



Monitoring Small Mammals in Alaska

Central Alaska Inventory and Monitoring Network, Data Quality Standards

Natural Resource Report NPS/CAKN/NRR—2018/1748



ON THE COVER

A northern red-backed vole (*Myodes rutilus*) is captured in Denali National Park and Preserve during the Central Alaska Network long-term monitoring program. This is one of three target species studied in the park.
(NPS/MELANIE FLAMME)

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September 2018

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Schmidt, J. H and M. J. Flamme. 2018. Monitoring small mammals in Alaska: Central Alaska Inventory and Monitoring Network, data quality standards. Natural Resource Report NPS/CAKN/NRR—2018/1748. National Park Service, Fort Collins, Colorado.

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Executive Summary

The purpose of this report is to document the standards used by the National Park Service (NPS) Central Alaska (CAKN) Inventory and Monitoring Network for activities related to the collection, processing, analysis, and publication of Small Mammals monitoring data as described in Small Mammals Monitoring Protocol for the Central Alaska Network (<https://irma.nps.gov/DataStore/Reference/Profile/2219630>, Flamme *et al.* 2018). This plan also serves as a guide for all CAKN personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail. The format and content of this document borrows heavily from Rattenbury and Schmidt (2017).

Acknowledgments

Funding for this project was provided through the National Park Service, Central Alaska Inventory and Monitoring Network. The creation of the protocol narrative involved the contributions of numerous individuals.

Introduction

The purpose of this report is to document the standards used by the Central Alaska Network (CAKN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in Small Mammals Monitoring Protocol for the Central Alaska Network. The policies and procedures documented in this quality-assurance plan for activities follow the quality-assurance plan for other monitoring activities conducted by the CAKN and supplement the National Inventory & Monitoring Division Quality Management Plan. The Standard Operating Procedures provide detailed protocol/program activities associated with Small Mammals monitoring. This plan serves as a guide for all personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

This protocol outlines how monitoring data will be collected, managed and reported for the Small Mammals “Vital Sign”, as part of the NPS Vital Signs Inventory and Monitoring program and as described in the CAKN Monitoring Plan (MacCluskie and Oakley 2005). The study design, data collection methods, and analytical protocols have been previously submitted for publication in peer-reviewed journal (Schmidt *et al.* 2017).

Rationale for Small Mammals Monitoring

The ability to detect and track resource changes over time and to understand the forces driving those changes are fundamental to accomplishing the NPS’s mission of conserving parks unimpaired for future generations (NPS 2006). The CAKN developed its monitoring program to encompass several trophic levels of park ecosystems so that the program would be as robust as possible to detecting change wherever it might occur (MacCluskie and Oakley 2005). Small mammals are useful for long-term monitoring because within Denali’s ecosystems, voles of the genera *Microtus* and *Myodes* consume seeds, fungi and invertebrates, provide a key prey resource for raptors and carnivorous mammals, and play an important ecological role as year-round resident animals by having the ability to influence species above and below them in the food chain (Boonstra *et al.* 2001; Boutin *et al.* 2001). While they are not highly visible in the boreal forest, their collective biomass contributes a larger proportion to the animal community than that of grizzly bears (Boonstra *et al.* 2001). Consequently, changes in the abundance or density of small mammals may subsequently affect the species that prey upon them. From these data and other studies, we know that population dynamics of small mammals may vary with: latitude (Haydon *et al.* 2003), season (Gilbert and Krebs 1991; Stenseth *et al.* 2003), climate (Ims *et al.* 2008), predation (Korpimäki *et al.* 2002; Getz *et al.* 2006), competition (Klemola *et al.* 2002), photoperiod (Halle and Lehmann 1987), age (Boonstra 1994), overgrazing (Klemola *et al.* 2002), density (Stenseth 1999; Schmidt *et al.* 2017), habitat (Getz *et al.* 2006; Reiter and Andersen 2008), plant productivity (Schmidt *et al.* 2017) and year (Bierman *et al.* 2006). However, the drivers for these population fluctuations remain unresolved and highly disputed (see Krebs 1966; Boutin *et al.* 2001; Boonstra and Krebs 2006; Getz *et al.* 2006; Lambin *et al.* 2006; Lima *et al.* 2006; Krebs *et al.* 2012; Schmidt *et al.* 2017). Data from DENA suggest that annual fluctuations in small-mammal populations are strongly related to abiotic factors like weather, climate

and timing of snowfall (Rexstad and Debevec 2008) and biotic factors such as primary productivity (Schmidt *et al.* 2017). Additionally, the relative abundance of small mammal species is directly related to local composition of plant species. Thus, any park-wide changes in weather or plant species composition will likely affect small-mammal composition, distribution and patterns of abundance in populations over time (Bangs 1984; Bierman *et al.* 2006; Getz *et al.* 2006; Hornfeldt *et al.* 1986; Carrier and Krebs 2002; Olofsson *et al.* 2012; Schmidt *et al.* 2017).

