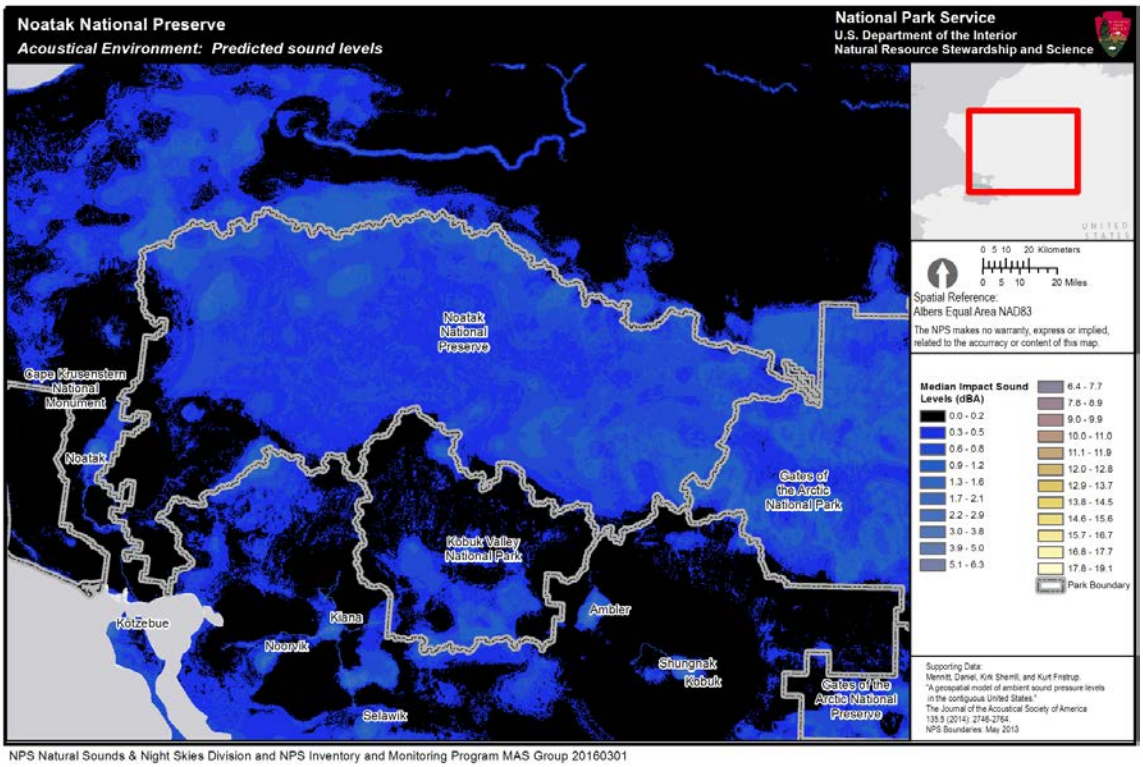
Indicator	Threshold (dBA)
Acoustic Impact Level A modeled measure of the noise (in dBA) contributed to the acoustic environment by man-made sources.	Threshold ≤ 1.5 *Listening area reduced by ≤ 30%*
	1.5 < Threshold ≤ 3.0 *Listening area reduced by 30 – 50%*
	3.0 < Threshold *Listening area reduced by > 50%*

Condition thresholds for the acoustic environment in non-urban parks

In 2009, natural soundscapes were recognized as a fundamental resource of Noatak National Preserve in its foundation statement, and in 2013 and 2014, NPS staff collected acoustic information at three sites in Noatak National Preserve. The results of this study are summarized in a Natural Resource Data Series Report (Betchkal 2015).

Criteria for Condition Status/Trend

Parks outside designated urban areas typically possess lower sound levels, and exhibit less divergence between existing sound levels and predicted natural sound levels. These quiet areas are susceptible to even subtle noise intrusions, so care should be taken to maintain low impact conditions in these places. Park units inside urban areas typically experience more interference from noise sources. Based on these assumptions, all Alaska parks are assessed using the non-urban criteria. Condition thresholds are listed in the table (above). Just as smog limits one's ability to survey a landscape, noise reduces the area in which important sound cues can be heard. Therefore, thresholds in the table are also explained in terms of listening area.



Map of predicted acoustic impact levels in the park for an average summer day. The color scale indicates how much man-made noise increases the sound level (in A-weighted decibels, or dBA), with 250 meter resolution. Black or dark blue colors indicate low impacts while yellow or white colors indicate greater impacts. Note that this graphic may not reflect recent localized changes such as new access roads or development.

2.2. Cultural Resources

Archeological Resources

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Sufficient research is conducted to understand the relationship of the park's archeological resources to the historic contexts for the park.		Major themes/historic contexts in NOAT are moderately well developed, but it is very likely that a significant number of archeological sites have not yet been identified or professionally documented. A relatively small proportion of all documented sites have been subject to detailed investigations. Steady, incremental progress is being made toward this goal with multi-year archeological inventory and condition assessment work funded and underway.
	Archeological resources are identified and evaluated using appropriate anthropological and historical contexts.		A substantial amount of archeological inventory has been conducted in NOAT, but the preserve is large and archeological resources remain only moderately well understood. Few sites have been formally evaluated against anthropological and historic contexts. The archeological inventory and condition assessment work underway includes development of historic contexts.
	Number of archeological context statements.		No park-wide, stand-alone context statements exist for NOAT, but relevant treatments can be found within various site and survey reports and publications. The archeological inventory and condition assessment work underway includes development of context statements.
	Scope of archeological resources in the park is understood and a determination has been made whether or not they are a fundamental or other important resource.		Sufficient inventory has been done to firmly establish archeological resources as a fundamentally important park resource. Sites within the preserve are significant on national and global scales. The scope of archeological resources is generally known, but further research is warranted to better understand the range of archeological site types, their ages, and their distribution throughout the preserve. The multi-year archeological inventory and condition assessment work underway are improving understanding of the scope of these resources.
	Percentage of archeology baseline documents with current and complete information.		No baseline documents that synthesize the archeological resources in Noatak have been produced; however a great deal of research that produced reports, dissertations, and theses has been completed, so the data exists. An Archeological Overview and Assessment would be a valuable document for management purposes; it would be ideal to develop this document in 3–4 years, once current surveys are complete and staff has better organized archeological site and survey data.

Archeological Resources (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge (continued)	The mechanisms affecting site stability and taphonomic influences are understood.		While the mechanisms affecting site preservation and stability are generally known, they are not precisely understood due to the extreme environmental conditions that characterize the park (high latitude, mountain, and riverine settings) and may impact archeological sites. Climate change further complicates the park's ability to predict impacts and prioritize preservation efforts. New threats (e.g., loss of frozen organic remains due to warming soils) are emerging and are only beginning to be recognized.
	Percentage of sites/archeological landscapes that are tied to information regarding influences from the physical and social environment.		Threats to sites are generally known, but have largely not been articulated in detail on a site-by-site basis. The multi-year archeological inventory and condition assessment work underway are improving understanding of influences on these resources.
	Percentage of sites with known date ranges associated with a research theme.		The NPS has made huge strides over the last 15 years in increasing the number of sites with known date ranges. While NOAT has a large number of radiocarbon dated sites relative to nearby parklands, the vast majority of known sites in NOAT remain undated. All sites with a reliable date can be associated with a research theme.
Inventory	Percentage of park intensively surveyed.		The percentage of the park that has been intensively surveyed is less than 1%. This is due to the fact that the park is large in size and difficult to access.
	Percentage of survey data included in the Geographic Information System (GIS).		The park has archeological GIS data; however none of the archeological GIS data meets current cultural resources standards. In order to meet current standards, the park needs to enter legacy geospatial data, including survey locations.
	Percentage of archeological resources with complete, accurate, and reliable data in the Archeological Sites Management Information System (ASMIS).		579 sites out of 646 in ASMIS (89.6%) have all required data. 67 sites (10.3%) have incomplete records. There appear to be 119 site records missing from the ASMIS database (646 sites) that are listed in the Alaska Heritage Resources Survey database (765 sites).

Archeological Resources (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Documentation	Percentage of known sites with adequate National Register documentation.		4 sites out of 646 (0.62%) have been recommended eligible for the National Register, 27 (4.1%) have been recommended ineligible, 553 (85.6%) have not been evaluated, 61 (9.4%) have no data, and 1 has been removed according to the ASMIS database.
	Percentage of archeological materials cleaned, conserved, studied, cataloged, and properly stored.		According to the 2015 Collections Management Report, 100% of NOAT's archeological materials are cleaned, conserved, studied, cataloged, and properly stored; however, this figure is not accurate and is probably closer to 80%. Lack of documentation is a problem in getting these collections cataloged. Collection items are in need of rehousing and many have never been properly processed for storage.
	Park base maps are prepared showing the location and distribution of archeological resources, the nature and extent of archeological identification activities, and the types and degree of threats and damages.		The park has a set of 1:63,360 quadrangles annotated with known sites and survey lines as of roughly 2004. Survey lines have not been digitized. Site locations are available in a GIS layer although not all locations reflect the most current, accurate information. Efforts should be made to update ASMIS with the most accurate locational data and ASMIS should be used as the master file from which to populate GIS. Detailed survey and mapping of known and newly identified sites and features has been conducted in coastal areas since 2006.
	Percentage or number of sites without assessed and defined threats and damages.		341 of 786 sites in ASMIS (43%) have undetermined threats and damages. Only 62 sites have been assessed for threats and damages in the past 10 years. Efforts to complete condition assessments and evaluate threats and disturbances are ongoing; threat and damage assessment now occurs on all site visits.
Certified Condition	Percentage of archeological resources certified as complete, accurate, and reliable in the Archeological Sites Management Information System (ASMIS) in good condition.		In ASMIS, 512 of 786 archeological sites (65%) are reported in good condition.

Resource Brief: Archeology in the Far North – High Alpine Lakeside Villages

The Noatak River watershed has been used seasonally by native peoples for thousands of years. They practiced subsistence living and built winter villages. Archeological research has been conducted throughout the preserve to better document and understand the culture of these tribes, notably including a unique set of prehistoric lakeside village sites. Three lakeside villages are an outstanding illustration of human adaptation to and interaction with a harsh arctic climate with limited available resources. The people living at these sites were not simply surviving in this environment; they were apparently flourishing.

These prehistoric Iñupait villages were marked by dense concentrations of houses, storage, caribou hunting facilities, and large remains of qarigis. A qarigi, or "men's house," was a significant structure within the Alaska Arctic Native culture, serving as a communal space for the village church, town hall, workshop, and entertainment center. The qarigi was often the focal point of the community, and was designed to accommodate the entire village as well as any visitors. Qarigis were generally the tallest structure in a community complex.

Petroglyphs at Feniak Lake. NPS Photo.

These structures are known in many Late Prehistoric age sites across northern Alaska, but the three qarigis at these lakeside villages are unique because they were each built using substantial circular boulder-lined foundations, some as large as 4–5 feet in diameter and as heavy as one hundred pounds. The work to build these structures necessitated a substantial amount of effort and coordination, and these structures come closer to the category of monumental architecture than anything else known from the American Arctic (Shirar et al. 2013).

A unique characteristic at each of these sites is the presence of petroglyphs on the surfaces of several of the foundation stones or on other boulders in and around the sites. The petroglyphs represented in northern Alaska are unique not only because there are few examples, but because they are fundamentally different than most of the rock art seen in other areas of the state. Alaskan rock art, whether petroglyphs or pictographs, generally consists of a realistic pictorial design (e.g., a human face or figure, an animal, etc.). The petroglyphs from northern Alaska, on the other hand, consist of abstract designs with no obvious naturalistic representation.

