



Informal Trail Status Along the Denali National Park Road Corridor 2012–2013

Natural Resource Data Series NPS/DENA/NRDS—2014/687



ON THE COVER

Braided section of informal trail near Eielson Visitor Center
NPS Photo by D. Abbe

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Natural Resource Data Series NPS/DENA/NRDS—2014/687

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Abstract

The Denali National Park Backcountry Management staff surveyed the north and south sides of the Park road corridor for informal trails (ITs) in 2012 and 2013. The purpose of this effort was to identify current conditions along the road corridor, discuss potential management actions regarding these areas, and prioritize areas of concern.

Data was collected using the *Informal Trail Monitoring Protocols: Denali National Park and Preserve*, developed by Dr. Jeff Marion and Jeremy Wimpey of Virginia Technological Institute. The Access Survey, Census Survey and Line Transect Survey methods from this protocol were used.

In 2012 a total of 204 informal trails south of the road were mapped and 119 along the north side in 2013. In addition to a spatial distribution, more specific data were collected in 2013 to gather information on whether or not ITs continued on from the road corridor to reach the Wilderness boundary or beyond. Point assessment data were recorded including trail width, soil incision, total incision, % vegetation cover on trail, % vegetation cover off trail, % bare soil on trail, % bare soil off trail and tread problems. These data are used to compare change over time and will be analyzed in the future.

For this monitoring effort, trail networks in 14 Backcountry Management Units along the road corridor were mapped and 12 specific areas were prioritized for management actions.

Acknowledgements

This report would not have been possible without the efforts of a small group of dedicated individuals. Informal Trails have long been an issue at Denali first recognized by John Dalle-Molle and Joe Van Horn in the mid-1970s. They began the process of documenting impacts. In the 1990s Elaine Furbish continued this work and began incorporating global position system (GPS) and global information system (GIS) mapping techniques to document informal trails. Many backcountry rangers began collecting GPS data on patrols starting in the late 1990s under the direction of Joe Van Horn. A concerted effort to document informal trails that start along the Denali Park Road was begun in 2011 and completed in 2013. Rangers Alonzo Mandanna, Sarah Hayes, and Sam Hooper utilized the protocols developed by Dr. Jeff Marion and Jeremy Wimpey (2011) to collect and process data on informal trails along the Denali Road. It was necessary to refine and adjust some of the protocols. Sarah, Sam, and Alonzo did an outstanding job insuring that adjusted protocols produced the highest quality data with the most relevance for Park management. Sam also developed and used GIS software to analyze some of the data. Alonzo Mandanna provided valuable input to insure the quality of this report, including much patience with editing maps using ArcGIS. Without their efforts this report would not have been possible.

Dan Ostrowski and Molly McKinley, Denali National Park & Preserve Trails, provided practical knowledge on trail development, maintenance, and visitor behaviors. A thank you to Andrew Ackerman for the day hiker use density map. Other Park staff helped in a variety of ways and the authors acknowledge this was truly an interdisciplinary effort demonstrating the commitment and quality of the Park's staff and partners.

Introduction

Informal trails (ITs) also known as social trails, are unmaintained trails used by visitors for the purpose of traveling through different terrain features and vegetation types to reach a destination. These trails are of concern to land managers when their numbers and use levels increase causing significant damage to the vegetation, soils or area. ITs are often less sustainable than their formal trail counterparts, because they lack professional design and construction and lack subsequent maintenance (Marion and Wimpey 2011). Unaddressed, many of these sites become points of erosion, vegetation trampling, trail proliferation, and a possible detriment to archeological or other sensitive areas.

The purpose of this report is to present the current state of knowledge about informal trails accessed from the Denali Park road; compare this current data with and past conditions and identify trends; and to make management recommendations for specific areas of concern.

Study Area

Denali National Park and Preserve is predominantly a wilderness park, including over six million acres of land. The park's "frontcountry" consists of developments limited primarily to the park headquarters area, the Kantishna Mining District, and an interconnecting park road providing the primary means of visitor access to the park. This 92-mile park road has a 300ft wide corridor with several wider development nodes. The first 15 miles of the road is paved, while the remainder is graveled. A limited number of formal trails are provided within the frontcountry portions of the park. A "no formal trails" policy discourages formal and informal trails in the backcountry and wilderness portions of the park "to preserve the unique wilderness character and wilderness experience" (NPS 2006a). Exceptions have been made to provide visitor opportunities at major visitor nodes or to address resource damage (Marion and Wimpey 2011).

Private vehicles are allowed access along the paved section of the road, but are restricted on the unpaved portion. A concession-operated Visitor Transportation System (VTS) provides visitor access on the remainder of the road through a shuttle bus/tour bus system. In addition, privately-owned lodges in the Kantishna area are permitted to operate shuttle and tour busses on the park road.

The primary visitor activity in Denali is a shuttle or tour bus ride along the park road. Busses stop at developed rest areas and the shuttle busses also stop at Eielson Visitor Center, road corridor campgrounds, and at other locations requested by day and overnight hikers. Visitor trampling impacts to vegetation and soils occur at places along the park road wherever visitor use is concentrated, primarily at these developed rest areas, campgrounds and visitor center. (Marion and Wimpey 2011).

To address these problem areas and assess impacts the informal trails study of 2012–2013, conducted by rangers, took place in this road corridor between mile post 3 and mile post 88 and along the south and north sides of the Park Road (Figure 1).

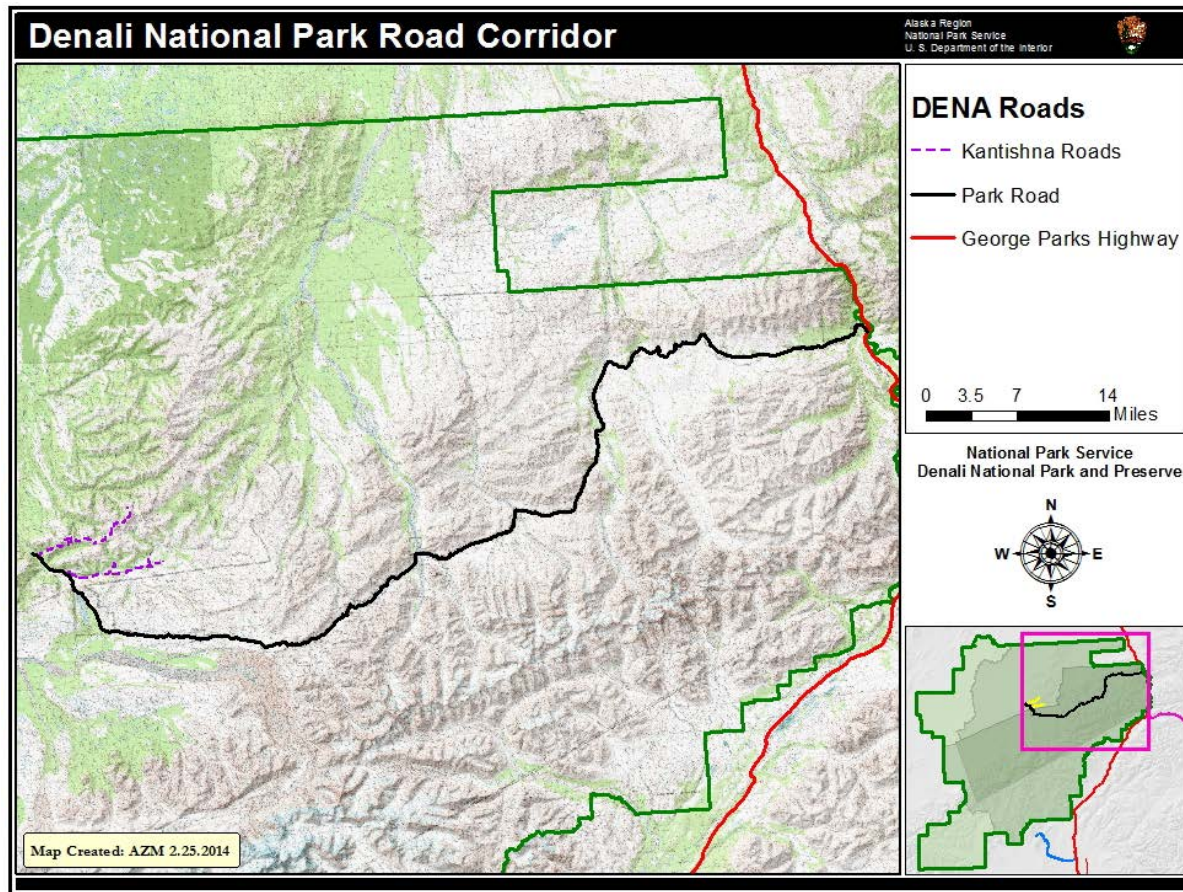


Figure 1. Map of the northeastern portion of Denali national park showing the Denali Park Road and topography. The Park Road provides access to the majority of dayhiking and backpacking use in the park and hence has the most issues with informal trails.

Park Policy

Denali National Park intends to maintain primarily a “no formal trails” policy for the designated Denali Wilderness area. Certain trails near the park entrance and the short loop trails along the park road corridor address crowded/busy areas and will be maintained for continued use. The decision to build and maintain these trails passed through the publically involved-decision making process. (NPS 2008 pg. 65) Visitor activity has been concentrated within the non-wilderness road corridor through the private vehicle restrictions and the Visitor Transportation System. Several trails such as: Savage Alpine Trail, Savage Loop Trail, Thorofare Alpine Trail and Polychrome Rest Stop to name a few, are within this area or that have trailheads within this area, have been designated as developed trails and are maintained by the park. Outside of these areas, park management has attempted to disperse visitor activity. No trails have been designated or maintained in these areas and visitors are encouraged to disperse when hiking. (Furbish 1996).

The purpose of this report is to summarize the informal trail data from 2012 and 2013, identify current conditions along the road corridor, discuss potential management actions regarding these areas, and prioritize areas of concern.

Backcountry Management Plan

The Backcountry Management Plan of 1976 incorporated the concept of Limits of Acceptable Change (LAC) and this concept continues to guide current backcountry management policies and programs. The LAC process formulated objectives for the factors critical to natural resource and sociological values that define the wilderness opportunity in an area. These objectives described the point at which the change in each of these factors was unacceptable. The following objectives which were used in the 1976 plan which are of particular importance to informal trail development are vegetation and soils. The LAC guidance is as follows: 1) Vegetation: Loss of vegetative cover, or damage to roots or aerial portions of trees and shrubs, due to trail or campsite formation or other human recreational activity should not exceed that which can be regenerated by natural processes by the following year. Extensive animal trails do exist in many areas, but vegetation loss due to human recreational use should not cause measurable changes in the character of animal trails. This includes widening, deepening, connecting, or multiplying these trails, or creating new trails. 2) Soils: Human recreational use can cause slumping of river cut banks, soil compaction and erosion on steep slopes. These processes should not adversely affect plant vigor, community composition or structure due to loss of soil or changes in density, nutrient qualities or moisture of the soil. (Van Horn 2011).

Denali National Park's Backcountry Management Plan of 2006 has created specific management areas each of which reflects an overall management concept or vision and provides for a related set of opportunities in the backcountry. Each area is defined by a set of desired current resource and social conditions. Allocation of management areas is a prescriptive process that describes the desired condition rather than the existing condition. (NPS 2006a pg 34). In this Management Plan trail disturbance was selected as a resource condition indicator. The road corridor through the Park falls under the Backcountry Day Use area and many of the ITs which have developed there continue on to cross into Management Area OP1 (Figure 2). In Management Area OP1 (the Old Park section 1) the trail disturbance indicator is medium (visitors notice occasional social trails, campsites, or cut or broken vegetation) (NPS 2006a). According to the BCMP the "Medium" descriptor is intended to match conditions in the Old Park in areas accessible from the park road corridor.

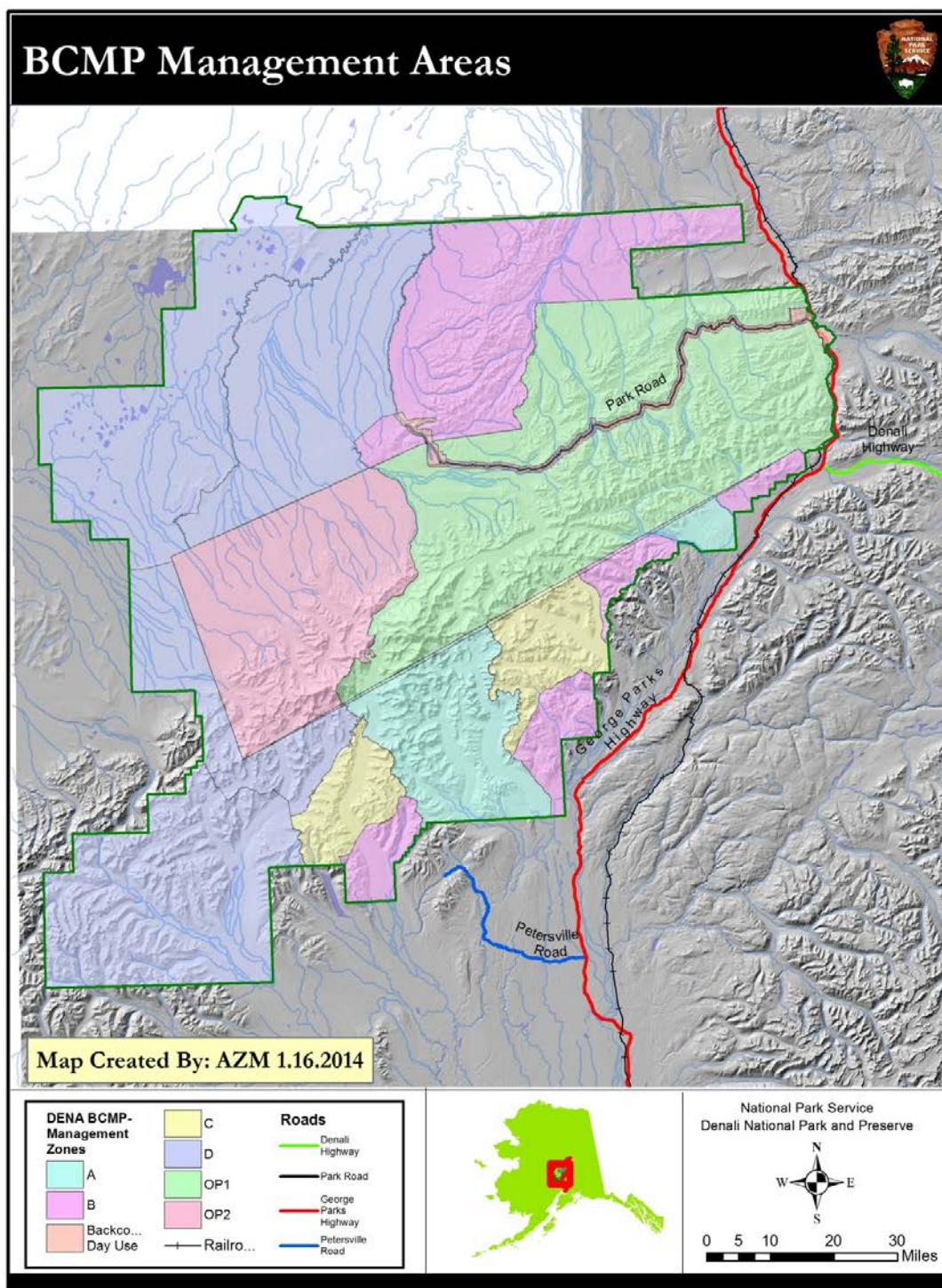


Figure 2. Management areas as delineated by Denali's 2006 Backcountry Management Plan (BCMP). For an explanation of the areas see Table 1, page 32 of the summarized Backcountry Management Plan (NPS 2006b).