Objective

The objective of CAKN Small Mammal monitoring project is to:

- Document long-term trends in small mammal populations on the DENA Rock Creek legacy plots, including temporal patterns of density and abundance and examine vole population cycles of three target species of voles, *Myodes* (formerly *Clethrionomys*) *rutilus*, *Microtus oeconomus* and *Microtus miurus*.

Sampling Design

The original small mammal survey methods were developed in 1992 by USGS, NPS and UAF under the Long-term Ecological Monitoring Program (LTEM) (Rexstad *et al.* 2005). In 2005, the small mammal monitoring was incorporated under new CAKN Vital Signs monitoring program (Oakley and Boudreau 2000; MacCluskie and Oakley 2005). The LTEM Small Mammal protocol (Rexstad *et al.* 2005) was revised over the years 1) to reduce morbidity and mortality of small mammal captures 2) to align with permitting requirements, 3) to increase survey efficiency and feasibility and 4) to update and improve field data collection and analytical methods.

The CAKN Small Mammal monitoring protocol herein is based on the LTEM protocol (Rexstad *et al.* 2005) with modifications adopted from: 1) the ARCN Dall's Sheep (Rattenbury and Schmidt 2017; <https://irma.nps.gov/DataStore/Reference/Profile/2238929>) and Yellow-billed Loon (Flamme *et al.* 2018a; <https://irma.nps.gov/App/Reference/Profile/2216938>) Park Observer protocols (for field data collection on the iPad); and 2) newer analytical methods developed for estimating small mammal density, abundance and distribution (see Schmidt *et al.* 2017). Modifications include:

1. CAKN Small Mammal monitoring utilizes larger field-crew sizes to get animals out of traps more quickly and mitigate trapping morbidity and mortality (for compliance with Institute of Animal Care and Use Committee (IACUC) and other permitting approvals).
2. CAKN Small Mammal monitoring uses plastic trap covers (started in 2010) to reduce morbidity and mortality of both birds (the covers may act as a deterrent) and small mammals (to minimize animals getting wet and hypothermic over overheated in the traps). This is for compliance with IACUC and other permitting approvals and to enhance live-trapping population estimates. NPS IACUC can be found at: <https://www.nps.gov/orgs/1103/iacuc.htm>.
3. CAKN Small Mammal monitoring has reduced the sampling area and schedule to just one session at the end of summer (targeting the week of August 12) at the four Rock Creek legacy plots as a compromise between cost and adequate survey frequency. This short, one-time sampling window supports assumptions of population closure for the analytical methods used and is sufficient to assess vole abundance, density and assess population cycles (see Schmidt *et al.* 2017, and Data Analysis SOP 10 for details).
4. CAKN Small Mammal monitoring has adopted Park Observer (enterprise data collection app developed by NPS) protocols (data sheets) on the iPad for field data collection, based on the ARCN Dall's Sheep (Rattenbury and Schmidt 2017) and Yellow-billed Loon (Flamme *et al.* 2018) SOPs. Software and hardware used for previous field computers have become obsolete.
5. CAKN Small Mammal monitoring has updated analytical methods. See SOP 10 and Schmidt *et al.* 2017 for additional details on analysis procedures. The mark-recapture data generated from live-trapping of three target species of voles was used to estimate population abundance and density and assess population cycles. We used spatially-explicit capture-recapture models (Royle and Dorazio 2008; Efford *et al.* 2009; Borchers 2012; Efford and Fewster 2013, Royle *et al.* 2014) fit in a Bayesian hierarchical framework (e.g., Royle and Young 2008; Gardner *et al.* 2009, 2010; Royle *et al.* 2009).

Site Selection

In the early 1990s, DENA was selected as a prototype park to develop and test methods for monitoring in subarctic parks under the Long-term Ecological Monitoring program (LTEM, now I&M program) (Oakley *et al.* 1999; Roland *et al.* 2003). In the original study design for DENA, detection of change in key characteristics of vegetation and animal communities in the park was the fundamental objective. Five representative watersheds spread throughout the park were selected for the original sampling design. Rock Creek, located close to DENA headquarters and in the front country (not wilderness) was administratively and economically feasible for sampling and co-locating monitoring (e.g vegetation, birds, small mammals, weather).