Cultural Anthropology

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Sufficient research is conducted to understand the relationship of the park's ethnographic resources to the historic context(s) for the park.		Although anthropological research has been conducted in the region by scholars, local residents, and federal/state agencies, the park lacks baseline documentation to assess condition and/or adequate protection of unknown or undocumented ethnographic resources. Completion of a comprehensive Ethnographic Overview and Assessment, with collaboration from other Arctic parks, is a top park anthropology research priority. Ethnographic studies would enhance and inform ongoing archeological field research and traditional ecological studies.

Cultural Anthropology (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge (continued)	The scope of resources significant to affiliated groups associated with the park is understood and a determination has been made whether or not they are a fundamental resource or other important resource or value.		The park lacks sufficient baseline documentation of ethnographic resources. Of particular concern is knowledge of sites and resources in areas vulnerable to erosion and other natural and human threats, particularly along coastal areas.
	Percentage of cultural anthropology baseline documents with current and complete information.		NOAT currently lacks an Ethnographic Overview and Assessment and relies on disparate existing sources of information.
Inventory	Appropriate studies and consultations document resources and uses, traditionally associated people, and other affected groups, and cultural affiliations.		The park should explore Traditional Use/Cultural Affiliation Studies with associated tribes in order to document resources and uses and ensure their consideration in park planning and protection. Efforts should be made to develop collaborative Traditional Environmental Knowledge (TEK) studies with affiliated communities to document traditional knowledge of the environment and natural resources, particularly those related to subsistence lifeways (a caribou TEK study was completed recently for NOAT). Each passing year marks the loss of knowledge bearers and Elders who can contribute to the documentation process.
	Traditionally associated groups are identified.		Traditionally associated groups have been identified through years of engagement with local communities and organizations and are regularly consulted under Section 106, NAGPRA, and other laws and regulations.
	Resources eligible for the National Register of Historic Places as traditional cultural properties (TCPs) are identified.		NOAT has not yet identified any TCPs.
Documentation	Planning documents contain current information on traditional resource users and uses, the status of ethnographic data, and the legislative, regulatory, policy, or other bases for use.		General ethnographic information is included in park planning documents. These documents include discussions of subsistence use, allotments, and other ethnographic information.

Cultural Landscapes

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Sufficient research exists to understand the relationship of the park's cultural landscapes to the historic context(s) for the park.		There are no inventoried cultural landscapes in NOAT. Three cultural landscapes have been identified as priorities for documentation in the next 5 years: Burial Lake, Desperation Lake, and Feniak Lake.
	Cultural landscapes are identified and evaluated using appropriate historical contexts.		Three cultural landscapes have been identified as priorities for documentation in the next 5 years: Burial Lake, Desperation Lake, and Feniak Lake. Other cultural landscapes may exist, but have not been identified. All of the park's cultural landscapes have been identified and evaluated using the park's established historical contexts, regardless of the completeness of the study of each landscape.
	Scope of cultural landscapes in the park is understood and a determination has been made whether or not they are a fundamental or other important resource.		The three identified cultural landscapes are incompletely scoped and a determination has not yet been made whether they are fundamental resources or other important resources. Nevertheless, NPS managers, recognizing the special relationship of the landscapes to local people, consult with the I.R.A. Councils, the Elders Councils, the City Councils, and the Native Corporations of the villages on a regular basis concerning management issues within the park.
Inventory	Percentage of landscapes eligible for the National Register in the Cultural Landscapes Inventory (CLI) with certified complete, accurate, and reliable data.		There are currently no completed CLIs for NOAT.

Historic Structures

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Historic Structures are identified and evaluated using historical contexts.		Most historic structures have been identified, but not all have been evaluated using historical contexts. Desperation Lake Quarigi, Feniak Lake Quarigi, Burial Lake Quarigi, and Noatak River Shelter Cabin have been included on the list of classified structures.
	Scope of historic structures in the park is understood and a determination has been made whether or not they are a fundamental or other important resource.		The scope of historic structures in the park is not understood and no determination has been made whether or not they are a fundamental or other important resource. The shelter cabins throughout the park need to be evaluated.
	Adequate research exists to document and preserve the historic structure's physical attributes that contribute to historical significance.		Adequate research does not exist to document and preserve the historic structures' physical attributes that contribute to historical significance.
Inventory	Percentage of historic structures eligible for the National Register in the List of Classified Structures (LCS) with accurate, complete, and reliable data.		Desperation Lake Quarigi, Feniak Lake Quarigi, Burial Lake Quarigi, and Noatak River Shelter Cabin have not been formally determined eligible for the National Register.
	Percentage of List of Classified Structures (LCS) data included in the Geographic Information System (GIS) meeting current cultural resource standards.		GIS data exists, but 0% meets current cultural resource standards.
Certified Condition	Percentage of historic structures certified as complete, accurate, and reliable in the List of Classified Structures (LCS) in good condition.		100% of historic structures (Desperation Lake Quarigi, Feniak Lake Quarigi, Burial Lake Quarigi, and Noatak River Shelter Cabin) are currently listed in good condition.

History

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Sufficient research is conducted to establish the reasons for park establishment and a history of the NPS management of the site.		NOAT lacks a Historic Resource Study and an Administrative History. There is a region-wide history of NPS subsistence management for Alaska (Norris 2002) and the book *Arctic Citadel* (Allan 2013), which focuses on early exploration history in the Brooks Range.
	Sufficient research is conducted to establish the reasons for park establishment and a history of the NPS management of the site.		The park currently lacks a historic theme study, historic resource study, or other work to inform management and future research endeavors. BIA ANCSA 14(h) (1) studies undertaken in the 1970s and 1980s identified historic and cemetery sites of note.
Inventory	Cultural resources are inventoried and evaluated in consultation with State Historic Preservation Officers (SHPOs).		The park actively engages and consults with the SHPO on matters related to archeological, ethnographic, and historic resources.
Documentation	Percentage of historic properties with adequate National Register documentation.		No National Register Nominations or Determination of Eligibility documents have been completed for historic resources in NOAT. A baseline of documentation needs has not been developed for this park.

Museum Collections

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Sufficient research and analysis exists to understand the relationship of the park's museum collection to the historic context(s) for the park.		The park currently has an adequate amount of research and reports to demonstrate the significance and context of the items in the museum collection; however, the park has the potential for both continued and expanded archeological, ethnological, historical, and natural history studies that would expand understanding.

Museum Collections (continued)

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge (continued)	Scope of museum collection in the park is understood and a determination has been made whether or not they are a fundamental or other important resource.		NOAT has a current Scope of Collections Statement, signed in 2013, that received great input from the park staff.
	Percentage of museum collection baseline documents with current and complete information.		70% of museum collection baseline documents have current and complete information. Baseline documents currently needed include a Collections Management Plan and a Collections Condition Survey. The Alaska Regional Curatorial Center (ARCC), located in Anchorage, is the official repository for the NOAT museum collection.
Inventory	Archival and manuscript collections are surveyed and described in the Interior Collections Management System (ICMS) and finding aids are produced.		The majority of NOAT's archival collections are surveyed and described in ICMS. All archives for NOAT, and some multi-park archives (that involve NOAT) are listed under a unique directory (NWAK, Northwest Alaska Management Unit). A finding aid is also available.
	Percentage of existing collection that is accessioned and cataloged.		According to the 2015 Collections Management Report, 73% of NOAT museum collections are accessioned and cataloged.
	Scope of Collection is consistently implemented; items or objects are researched to determine their appropriateness for inclusion in the museum collection.		Since 2010, there has been consistent implementation of the Scope of Collections Statement.
Documentation	Accession and deaccession files are complete with all appropriate signatures.		All accession and deaccession files are complete with appropriate signatures.
Certified Condition	Percentage of museum collection reported in Collections Management Report (CMR) and checklist report in good condition.		Overall, the museum collections are in good condition and the storage area is environmentally stable and very secure. 96% of the collection cataloged in ICMS is in good condition or better; there are 16,394 records in ICMS with 36% reported as excellent condition and 60% reported as good condition.

Resource Brief: Late Prehistoric Arrowpoint

Excavations were conducted within the Kugururok River Valley in Noatak National Preserve during the summer of 1996 to recover data from a severely vandalized archeological site. It may be hard to fathom, but even sites above the Arctic Circle, in remote wilderness areas, are at risk from looting. Site disturbance was recorded and then excavation began in looted areas in the hopes of documenting as much archeological information as possible.

A wide range of chipped stone artifacts were present in the assemblage from the site. One of the artifacts recovered from the site was the stone arrowpoint pictured here. This particular arrowpoint is complete, chipped from maroon and gray chert, and has a t-stem. One side of the point is horizontally flaked and the other side shows a pattern of parallel oblique flaking. Interestingly, this specimen does not seem to have been used, as there is no evidence of edge grinding. The point measures 10.25 cm x 2.62 cm x 0.87 cm and has been added to the park's museum collection.

***Left*: Stone arrowpoint found in Noatak National Preserve. NPS Photo.**

2.3. Visitor Experience

Visitor Numbers and Visitor Satisfaction

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Number of Visitors	Number of visitors per year		The total of 16,907 visitors to the preserve in 2013 is higher than the 11,722 visitors in 2011. The 10-year annual average of visitors for 2003–2012 was 6,024. The preserve is remote and has no public roads, entrance station, or facilities. Non-local and recreational visitors rely on concessionaires for access to the park by aircraft. Visitation numbers are estimates by staff who conduct field work in the park. Counts include outside visitors plus local area residents who travel through the park. Web presence has increased actual visitation in the last 5 years.
Visitor Satisfaction	Percent of visitors who were satisfied with their visit		Park staff does not conduct visitor satisfaction surveys because the park is remote and there is limited ability to gather survey data. However, contact with visitors in the Northwest Arctic Heritage Center, community feedback, and social media suggest that visitors have significant appreciation for wilderness solitude and the effort it takes for a once in a lifetime trip in the preserve.

Interpretive and Education Programs – Talks, Tours, and Special Events

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Education Programs	Number and quality of programs, and number of participants		Park rangers go to classrooms to deliver in-person programs at 11 villages in northwest Alaska. K–12 students and their teachers get experiential, curriculum-based programs on science, history, and the mission of the NPS. The 5-year average (2010–2014) is 2,669 students served per year (Western Arctic National Parklands Servicewide Interpretive Report).
Ranger Programs	Number and quality of programs and attendance		Park rangers deliver formal and informal interpretive programs such as a weekly film series, workshops on local medicinal plants, science talks about current research, and impromptu map talks.
Junior Ranger Programs	Number and quality of programs and attendance		Park rangers deliver a unique suite of Junior Ranger program that enable youth to earn rewards by participating in Roving Rangers around Kotzebue, art classes, and completing activity booklets. The 5-year average (2011–2015) is 613 participants per year.

Interpretive and Education Programs – Talks, Tours, and Special Events (continued)

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Special Events	Variety and longevity of events, community involvement		Park rangers, along with natural and cultural resource staff, cooperate to deliver special events around the community of Kotzebue and other villages. Events include Subsistence Resource Commission meetings, training, and science workshops. The 5-year average (2011–2015) is 195 participants per year.
Visitor Center	Contacts with park staff in the visitor center		The park makes contacts with visitors who come to the Northwest Arctic Heritage Center for general information, as well as attendees at public meetings coordinated by local groups. Local meeting numbers are stable, but general walk in numbers are down due to the fact that the visitor center building and exhibits need significant repair. A new welcome banner outside and a new Facebook page to highlight public events are in development to increase local visits. The 5-year average (2011–2015) is 4,363 visitors per year.
Community Programs	On and off-site programs in local community		Park rangers and staff cooperate to deliver community programs around the village of Kotzebue and other villages. Events include birdwatching trips, teacher in-service classes, KOTZ radio show, and a 4th of July education booth on current topics such as the Wilderness Act anniversary, muskox ecology, and bear safety. The 5-year average (2011–2015) is 1,889 participants per year.