While the BCMP does stipulate the “no formal trails” policy, which plan along with the Final Entrance Area and Road Corridor Development Concept Plan (NPS 1996) do also allow for a few formal trails in high traffic Backcountry areas, if needed. In addition the BCMP states that the National Park Service would designate Backcountry Hiker areas along these trail corridors:

1. Some existing social trails within units 41, 42, and 43 in Kantishna formalizing a trail system in this area
2. From Eielson Visitor Center to Gorge Creek
3. A loop from the water tower above Wonder Lake Campground up to the bench west of Wonder Lake and return
4. From the Mount Healy overlook down a spur ridge to create a loop to the Taiga Trail
5. From the west end of Thorofare Bluffs down to the Thorofare River bar
6. Triple Lakes trail (7 miles) with footbridge connecting to the Riley Creek Campground area (upgrade and relocate as needed).
7. A loop trail system in the Savage River area that includes a $\frac{1}{4}$ - $\frac{1}{2}$ mile loop located downstream (north) of the parking lot and bus stop. A longer loop extending about 1 mile downstream with a footbridge for the 1 mile return on the opposite side of the river. The trail downstream could possibly incorporate the historic horse trail.
8. A trail up the ridge to the east of the Savage River parking lot. This trail would connect to hiking trails extending to the top of the ridge and connecting to the Savage River campground (Mountain Vista Rest Area).
9. A $\frac{1}{4}$ - $\frac{1}{2}$ mile accessible loop trail at Primrose pullout.
10. A 1 mile loop trail to the ridge north of Eielson Visitor Center.
11. A $\frac{1}{4}$ - $\frac{1}{2}$ mile loop trail at each of the proposed Savage and Toklat rest areas.
12. A $\frac{1}{4}$ mile river access trail at the Teklanika rest stop.
13. McKinley Bar trail from Wonder Lake campground access road to the river (upgrade and relocate this 2 mile trail as needed).

To date most of the trails above have seen construction/hardening except 1, 2, 4, 5, 9, and 12.

Informal Trail Development and Management

Many factors contribute to the development of ITs. While overnight backcountry use is limited by a permit system, day hiking is unrestricted. Where the shuttle bus system limits road traffic, it concentrates visitor use along the road corridor and increases the potential for greater hiking activity in this area. ITs which have been established will see continued use and since they are unmanaged may degrade over time. Day hiking is likely a significant contribution to reshaping animal trails near the road into informal human use trails (Van Horn 2011). Guidebooks have contributed to the

creation of new informal trail impacts by giving extremely specific information on where to leave the park road (i.e. Waits 2010).

Management actions have the ability to remove informal trail and restore to a more nature condition heavily impacted areas, or even develop formal trails, potentially increasing the area of impact. Management may also close an area permanently or temporarily. They could open a section of road to private vehicle use which may generate a higher number of day-hiker impacts.

History of Past Monitoring Efforts

Since the mid 1970's with improved access to the northeastern quarter of Denali National Park through the completion of the George Parks Highway and the shuttle bus system along the Park road, ITs have developed and become a concern for managers. The need for monitoring areas of the road corridor for IT development was recognized and many efforts have been made to do so.

1976 - Inventory and monitoring of the extent and condition of informal trails was begun in 1976 by the backcountry ranger staff and later continued in the 1980's by Resource Manager John Dalle Molle and Biological Technician Joe Van Horn (Van Horn 2011). Established social trails were named, mapped, described in narrative form (including descriptive factors to be used for assessing impact levels), and photographs were taken to document conditions. (Furbish 1996).

1995 - Another comprehensive park-wide effort initiated in 1995 by Resource Manager Elaine Furbish. Known as the Trail and Nodes Monitoring Program it applied trail condition measurements in a three-tiered monitoring system designed to:

1. Detect the creation of new impacted areas, including trails and various other sites impacted by foot traffic within the road corridor
2. Evaluate the condition of all impacted areas through application of standardized monitoring procedures
3. Monitor changes in conditions at selected locations, particularly those with substantial impact or having historical significance. (Van Horn 2011).

Late 1990s-2010 – Backcountry ranger patrol reports and field observations provide another source of information on informal trail formation patterns over the years. While mainly anecdotal and only approximately mapped, this information does give some indications where informal trails may have changed in the very remote areas of the backcountry over the last 20-30 years. It is also useful for determining where the near road informal trails begin to dissipate as use drops off away from the park road. (Van Horn 2011).

2011 – New procedures that utilize improved GPS technology for monitoring informal trails were developed during a three year effort ending in 2011. Dr. Jeff Marion of Virginia Technological Institute worked with park staff to prepare a comprehensive monitoring approach. (Van Horn 2011). The protocol that developed from this study will be summarized in the Methods section of this report as it was used to gather data for the present IT monitoring effort.

Visitor Use Patterns

Although the amount of use each IT receives is difficult to determine, general patterns of use are known from several sources including Backcountry Use Permits (BUPs), a visitor survey of day hikers and backpackers (Fix 2011), NPS staff record keeping of Discovery Hikes, administrative use (i.e. science fieldwork, backcountry patrols), and some limited data on guided hikes (Abbe and Burrows 2014). Along the Park Road, VTS buses drop visitors off along any section of road they are asked but hiker numbers and destinations are not recorded. The Park has asked VTS bus drivers to drop hikers off in areas where there are durable soils - gravel drainage's or dryer areas. It is believed this management practice has helped to reduce the development of social trails and should be continued.

The Backcountry Information Center issues BUPs during the summer season (May – September). The number of BUPs issued for visitors backpacking in Denali National Park and Preserve is a subset of total backcountry overnight use. However, BUPs are issued to the majority of those accessing the backcountry from the Park Road corridor. Thus, it is an effective management tool to track most of the backpacking use in the Wilderness and backcountry of the Park. Over the last ten years there is a downward trend in the number of BUPs issued from a high of 2,384 in 2002 to a low of 1,512 in 2009. Since 2009 use appears stable. (Figure 3).

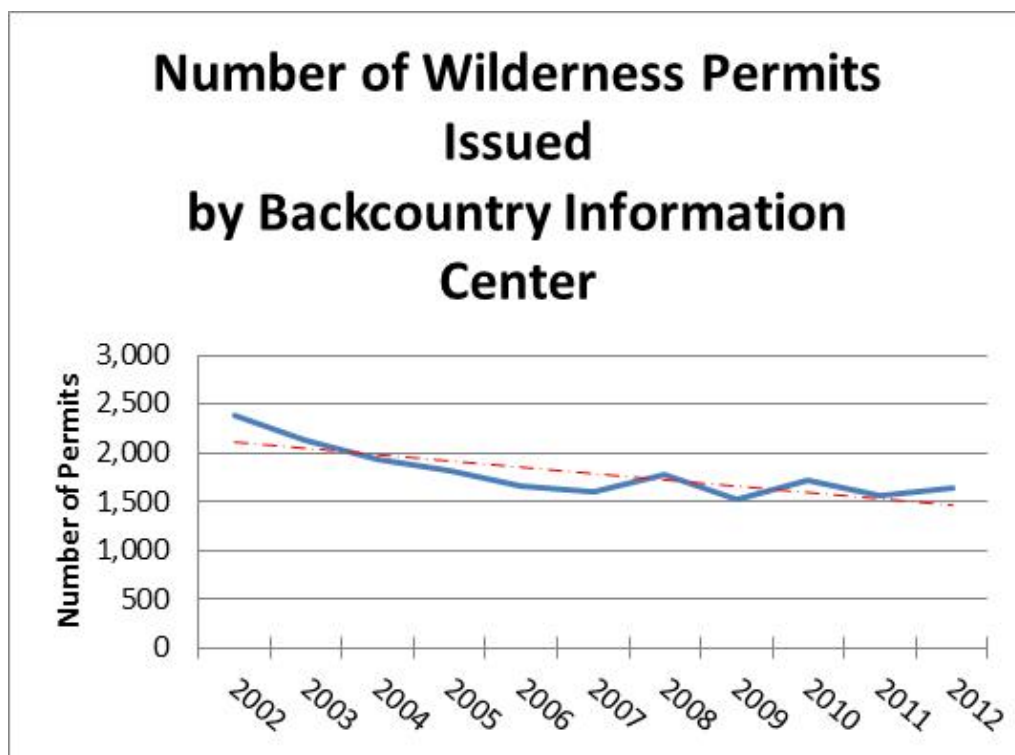


Figure 3. Number of wilderness permits issued by Backcountry Information Center.

The number of day hikers are less well known than for overnight users, however they are more numerous than overnight users. Day user groups include 1) independent day hikers either using the VTS or their own vehicle (in the entrance area and to mile 15 on the Park Road only); 2) A substantial number of non-commercial guided hikes for educational use (Discovery Hikes and Murie Science and Learning Center field seminars); and 3) commercially guided hikes.

Discovery hikes are off-trail day hikes led by an NPS interpretive ranger with up to 12 people. These are popular with visitors and fill mostly to capacity throughout each summer (Figure 4). NOTE: the large jump in numbers in 2010 is due to an increase in the number of hikes per day from 1 to 2. (NPS 2012).

Spatial patterns of visitor use are beginning to emerge but not reported here. Some of the patterns are reported in Fix (2011) and Abbe and Burrows (2014). Watch future reports for results and analysis of spatial patterns of hiker use along the Denali Park Road corridor.

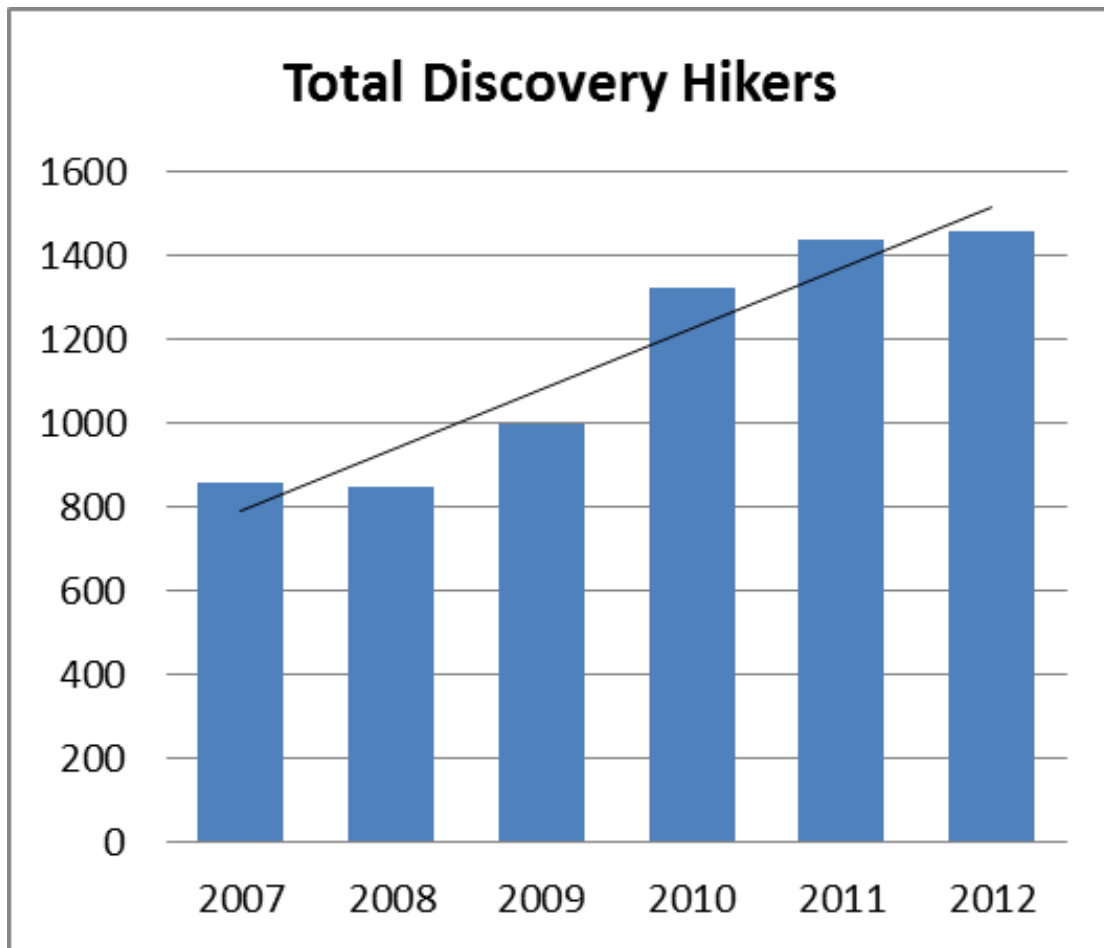


Figure 4. Total Discovery Hikers. Note that the upward trend is primarily due to the NPS offering 2 hikes per day starting in 2010 (From at least the late 70's until 2004 two discos were offered per day. In 2004-2006 and 2009 there were one or two per day (two every other day or so). In 2010 it went back to the model that occurred until 2004.). A hike is limited to 12 total participants including the leader.

Methods

In 2011 Dr. Jeff Marion and Jeremy Wimpey of Virginia Technological Institute completed the report *Informal Trail Monitoring Protocols: Denali National Park and Preserve*. They together with park staff developed a comprehensive monitoring approach for informal trails in Denali. This research did face a number of challenges: 1) protocols had to be flexible and highly efficient due to limited staffing and budgets, 2) traditional trail survey methods have been developed for single, well-used/discerned, continuous trails, rather than lightly used, discontinuous, braided trail networks, (as seen in Denali) and 3) some wildlife create trails that can be confused with visitor-created trails. (Marion and Wimpey 2011). To address these challenges they developed a “toolbox” of IT monitoring protocols, allowing managers and field workers to select from these only those trail survey options and indicators that address their information needs, which may additionally vary by management zone. (Marion and Wimpey 2011). The survey methods described below are a result of their research.

During the summer of 2012 seasonal resource rangers Alonzo Mandanna and Sarah Hayes tested and applied the new monitoring protocols. After reviewing these protocols they decided to revise them to better meet Park needs. Two survey types from the protocol were employed in 2012 the Access and Census based surveys. These were put into effect along the south side of the Park Road. The Access Survey was more broadly used and the Census Survey employed in areas of heavy use. In 2013 the Access, Census, and Line Transect surveys were used along the north side of the Park Road.

Monitoring Protocols

Three types of surveys are outlined below: access, census, and line transect. These surveys use a common set of measurements mapped and recorded with a Trimble GPS with sub-meter accuracy in order to document IT conditions in time and space:

- Mapping the path of the trail tread.
- Point assessments document conditions of the trail in a very small length of the trail tread (at a “point” on the trail). Observations include: trail width, maximum vegetation and soil incision, vegetation cover on- and off-trail, bare soil on- and off-trail, and the presence of tread problems like muddiness or active soil erosion. A point assessment can be used at any point of interest (trail intersections, problem areas, etc.) or at predetermined points (determined, by a grid, regular intervals on the trail, or randomly located).
- These methods also utilize photo documentation. Cameras were used to create a photographic log of the current state of impact at point assessments and other points of interest.
- GPS data are post-processed by using GPS Pathfinder, ArcMap and GPS Photolink, and imported along with attribute and digital photographs into ArcGIS geodatabase files for further analysis and archiving. (Mandanna and Hayes, 2012).

Access Survey

This survey method documents the number and distribution of ITs that intersect a road or formal trail corridor. This is an efficient survey method that can be conducted quickly but doesn’t provide information on trail alignments or destinations. The GPS with sub-meter accuracy is used for this survey to obtain accurate spatial data on IT trailheads and to efficiently enter and transfer optional

point assessment data. At 150 feet, or the wilderness boundary, condition assessment data are recorded and a point logged.

The Access Survey method was used in 2012 along the south side of the park road between mile marker 3, at the HQ flagpole, and mile marker 88 at the old park/new park sign. Points were logged where social trails exited from the road and also 20 feet down each trail. At the 20 foot mark, condition assessment data were collected. In 2013 this survey was conducted along the north side of the park road also between mile markers 3 and 88. Again points were logged as in 2012 where trails exited from the road, but were then extended to 150 feet down the trail, where it meets the wilderness boundary. This better indicates what trails are extending into the wilderness and the potential concerns that come with that.

Census Survey

This survey method documents the location, spatial distribution, and lineal extent of all visually obvious ITs judged to be predominantly human use. (Marion and Wimpey 2011). The GPS with sub-meter accuracy is used to log a line along an IT, from its beginning until it fades out of sight. Where additional trails intersect with the main trail a point is logged to map that trail junction, and comments written to describe the intersecting trail (wildlife trail, predominantly human use trail, etc.). Additionally these intersecting trails or any parallel trails in the area are mapped in the same manner. Point assessments can be conducted at the trail intersection points, at predetermined random or regularly spaced points and/or at any other point of interest.

In 2012 the census method was applied to areas of high impact and through the backcountry units south of the park road, 1-15, 18-20 (Mandanna and Hayes, 2012). In 2013, this survey was conducted in units north of the park road.

Line Transect Survey

This survey method finds and documents the number, location, and condition of ITs in areas where there are (or likely to be) several braided and/or parallel trails. One or more line transects are established roughly perpendicular to the anticipated direction of travel. All well-defined ITs that intersect with each transect are inventoried as point features, with point assessment measurements..

In 2013 the line transect survey was used along with the census survey to gain a complete picture of the extent of IT development in several areas.