The CAKN Small Mammal monitoring program was started as one prototype study of the original LTEM programs, and it persists to this day under the National Park Service's current nationwide Long-Term Inventory and Monitoring Program. Small mammals have been monitored at the four Rock Creek legacy plots from 1992-2018 (Figure 1). Two of these four plots, RF1 and RR2, have been sampled continuously from 1992-2018 (Table 1).

Table 1. Years of trapping (1992-2018) at each Rock Creek legacy plot during Central Alaska Network Small Mammal monitoring in Denali National Park and Preserve, Alaska, U.S.A. From 1992-2004, sampling occurred multiple times and throughout the summer. From 2005-2018^a, sampling occurred once annually in August.

Sampling Location	Years Sampled	Distance to Rock Creek	Trapping Configuration	No. Plots	No. Traps Deployed
Rock Creek (RF1)	1992-2018 ^a	~500 m	10x10 m square	1	100
Rock Creek (RF2)	1997-2003, 2005-2018 ^a	~500 m	10x10 m square	1	100
Rock Creek (RR1)	1992- 1993, 1997-2018 ^a	~300 m	10x10 m square	1	100
Rock Creek (RR2)	1992-2018 ^a	~200 m	10x10 m square	1	100

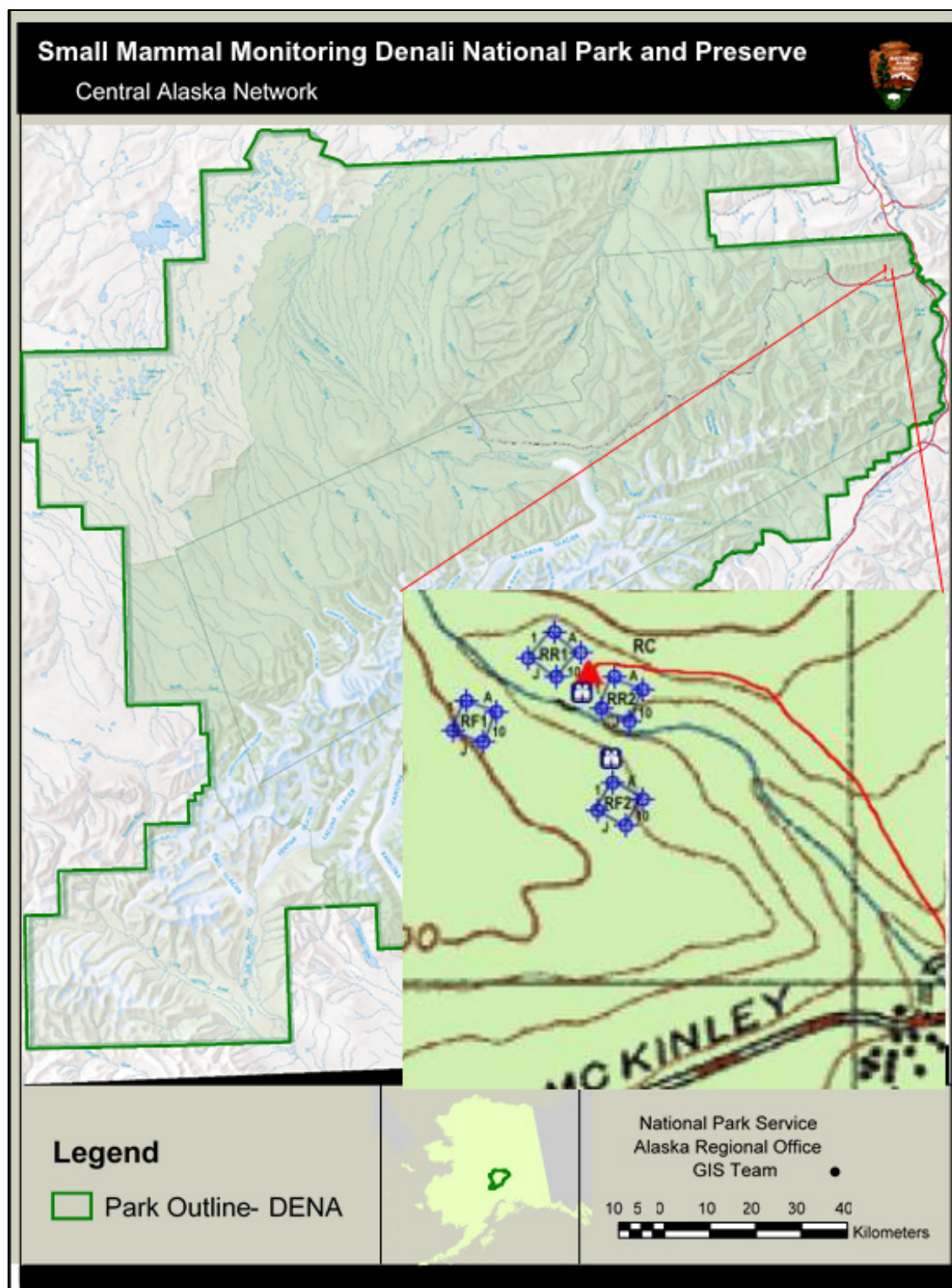


Figure 1. The Central Alaska Network Small Mammal monitoring program has occurred in Denali National Park and Preserve, Alaska, U.S.A., from 1992-2018. The red dot denotes the location of the Rock Creek legacy plots within the park. The expanded inset shows the four Rock Creek legacy plots, RR1, RR2, RF1 and RF2, in relation one another, the Rock Creek trail (curved red line), Rock Creek (blue line) and to the park road (red and white line).

Rock Creek Legacy Plots

The long-term survey area occurs on four, ~.08 ha Rock Creek legacy plots located at 63°43'46.94"N 148°58'41.68"W (Figure 1; Rexstad *et al.* 2005). Rock Creek intersects mile three of the park road. The four plots are located along Rock Creek (elevation 2400 ft.) and are approximately 1.5 km north of the park road. The plots are accessed via a 30-minute walk along the Rock Creek park trail and moose trails that traverse the eastern ridge above Rock Creek. Two of the plots, (RR1 and RR2) are in riparian habitat and the other two (RF1 and RF2) are on the forested west ridge overlooking Rock Creek. The plots are named such that the first letter represents the watershed (i.e. “R” is for Rock Creek) and the second letter represents the habitat type of the plot (i.e. “R” for riparian and “F” for forested). Habitat on the plots represents a typical boreal forest with a mix of dwarf birch and willow, wild grasses, sphagnum, and various berries with mixed black, white, aspen and popular forest stands. A map of the four Rock Creek plots is shown in Figure 1.

Sampling Methods