Resource Brief: Northwest Arctic Heritage Center

The Northwest Arctic Heritage Center opened its doors to the public in December 2009. Both a winter and spring celebration welcomed the community and state dignitaries. Modern exhibits on cultural lifeways, the Western Arctic Parklands, and natural history bring people in the door to learn more. Many community members in nearby villages volunteered their time to tell stories that are now featured in listening stations (exhibits) for everyone to enjoy. Because the building is virtually the first facility seen after leaving the Kotzebue airport, the Heritage Center attracts nearly everyone who visits the village of Kotzebue. The opportunity to provide high quality interpretive services to all visitors is rewarding.

Northwest Arctic Heritage Center in Kotzebue. NPS Photo.

In addition to interpretive activities for visitors, community groups and other agencies use the facility for select purposes. In 2010, seven conferences from outside entities were held at the center and three events took place that were co-sponsored by the NPS.

Interpretive Media – Brochures, Exhibits, Signs, and Website

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Wayside Signs	Condition and currency of signs		A landscape plan is currently being designed to provide visitors with a brand new outdoor learning space next to the Northwest Arctic Heritage Center. A select number of NOAT landscape and cultural features will be interpreted on a variety of signs within the ½ acre space. The landscaping and signage will be complete in 2017.
Exhibits	Heritage Center exhibits		Exhibits in the Northwest Arctic Heritage Center are displayed in 3 main spaces. • Lobby – maps & native tools to orient visitors to the Western Arctic Parklands and indigenous Iñupiaq people. • Exhibit Hall – diorama of artwork, landscape features, taxidermy animals, ethnographic stories, and archeological resources to tell the story of regional natural and cultural history. • Meeting Room – rotating exhibits on all park resources. Dry air and hard use by visitors is degrading the quality of exhibits in the Exhibit Hall. Vandalism has occurred. Exhibits are functional in the lobby and meeting room. Lighting in all exhibit areas needs repair and replacement bulbs.
Print Media	Accuracy and availability of primary park publications		Park maps are available at Northwest Arctic Heritage Center and online. Park brochures are accurate, up-to-date, and inventoried. Interpretive staff manages a large supply of other applicable publications, including information about Arctic research and the natural/cultural history of NOAT.
Audio-visual Media	Orientation films		Online videos about specific park resources are growing yearly. No feature length film exists for NOAT. Media specialists have been hired yearly in the last 3 years. Park orientation digital slideshows are available for visitors.
	Multi-media development		A bank of 150 films on regional and worldwide conservation issues (with more added every year) exists and is shown to visitors regularly. Rangers give special attention to all locally made films. iPads are available with story maps, park videos, a new Iñupiaq legend video game (called “Never Alone”), and educational applications for kids and adults.
	Local radio spots		Interviews on local radio stations are frequently conducted in conjunction with press releases for special events, changes to regulations, and as other public information becomes available. Many local people listen to the weekly KOTZ radio show.

Interpretive Media – Brochures, Exhibits, Signs, and Website (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Websites	Currency and scope of website; number of website visitors		The park website was recently updated for the NPS Centennial. Park staff regularly adds content, and website views are slowly increasing. Poor data speed/ connectivity impede progress, but new high speed fiber-optic cable is anticipated in the future.
	Social media: Facebook updates and "likes," overall activity		Twitter and Flickr accounts exist for Noatak National Preserve. A Northwest Arctic Heritage Center Facebook page will begin soon, and will provide up to date information on the Western Arctic Parklands, including NOAT. One blog exists and another will begin soon.

Accessibility

web

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Mobility	ADA compliance		Noatak is a remote area managed as wilderness, with no roads, trails, or facilities. Accessibility is challenging for all visitors. An Accessibility Assessment was completed in 2014. At the Northwest Arctic Heritage Center, a ramp provides accessibility to the front door, a wheelchair is available to visitors, and bathrooms are accessible.
Visual Accommodation	ADA compliance		No signs or facilities exist in the preserve, so there are no associated visual accommodations. In the Northwest Arctic Heritage Center, subtitles are available for film programs. A braille translation of the park map exists. Park staff plan to increase the Northwest Arctic Heritage Center exhibit visual accommodations based on the Accessibility Assessment completed in 2014.
Auditory Accommodation	ADA compliance		No signs or facilities exist in the preserve, so there are no associated auditory accommodations. In the Northwest Arctic Heritage Center, assisted listening devices exist for AV programs. A licensed American Sign Language interpreter is available locally by contract if a visitor requests the service. Park staff plan to increase the Northwest Arctic Heritage Center exhibit auditory accommodations based on the Accessibility Assessment completed in 2014.
Multi-lingual Resources	Audio and print materials in multiple languages Bi-lingual staff		The park map exists in a Russian translation. Requests for multi-lingual materials at the Northwest Arctic Heritage Center are rare. Park staff plans to increase Northwest Arctic Heritage Center multi-lingual accommodations for more audio and print materials based on the Accessibility Assessment completed in 2014.

Safety

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Visitor Safety	Recordable incidents		The safety of visitors is a park priority. The park works to quickly identify and mitigate potential hazards, and the number of accidents is very low. No visitor injuries due to dangerous facilities or staff negligence have been reported in the Northwest Arctic Heritage Center. Park staff is working to address ramp icing at the Northwest Arctic Heritage Center. Park staff is also developing a system for bear barrel loans.
Staff Safety and Training	Completion of required safety training		Because of the remote wilderness setting of the park, specialized training courses are required, including aviation management, wilderness first aid, and firearm safety. Operational Leadership Training has been completed by park staff; new seasonal staff receives training each year; and CPR, First Aid, and AED training are offered to staff on a space-available basis. Job Hazard Analysis is conducted before projects take place throughout the park. Safety messages are regularly given and distributed to staff members and a new safety committee is working to address current safety issues.

Resource Brief: Kotzebue Trade Fair

Drums, dancing, and doughnuts. Crafts, Chukotkans, and competition. Potlucks, performances, and pulls. Fur, food, and fashion. Every two years, a week-long trade fair and festival called Qatnut is held in Kotzebue. It honors the days when people on both sides of the Chukchi Sea gathered at the site of present day Kotzebue to trade things like seal oil, caribou meat, and birch baskets. People from many villages travel many miles to participate.

In 2013, NPS staff helped to make the biannual event a success. The NPS Shared Beringian Heritage Program made a big contribution by funding visa-free travel for 17 Russians to come from Uelen and Larentiya.

The event featured a wide variety of entertainment, including:

- A competition for best regional delicacies (Russian visitors entered fish soup, seal meat, and doughnuts in the competition),
- Dance performances (including a marvelous squirrel dance performed by a Russian-born Kotzebue resident), and
- A messenger race and stick pull.

Throughout all the traditional dancing, games, and art displays, people applauded the competitors and shared traditional food to create a family atmosphere for kindred spirits. The next festival is scheduled for July 2017.

A Savoonga resident passes out muktuk to many people eager for a bite. NPS Photo by Elizabeth Shea.

Partnerships

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Volunteers	Number and hours contributed		Volunteer numbers (including Volunteers-in-Park and interns) go up every year. In the past 5 years, volunteers have donated 10,630 hours to the Western Arctic Parklands, including NOAT. Volunteers in the park require highly specialized skills to assist rangers and scientists in remote backcountry locations and indigenous communities. Volunteers contribute complex products such as ethnographic stories of traditional skills in the form of video productions (WEAR VIP annual activity & expense report).
Partnerships	Number of partnerships		Community partnerships are very active, and local groups rent the Northwest Arctic Heritage Center meeting room often. Arctic parks have a strong 16-year relationship with the Northwest Arctic Borough School District. A partnership with Sulianich Art Store provides opportunities for cross-cultural training. Cooperative education programs are planned in with Selawik National Wildlife Refuge and the Alaska Department of Fish and Game. The park hopes to increase collaboration with Borough tourism and local craft experts for increased community workshops. Consultation-related partnerships include: • 13 local city governments • Local and regional Native corporations (KIC, NANA) • Northwest Arctic Borough • Permit cooperation with the Alaska Department of Fish and Game • Other federal agencies • State agencies • 13 traditional village councils • Universities • Regional Native non-profit (Maniilaq Association)

Recreational Opportunities

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Sport Hunting and Fishing	Quality of recreational opportunities		With the appropriate licenses, non-local hunters harvest brown bears, caribou, and moose in the preserve. They also fish for Arctic char, salmon, and grayling on the Noatak River and its tributaries. There are no entrance stations to count visitors, but recreational use is assessed by backcountry ranger patrols, business client counts, and observations by interpreters. Charter aircraft are available to take visitors throughout the preserve, but harvest is still challenging because of high flight costs and remote territory, which requires wilderness survival skills.
Flightseeing, Hiking/ Backpacking, Floating	Quality of recreational opportunities		Designated and eligible wilderness covers a wide area of the preserve, so there are many opportunities for solitude, floating, and hiking. Planes can be chartered from several companies to access areas for hiking and floating. No signs or trails exist, so visitors must navigate on their own and possess wilderness survival skills. Flightseeing tours enable visitors to view natural flowing rivers and unique permafrost features on the landscape. There are no entrance stations to count visitors and no backcountry permits are required.
Birding and Wildlife Observation	Quality of recreational opportunities		There are opportunities to see unique Arctic wildlife such as large bird migrations, caribou herds, and even small animals like northern bog lemmings. Peregrine falcons nest in the canyons along the Noatak River. Snowy owls pass through on their way to northern nesting sites. Planes can be chartered from several companies to access areas for wildlife viewing.

Scenic Resources

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Scenic Views	Scenic view quality & protection		NOAT is notable for its pristine and natural character. Scenic resources at the preserve are in good condition, but development may result in scenic impairments. The primary risk to the scenic resource quality of the preserve is gravel mining on park borders. A gravel mining operation near the southern boundary of the preserve started 5 years ago. Gravel removal will likely continue for several decades. There are also a number of campsites needing restoration along the Noatak River and at backcountry airstrips used for hunting and recreation.

2.4. Wilderness Character and Stewardship

The Noatak Wilderness is located in northwestern Alaska in the western Brooks Range. Predominately surrounded by other public lands, the Noatak Wilderness lies at the center of a vast network of protected lands. The Wilderness Act of 1964 requires the NPS to maintain wilderness character, including the qualities of being "…untrammeled by man…undeveloped…natural," and allowing for "…solitude or primitive and unconfined recreation." The Noatak Wilderness Character Baseline Assessment (Landres 2015) has more detail about the Noatak Wilderness; readers are encouraged to read more there. A summary of wilderness character for the park is summarized below.