Results

Access Survey

The following data show the number of ITs found in 2012 and 2013 while conducting the Access Survey along the park road. Table 1 and Figure 5 below show the density of trails by backcountry unit. The length of the road contiguous with each backcountry unit was measured, and a ratio of the number of trails to this length was calculated. In the maps each unit is represented by a buffer along the road to illustrate that the impacts documented (or lack thereof). This is for illustrative purposes only and do not reflect resource conditions throughout the entire backcountry unit, but are focused along the road corridor (Mandanna and Hooper, 2013).

Table 1. Total trails per mile by Backcountry Unit.

BC Unit Name	BC Unit	Length of Road (mi)	Total Count	Total Trails per Mile of Road
Jenny Creek	3	12.4	14	1.13
Upper Savage	4	6.5	21	3.23
Upper Sanctuary	5	7.7	9	1.17
Upper Teklanika	6	11.8	34	2.88
Upper East Fork	7	5.0	1	0.20
Polychrome Glaciers	8	6.6	17	2.58
East Branch Upper Toklat	9	3.2	2	0.62
West Branch Upper Toklat	10	1.4	2	1.47
Stony Dome	11	8.6	5	0.58
Sunset/Sunrise Glaciers	12	2.9	4	1.37
Mount Eielson	13	5.3	9	1.70
McKinley Bar East	14	11.5	30	2.61
Mount Healy	24	7.3	6	0.83
Healy Ridge	25	7.5	13	1.74
Primrose Ridge	26	5.6	14	2.49
Mount Wright	27	5.1	9	1.77
Sushana River	28	2.3	4	1.74
Igloo Mountain	29	13.9	16	1.15
Tributary Creek	30	1.7	1	0.59
Polychrome Mountain	31	9.3	17	1.84
Middle Toklat	32	12	2	1.72
Stony Hill	33	12.2	9	0.74
Mount Galen	34	5.3	9	1.69
Moose Creek	35	7.5	6	0.80
Jumbo Creek	36	9.1	12	1.32

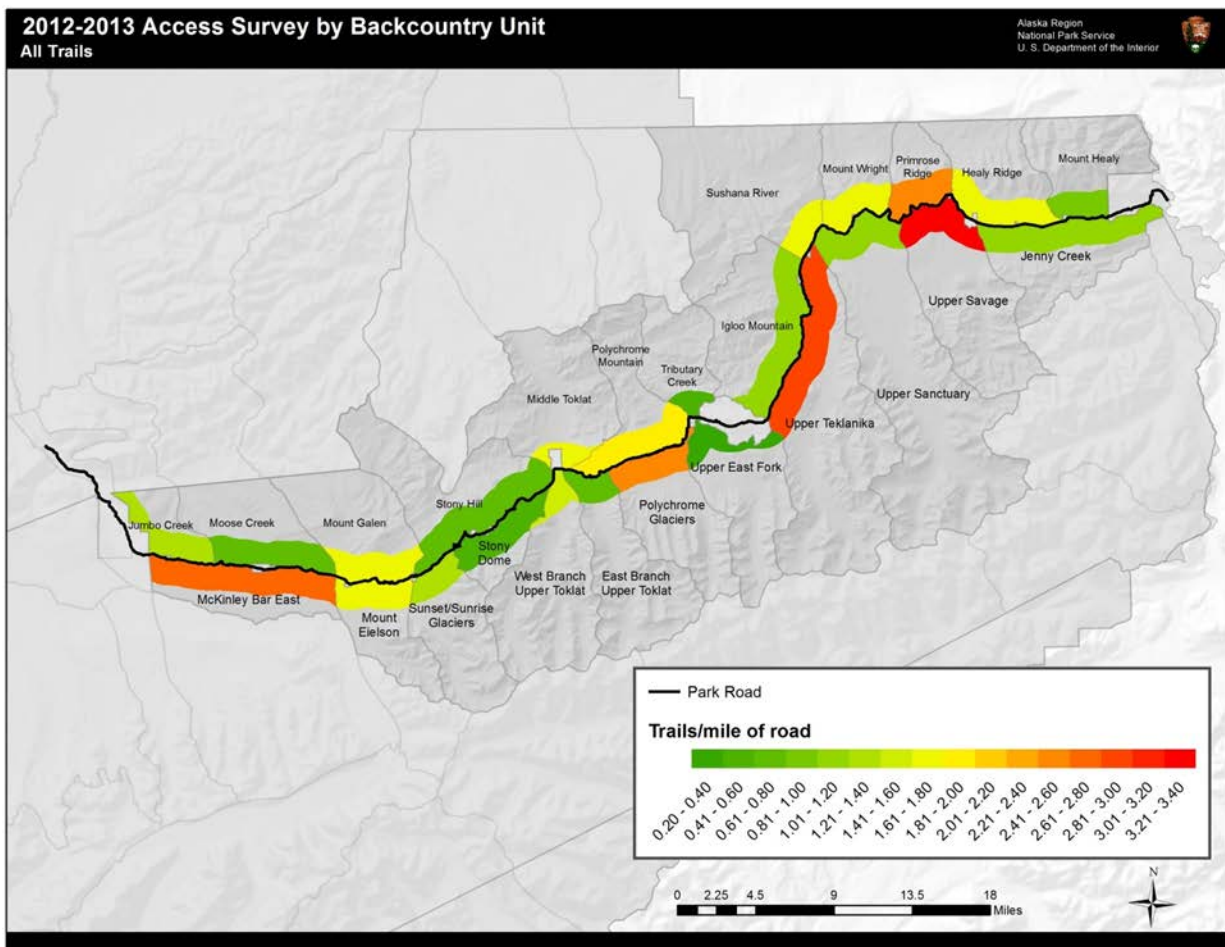


Figure 5. Results of the access survey by backcountry unit showing the density of trailheads along the road segments bordering each backcountry unit.

Figure 6 shows the density of trails per mile of road. More trails were documented on the south side of the road than the north side. In 2012, a total of 204 trails south of the road were mapped whereas only 119 were mapped on the north side in 2013. These included those with multiple trails radiating from a single access point. At locations with high densities of trails (e.g. campgrounds, rest areas, and pullouts), more trails were found south of road. This is to be expected considering vegetation, terrain, and the number of destination features like glaciers on the south side. (NPS unpublished data 2013).

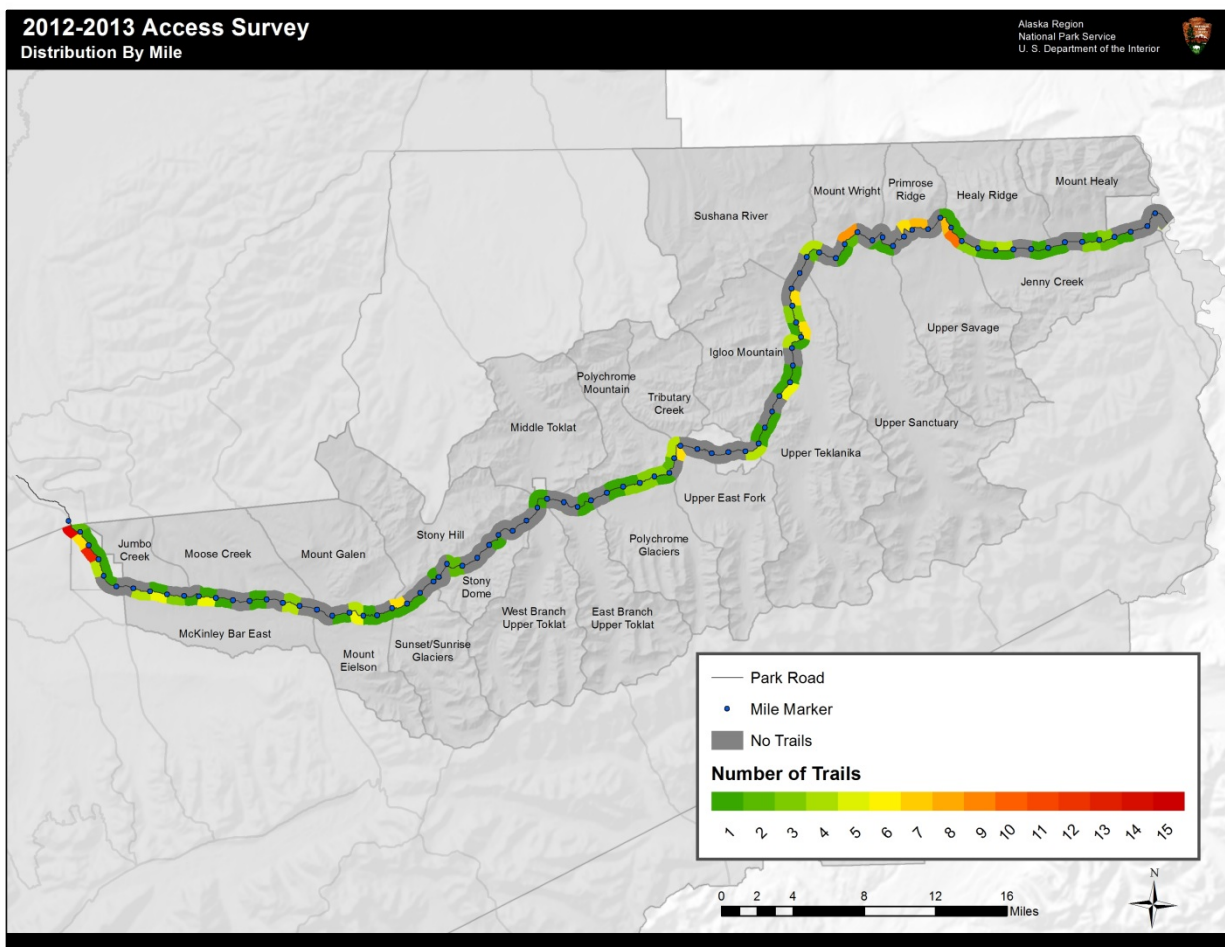


Figure 6. 2012 -2013 Access Survey, density of trails per mile of road.

In addition to spatial distribution, other data were collected in 2013 to gather more specific information about the extent of informal trails. Specifically, a trail was mapped until it either stopped or it reached the Wilderness boundary 150 feet from the Park Road (Figure 7 Figure 8, Table 2). This was the only significant departure from the protocol from 2012. Essentially, this allowed for a more detailed view of social trail formation; trails that extend further away from the road and potentially create larger impact were separated from those that cease after only a short distance. Potential areas of higher impact became more visible, and more focused monitoring effort can be conducted at these locations in the future. Furthermore, this method was adopted after the Access Survey had been completed for miles 3-15, so data for this section of the road could only be included in analysis of the distribution of total trails. (Mandanna and Hooper 2013).

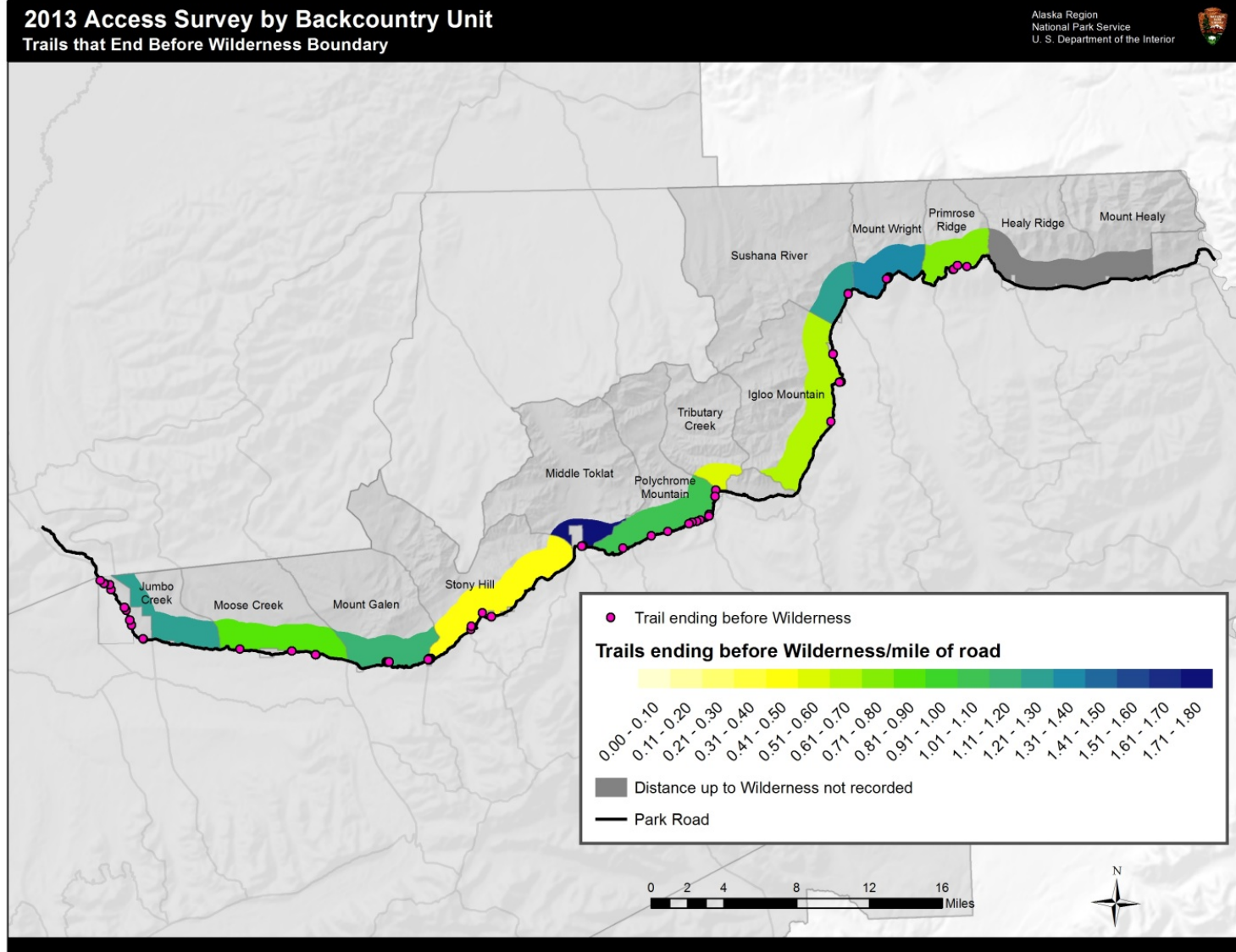


Figure 7. Trails ending before wilderness boundary per mile of road (by backcountry unit road segment).

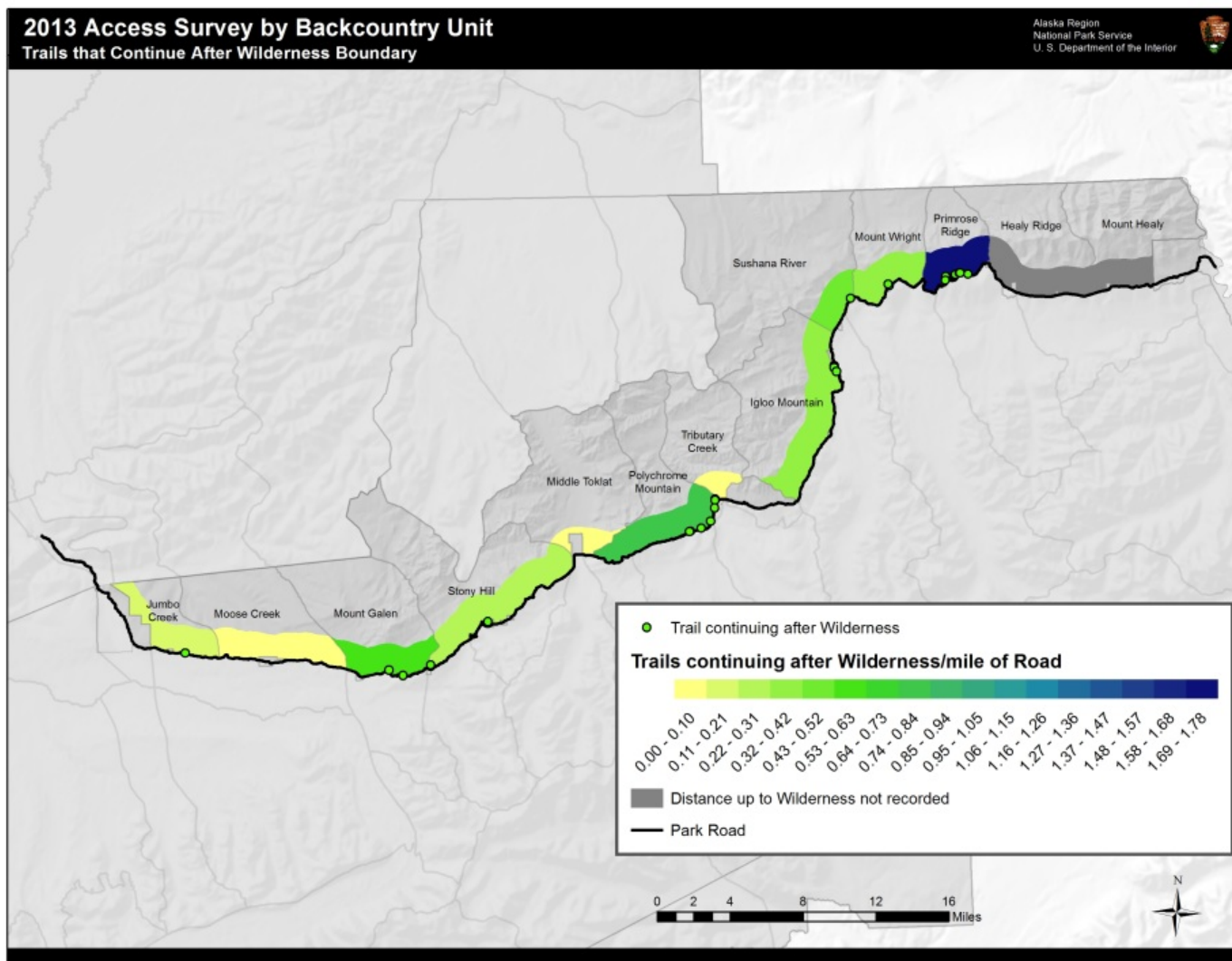


Figure 8. Trails continuing after wilderness boundary per mile of road (by backcountry unit road segment).