Trapping methods follow those outlined in the protocol developed during the LTEM pilot work (Rexstad 1996; Rexstad *et al.* 2005) and the CAKN monitoring program (Schmidt *et al.* 2017). Each of the four Rock Creek plots is a 10m x 10m square grid, approximately 0.8ha in area, containing 100 Sherman live-traps placed 10m apart. All trap locations are permanently marked with subtle metal tags denoting the name of each trapping plot and trap location identification (e.g. plot RR1, trap 1B) so traps can be placed within 1 m of the same location each year. During the trapping week, flagging marks each trap location so traps can be quickly located and accurately identified. The temporary flags are labeled with the exact trap location to mitigate errors in trap identification. Further, because trap line trails are also used by moose and are circuitous, entire trap lines of 10 traps (e.g. line 1, traps A-J; line 2, traps A-J; line 3, traps A-J) are labeled alternately with either blue or pink flagging so field technicians can easily follow and stay on the correct trap line. Flagging in this way prevents accidental sampling of traps on adjacent lines. Pink and blue flagging are used because foliage begins to change color in DENA in August and other colors, such as orange, yellow, green and red become difficult to distinguish from vegetation. Flagging is removed after the survey week but the metal tags remain to re-establish trapping plots in subsequent years.

We conduct field work for one week, including travel to and from DENA, training, camp and plot set up, sampling, and camp and plot break down. The crew camps on site for the week to increase sampling efficiency and mitigate trapping mortalities. Sampling begins on a Monday and concludes on a Sunday, with sampling days occurring Tuesday evening through Saturday evening (Table 2). All camping and scientific equipment is backpacked into the plots on Monday. Four hundred Sherman live traps are deployed on the four Rock Creek Legacy plots (Furtsch 1995; Rexstad 1996; Rexstad *et al.* 2005; Schmidt *et al.* 2017) on Tuesday. Traps are baited with irradiated sunflower seeds (microwaved to prevent germination) and biodegradable cotton bedding (nestlets). Biodegradable bedding, such as cotton nestlets and down feathers, is preferable to synthetic bedding because it will not leave debris in the park if stolen by birds and squirrels. Further, synthetic bedding, such as batting used in pillows, poses a choking hazard for the animals when they shred it by mouth to make a nest. Traps are covered with plastic trap covers to protect them from the rain and sun and are

checked 3 times per day (0600hrs, 1300hrs and 2000hrs) to minimize mortalities. By the end of the four-day sampling period, 4800 trap checks are conducted [(400 traps x 3 checks x 4 days).

Table 2. Weekly sampling schedule for Small Mammal monitoring in DENA.