Overall Wilderness Character  web

Wilderness Quality	Condition Status/ Trend	Rationale
Natural		Wilderness with natural character maintains ecological systems that are substantially free from the effects of modern civilization. The natural quality of wilderness character assesses the integrity of local ecosystems and their freedom to change and develop without human manipulation. Monitoring ecosystem changes inside wilderness is key to understanding how human actions impact the natural quality of wilderness. Despite the remoteness and untouched appearance of NOAT, pollutants affect air and water quality and are found in many of the plants and animals. Sources vary from global deposition brought on winds and with snow and rain, to local sources like the Red Dog Mine just beyond the western edge of the wilderness. Contaminants—which have included mercury and other heavy metals, persistent organic pollutants, and excess nitrogen—have the potential to affect the integrity of natural resources, which are imperative to the natural quality of the Noatak Wilderness and to subsistence users who rely on clear water and air, unfettered wildlife movements, and intact natural systems (Landres 2015).
Untrammeled		Actions that intentionally manipulate, hinder, restrict, or control "the earth and its community of life" are considered trammeling actions. Actions occurring as part of research projects and administrative actions that have foreseeable and substantial impacts on the biophysical environment impact the untrammeled quality of wilderness. At this time, few authorized actions occur within the Noatak Wilderness that manipulates wildlife or vegetation. The Noatak River remains one of the largest unmanipulated river systems in the world. From its headwaters in the Brooks Range, the river cuts through hundreds of miles of rugged mountains, symmetrical glacially sculpted valleys, boreal forests, and open tundra. Virtually no trammeling actions have occurred in NOAT since documentation started in 1980. One exception is wildfire suppression; however, suppression activities take place infrequently enough that they have not affected the trend in this quality. Likewise, wildlife collaring activities have occurred, but infrequently enough so as to maintain a stable trend for this quality. In short, the untrammeled quality of NOAT has remained virtually unchanged since its wilderness designation in that the earth and its community of life in the Noatak Wilderness is essentially uncontrolled and unmanipulated by human actions.

Overall Wilderness Character (continued)

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Wilderness Quality	Condition Status/Trend	Rationale
Undeveloped		The Noatak Wilderness has evaded many influences of modern civilization. Visitors find few barriers between themselves and the landscape, as few developments or improvements are present. An occasional research installation or administrative structure is present, or perhaps a cabin or some debris can be seen. But camouflaged by the vastness of the surrounding geography and buried beneath snow during winter, these developments are virtually unnoticeable and Noatak retains a feeling of freedom from modern influences. A primary source of new installations in wilderness is research; in particular, increasing use of sub-surface site markers. The majority of new above-ground developments since 1980 are research instrumentation. It also important to note that all six administrative and shelter structures currently in the Noatak Wilderness were present prior to 1980. Research activities should be examined for their effects to wilderness character, while recognizing that research is a fundamental purpose of the Noatak Wilderness. Use of aircraft, snowmachines, and motorboats in Alaskan wilderness areas is allowed under the Alaska Native Interest Lands Conservation Act of 1980 (ANILCA). Still, these uses affect the quality of wilderness and motorized use represents one of the primary impacts to the undeveloped quality of the Noatak Wilderness. Access and travel to the wilderness is difficult and visitors, commercial operators, scientists, locals, and agencies—including the National Park Service—typically access the wilderness by motorized methods. Yet in this vast landscape, the whine of engines quickly fades as the small planes are swallowed by the sky and dwarfed by the mountains.
Solitude or Primitive and Unconfined Recreation Opportunity		Opportunities for solitude or primitive and unconfined recreation can be difficult to find as modernization and civilization continue to expand. Opportunities for solitude in the Noatak Wilderness are unparalleled. The expectation in the Noatak is often one of complete solitude, where seeing any other visitor, even when crossing hundreds of miles, can significantly affect the experience. Due in part to its remoteness from population centers, many concerns that other wilderness areas face relating to recreation are not as prominent in Noatak. The remoteness of the Noatak Wilderness from the sights and sounds of human activity has remained relatively constant. Opportunities for primitive and unconfined recreation have likewise remained essentially unchanged since 1980. Visitors are still able to travel the Noatak Wilderness in the same ways as people did 35 years ago.

Overall Wilderness Character (continued)

web

Wilderness Quality	Condition Status/Trend	Rationale
Other Features and Values		Wilderness may possess physical, site-specific features of value that are integral to wilderness character and make the area's meaning and significance as wilderness clearer and more distinct. Noatak is part of the ancestral home of the Iñupiaq people and countless cultural and archeological resources are found within the wilderness. With artifacts extending back thousands of years, the Noatak Wilderness contains archeological and cultural evidence from some of the first peoples to cross into the North American continent across the Beringia—the land bridge that connected Asia and North America 13,000 years ago. Today, archeological evidence of these ancient peoples can be found in stone tools, depressions left by house pits, cairns, ancient fire pits, and other artifacts. These resources are considered invaluable to the wilderness character of Noatak, and loss of these resources degrades wilderness character. Today, these resources face threats from natural disturbance such as erosion, wildfire, floods, and animal digging, as well as human-caused disturbance such as looting, digging catholes, and other visitor and authorized uses. Due to the immense size of the Noatak Wilderness, it is estimated that less than 1% of the entire wilderness has been surveyed for archeological and cultural resources.

Wilderness Stewardship

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Stewardship to Preserve Wilderness Character	Key Information		NOAT does not have a Wilderness Management Plan or Wilderness Character Monitoring Program. Without a Wilderness Management Plan to help provide guidance, the wilderness program has lacked consistency, direction, and focus for many years.
	Management Operations		The park National Environmental Protection Act (NEPA) coordinator and members of the compliance team make efforts to evaluate each project for impacts to natural resources, cultural resources, subsistence, and Wilderness. For example, a Wilderness Minimum Requirements Analysis (MRA) is used for those projects thought to have a moderate or greater impact.
	Status of Plans		The park completed a Wilderness Character Narrative in 2015. No Wilderness Management Plan exists for NOAT and the preserve does not conduct wilderness character monitoring.
	Completed Training		The preserve has not completed wilderness training for all staff members.

2.5. Subsistence

Opportunity and Continuity for Subsistence Activities, Availability of Subsistence Resources		web ▸

Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Knowledge	Up-to-date documentation is available about subsistence resources and their uses in communities eligible to harvest resources in the park/ preserve/ monument		NOAT is a National Preserve. Eligibility for pursuing subsistence uses of fish and wildlife is primarily a function of the Federal "Customary and Traditional Use" determinations made by the Federal Subsistence Board. However, the majority of subsistence use in NOAT likely comes from Kotzebue, Noatak, and Kivalina; the residents of the other eight communities within the NANA Region pursue subsistence activities to varying degrees. Some occasional use by residents of adjacent Game Management Units (26, 24, and 22) may also be occurring in NOAT. Sharing of subsistence foods with relatives and friends is an important cultural practice, even extending beyond the region. Each of the communities in the NANA Region has a baseline comprehensive community household harvest survey and several have more than one partial survey, allowing for detection of changes in subsistence patterns over time. In addition, several communities have more focused surveys related to use of specific subsistence resources, as well as sharing and trading activities. These studies roughly span the last thirty years; many of the more recent studies were completed within several years. There is also extensive anthropological and historical literature, which provides descriptive information about subsistence resources.
Opportunity and Continuity for Subsistence Activities	Proportion of users who are able to engage in all the subsistence uses they would like to pursue		The opportunity to pursue key subsistence activities is decreasing. This is due to four primary reasons: 1) declines in the biological status of several important wildlife species (caribou and moose); 2) reduction in access to resources due to climate change (lack of snow cover for winter travel); 3) a regulatory system that often conflicts with traditional harvest practices; and 4) increasingly higher costs of pursuing subsistence activities (Arctic Council 2009b).

Opportunity and Continuity for Subsistence Activities, Availability of Subsistence Resources (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Opportunity and Continuity for Subsistence Activities (continued)	Subsistence users are engaged in subsistence management		Opportunities exist for local subsistence users to participate in a number of federal and state advisory groups (Federal Regional Subsistence Councils, Local Fish and Game Advisory Committees, and NPS Subsistence Resource Commissions) and special groups established for targeted recommendation (Western Arctic Caribou Herd Working Group, Unit 23 Working Group, and Statewide Sheep Management Group), which make recommendations to the regulatory boards (Federal Subsistence Board and State Boards of Fish and Game). During public meetings, many subsistence users state that they are insufficiently represented in the actual decision making bodies, and/or they should share decision making responsibility through some other regulatory structures, such as co-management arrangements (ICC 2014).
	Continuity of subsistence uses		There is strong continuity of subsistence uses in outlying villages, in terms of resources as well as the cultural systems of beliefs and practices in which uses are embedded. The adoption of new technologies—such as snowmachines replacing dogsleds and use of rapid fire firearms—represents the most noticeable change in subsistence. Adoption of technology may reshape the harvest patterns. Continuity of subsistence uses is less strong in regional centers—such as Nome and Kotzebue—where populations have greater ethnic and cultural variety. However, these regional centers contain significant components of the underlying regional culture, which remains strong.
Harvest of Fish, Wildlife, and Vegetation	Fish Resource Availability		Fish of several species comprise very significant components of the subsistence harvest for all the communities in the region. Overall, fish remain available (Menard et al. 2015), but no rigorous fish monitoring data have been collected. Changes in run timing of anadromous species and changes in weather patterns (which disrupts processing fish harvests)—both potentially linked to climate change—pose significant concerns for subsistence users. In the long term, ocean acidification may also impact fisheries and subsistence resource availability.

Opportunity and Continuity for Subsistence Activities, Availability of Subsistence Resources (continued)

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Indicators of Condition	Specific Measures	Condition Status/Trend	Rationale
Harvest of Fish, Wildlife, and Vegetation (continued)	Terrestrial Wildlife Resource Availability		Wildlife species of primary importance for subsistence users in the region are caribou, moose, and Dall's sheep. Sheep have drastically declined and caribou have been declining over the past decade. Moose are at the northern limits of their range and tend to remain at a fairly low density. This has resulted in regulatory attempts to lower harvest by shortening seasons, closing seasons, reducing overall estimates of harvestable surplus, and restricting individual harvest by reducing the individual harvest limits and/or reducing the number of harvest permits that are made available. The result is a situation where the availability of important wildlife resources is being reduced for an increasing number of subsistence users (Dau 2013, Schmidt and Gorn 2013). This may also result in increased competition for whatever subsistence resources remain available.
	Marine Mammal Resource Availability		Marine mammal resource availability is influenced both by animal populations and by access challenges to hunting these animals. Seals, walrus, and beluga are important subsistence commodities. These animals constitute 60%–80% of the local population's subsistence harvest (Arctic Council 2009b). Currently, the availability of marine mammal resources is decreasing. Decreased availability is primarily due to deteriorating sea ice conditions—which reduces hunters' access to the animals—but is compounded by a documented decline in the abundance of marine mammal species. Subsistence users experience difficulty accessing marine mammal hunting areas due to lack of sufficient sea ice; reduced boat access and timing of open water presence both influence hunting opportunities (Aurand and Essex 2012). Timing of sea ice presence has serious implications for when subsistence users can go out, and where animals can be processed (Arctic Council 2009b, ICC 2015). There are also increased safety risks due to ship traffic in the Chukchi Sea. Community interactions and traditional ecological knowledge also indicate that marine mammal populations are declining.
	Vegetation Resource Availability		Vegetation resources (such as berries and greens) generally remain available, although there have been fluctuations in abundance and/or timing of availability of individual species. Climate change may lead to an increase in these fluctuations, as number of shrubs (including berry-producing shrubs) increases.

Resource Brief: Subsistence as a Way of Life in Northwest Alaska

Iñupiaq subsistence skills, such as fish cutting, are taught at Camp Sivu. Source: NPS Photo.

Subsistence as a Way of Life

Since people first entered Alaska, they have (until very recently) depended upon the harvest of naturally occurring living resources (fish, wildlife, and plants) from the land and sea. The majority of Alaska's rural residents still depend upon these resources. This necessity of hunting, fishing, and gathering has given rise to both an economy and a way of life often referred to today as "subsistence." Even today, given the increasingly rapid cultural change and globalization, subsistence remains at the core of life for the majority of northwest Alaska's residents, most of whom are Alaska Natives.