Table 2. Trails ending or continuing past Wilderness Boundary per mile of road.

BC Unit	Length of Road (mi)	Total Trails	Ending Before	Continuing After	Extent Not Recorded*	Total Trails/mi	Trails Ending/mi	Trails Continuing/mi
24	7.3	6	N	0	6	0.83	0.00	0.00
25	7.5	13	0	0	13	1.74	0.00	0.00
26	5.6	14	4	10	0	2.49	0.71	1.78
27	5.1	9	7	2	0	1.77	1.38	0.39
28	2.3	4	3	1	0	1.74	1.30	0.43
29	13.9	16	9	5	2	1.15	0.65	0.36
30	1.7	1	1	0	0	0.59	0.59	0.00
31	9.3	17	10	7	0	1.84	1.08	0.76
32	1.2	2	2	0	0	1.72	1.72	0.00
33	12.2	9	6	3	0	0.74	0.49	0.25
34	5.3	9	6	3	0	1.69	1.13	0.56
35	7.5	6	6	0	0	0.80	0.80	0.00
36	9.1	12	11	1	0	1.32	1.21	0.11

Census Survey

The aim of the Census Survey was to be able to document more completely those trail networks determined to be of significant concern based on field observations or from discussions with backcountry monitoring staff, trail crew or rangers. Point assessment data were also recorded along these trail segments. Information gathered includes trail width, soil incision, total incision, % vegetation on trail, % vegetation off trail, and tread problems. The purpose of the point assessment data is to compare change over time at fixed easy to return to points on the trails.

Table 3 below shows the areas mapped, the total length of trails found, and if previously surveyed with mapping grade GPS, the difference in length over time.

Table 3. Backcountry Unit and Total Length of ITs mapped so far in each unit.

Trail Network Name	BC Unit Name	BC Unit	2013 Length (ft)	2012 Length (ft)	Previous Length (ft)	Difference
Sanctuary	Upper Sanctuary	5			5124**	
Cathedral – main trail	Upper Teklanika	6		8918	7363*	1555
Cathedral – side trails	Upper Teklanika	6		6582		
Cathedral NE	Upper Teklanika	6	1,936			
Igloo Bridge SR	Upper Teklanika	6	2,327			
West Branch Toklat	West Branch Toklat	10		6597		
Upper West Stony Creek	Stony Dome	11		5944	5544*	400
Fish (Krier) Creek	Stony Dome	11		2709	2057*	652
Upper Stony Creek E	Stony Dome	11	2,796			
Gorge Creek	Sunset/Sunrise	12		20,164		
Grassy View Overlook	Mount Eielson	13		4216	1583*	2633
Grassy Pass	Mount Eielson	13	2,181		1,609*	572
Thorofare Cabin/Govt. Draw	McKinley Bar East	13	7,295			
McGonagall Pass	McGonagall Pass	20		n/a	82,613*	
Primrose Rest Area NR	Primrose Ridge	26	10,928		9,097***	1,831
Igloo Bridge NR	Igloo Mountain	29	997			
Igloo Mountain East	Igloo Mountain	29	3,602			
Tattler Creek	Igloo Mountain	29	18,010		19,359***	-1,349*****
East Fork Bridge NR	Tributary Creek	30	1,678			
Polychrome East NR	Polychrome Mountain	31	5,986			
Polychrome Rest Area NR	Polychrome Mountain	31	11,350			
Polychrome West NR	Polychrome Mountain	31	3,132			
Cabin Peak	Middle Toklat	32		320		
Cabin Creek	Middle Toklat	32	5,112			
Lower Stony Creek	Stony Hill	33	14,640			
Moose Creek Access Trail	Mount Galen	34	1,616			
Thorofare Ridge	Mount Galen	34	6,039			

* Documented in 1997.

**Documented in 2007.

***Documented in 2010.

****Documented in 2011.

*****not all trails may have been mapped due to malfunctioning equipment.

Not all data of previous length was useable due to differences in collection methods.

Figures D1 through D14 show the location of each trail network by backcountry unit. These are included in Appendix D at the end of this paper.

In addition to total change in length from a census survey, a new GIS analysis method was developed by Sam Hooper in 2013 to illustrate specific trail segment that have changed in usage/impacts since the last survey. The analysis needs a set of surveys that have been mapped with a high degree of spatial accuracy, thus will become more useful in the future. In addition the person doing the mapping needs to be fastidious in checking for changes while mapping in the field. Two areas lend themselves to this analysis: Primrose Ridge (Figure 9) and Tattler Creek (Figure 10) (Mandanna and Hooper 2013). The GIS analysis compares a previously mapped census survey with a recent census survey and detects segments of the trail network that have faded (not detectable during the most recent survey) and those that have newly formed (detected during the most recent survey but not at the previous).

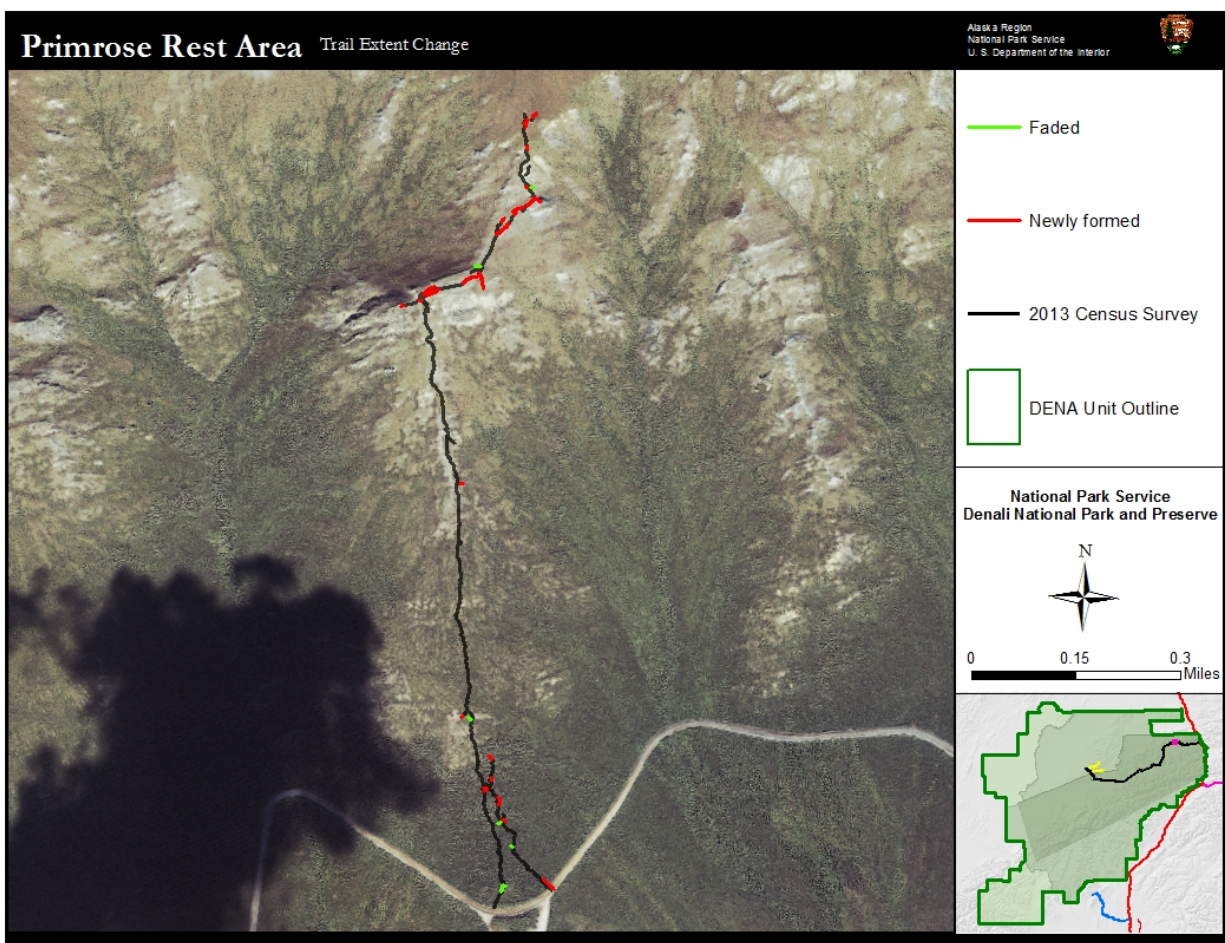


Figure 9. Trail extent change from 2010 to 2013 on Primrose Ridge, near Primrose rest area. The black 2013 census survey line is trail that was mapped both in both years.

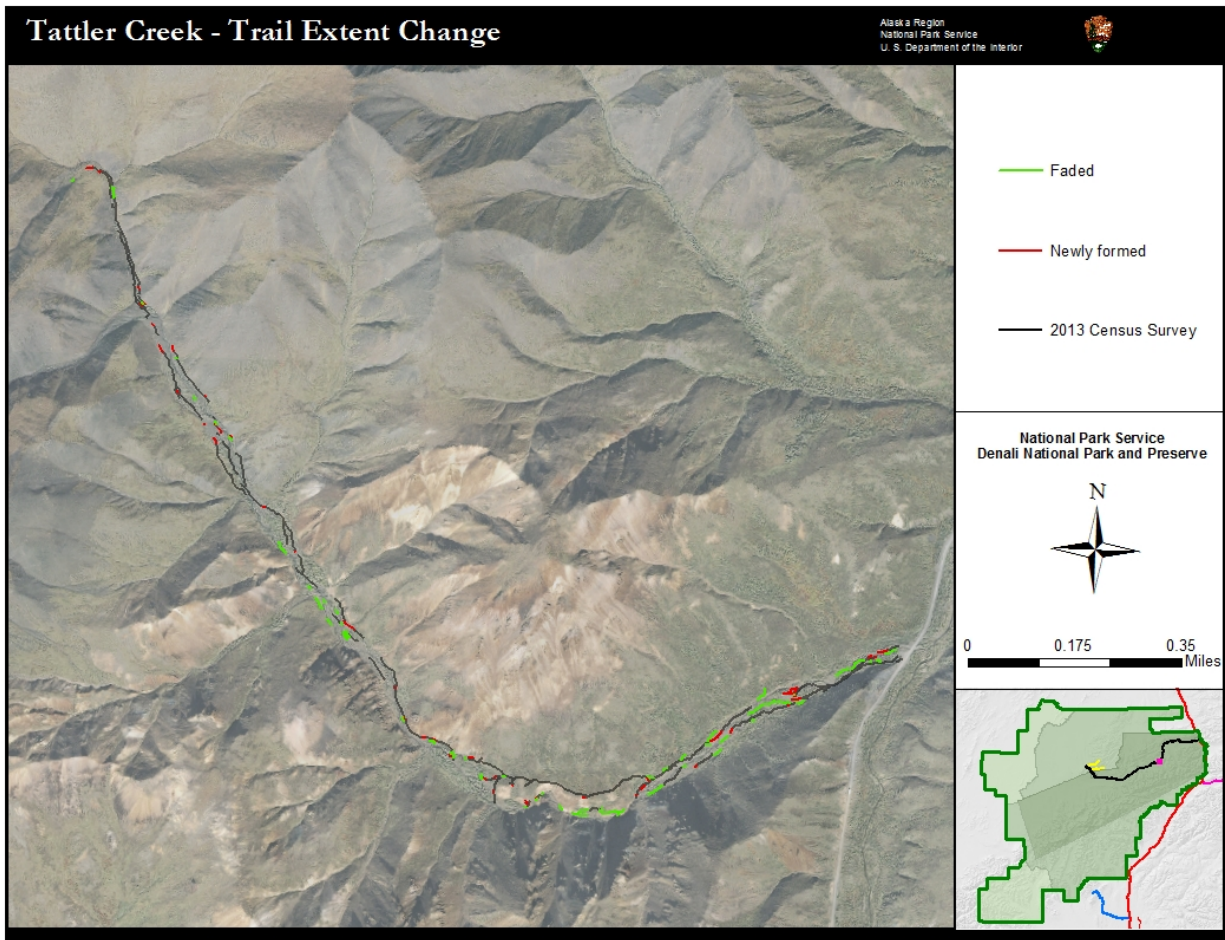


Figure 10. Trail extent change 2010 to 2013, Tattler Creek. The black 2013 census survey line is trail that was mapped both in both years. **There is some uncertainty in the 2013 survey because of GPS malfunction, thus this particular map should be used with caution.** A 2014 season field effort will tie up these loose ends.

Management Tools for Addressing Informal Trails

As the road corridor is surveyed and areas of concern start becoming more apparent managers need guidelines to address all levels of informal trail formation. These can be found in the Denali National Park and Preserve Backcountry Management Plan – Final EIS as follows:

“To prevent vegetation damage and social trail formation, the National Park Service would take the following actions:

1. Apply the Access Management tools (Appendix A of this report) specified for the situations described in Appendix B of this report (Decision Guide for Addressing Social Trail Formation).
2. Establish a social trails working group consisting of NPS staff, guided hiking concessioners, Murie Science and Learning center staff and associated non-profit partners, and commercial services that conduct guided hiking and/or provide access to the backcountry (by shuttle bus and air taxi). This group would address specific problem areas through coordinated action.
3. Develop Leave-No-Trace guidelines that are specific for Denali National Park and Preserve in consultation with the internal working group, NPS resource managers, and the Murie Science and Learning Center.” (NPS 2006a pg. 48).

Also, a more detailed hierarchy of Management actions is suggested where the least amount of action is taken to reduce or repair impact to an area and a greater degree of action is taken as needed to address higher impact areas. See the examples below:

Management Actions

Low Degree of Action

Informal Education – have visitor and resource protection and interpretive rangers guide people away from ITs. Have bus drivers talk to visitors as they drop them off along the road and encourage them to disperse while hiking or to use already formed trails, whichever is decided on to be the best alternative for each specific area. Apparently bus drivers used to take an active role in IT education and somewhere along the way their efforts diminished. (pers. com., NPS, E. Lynn, Assistant Superintendent - Operations). Bus drivers have daily contact with visitors and are often the only ‘park’ contact visitors’ encounter. They are an excellent resource to reestablish the importance of an IT message and should be included in discussions.

Formal Education – The National Park Service would provide printed material, public presentations, targeted presentations to user groups, and Internet-based programs, with the goal of actively involving visitors in helping the park achieve the standards for all management areas. (NPS 2006a pg. 47).

Higher Degrees of Actions

Signage – In order to keep visitors from using certain ITs “No Tread” signs have been used to encourage people to “stay off.” This has seen mixed results and may be more effective with ranger presence. Other signs directing visitors to formal trails may guide people away from ITs. Creating

interpretive signs informing visitors of the damage done by ITs and placing these signs in areas of IT development may have a direct influence on visitor behavior.

Rehabilitation of social trails - There are many examples of short spurs of social trails that have been either closed or abandoned (in an effort to re-route). Examples include social trails around the MSLC, the old Rock Creek Trail behind the Maintenance Buildings, Triple Lakes' old alignment, the face above Savage Rock, and Polychrome-area trails.