Mon	Tues	Wed	Thur	Fri	Sat	Sun
Drive to DENA	Training	Trap check 0600	Trap check 0600	Trap check 0600	Trap check 0600	Pull traps
Training	Set up plots x2	Trap check 1300	Trap check 1300	Trap check 1300	Trap check 1300	Break camp
Haul gear (2-3 trips)	Set traps x4 plots	Trap check 2000	Trap check 2000	Trap check 2000	Trap check 2000	Haul gear (2-3 trips)
Set up camp	Open traps 2000	–	–	–	Close and pull traps	
Set up plots x2	–	–	–	–	–	Drive to FAI

Small mammal populations, including three target species of voles (northern red-backed vole, *Myodes* [formerly *Clethrionomys*] *rutilus*; tundra vole, *Microtus oeconomus*; and singing vole, *Microtus miurus*) are sampled using mark-recapture methods via live-trapping techniques. Non-target species, such as shrews (*Sorex sp.*), weasels and squirrels are identified to species and released. When animals are captured, individuals are scanned for a tag, identified by sex and species, and weighed and checked for parasites and reproductive status. Unmarked target individuals, are implanted subcutaneously near the shoulder blades with passive integrated transponder (PIT) tags (about the size of a grain of rice). Once implanted, animals are scanned for their unique, 10 to 15-character, alphanumeric identification code and released. Data are error-checked in the field and PIT tag codes are verified against an inventory list to prevent typographical errors and ensure data integrity.

Monitoring Schedule

The Central Alaska Network Small Mammal Monitoring has occurred annually from 1992-2018. All four of the Rock Creek plots are scheduled to be sampled annually and in perpetuity. Since 2005, the survey has targeted the week of August 12 so monitoring occurs approximately at the same time each fall. This is the time of year when annual densities are expected to be highest after a summer's worth of reproduction but before inclement winter weather diminishes the population.

Data Quality Objectives

This section is intended to demonstrate how this project generates data of known and documented quality, resulting in complete, accurate and transferable information.

Representativeness and Data Comparability

We will use spatially-explicit capture-recapture models (Royle and Dorazio 2008; Efford *et al.* 2009; Borchers 2012; Efford and Fewster 2013) fit in a Bayesian hierarchical framework (e.g., Royle and Young 2008; Gardner *et al.* 2009, 2010; Royle *et al.* 2009) for data analysis. Spatially-explicit capture-recapture models are considered to be the standard approach for analyzing datasets such as ours, and the basic underlying theory is well developed (Royle and Young 2008; Gardner *et al.* 2009; Efford and Fewster 2013; Royle *et al.* 2014). Spatially-explicit capture-recapture approaches utilize the locations of recaptures to estimate the activity center of each individual, while also addressing the decline in detection probability with distance of the activity center from each trap (Royle and Young 2008; Gardner *et al.* 2009; Efford and Fewster 2013). This straightforward combination of the process and detection models allows the direct estimation of abundance or density within the sampling area without requiring the concept of the somewhat ambiguous effective trapping area (Efford and Fewster 2013). Data augmentation (Royle *et al.* 2007) is employed to address the problem of an unknown number of activity centers within the sample area (Gardner *et al.* 2010).

The once annual sampling rotation targeting the end of the summer is sufficient to detect trends local density and abundance patterns. Preliminary results suggest estimator precision will be sufficient to meet study objectives (see Schmidt *et al.* 2017).

Completeness

If surveys are unable to be completed in a scheduled year due to funding or logistical issues, they will be attempted in the next year if possible to provide density and abundance information. Although completing surveys on all plots is desirable, it is not required. Due to the flexibility of the analytical framework, valid estimates can still be produced if some plots are not surveyed. That said, at some point, incomplete coverage becomes a problem. Consultation with a biometrician is considered necessary if >25% of plots remain uncompleted at the end of the survey period. The biometrician must use expert judgement to determine proper inference when surveys are incomplete.

Measurement Quality Objectives and Performance Standards

Field measurement quality objectives are outlined in Table 3.

Table 3. Field observation measurement quality objectives for the CAKN small mammal monitoring protocol.

Measure / Quality Indicator	Quality Objective
Location accuracy	+/- 1 m (horizontal), no standards for vertical accuracy
Species ID	Observers must mutually agree on the species

Table 3 (continued). Field observation measurement quality objectives for the CAKN small mammal monitoring protocol.

Measure / Quality Indicator	Quality Objective
Abundance	Spatially-explicit capture-recapture models (SOP 10, Schmidt <i>et al.</i> 2017)
Density	Spatially-explicit capture-recapture models (SOP 10, Schmidt <i>et al.</i> 2017)

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NPS 953/148503, September 2018

National Park Service
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