The economic and nutritional importance of wild foods is significant; in 2012, residents of Arctic Alaska harvested 438 pounds per person of wild foods, and residents of Anchorage harvested 17 pounds per person (ADF&G 2014). The estimated replacement cost of those harvested wild foods ranges between approximately $44 million and $88 million (ADF&G 2014). Wild foods also contributed 280% of the minimum required protein and 39% of the required calories for people in Arctic Alaska, compared to 11% and 2% respectively in the Anchorage area (ADF&G 2014).

Less apparent is the fact that subsistence is entwined in the broader social and cultural patterns of the rural communities of northwest Alaska. The procurement of wild food helps shape the social organization and structure of a community, as well its beliefs, attitudes, values, behaviors, and even the mental health of its members. Consider the role and place of an esteemed whaling captain, a skilled caribou hunter who brings in meat enough for many in the community, and a skilled seamstress who can convert caribou skins into clothing items. Elders are respected as repositories of the traditional knowledge that has ensured the survival of families and communities for countless generations. Subsistence lifestyles are also associated with a holistic view of the world as a system of interrelated elements (including people), held together by behavioral norms of sharing, respect, and mutual obligations.

Subsistence is characterized by a number of distinctive features:

- it is heavily focused around a strong sense of place—harvesting is largely focused on the resources closer to home when they are adequate to support the group;
- practices related to the harvesting, processing, distribution, and consumption of resources generally take place within the framework of kinship and community ties;
- cultural practices, beliefs, and values related to subsistence are based on tradition, and are transmitted across generations largely by observation and practice supported in the oral traditions of stories, myths, and legends;
- it facilitates a very detailed knowledge and understanding of the environment of the local area, which is made possible only by very close and sustained contact and interaction with that environment over a very long time;
- as an economic system, it tends to be marked by efficiency; the methods and means of harvest as well as resource selection tend to favor maximizing the harvest amount while reducing the harvest effort, given the available technology and the characteristics and nature of the resource;
- it features the utilization of a very wide range of different resources; and
- it focuses on the community and not on the individual.

The importance of subsistence in the lives of people of and from the region can be seen in the persistence of two behavioral characteristics: (1) the expectation that a young hunter will give his first kill to an elder outside of his own family, thus reinforcing the value of sharing and the role of community provider and (2) the strong need to provide traditional foods to relatives who have left the community for any number of reasons, illustrating the great degree to which traditional foods are a part of who they are as a people.

The activities of subsistence users in northwest Alaska are largely structured around a cycle of biological events that make available for harvest the food resources that are needed by communities. These events include the spring and fall migrations of the Western Arctic Caribou Herd, as well as its distribution on the winter range; the summer runs of salmon up rivers and streams in the region; the spring and fall migrations of key marine mammal resources, such as whales and walrus; the spring and fall migrations of waterfowl; the winter freeze of sea ice, allowing access to polar bears and seals; the spring and early summer gathering of plant greens; and the summer ripening of berries.

Resource Brief: Subsistence as a Way of Life in Northwest Alaska (continued)

The Communities

There are three park units in northwest Alaska centered around Kotzebue: Cape Krusenstern National Monument, Kobuk Valley National Park, and Noatak National Preserve. These parks have eleven closely associated communities (Kotzebue, Buckland, Deering, Kivalina, Noatak, Selawik, Noorvik, Kiana, Ambler, Shungnak and Kobuk) totaling 7,156 people, predominately Alaska Natives (about 89%). Excluding of Kotzebue—the regional center, which has a population of 3,209 people, including about 74% Alaska Native—the communities range in size from Deering (132 residents, about 87% Alaska Native) to Noorvik (668 residents, about 88% Alaska Native) (Population Data: Alaska DCCED 2016). In addition, there are occasionally some residents from outside of the area with customary and traditional use determinations who also seek resources from the parks. These eleven communities are almost entirely located either along a coastal area adjacent to marine waters, or inland and adjacent to major rivers. Because the availability of subsistence resources can vary significantly across both time and space, and because the harvest of resources tends to be locally focused, each community has a distinctive harvest pattern.

Men retrieving seal harvested for various uses including meat, seal oil, and the hide. NPS Photo.

Three communities are described here to illustrate the patterning (Harvest Data ADF&G CSIS 2016):

(1) Kotzebue (population 3,209, 74% Alaska Native) is located at the tip of Baldwin Peninsula, which juts out into the Chukchi Sea. A 1991 harvest study found that fish, large land mammals, and marine mammals accounted for 97% of Kotzebue's total subsistence harvest. Fish of several species were the top contributor to the subsistence harvest (just over 40% of total harvest weight). Large land mammals accounted for nearly 30% of total harvest, and marine mammals accounted for nearly 27%.
(2) Kobuk (population 151, 90% Alaska Native) is located inland, 151 air miles northeast of Kotzebue on the bank of the Kobuk River. A 2012 harvest study indicated that fish and large land mammals contributed to about 93% of the total harvest. Fish of several species (57% of total harvest weight) were the leading contributors to the subsistence harvest. Large land mammals (predominately caribou with some moose) accounted for just over 36% of the total harvest weight. The same survey estimated that 16,173 pounds of caribou were harvested, compared to 1,936 pounds of moose. This clearly suggests that a resource failure of caribou could adversely impact the community's ability to meet its subsistence needs.
(3) Kiana (population 361, just over 90% Alaska Native) is located 51 air miles east of Kotzebue on the bank of the Kobuk River. A 2006 harvest survey indicated that fish of several species contributed to about 53% of the total harvest. Large land mammals accounted for almost 38% of total harvest (caribou at nearly 41,612 pounds compared to moose at 8,629 pounds), and plants provided an important (but quantitatively weak) 4% of total harvest.

The Future – Challenges

The subsistence way of life will likely face significant challenges in the coming years. The three major threats to subsistence are:

(1) *Global climate change.* Climate change may be the greatest long-term threat as ecosystems are transformed, including potentially significant changes in the abundance and distribution of key subsistence resources. In addition, there may be climate-associated difficulties in accessing resources (increased frequency and severity of storms, coastal erosion, thinning ice, longer periods of open water, and reduced snow cover limiting the use of snowmachines). Will people be able to adapt and still maintain a subsistence way of life?
(2) *Development.* Development in the Arctic—such as mining, oil and gas development, and increased shipping activity through the Bering Strait—may have impacts from construction, operations, and accidents (ship collisions, groundings, oil spills into key habitat areas).
(3) *External Influences.* The increasing influence of external management and regulatory systems that are disruptive or counter to subsistence practices may result in the erosion of the subsistence way of life. One example of this is that most Euro-American harvest limit restrictions in hunting are focused on the individual hunter (one moose per year, five caribou per year) whereas in subsistence-based communities, a relatively small number of hunters may be harvesting enough animals to meet a community's needs.

The challenges faced by subsistence users will be reflected in the challenges park managers also face as they continue to implement Federal Law in the form of Public Law 96-487 (ANILCA of December 1980). ANILCA mandates that the NPS provides the opportunity for rural residents engaged in a subsistence way of life to continue to do so in accordance with recognized scientific principles of fish and wildlife management and the purposes for which each park unit was established.

Chapter 3. Summary of Key Stewardship Activities and Accomplishments

Activities and Accomplishments

The list below provides examples of stewardship activities and accomplishments by park staff and partners to maintain or improve the condition of priority park resources and values for this and future generations:

Natural Resources

- NPS Arctic Network Inventory and Monitoring Program conducted monitoring in NOAT on vital signs including Dall's sheep, muskoxen, moose, caribou, landbirds, terrestrial vegetation (including lichen), terrestrial landscape patterns, permafrost, fire, large lakes, shallow lakes, streams, weather and climate, and snowpack.
- NPS partnered with the U.S. Forest Service to produce a model of the effects of climate change on the habitat of over 200 species of birds and mammals.
- NPS conducted intensive Dall's sheep surveys on a population experiencing sharp decline.
- NOAT partnered with Alaska Department of Fish and Game to complete an expanded survey of the Cape Thompson muskox population. This survey is the largest in spatial extent of any interagency wildlife survey in the state.
- An aerial brown bear survey was conducted in the lower Noatak River within NOAT and Cape Krusenstern in 2016; this will be the first reliable population estimate for this area in over 20 years.
- NOAT conducted a study of hunting party transporters, sound disturbance, and caribou movements in the lower Noatak River basin as part of an initiative to characterize impacts of sport hunting on subsistence caribou hunting.
- NOAT participated in a large-scale study of persistent organic pollutants and other toxic substances (e.g., mercury) in fish, lake water, sediment, lichens, and vegetation. Results indicated generally low levels of contaminants though thresholds would be exceeded by high consumption of several species of long-lived top predator fish by subsistence users and birds.
- NPS created a database and monitoring program for campsites needing restoration. Some rehabilitation is underway.
- NPS completed a major mapping study of permafrost thaw slump features, which are prominent in NOAT.
- NPS partnered with the interagency Terrestrial Environmental Observing Network to study the biology, chemistry, and physical properties of changes to permafrost ecosystems.
- NPS partnered with the University of Alaska to study the physical drivers of changes in treeline along the boundary zone between tundra and forest.
- NPS and university partners completed a major study of historic fire return intervals, vegetation, and climate in NOAT based on charcoal and pollen in lake sediment cores.
- NPS partnered with the Alaska Department of Fish and Game to study the populations and distribution of overwintering Dolly Varden.

Cultural Resources

- NOAT's archival processing has been brought up-to-date. 205 linear feet of archives with a finding aid were produced for all northwest Arctic parks including Bering Land Bridge, Cape Krusenstern, Kobuk Valley, and Noatak.
- In the summer of 2015, the National Park Service collaborated with Alaska Geographic, Bering Straits Native Corporation, Kawerak Incorporated, Carrie McClain Museum, and UAF Northwest Campus to host Nome Archaeology Camp, an opportunity for Alaskan teens to learn more about the heritage of the Bering Straits region through archeological methods, oral history, and museum studies.
- Archeologists from the University of Alaska Museum and the NPS recently conducted work on several sites in Noatak National Preserve that include large, rock-lined communal structures (qargit), and dozens of petroglyphs, which taken together are a completely unique set of prehistoric lakeside village sites for Alaska.
- In a 2015 study by University of Alaska Fairbanks anthropologists, interactions between local and non-local caribou hunters were analyzed and linked to traditional Iñupiaq management of access and use of resources. This study examined changes in caribou migration and the effect on local caribou hunting success, which have been perceived to be the result of interaction with non-local hunters and commercial aircraft operators transporting non-locals.
- The NPS financially supported several place name documentation projects in the region during the 1970s and 1990s. For a number of years, NPS staff has been working to identify existing Iñupiaq place names data sets that may be suited for digitization into a Geographic Information System (GIS). Although issues of cultural sensitivities may limit the degree to which the data is distributed and shared, Native communities who created the data will certainly benefit from the consolidation of this type of information into a GIS format.

Visitor Experience

- Technologically savvy interpreters and biologists are working hard to reach new visitors and help them learn about Arctic public lands through 6 new web videos, hundreds of twitter posts, 107 new Flickr images, 2 new blogs, 8 photo galleries, and an innovative Facebook page for the Northwest Arctic Heritage Center. These creative online features are a response to the new ways that people want to learn about national parks.
- The curriculum-based school program has been strong for 16 years. 2013 was a record-breaking year of invitations to classrooms. The education specialist—nearly single handedly—gave 247 hour-long lessons to 3,196 students in kindergarten through 12th grade. As one teacher said in a thank you card: "I can't imagine our science class without you—you are so important to our students. Thanks for being a part of our 4th grade team!" Strong relationships like this between rangers and local students and teachers will keep support for the park strong for generations.
- Two Artists-In-Residence have had spectacular experiences in NOAT and produced artwork in recognition of the 50th Anniversary of the Wilderness Act and Iñupiaq heritage. Both pieces—one from MK MacNaughton and one from Robert Winfree—are original paintings and are on exhibit in the Northwest Arctic Heritage Center.