The outcome of these efforts is varied. The old Triple Lakes alignment is shut-down, not being used by hikers, and re-vegetating nicely in many locations. Other trails, are not as successfully closed such as in cases where the old alignment is the most direct route to a destination. (pers. Com. NPS M. McKinley, Trails Volunteer Coordinator).

Construct formal trails - Since 2007 there has been an increase in the number of miles of official trail maintained and its associated infrastructure (bridges, boardwalk, and signing) within the Denali Wilderness. This can be attributed to both new trail construction and to bringing non-maintained trails up to an acceptable standard. As a general rule, Denali has had a “no formal trails” policy. However, in heavily impacted areas showing vegetation trampling, development of bare ground, soil compaction, erosion, and social trail development, formalized trails have mitigated impacts and better protected park resources. (NPS 2012).

Enforcement – Temporary or permanent closures may be enforced in areas where revegetation efforts are in progress or in areas which may be able to return to a natural state with the absence of use. Decisions can be made after monitoring these areas on future use levels.

Once management actions are taken for an area, the next step is to set up a monitoring schedule. Again the Backcountry Management Plan guides managers here. Social trails are a resource indicator and as such monitoring would occur on a continuous basis at three levels (from BCMP Appendix C):

1. The use of an existing grid system of plots for monitoring changes in vegetation cover that are randomly distributed through the park and preserve,
2. A set of index sites where known social trail or campsite formation can be monitored, and
3. A random sample of additional locations selected each year. (NPS 2006a pg. 39).

Numbers 2 and 3 would be more practical for social trails originating from the road.

Discussion & Conclusion

Looking at the data collected by the Access Survey it is apparent that there are places along the road where ITs are in high concentration (Figure 11). These areas include Upper Savage, Upper Teklanika, McKinley Bar East, Wonder Lake area to the south, Primrose Ridge, Mt. Wright, Polychrome, and Mt. Galen. These areas should continue to be monitored, adding census work to those trails found south of the road, and possibly closing access to areas where trail networks are too extensive or have significant muddiness or erosion problems.

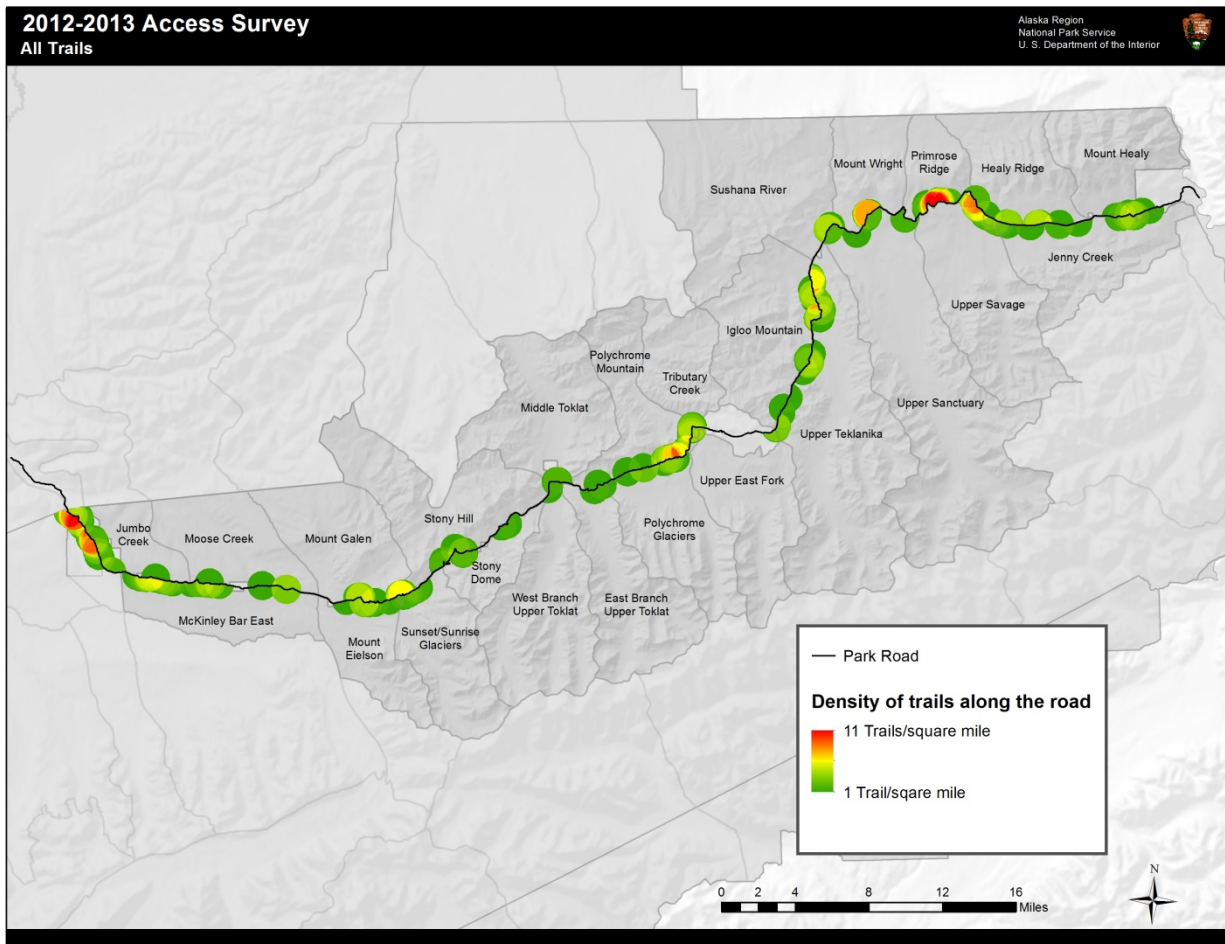


Figure 11. Density of trails along the park road.

After reviewing the data gathered with the Census and Line Transect Surveys, and discussions with Park staff, areas were prioritized for management action according to the level of impacts and degree of visitor use. The highest priority areas were those that showed unacceptable resource degradation as identified in the BCMP (NPS 2006a pg. 49) and consistently high levels of visitor use. These are listed in Table 4 and will be discussed below in order of highest priority.

Table 4. List of Informal Trail Areas and their priority rating.

INFORMAL TRAIL AREA	PRIORITY
Gorge Creek	High
Polychrome	High
Grassy Pass/Grassy View	High
Cathedral Mountain Trail	Medium-High
Thorofare Ridge Trail	Medium
Tattler Creek	Medium
Cabin Creek/Cabin Peak	Medium
Primrose	Medium
Thorofare Cabin Trail	Low
Upper West Toklat Trail	Low
Upper Stony Creek Trail	Low
Lower Stony Creek Trail	Low

Gorge Creek Trail Network at Eielson Visitor Center

This is a high priority area and impacts have been recognized since the early 1970's. Gorge Creek ITs were mapped in 1997 and in 2012. Although a portion of the trail network mapped in 1997 has been formalized and hardened to create the Tundra Trail loop, ITs in this area have expanded to reach a total length of 20,164 ft. Gorge Creek has one of the worst levels of soil loss observed by trail monitoring staff anywhere throughout the Park (Figure 12 and cover photo). Some locations have ruts approximately 3 feet deep and mud with depths of 6-12". (Mandanna and Hooper, 2013)

Gorge Creek is an area identified for possible trail construction in management plans and such work is currently in the planning stages. A field trip lead by Dan Ostrowski and Molly McKinley was organized in June of 2013 in an effort to share information with all management staff and gather ideas for solutions to this problem area. Some ideas and possible solutions that came out of this field trip are discussed below.

The 'Gorge Creek Trail' is identified on park signs (Figure 12.) and leads hikers off the Tundra Trail down toward the wilderness boundary. This section is currently eroded and braided so finding a way to provide better drainage and limit it to a single tread would reduce impacts and better protect the area (Figure 13.). If this section of trail were to be hardened, the route of the trail was discussed and a potential solution was created. Use of the social trail, with water drainage construction added, to where it drops off the high bench and then reroute the informal trail to the east into the willows and form switchbacks down to the floodplain. This would eliminate the steep section (Figure 14.) which could be rehabilitated.



Figure 12. Photos of Gorge Creek trail sign.



Figure 13. Photo of eroded and braided section of Gorge Creek Trail.



Figure 14. Photo of steep section of Gorge Creek informal trail.

An additional popular route and impacted area off the Tundra Trail is to a viewpoint knob about halfway down the west set of social trails. A possible solution here is to harden a single trail to this area and build a rock overlook at the viewpoint to keep people from enlarging the footprint of impact.

Another problem discussed is the fact that current 'restoration' signing is not effective (Figure 15.) and examples of people stepping over signs to use social trails was witnessed. Some possible solutions here may be to construct an interpretive sign explaining the problem of social trails, education of visitors by NPS staff and bus drivers to use only designated trails, random but frequent patrols by Rangers (General, Interpretive, and LE) to remind people to stay on the trails, more aggressive 'restoration' efforts to include rehab/disguising and more aggressively signing 'Stay Off' of social trails.



Figure 15. Photo of trail continuing past no tread sign.

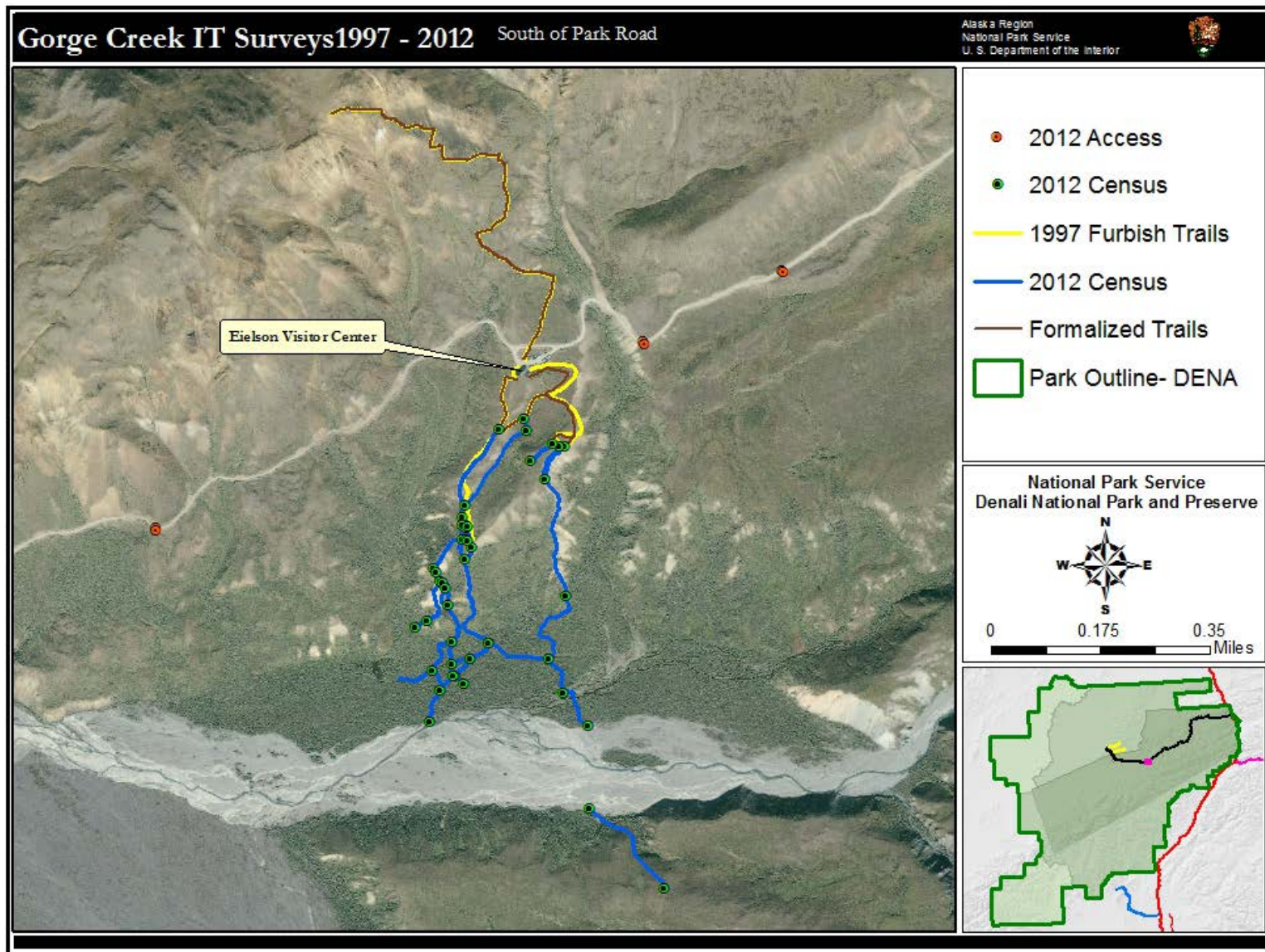


Figure 16. Gorge Creek IT Surveys 1997 – 2012.

Polychrome

The Polychrome IT network was mapped in 1997, 2011, and 2013 with reports of these trails being present as early as the 1970's. The Polychrome rest area, on the north side of the road is a popular place for buses to stop and give passengers time to take photographs and stretch their legs. Anecdotal information from Park staff and bus drivers indicate that even after the chemical toilets were removed visitor use has not decreased. This area is popular for its scenic views and photographic opportunities. In addition, bus drivers use this as a staging area so as not to overcrowd the narrow section of road to the west.

From mapping efforts we know the main trails generally converge in the direction of the shallow pond north of the rest area (Figure 17). A linear trail continues past the lake for about ½ mile. Another spur leads toward the ridge northwest of the rest area, but stops shortly after a brushy drainage. Nearly all of the trails within a 1/4 mile of the formalized trails are highly developed with little to no vegetation cover remaining. (NPS unpublished data 2013). The potential for expansion in this area is high due to the popularity of the area as a scenic bus stop and short rest break and the inclusion in published hiking routes. (Waits, 2010).

This Polychrome area is of high concern and has been discussed in depth by DENA Trail crew, Backcountry District Rangers, and Resource staff to find short and long term solutions. In the short term it was decided that trail crew would replace the "Restoration Area" signs that are missing and possibly make them a little higher off the ground to be more noticeable and serve as a minor physical barrier. It was also suggested to strategically place rocks in areas to delineate the formal trail more clearly.

Long term strategies to address the impacts being observed could include:

- harden some of the informal trails such as the prominent knoll to the east of the stairs and extend some of the trails that lead away from the rest area;
- ask bus drivers to deliver an education message about informal trail development and negative impacts that can occur reinforcing the importance of staying on established trails;
- place interpretive/informational signs about informal trails and the importance of staying on established trails;
- more aggressively manage visitor use by limiting bus numbers and/or duration allowed to stop in the area;
- although problematic after discussions with trail crew, restoration and re-vegetation of informal trails to discourage continued use.

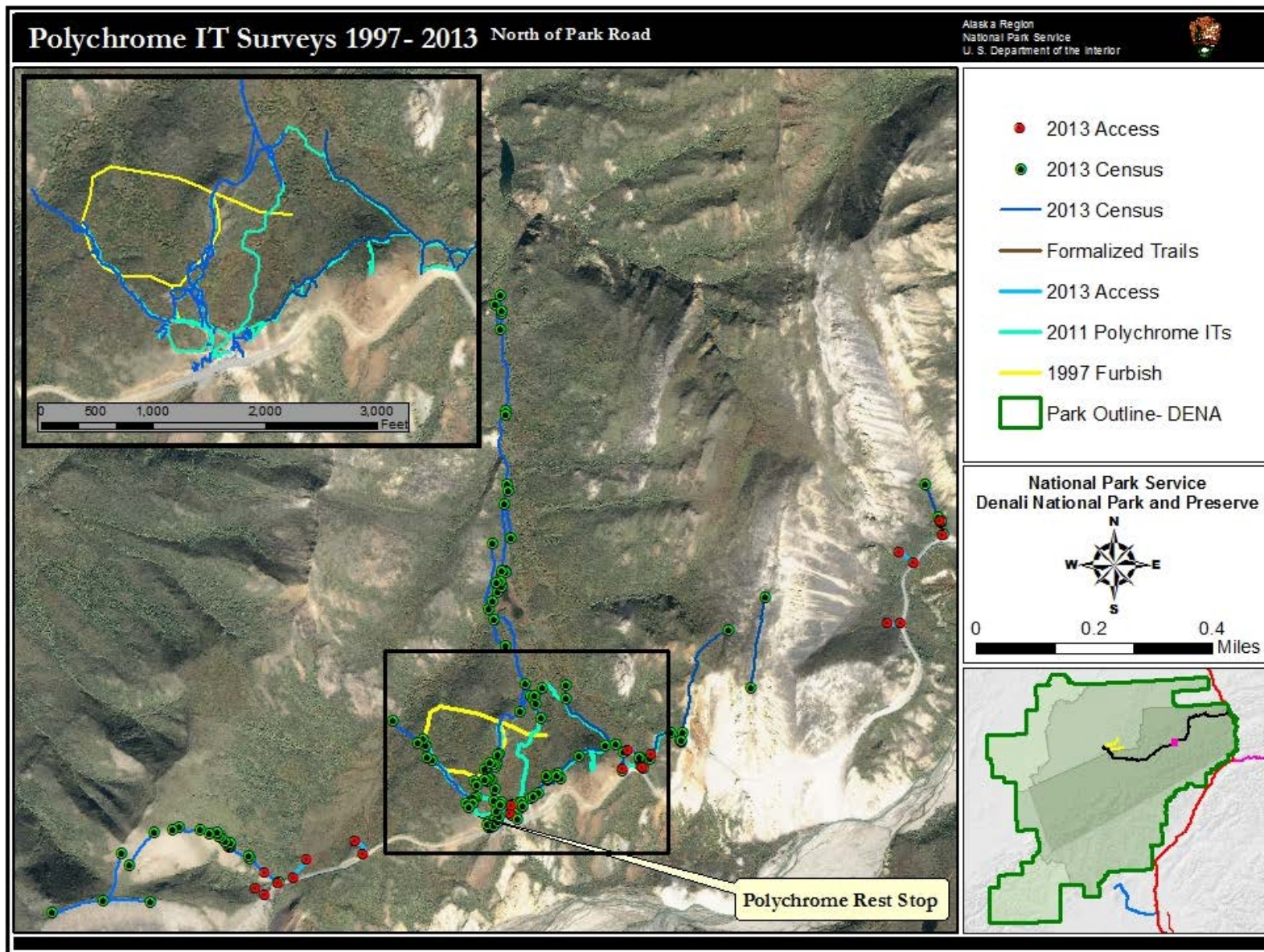


Figure 17. Polychrome IT Surveys 1997 – 2013.

Grassy Pass/ Grassy View

Grassy Pass (“The Otter Slide”) was mapped in 1997 and 2013. The total length of trails in this area increased by 572 ft. This trail network takes a nearly direct route from its start at the road down toward the Thorofare gravel bar where it disperses onto the rocky surface. This steep trail is heavily impacted by hiker activity and road runoff water. In many places, ruts have formed that are more than 3 feet deep and several feet wide. Trail users have widened the affected area of the trail at these locations while trying to avoid these difficult and sometimes hazardous areas (Figure 18). The trail is mostly linear due to the impenetrable brush and topography. It is a natural travel corridor for both people and wildlife from the Grassy Pass area to the Thorofare River bar. There are a handful of alternate routes that do stem from some of the muddier areas but potential for expansion is minimal. This is a high priority area due to the condition of the trail and popularity.

Grassy View was mapped in 1997, 2009 and 2012. This trail is considered to be on generally stable terrain but the total length has increased by 2,633 ft. and therefore of high priority.

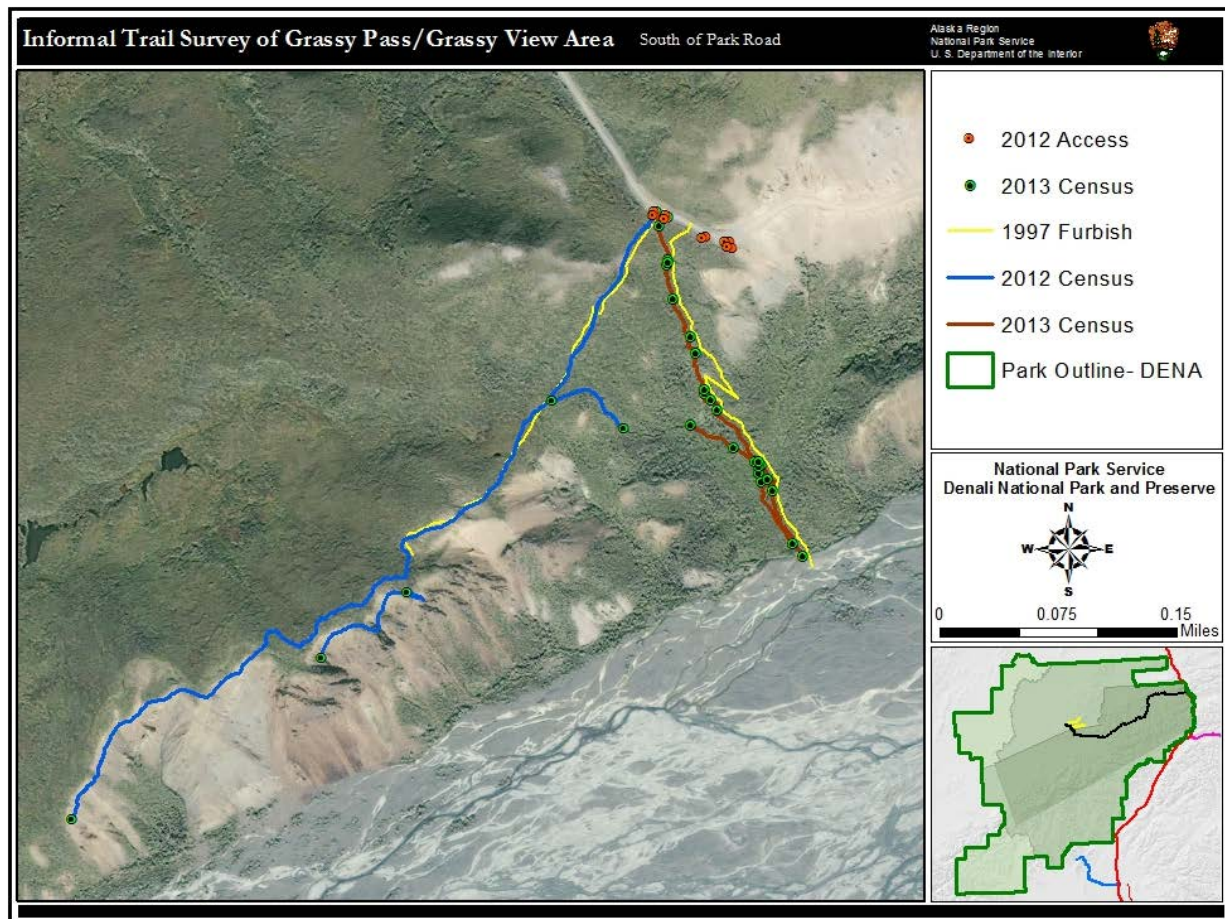


Figure 18. IT Survey of Grassy Pass/Grassy View 2009 – 2013.

Cathedral Mountain Trail

The Cathedral Mountain trail network was surveyed in 1997, 2010, and 2012. The length of the main trail has increased from 1997 by 1,555 ft.

The trail has several access points and the main trail is very well established, with little or no vegetation along the majority of its extent. The surface is mostly durable but when wet some muddy areas develop. This causes some braiding although these loop back into the main trail fairly quickly. The trail ends pretty abruptly past the ponds as people can overlook the Teklanika River bar. This is considered a medium-high priority area due to the number of access points and the increase in trail length.

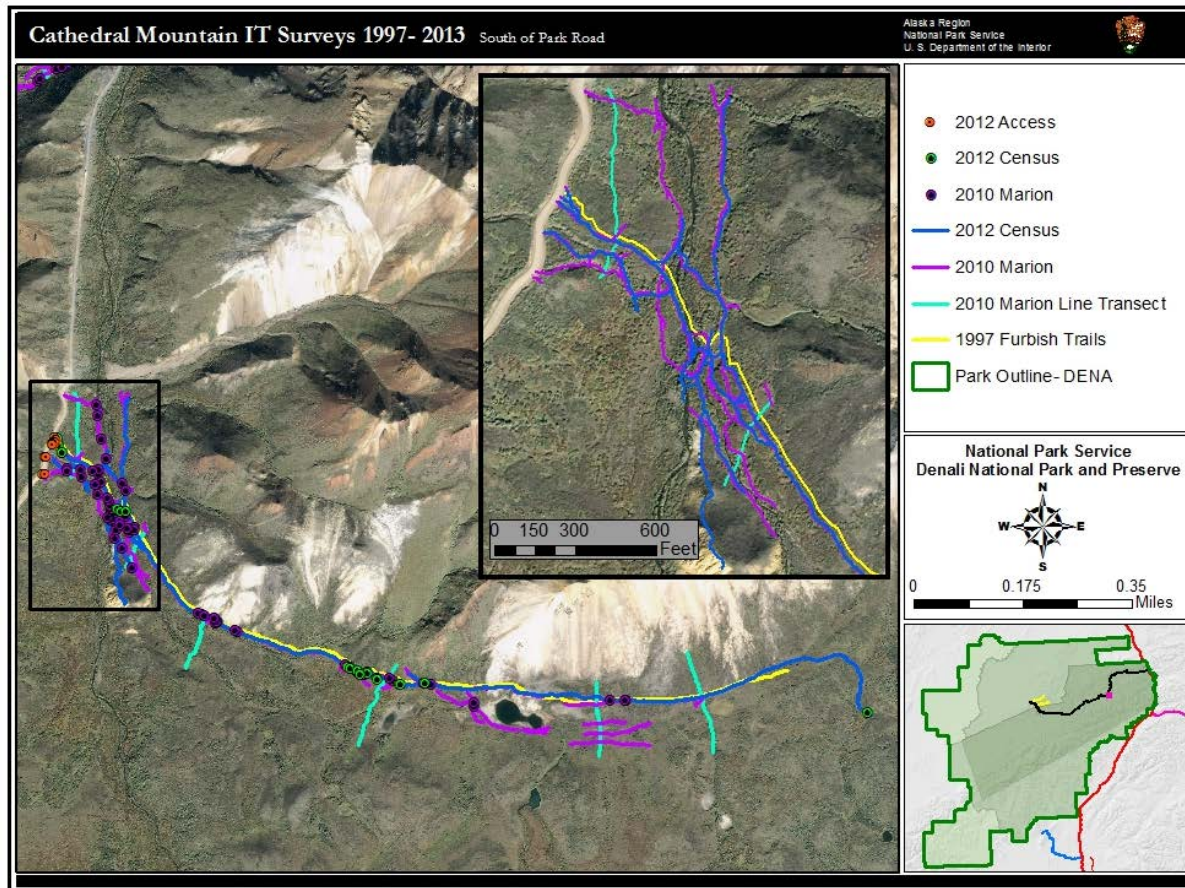


Figure 19. Cathedral Mountain IT Surveys 1997 – 2013.

Thorofare Ridge Trail

The Thorofare Ridge area was mapped in 1997 and 2013. The section mapped in 1997 was later formalized and hardened off as the Alpine Trail. The Thorofare Ridge Trail begins beyond the end of the Alpine Trail and travels east and west along the Thorofare Ridgeline comprising 6,039 ft. of trail. There are no significant tread problems at this time. There are many short branches that originate from the main trails but do not continue very far. (Mandanna and Hooper 2013).

At present this area is fairly stable but considered a medium priority area and continued monitoring is recommended due to the amount of use the area receives by day hikers and guided hikes.

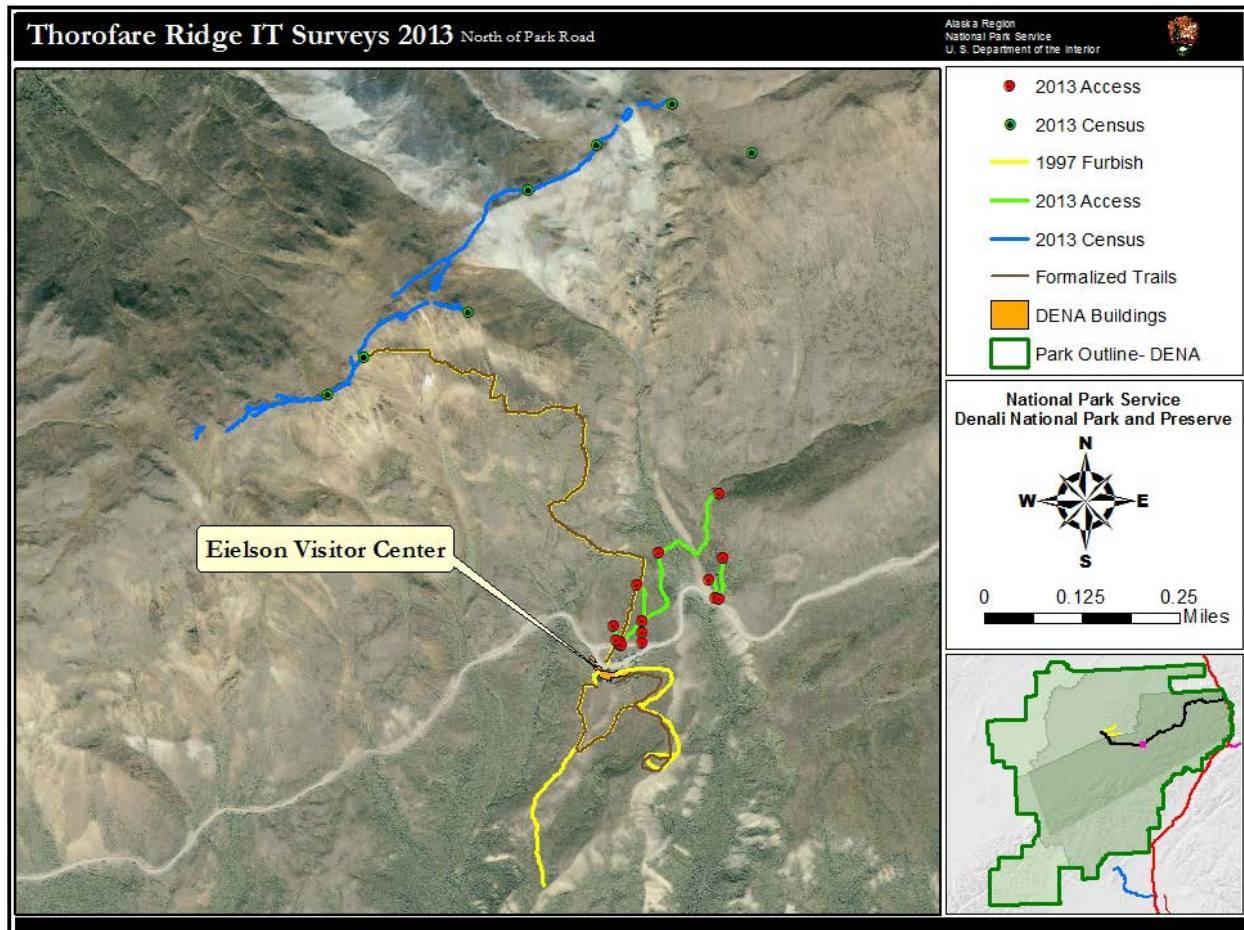


Figure 20. Thorofare Ridge IT Surveys 2013.

Tattler Creek

The Tattler Creek trail network was surveyed in 2010 and again in 2013. There was a difference in total trail length of -1349 ft. between the surveys. This result is not fully conclusive since a malfunction in surveying equipment may have led to incomplete coverage of the area. (pers. Com. A. Mandanna).

The trail network within Tattler Creek is fairly extensive with trails starting at the road and extending more than a mile up the drainage. These trails run both along the creek side and away from the creek cutting through bluffs, slopes, brush and rocky creek areas.

The majority of the trails do not have any tread problems. However some tread problems do occur in areas where the trails move up steeper slopes or in areas that retain larger amounts of water (Mandanna and Hooper 2013).

This trail system can likely be managed through education of visitors. If visitors will stay down in the riverbed and not up on the benches they would be traveling through areas of greater durability.

The major concern here is the paleontological resource. With the growing knowledge of dinosaur track fossils in this area the use of this trail system is expected to increase, thus bringing more impact to the area and resources, and therefore considered a medium priority area.