Wilderness

- NOAT completed the mapping of current wilderness boundaries and calculation of current wilderness acreage.
- NPS Western Arctic Parklands compiled the legislative history of Wilderness in Noatak National Preserve, Kobuk Valley National Park, and Cape Krusenstern National Monument.
- NOAT completed a Wilderness Character Narrative in 2015.
- NOAT selected measures for wilderness character monitoring.

Subsistence Use

- NPS released new regulation changes allowing customary and traditional uses of horns, antlers, and plant materials collected from parklands (Federal Register 2017).
- NPS continues to work within a regulatory framework to balance subsistence uses with conservation of wildlife populations. The NPS manages one muskox hunt and four sheep hunts within and adjacent to Noatak National Preserve and coordinates with the State of Alaska.
- NOAT, in conjunction with the other Western Arctic Parklands, continues to support the Western Arctic Caribou Herd Working Group, which was established to "ensure conservation of the Western Arctic Caribou Herd, safeguard the spiritual and cultural well-being of Alaska Natives and the interests of all users of the herd, and integrate indigenous knowledge with Western Science."
- NOAT, in conjunction with the other Western Arctic Parklands, continues to support and participate in the Unit 23 Working Group, whose goal is to protect subsistence uses and identify and minimize user conflicts resulting from the influx of fall hunters to Game Management Unit 23.
- NOAT, in conjunction with the other Western Arctic Parklands, helped support and facilitate a Traditional Ecological Knowledge (TEK) study of caribou migration, subsistence hunting, and user group conflicts in northwest Alaska in collaboration with University of Alaska, Fairbanks.

Chapter 4. Key Issues and Challenges for Consideration in Management Planning

Noatak National Preserve is managed as a unit within the Western Arctic Parklands (WEAR), which protect a northwest Alaskan Arctic landscape of rugged beauty. WEAR includes Cape Krusenstern National Monument, Kobuk Valley National Park, and Noatak National Preserve. Together, these parks represent over 9 million acres of arctic tundra and boreal forest atop permafrost, and large expanses of the Brooks Range, lowlands, and coastal plains. These parklands are well-known for their abundant wildlife including the Western Arctic Caribou Herd (one of the largest caribou herds in North America), brown bears, Dall's sheep, moose, and migratory birds from five continents. Included in these holdings are 300 km of world-class soft-sediment coastlines comprised of fractal-patterned lagoons teeming with waterbirds, salt-marshes, brackish wetlands, and a wide assortment of arctic marine mammals. Established by ANILCA in 1980, these parks not only protect habitat for and populations of fish and wildlife, but also provide opportunities for the continuing subsistence and cultural heritage of the Iñupiaq people who have lived here for millennia.

As the issues of the outside world reach these remote parks, the NPS must adapt. Landscape and ecosystem change driven by climate change is beginning and is likely to catalyze fundamental changes to the appearance and function of these parks. In the future, the NPS may find itself in the incongruous position of managing a boreal landscape set aside to protect arctic tundra and free-roaming caribou herds when they may no longer occur there. The rise of the Arctic shipping industry brings a large set of challenges and risks to coastal and aquatic ecosystems. Managing for subsistence and wildlife amidst this transformation is complex both philosophically and practically.

As the Western Arctic Parklands move forward in changing times, the major management challenges facing these parks include:

- The effects of climate change on ecosystem parts, processes, and services
- Wildlife management
- Current and threatened impacts from outside park boundaries
- Logistical challenges unique to WEAR parks

4.1 Climate-driven Challenges

The Arctic has been warming at twice the rate of the temperate latitudes, which has led to several physical and ecological changes with many more anticipated. Downscaled models (Rupp and Loya 2009a, b, c) predict that these parklands are expected to experience warming of up to 10 °F mean annual temperature over the next 60 years. Sea ice has retreated to historic lows in both extent and thickness, and researchers predict an ice-free summer Arctic Ocean by 2035. With a changing climate comes a host of current and potential issues requiring adaptation in terrestrial, coastal, and aquatic environments.

4.1.1 Terrestrial

There are myriad changes predicted to occur on NOAT's ecosystem over the coming decades and within the century. The most dramatic of these include:

- Tall shrub increase and the movement of forest into much of NOAT's currently open dwarf and low shrub tundra
- Loss of ungulate lichen winter range and open tundra currently hosting abundant lichen cover types
- Permafrost thaw and degradation of ice wedge polygons
- Increased fire frequency leading to more of the landscape being in an early successional state with fewer lichens
- Increases in winter icing events leading to wildlife winter forage difficulties
- Changes in the composition of wildlife and bird communities with declines in tundra-adapted species and increases in boreal species
- Reduction in the availability of and access to key wildlife species hunted for subsistence by local residents, especially caribou
- Mismatch of migration, forage and pollination timing because of earlier green-up and longer snow-free season

While recognizing that preventing many of these changes is beyond park managers' control, the NPS may consider a suite of adaptations.

Vegetation and Ecosystem Change

Arctic warming has led to the increase of tall shrubs on previously dwarf-shrub tundra throughout the world's arctic ecosystems (Tape et al. 2006). Currently, about a quarter of vegetation plots sampled by the NPS showed modest shrub increase and afforestation since 1980 (Swanson 2013), with changes concentrated in lowlands habitats. A recent vegetation model concluded that a large proportion of WEAR is likely to experience increase in tall shrub cover during coming decades (Swanson 2015). A recent pan-arctic study showed significant ice wedge degradation (Liljedahl et al. 2016) in the circumpolar north and NPS research (Swanson 2013) showed minor degradation on 10% of plots with wedges present.

Future climate scenarios forecast arctic ecosystems that are drastically different from those that occur now (Murphy et al. 2010). Open tundra habitats within NOAT that currently support abundant and diverse lichen communities will likely be replaced by taller shrublands and forests which host far less lichen biomass (Marcot et al. 2015, Walker et al. 2006). Increasing fire frequency is likely to compound this problem. Lichen winter range is the key winter forage for the Western Arctic Caribou Herd and other ungulate species. Without this extensive winter range, herds are more likely to be smaller and spatially isolated as is the case with the herds in interior Alaska.

Potential Adaptation: NPS should consider how to obtain the best predictive data on ecosystem change and develop a suite of possible mitigation strategies. Supporting landcover monitoring and research by the NPS and a broad consortium of partners is a key first step. Promoting discussions on adaptive management of landscape change with stakeholders including local communities, federal and state agencies, and the broader public is quickly rising in importance along with rising temperatures.

Caribou and Habitat

The Western Arctic Caribou Herd is a major subsistence resource for northwest Alaska and reached 490,000 animals in 2003 (Western Arctic Caribou Herd Working Group 2011). The population has declined over 50 percent since 2003. In 2016, the population was estimated at 201,000 animals (Parrett 2016). The heritage, traditions, and subsistence needs of Alaska Natives in approximately 40 local communities have been shaped by the availability of the caribou (Western Arctic Caribou Herd Working Group 2011). The presence and relative abundance of the Western Arctic Caribou Herd has substantial impacts on the populations of wolves, bears, and wolverines in the area. Arctic herds of caribou are known for their large population fluctuations. Although this characteristic of arctic caribou herds is well known by local area residents, it provides little solace when this important subsistence resource becomes scarce.

Available habitat for the Western Arctic Caribou Herd is likely to decline under predicted climate change scenarios (Marcot et al. 2015). Primary forage for caribou includes leaves, grasses, and sedges in the summer and lichen in the fall and winter (Miller 2003). These food sources are likely to decline over the long term, with a warming climate due to tall shrub and tree increase in open tundra communities (Holt and Neitlich 2010, Joly et al. 2009). Lichen winter range may potentially suffer additional decline from more frequent wildfire (Racine et al. 2006). Models investigating the effects of climate and fire on Western Arctic Caribou habitat project a fire-mediated decrease in the extent of caribou winter range and an increase in moose habitat due to a decrease in lichen and an increase in shrubs (Joly et al. 2012). Lichen winter range may also decline due to increasing inputs of nitrogen and sulfur from regional development and shipping (Linder et al. 2013). Caribou are parasitized by blood-sucking insects including mosquitoes, botflys and warble flies. Activity and harassment of caribou by these parasites are correlated with warmer temperatures (Witter et al. 2012). Under severe conditions, these parasites can impact foraging by caribou and impact their fat reserves.

Historically, caribou arrive on the calving grounds and give birth to their calves synchronously in early summer when vegetation is at its most nutritious. Increasingly early green-up may place these cycles out of sync (Post et al. 2008), potentially impacting the energetics and reproductive success of caribou.

Potential Adaptation: NPS should continue to engage with partners to continue to study and manage caribou and their habitat in a changing ecosystem.

Fire

Data suggest that fires are increasing in frequency, extent, and severity in northern Alaska, including those in tundra areas. Fire can exert strong landscape-scale effects on vegetation, wildlife, permafrost, nutrient cycling, carbon storage, hydrology, and water and air quality. In some instances, a repeat fire regime can favor a landscape dominated by early successional vegetation (e.g., grasses and sedges) and reduce the dwarf shrub-lichen tundra components key to ungulate forage.

Potential Adaptation: NPS should continue to consider the implications of fire suppression options in order to save lichen winter range.

Permafrost

Most of the Western Arctic Parklands are underlain by continuous permafrost (soil that remains frozen for two or more years). Under current climatic conditions and projected global climate change scenarios, permafrost is vulnerable to thawing (Jorgenson and Osterkamp 2005). The rate of permafrost degradation is expected to increase and the consequences of this thaw include:

- Thermokarst formation (i.e., subsidence, collapse, erosion, and ground surface instability caused by thawing permafrost)
- Land surface drying (and subsequent ecosystem changes)
- Disappearance of many shallow lakes and formation of a much smaller number of new lakes
- Altered stream flow with increased sedimentation and erosion
- Release of stored carbon, methane, and contaminants (e.g., mercury)
- Formation of thaw slumps (small landslides)

Potential Adaptation: NPS should continue to monitor permafrost and could increase research of thaw-driven landscape change.

Winter Icing Events

Climate projections for northern Alaska predict that winter temperatures will increase by over 35% (Rupp and Loya 2009a, b, c). The combination of greater precipitation and warmer temperatures provides greater potential for icing events following rain-on-snow events or mid-winter thaws. The WEAR parks, including NOAT, have experienced 3–4 thaw-refreeze events/year over the last decade (Wilson et al. 2013). Mammalian herbivores face challenges obtaining adequate winter forage during years with particularly bad winter icing. Winter icing events have increased over the past decade and this trend is expected to continue.

Potential Adaptation: NPS could consider multi-agency partnerships to identify areas less prone to icing events as critical areas for caribou and other wildlife species.

Life Cycle Mismatches

Potential mismatches may occur for caribou and their summer forage, ptarmigan and hare and their camouflage (color camouflage timing problems due to earlier snow melt, Zimova et al. 2014), migratory birds and their prey (van Gils 2016, Clausen and Clausen 2013), and co-occurrence of pollinators and flowers.

Potential Adaptation: NPS could consider multi-agency partnerships to identify the extent of mismatches occurring and projected for caribou and other species.

Wildlife Winners and Losers

A recent modeling effort (Marcot et al. 2015) provided a predictive framework describing how climate change may affect habitat, wildlife species, and ecosystems in the future. With the increase in forest and tall shrub ecosystems and decline in open habitats, 26 mammal species and 68 bird species are expected to face habitat decline and population decrease. Some species, such as moose and boreal forest birds may experience a population increase with better habitat.