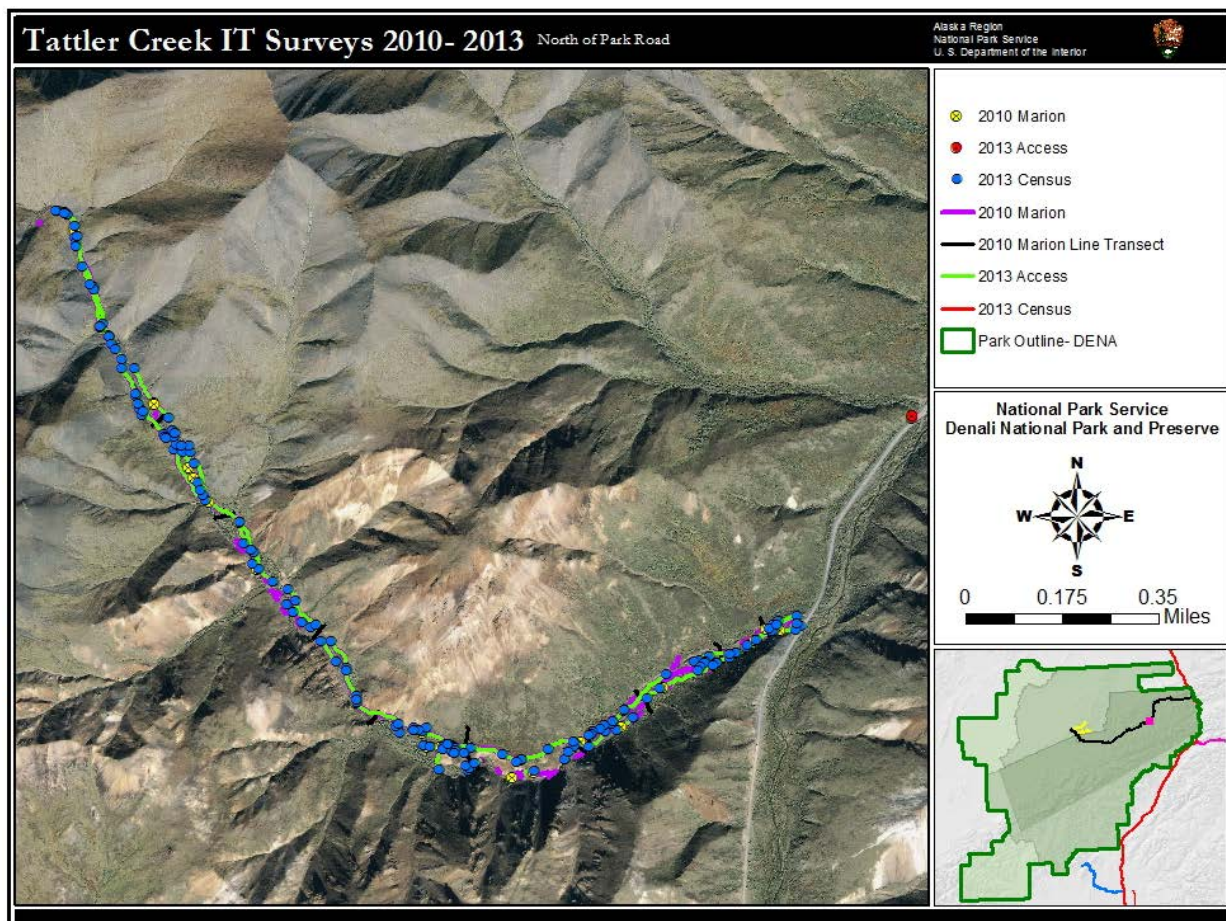


Figure 21. Tattler Creek IT Surveys 2010 – 2013.

Cabin Creek/Cabin Peak

Cabin Creek was surveyed in 2013 and Cabin Peak in 2012.

The Cabin Creek trail network starts at the mouth of the creek on the Toklat gravel bar and continues east for approximately a mile. Most of the trail segments are not very distinct as much of the trail network is overtop of gravel. The trail is mostly stable and the potential for expansion is low (Figure 21).

The Cabin Peak trail segments were measured at 320ft. in length and of concern here is the paleontological resource in the area. As the knowledge of this resource spreads, use is likely to increase and impact trail formation, and therefore considered a medium priority area, and a high priority for frequent monitoring.

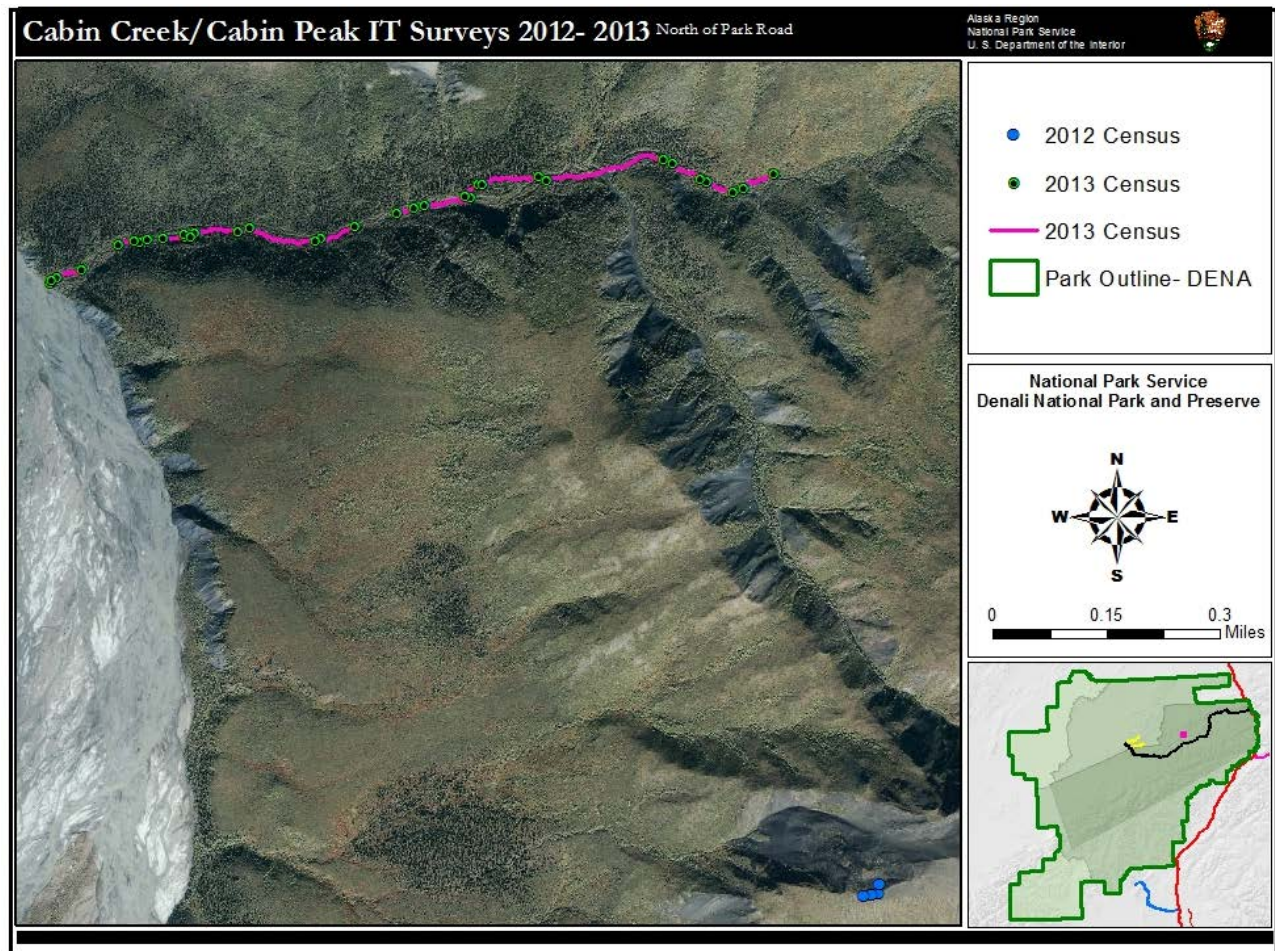


Figure 22. Cabin Creek/Cabin Peak IT surveys 2012 – 2013.

Primrose

After repeating the 2010 Line Transect survey done by Marion and Wimpey (2011), there was no change in trail extent, tread problems, branching, paralleling and vegetation or substrate stability. The trail is primarily linear with a second trail paralleling for a few hundred feet at the lower end. The north end of the trail network leads to a wide moderately inclined slope and foot traffic is dispersed here to the top of the ridge (Figure 18).

This area was described by Joe Van Horn as having trails through the brushy areas of the lower slopes prior to the 1970's and continuous trails formed along the crests of the spur ridges by the mid 1980's. No trails had formed during his time from these ridges to the open wet meadows near the top of the main ridge system.

This area seems fairly stable and medium level priority, it needs continued monitoring due to the high use it receives from day hikers and guided MSLC hikes.

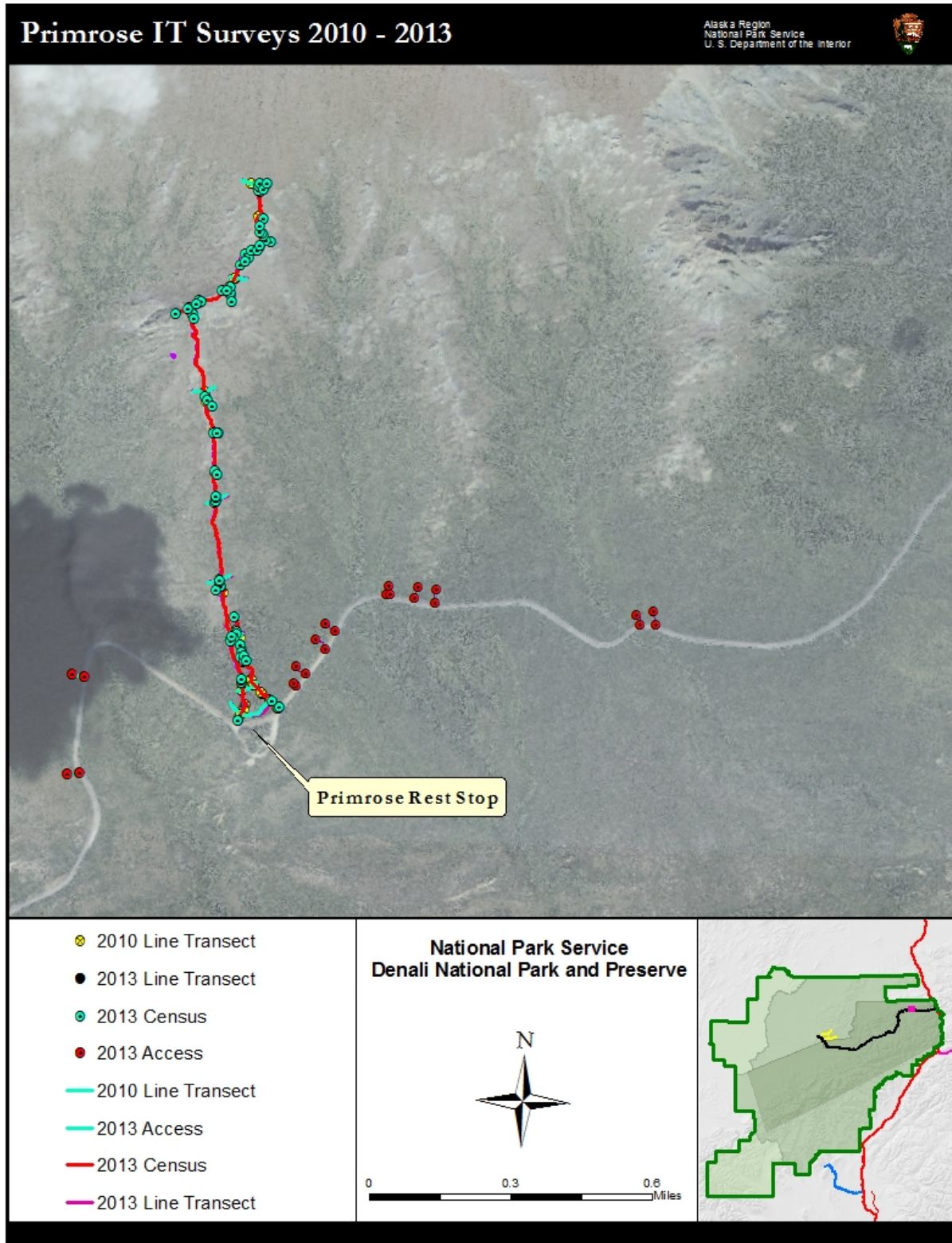


Figure 23. Primrose IT Surveys 2010 – 2013.

Thorofare Cabin Trail

The Thorofare Cabin trail was mapped in 2012 and 2013. This trail network is 7,295 ft. in length. It begins at the Moose Creek gravel pit, an area not regularly accessed by busses and was created by employee use of the cabin it leads to. It is a low priority area due to limited use but should be monitored for increased trail formation.

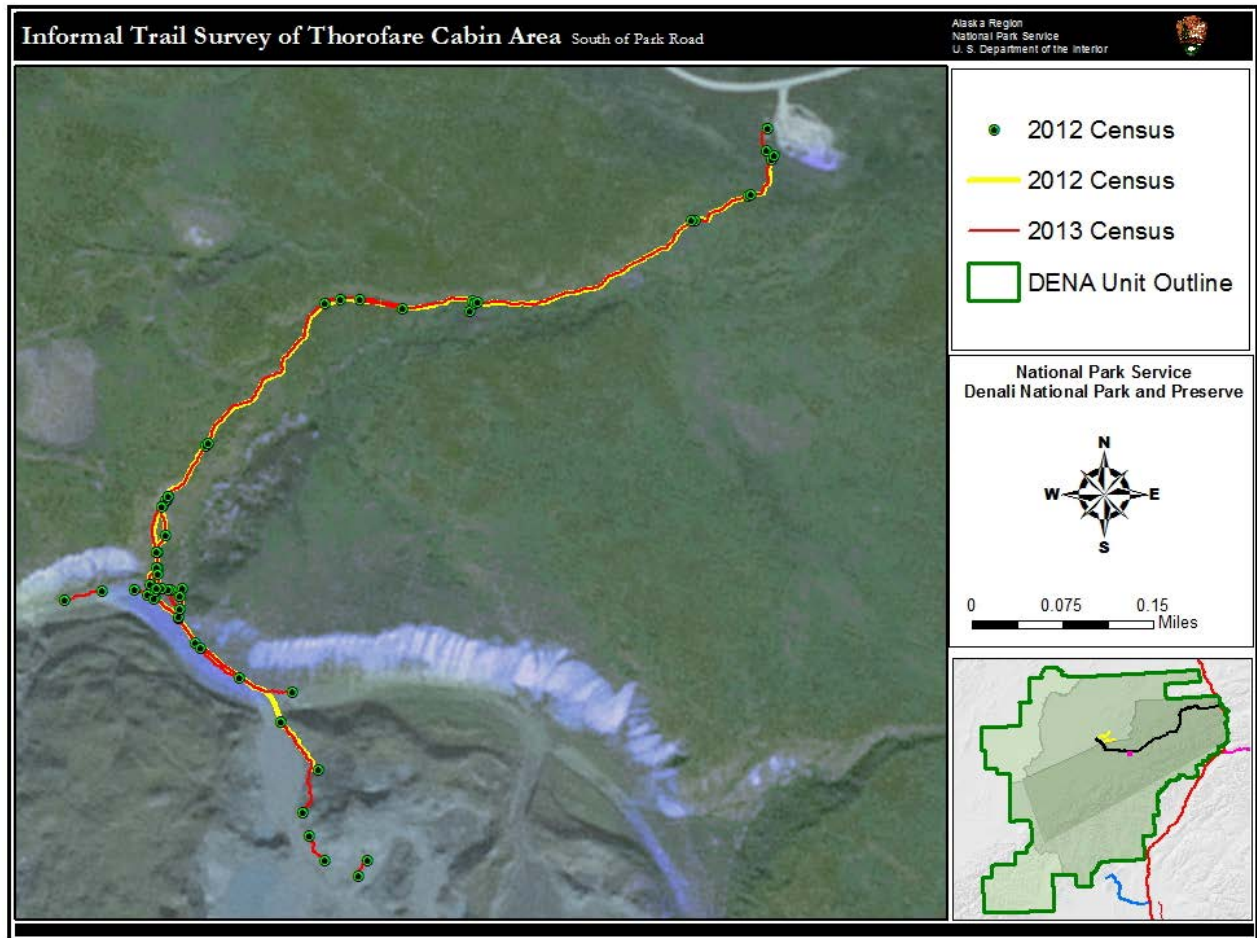


Figure 24. IT survey of Thorofare cabin area 2012 – 2013.