Potential Adaptation: NPS should continue to participate in international conservation efforts; this is key to building the network for migratory species, especially birds, facing habitat decline from climate, development, and pollution. Assisted migration has also frequently been proposed as a solution for plants and animals challenged by changing climate and distributional limitations. NPS may potentially be faced with some decisions on assisted migration either as a donor or recipient.

4.1.2 Aquatic

In parallel with changes on the land, NOAT's aquatic resources are expected to change dramatically, presenting a number of management challenges. Shallow lakes and ponds have shown a modest decrease in number and size, a trend expected to intensify. Aquatic habitat for birds will be accordingly reduced. Rivers will warm and become more filled with sediment seasonally, presenting challenges to arctic fisheries. As peat decomposes, it is expected to release nitrogen and mercury into surface waters.

Fisheries

Local residents rely on fisheries for subsistence, particularly chum salmon, and several other species of whitefish from lagoons. The thermal and hydrologic regime of aquatic systems in northern Alaska are particularly susceptible to increased temperatures associated with climate change due to the presence of permafrost (IPCC 2013) and the influence of aquatic ice. While warmer temperatures in winter may increase primary productivity and create more winter habitat, they may also change the distribution of fish species. As permafrost thaws, riparian bluffs are likely to erode more quickly; this in turn is likely to introduce new sediment into the streams, which may influence water quality and spawning success. Release of nutrient nitrogen from permafrost thaw may influence the abundance of primary producers, dissolved oxygen levels, and ultimately fish. Ocean acidification is likely to reduce the abundance of carbonate-based plankton that form the base of the food chain for anadromous fish in the North Pacific and arctic Alaska (Healey 2011).

Potential Adaptation: The Western Arctic Parklands do not currently have a fish biologist, but need to work more proactively with other NPS fish biologists and cooperators to develop a robust fisheries program.

Contaminants

Despite their remoteness, northern Alaska parks receive steady inputs of mercury and persistent organic pollutants from global sources. Long-lived fish species occupying high trophic levels such as northern pike and burbot, may bioaccumulate certain pollutants. A 2006 survey that included two lakes in Arctic parks (Landers et al. 2008) found that concentrations of methyl-mercury in lake trout in these lakes were higher than recommended for human consumption. Thawing permafrost has the potential to release additional mercury into the environment. Concentrations of the banned pesticide Dieldrin were above advisory levels for fish-eating mammals and birds. Release of nutrient nitrogen from permafrost thaw may influence the abundance of primary producers, dissolved oxygen levels, and ultimately fish.

Potential Adaptation: NPS should continue to monitor fish for toxic substances and communicate advisories with local communities.

Waterbirds

The disappearance of shallow lakes will reduce lake fish habitat as well as the habitat and food for waterbirds. Changes in the abundance and distribution of fish may also influence the abundance and distribution of piscivorous birds. As described above, participation with national and international conservation efforts is paramount.

Potential Adaptation: NPS should consider increasing international cooperation on migratory species.

4.1.3 Subsistence

NOAT was created in part to provide for subsistence opportunity for local residents. A large fraction of subsistence harvest in the Kotzebue Sound region is represented by marine mammals, most notably several species of ice seals. Local hunters report that conditions on the sea ice are much more dangerous than in past years due to a thinned ice pack, and that the windows of hunting opportunity are far less than in the past (NOAA 2012). Whitefish are a key subsistence resource for local communities (Georgette and Shiedt 2005). Coastal erosion as a result of climate change has the potential to alter the coastal subsistence fisheries for whitefish, because new dynamics of lagoon breaching will alter overwintering patterns of whitefish (Whiting et al. 2011). Local fishermen have observed the loss of "countless numbers" of whitefish in some areas of Kotzebue Sound, emphasizing the need to understand factors driving such perceived declines. Furthermore, increases in shipping and development in the region have increased risks of oil spills and coastal modification due to activities such as: maritime transport associated with oil and gas activities, consideration of deep-water ports in the region, and international shipping along the Northern Sea Route.

On land, subsistence opportunity for caribou is likely to face increasing hardship as the herd numbers have dropped over 50% from approximately 500,000 and the Western Arctic Caribou Herd is likely to face habitat constriction due to changing vegetation. The Western Arctic Caribou Herd's annual migration south after the summer calving is the time at which local residents harvest caribou. The timing and pathways of migration have changed over the past decade, which has led to much more hunting uncertainty and has created the potential for conflict over sport hunting closure dates to protect subsistence opportunity.

Potential adaptations: NPS subsistence managers should continue to be regularly engaged with local communities and advisory groups to discuss adaptation to climate change.

4.2 Wildlife-related Challenges

Protecting habitat for and populations of fish and wildlife is a central tenet of ANILCA. ANILCA also protects resources related to subsistence needs; provides for subsistence use by local residents in Noatak; allows sport hunting in Noatak; and provides for non-consumptive uses including recreation in all park units.

Wildlife management in WEAR must balance the multiple uses provided for by ANILCA within the resource management framework unique to parks created by ANILCA. Like other park units in the nation, WEAR parks are overseen by a Superintendent; national parks in Alaska, however, also include management that involves local stakeholders.

As per ANILCA, wildlife management in the parks as it relates to subsistence includes involvement of local residents and Native Alaskans through Regional Advisory Councils (RACs) and Subsistence Resource Commissions (SRCs). RACs are composed of residents of the region and provide a forum for expressing opinions, making recommendations, evaluating proposed regulations, and participating in decisions related to subsistence uses of fish and wildlife within the region. NOAT falls under the purview of the Northwest Arctic RAC.

4.2.1 Wildlife management challenges

There are several important challenges to wildlife management in NOAT and the other Western Arctic Parklands. The parks lack data on wildlife populations that are critical to meeting ANILCA's mandates of protecting habitat for and populations of fish and wildlife, providing for subsistence, protecting resources related to subsistence needs, and providing for non-consumptive uses. Aerial surveys and monitoring are conducted for moose, brown bears, and Dall's sheep to determine population trends over time. Aerial surveys alone, however, do not provide information on movement, demographics, and habitat use that are key to managing populations. This lack of data leaves the parks unable to appropriately respond to proposed State and Federal wildlife regulatory proposals that affect park wildlife resources, including the management of predators. The Western Arctic Parklands lack critical wildlife data primarily because of the lack of funding for wildlife studies. Although, the parks are highly visited, especially by local residents, the parks do not generate user fees. For many parks, user fees help fund wildlife and other projects. Also, the Western Arctic Parklands compete for wildlife funding from a limited pot of money with other parks that are able to fund projects from visitor fees.

Additional challenges stem from divergent park uses including subsistence hunting and gathering, recreational boating, wildlife watching, and sport hunting. Some of these uses can be at odds with others, which presents management challenges of mitigating the effects of these activities on park resources as well as the impacts of the different user groups on each other's activities.

Other challenges relating to wildlife management are appropriate staffing to provide for the logistics of permitting of hunts and enforcing of wildlife regulations over the >9 million acres comprising the Western Arctic Parklands.

Potential Adaptations: NOAT and the other WEAR parks could advocate for the need to secure funding for wildlife projects in order to better respond to proposed wildlife actions and to protect habitat for and populations of fish and wildlife. To better fund wildlife projects, the Western Arctic Parklands could point out the inconsistency of non-fee based parks competing with fee-based parks for limited funds of money.

4.2.2 Key Species-specific Challenges

Dall's Sheep

The majority of Dall's sheep within the Western Arctic Parklands occur in Noatak. Although sheep populations fluctuate naturally, based on information from aerial surveys, the sheep population in WEAR declined by 70% from a peak in 2011 to 2014. Large declines have been linked to severe winter weather such as the cold spring in 2013, deep snow in the early 1990s, and icing events that may reduce nutritional condition and increase vulnerability to predation (Nichols and Bunnell 1999, Shults 2004). Aerial surveys are used to estimate sheep populations (Schmidt et al. 2012); and determine population trend; however, there have been no focal studies to elucidate the drivers of population change and offer mitigations.

Potential Adaptations: NPS should perform studies of survival, recruitment, and habitat condition to inform population recovery and management.

Brown Bears

Important information gaps exist for brown bears in the Western Arctic Parklands, including NOAT—reliable population estimates, movements, demographics, and habitat use information have not been produced in over 20 years. As of this writing, there are five wildlife proposals under consideration by the Alaska Board of Game to facilitate or increase bear harvest in Game Management Unit 23, of which NOAT is a part. A significant management challenge is for the Western Arctic Parklands to respond to these proposals without data. Most brown bears in Unit 23 are harvested out of the Noatak drainage; impacts of the Red Dog Mine have caused den abandonment and direct mortality (Ayres 1991), and future pressures include nearby mining prospects, plans to develop a wind farm along the Delong Mountain Transportation System (DMTS), and a proposed road from Ambler to the DMTS. During the last 20 years, the Arctic has warmed, leading to phenological changes, and the commercial salmon fishery has declined causing more salmon to reach spawning areas far inland; both of these factors may have changed bear habitat use. Residents of Unit 23 report seeing more bears, suggest bears are contributing to the decline of the Western Arctic Caribou Herd through predation, and consider bears a nuisance or threat. Brown bears are a NPS Arctic Network Vital Sign; five parks are slated for population census via aerial survey once every 4–5 years. Aerial survey data, however, cannot provide information about habitat use, movements, demographics, or whether parks are acting as population sources or sinks.

Potential Adaptations: NPS should conduct studies of habitat use, movements, demographics, and predation to better inform wildlife management decisions related to bears, their prey, and potential mitigations of human-bear conflict.

Caribou

Caribou present a management challenge for the Western Arctic Parklands due to their importance for subsistence hunting, cultural continuity for Iñupiaq people, and sport hunting. During the mid-1970s the population reached an all-time low of 75,000 caribou (Dau 2011), but then steadily increased to 490,000 animals in 2003 (Dau 2011). The Western Arctic Caribou Herd is currently at the low end of its population cycle. Since 2003 the herd has declined over 50 percent and now numbers 201,000 animals (Parrett 2016). Residents of Unit 23 report seeing more bears and wolves, suggest bears and wolves are contributing to the decline of caribou through predation, and consider these predators a nuisance or threat. In general, however, the health and success of the various caribou herds in the region is stable, with some natural fluctuation.

The Western Arctic Caribou Herd moves fluidly across the boundaries of many jurisdictions and harvest and management requires involvement of many groups. Because of the importance of the herd as a resource, the Western Arctic Caribou Herd Working Group (WACH WG) was established to "ensure conservation of the Western Arctic Caribou Herd, safeguard the spiritual and cultural well-being of Alaska Natives and the interests of all users of the herd, and to integrate indigenous knowledge with Western Science" (WACH WG 2011.

Potential Adaptations: NPS should continue to support the work of the WACH WG and ensure that staff is involved in research and monitoring studies of the Western Arctic Caribou Herd that will inform management decisions related to caribou and their habitat.

Muskoxen

Muskoxen represent a unique conundrum for managers. Once common in Alaska, muskoxen were heavily hunted and extirpated from Alaska by the mid- to late-1800s (Lent 1988, Allen 1912). Muskoxen were reintroduced to Alaska in 1935 and now occur in NOAT and Cape Krusenstern (CAKR) (Gunn and Forchhammer 2008, ADF&G 2016b). As a result of their extirpation, several generations of Iñupiaq people did not experience hunting muskoxen and living on the landscape with them. Key management issues include establishing an allowable harvest for muskoxen and engaging the State of Alaska in population management. There has been increased interest in expanding subsistence hunting opportunity in the Cape Thompson population that inhabits CAKR and NOAT. Also, recent concern about the overharvest of adult bulls and subsequent declines in muskoxen populations (Schmidt and Gorn 2013) has highlighted the need for more frequent and precise estimates of abundance and sex and age composition of the population. Since 1988, population estimates and composition surveys have been conducted on the Cape Thompson muskoxen population in what is called the "core area" in and adjacent to CAKR. Since 2004, the Cape Thompson population declined in the core area or shifted eastward into what has been called the "expanded area" in NOAT (Schmidt and Westing 2011). To investigate this in 2011, the NPS and the Alaska Department of Fish and Game conducted an aerial survey of an expanded area—encompassing the whole Cape Thompson population—and found that at least half of the population resided in the expanded area. This survey was repeated in 2016, and the results showed that the population in the expanded area did not significantly change in size between 2011 (576 animals) and 2016 (556 animals) (Schmidt et al. 2016). When looking at the data from 1988 to present in the core area, it appears the population declined from a high of about 370 animals in 2005 to around 220–230 animals in 2011 and has stabilized at that level. The proportion of adult males to females within the core population and in CAKR, however, decreased between 2011 and 2016, which gives managers pause for thought when managing muskoxen harvest in this area.

Potential Adaptations: Continue aerial population and composition surveys of muskoxen. Encourage the State of Alaska to determine a total allowable harvest for muskoxen and to coordinate management of harvest. Thereafter, develop a management plan for the Western Arctic Parklands.

Moose

Moose occur in all of the Western Arctic Parklands, but calf recruitment and population numbers are low throughout much of Unit 23 (Westing 2012), of which NOAT is a part. Of the WEAR park units, moose abundance is generally highest along the Kobuk River downstream (west) of Kobuk Valley National Park. Sport hunting is allowed in NOAT. In NOAT, moose underwent a decline in abundance in the late 1980s and early 1990s, and although they rebounded, the population in eastern NOAT remains very low. Management challenges for moose include better understanding which factors—other than predation and harvest, such as browse condition—may contribute to population declines.

Potential Adaptations: NPS should continue aerial population and composition surveys and conduct studies of range condition to look at factors other than predation and hunting that might be limiting moose populations.

4.2.3 Wildlife Conflict

Wildlife, in addition to being important resources for subsistence, can be the source of conflicts with local residents. Addressing wildlife conflicts in a non-lethal way is a management challenge for the Western Arctic Parklands. For example, local residents believe that there are numerous bears in Game Management Unit 23. Local residents have reported bears damaging cabins, bears taking fish from drying racks, and a general concern for human safety. People have also expressed concerns over wolves becoming more brazen near villages and more numerous in general. Muskoxen also present challenges resulting in conflicts with residents. For example, muskoxen knock over grave markers and trample graves while they attempt to rub on grave markers. Additionally, residents report feeling intimidated by muskoxen while berry picking.

Potential Adaptations: NPS should convene a wildlife conflicts working group that includes participation from and solicits input from various agencies and local groups. WEAR could develop a plan on how it will manage conflicts on parklands in cooperation with other agencies.

4.3 External Challenges

A number of current impacts and future threats to NOAT's natural resources come from external sources including mining, air pollution, marine debris, introduction of invasive species, and illegal activity. Red Dog Mine has a congressionally-granted 18-mile road easement through nearby Cape Krusenstern for the transport of lead and zinc concentrates. This activity has resulted in the release of heavy metal-containing fugitive dusts into the environment over many years. Other emerging threats include proposed mining and access roads, increased regional pollution, increased potential for invasive species introduction, and ongoing illegal activity such as looting of archeological and paleontological resources.

4.4 Logistical Challenges

Working in the Arctic presents unique logistical challenges. Fieldwork in these remote, roadless parks requires access by boat or plane and is hampered by high costs of supplies, poor weather, and lack of infrastructure. The Western Arctic Parklands are understaffed and struggle with high staff turnover, difficulty hiring local residents (due to low federal wages compared to the high cost of living in Kotzebue), lack of housing, and slow telecommunications. Parks have started to test creative arrangements for basing certain operations (e.g., aviation management, law enforcement, science, administration) more centrally in Alaska, which may help WEAR and other remote Alaska park units.

Potential Adaptation: NPS should continue to explore shared employee arrangements, basing more logistical services from NPS primary hubs, and other creative solutions to high staff turnover.

References

See the State of the Park Report for the Park website for a more complete list of references to documents and data sets upon which the assessments in this State of the Park report are based. References for several of the key documents cited in this report are as follows:

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See Also:

Collection of Natural Resource-Related References

Collection of Cultural Resource-Related References

Collection of Visitor Experience-Related References

Glossary

See the State of the Parks home page for a link to a complete glossary of terms used in State of the Park reports. Definitions of key terms used in this report are as follows:

Americans with Disabilities Act (ADA)	Law enacted by the federal government that includes provisions to remove barriers that limit a disabled person's ability to engage in normal daily activity in the physical, public environment.
Archeological Sites Management Information System (ASMIS)	The National Park Service's standardized database for the basic registration and management of park prehistoric and historical archeological resources. ASMIS site records contain data on condition, threats and disturbances, site location, date of site discovery and documentation, description, proposed treatments, and management actions for known park archeological sites. It serves as a tool to support improved archeological resources preservation, protection, planning, and decision-making by parks, centers, regional offices, and the national program offices.
Arctic Network (ARCN)	One of 32 I&M networks established as part of the NPS Inventory and Monitoring Program. The Arctic Network provides scientific data and expertise for natural resources in five parks located in Alaska.
Baseline Documentation	Baseline documentation records the physical condition of a structure, object, or landscape at a specific point in time. A baseline provides a starting point against which future changes can be measured.
Carbon Footprint	Carbon footprint is generally defined as the total set of greenhouse gas emissions caused by an organization, event, product, or person.
Cultural Landscapes Inventory (CLI)	A Cultural Landscapes Inventory describes historically significant landscapes within a park. The inventory identifies and documents each landscape's location, size, physical development, condition, characteristics, and features, as well as other information useful to park management.
Cultural Landscape Report (CLR)	A Cultural Landscape Report is the principal treatment document for cultural landscapes and the primary tool for long-term management of those landscapes. It guides management and treatment decisions about a landscape's physical attributes, biotic systems, and use when that use contributes to historical significance.
Curation	National parks are the stewards of numerous types of objects, field notes, publications, maps, artifacts, photographs, and more. The assemblage of these materials comprises a museum collection. Curation is the process of managing, preserving, and safeguarding a collection according to professional museum and archival practices.
Facility Condition Index (FCI)	FCI is the cost of repairing an asset (e.g., a building, road, bridge, or trail) divided by the cost of replacing it. The lower the FCI number, the better the condition of the resource.

Foundation Document	A park Foundation Document summarizes a park's purpose, significance, resources and values, primary interpretive themes, and special mandates. The document identifies a park's unique characteristics and what is most important about a park. The Foundation Document is fundamental to guiding park management and is an important component of a park's General Management Plan.
Fundamental and Other Important Resources and Values	Fundamental resources and values are the particular systems, processes, experiences, scenery, sounds, and other features that are key to achieving the park's purposes and maintaining its significance. Other important resources and values are those attributes that are determined to be particularly important to park management and planning, although they are not central to the park's purpose and significance. These priority resources are identified in the Park Foundation Document and/or General Management Plan. The short-cut name that will be used for this will be Priority Resources.
General Management Plan (GMP)	A General Management Plan is a strategic planning document that outlines the future management of a National Park Service site for the next 15 to 20 years. The plan will set the basic philosophy and broad guidance for management decisions that affect the park's resources and the visitor's experience.
Historic Integrity	Historic Integrity is the assemblage of physical values of a site, building, structure, or object and is a key element in assessing historical value and significance. The assessment of integrity is required to determine the eligibility of a property for listing in the National Register.
Historic Resource Study (HRS)	The historic resource study is the primary document used to identify and manage the historic resources in a park. It is the basis for understanding their significance and interrelationships, a point of departure for development of interpretive plans, and the framework within which additional research should be initiated.
Historic Structures Report (HSR)	The historic structure report is the primary guide to treatment and use of a historic structure and may also be used in managing a prehistoric structure.
Indicator of Condition	A selected subset of components or elements of a Priority Resource that are particularly "information rich" and that represent or "indicate" the overall condition of the Priority Resource. There may be one or several Indicators of Condition for a particular Priority Resource.
Integrated Resource Management Applications (IRMA)	The NPS-wide repository for documents, publications, and data sets that are related to NPS natural and cultural resources.
Interpretation	Interpretation is the explanation of the major features and significance of a park to visitors. Interpretation can include field trips, presentations, exhibits, and publications, as well as informal conversations with park visitors. A key feature of successful interpretation is allowing a person to form his or her own personal connection with the meaning and significance inherent in a resource.
Invasive Species	Invasive species are non-indigenous (or non-native) plants or animals that can spread widely and cause harm to an area, habitat, or bioregion. Invasive species can dominate a region or habitat, out-compete native or beneficial species, and threaten biological diversity.
List of Classified Structures (LCS)	LCS is an inventory system that records and tracks the condition of the approximately 27,000 historic structures listed in the National Register of Historic Places that are the responsibility of NPS.

Museum Collection	NPS is the steward of the largest network of museums in the United States. NPS museum collections document American, tribal, and ethnic histories; park cultural and natural resources; park histories; and other aspects of human experience. Collections are managed by professionally-trained NPS staff, who ensure long-term maintenance of collections in specialized facilities.
Native American Graves Protection and Repatriation Act (NAGPRA)	A federal law passed in 1990. NAGPRA provides a process for museums and federal agencies to return certain Native American cultural items (e.g., human remains, funerary objects, sacred objects, objects of cultural patrimony) to lineal descendants and culturally-affiliated Indian tribes and Native Hawaiian organizations.
Priority Resource or Value	This term refers to the Fundamental and Other Important Resources and Values of a park. These can include natural, cultural, and historic resources as well as opportunities for learning, discovery, and enjoyment. Priority Resources or Values include features that have been identified in park Foundation Documents, as well as other park assets or values that have been developed or recognized over the course of park operations. Priority Resources or Values warrant primary consideration during park planning and management because they are critical to a park's purpose and significance.
Project Management Information System (PMIS)	A servicewide intranet application within the National Park Service to manage information about requests for project funding. It enables parks and NPS offices to submit project proposals to be reviewed, approved, and prioritized at park units, regional directorates, and the Washington Office.
Resource Management	The term "resources" in NPS encompasses the many natural, cultural, historical, or sociological features and assets associated with parks. Resource management includes the knowledge, understanding, and long-term stewardship and preservation of these resources.
Specific Measure of Condition	One or more specific measurements used to quantify or qualitatively evaluate the condition of an Indicator at a particular place and time. There may be one or more Specific Measures of Condition for each Indicator of Condition.
Volunteers In Parks Program (VIP)	The Volunteers In Parks Program was authorized by Public Law 91–357 enacted 1970. The primary purpose of the VIP program is to provide a vehicle through which the National Park Service can accept and utilize voluntary help and services from the public. The major objective of the program is to utilize this voluntary help in such a way that is mutually beneficial to the National Park Service and the volunteer. Volunteers are accepted from the public without regard to race, creed, religion, age, sex, sexual orientation, national origin, or disability.
Western Arctic Parklands (WEAR)	WEAR is a group of 3 remote, Arctic National Park units managed by one team. WEAR includes Cape Krusenstern National Monument, Kobuk Valley National Park, and Noatak National Preserve. Before 2016, the group also included Bering Land Bridge National Preserve, which now has its own dedicated staff.
Wilderness	A designation applied to certain federal lands set aside for preservation and protection in their natural condition, in accordance with the Wilderness Act of 1964.