Upper West Toklat Trail

This trail network was mapped in 2012. A non continuous trail with a total length of 6,597 ft. was recorded. This is a durable surface area and mainly used by wildlife and overnight hikers. Hikers don't always find this trail if it is their first time hiking up the valley, but on a down valley trajectory and with the current course of the river they are naturally funneled on to the trail to avoid crossing the river. The trail follows the edge of a bluff above the braided river plain and has very good visibility for wildlife travelling up and down the valley. This is a low priority area. This area should be monitored by backcountry ranger staff and re-surveyed when new impacts are noted.

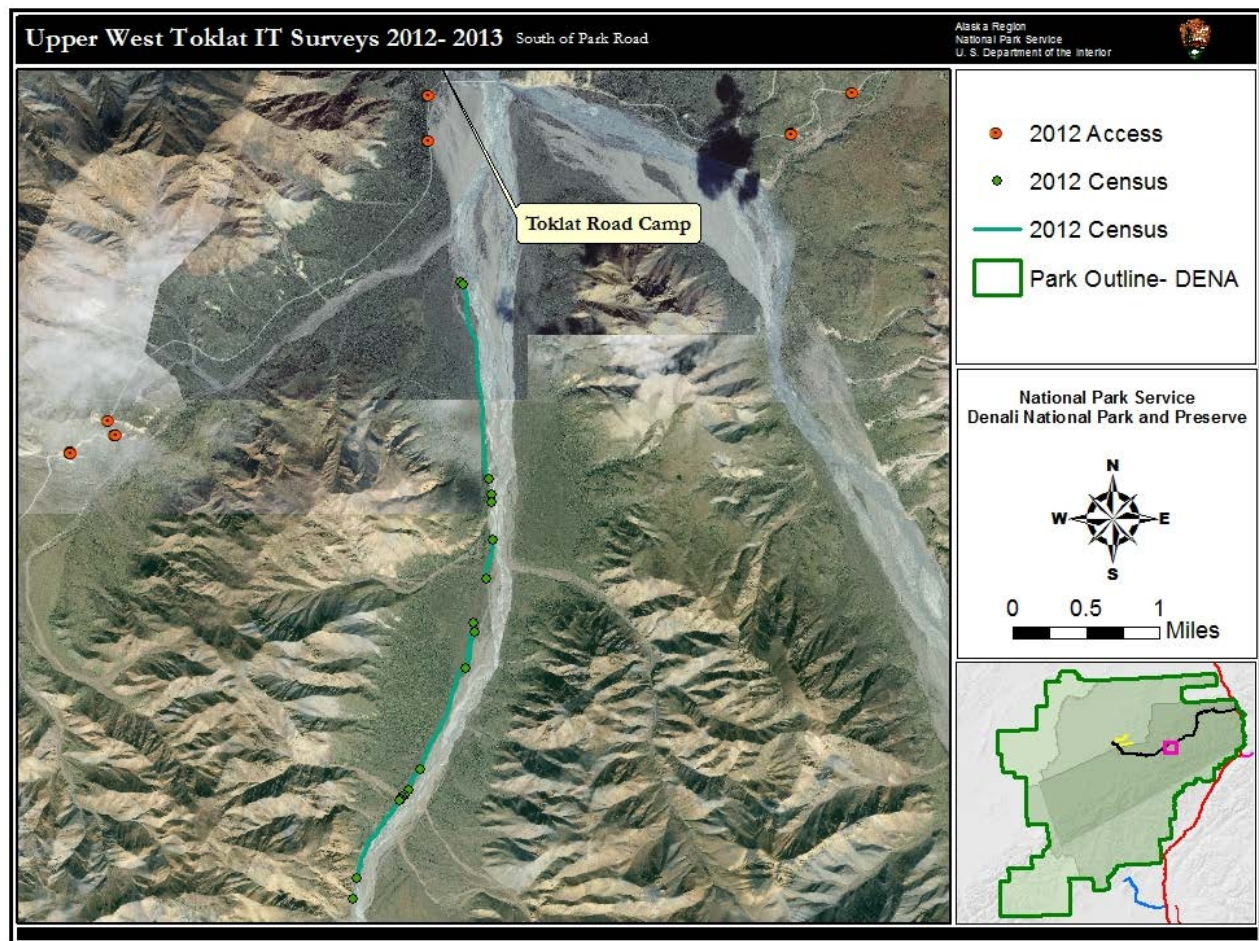


Figure 25. IT survey of Upper West Toklat 2012 – 2013.

Upper Stony Creek Trail

This trail network is not very extensive. The trails are linear, disjointed, and run along the edges of the river or gravel bar. The segments are short in length totaling nearly 2800 ft. of impacted trail, and no significant tread problems were recorded. Vegetation and substrate appear to be stable. (NPS unpublished data 2013).

This area is low priority but the potential for increased impact is present due to the use the area receives from day hikers and guided group hikes. Continued monitoring is needed.

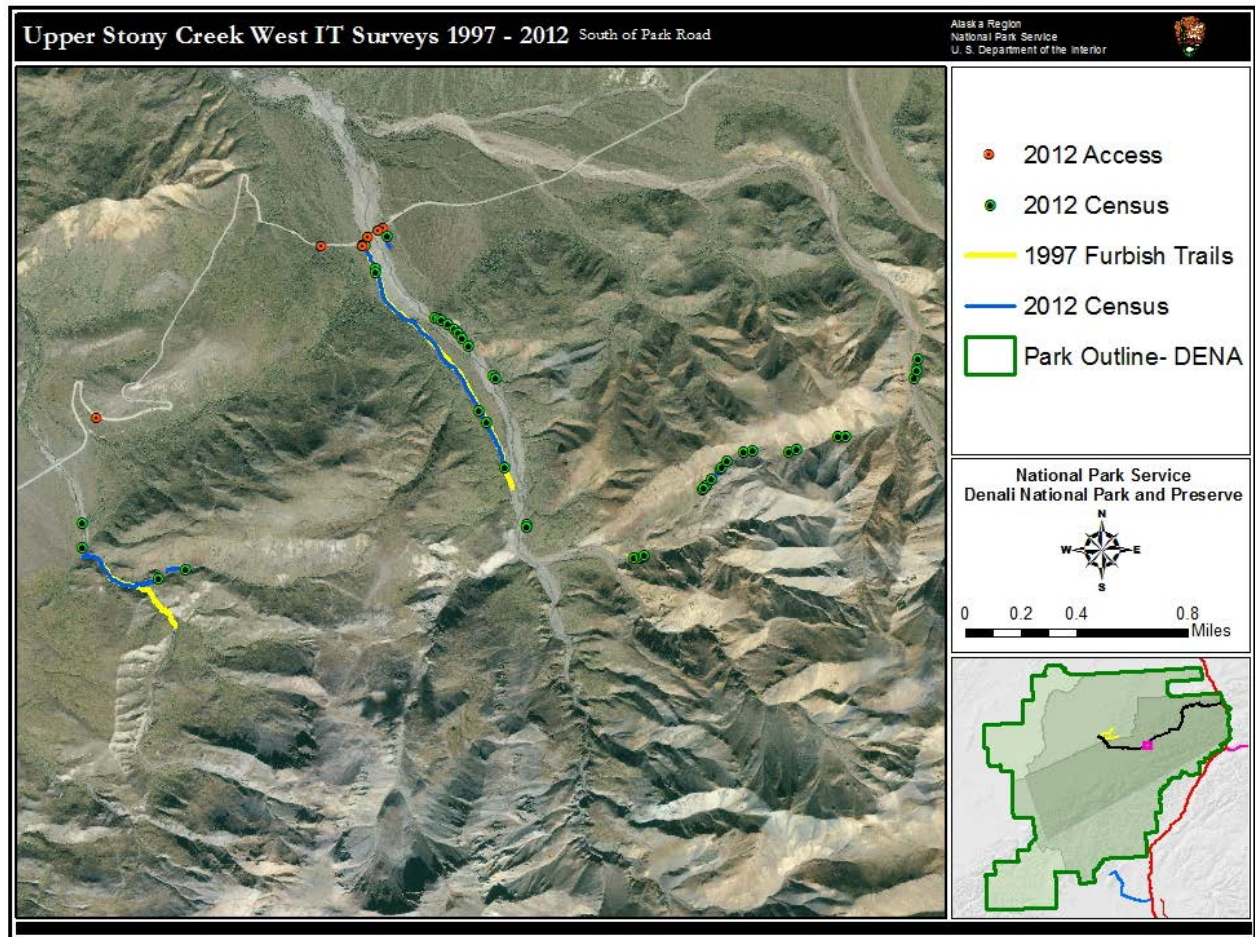


Figure 26. IT Surveys of Upper Stony Creek West 1997 – 2012.

Lower Stony Creek Trail

This trail network was mapped in 2013 but known to have existed since the late 1970's. The mapping effort in 2013 showed sections of continuous and segmented trails totaling 14,640 ft. in length. Continuous trailing was present along the creek bottom through narrow and confined areas of the drainage but became more segmented in the denser vegetated and broader canyon areas. The stability of the area is fairly resilient with one section of highly eroding soil. (VanHorn 2011) (Hooper and Mandanna 2013).

This trail network is low priority but monitoring needs to continue due to the use the area receives with day hikers, overnight use, and guided hikes.

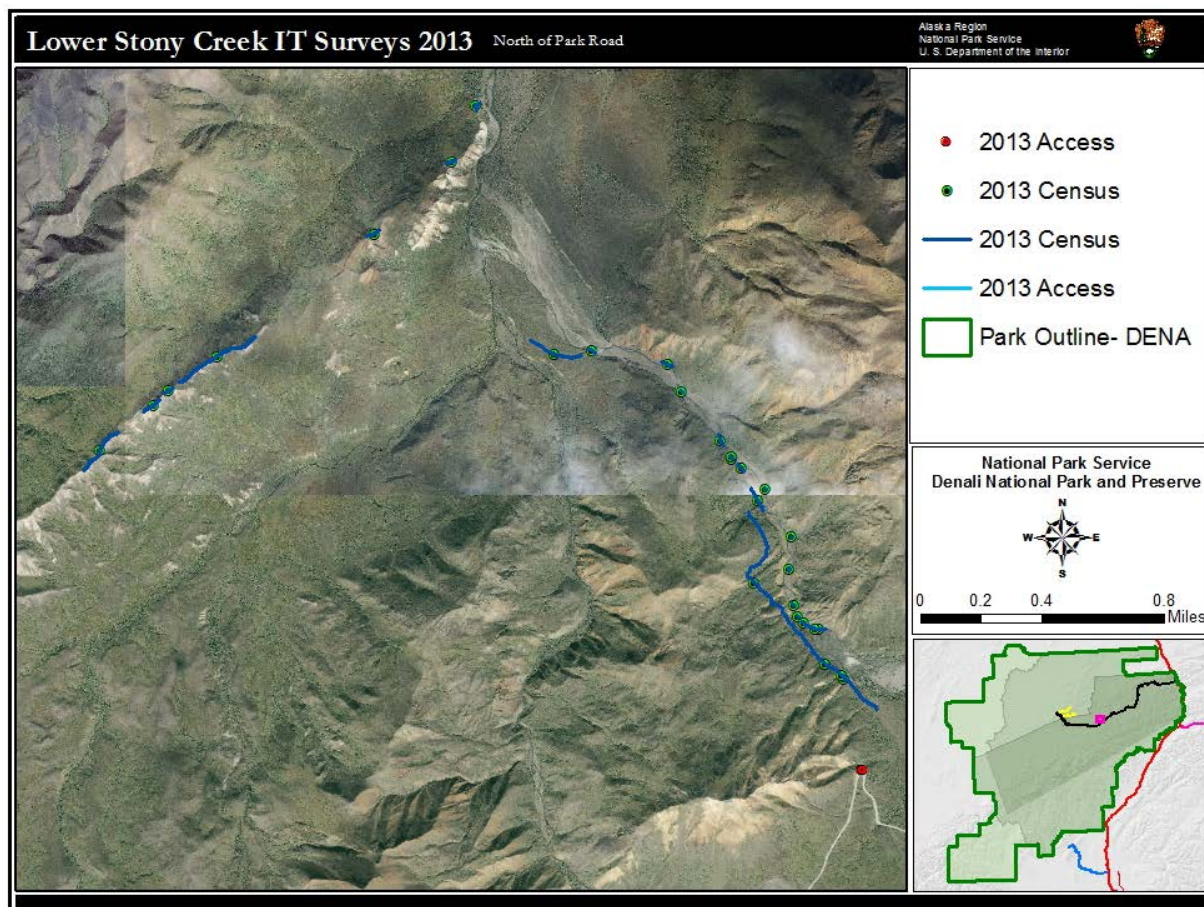


Figure 27. IT survey of Lower Stony Creek.

Literature Cited

- Abbe, D.J. and R. Burrows. 2014. Denali National Park and Preserve State of the Backcountry. Natural Resources Report, in preparation. National Park Service, Fort Collins, Colorado.
- Fix, P.J. and H. Hatcher. 2011. Monitoring indicators of the visitor experience and resource conditions in the Denali backcountry: Summer 2010. Natural Resource Technical Report NPS/DENA/NRTR-2011/480. National Park Service, Fort Collins, Colorado.
- Furbish, C. E. 1996. Denali National Park – Trails and Nodes Monitoring Program, Report on Progress at End of 1995 Season. Unpublished Report, Denali National Park, Alaska.
- Mandanna, A.Z. and Hayes, S., 2012. Informal Trail Mapping Summary 2012. U.S. National Park Service Unpublished Report, Denali National Park, Alaska.
- Mandanna, A.Z. and Hooper, S., 2013. 2013 Informal Trail Monitoring Summary. U.S. National Park Service Draft Unpublished Report, Denali National Park, Alaska.
- Marion, J. L., and J. Wimpey. 2011. Informal Trail Monitoring Protocols: Denali National Park and Preserve. Research Report. U.S. Department of the Interior, U.S. Geological Survey distributed by Virginia Tech, College of Natural Resources and Environment, Department of Forest Resources and Environmental Conservation.
- National Park Service. 1996. Final Entrance Area and Road Corridor Development Concept Plan Abbreviated Final Environmental Impact Statement. 358 p.
- National Park Service. 2008. Consolidated General Management Plan for Denali National Park and Preserve. U. S. National Park Service, Denali National Park, Alaska.
- National Park Service. 2006a. Denali National Park and Preserve Final Backcountry Management Plan. General Management Plan Amendment Environmental Impact Statement. January 2006. U.S. National Park Service, Denali National Park, Alaska.
- National Park Service. 2006b. Summarized Backcountry Management Plan. February 2006. U.S. National Park Service, Denali National Park, Alaska.
<http://www.nps.gov/dena/parkmgmt/upload/Denali%20Backcountry%20Management%20Plan%20Summary%20Document.pdf>
- Van Horn, J. 2011. History and condition of Informal Human Use trails in Denali National Park and Preserve. U. S. National Park Service Unpublished Report, Denali National Park, Alaska.
- Waits, I. 2010. Denali National Park, Alaska: Guide to Hiking, Photography and camping, Third Edition. Wild Rose Guidebooks, Anchorage, Alaska, 256p.

Appendix A. Access Management Tools

Table A1. Access Management Tools

1) Education	The National Park Service would provide printed material, public presentations, targeted presentations to user groups, and Internet-based programs, with the goal of actively involving visitors in helping the park achieve the standards for all management areas.
2) Increased enforcement of existing regulations	The National Park Service would prioritize enforcement of existing regulations to assist in achieving standards for management areas. For example, enforcement of the snowmachine speed limit or the sound level limits on motorized equipment could assist in achieving standards for sound quality.
3) Voluntary restrictions	The National Park Service would ask visitors to restrict their use voluntarily. Examples of such measures could include: voluntary registration; use of low-impact equipment; avoidance of certain areas of the park or preserve; or avoidance of areas during particular seasons or times of day. Voluntary registration would not require a permit and could be accomplished by trailhead register, phone or radio call-in, or the Internet.
4) Required registration	The National Park Service would require visitors to register. Visitors would be issued a permit that provides information about park rules and conditions for use necessary to protect park resources. Permit conditions could include minimum impact travel and camping requirements and resource protection requirements; however, a registration process would not limit the number of visitors or the type or amount of access. Registration is a means to gather information about visitor use levels and to ensure visitors receive necessary resource protection and safety information.
5) Technology requirements or other requirements governing means of access	To achieve management area standards, the National Park Service would place requirements on the means of access. For example, the NPS could require individuals to use technology that meets specific noise specifications if those individuals are accessing the park by snowmachin, motorboat, or airplane.
6) Management of commercial activity	The National Park Service would adjust concession contracts and other commercial use permits to govern use levels or direct authorized commercial activity to locations, seasons, or times of day as necessary to achieve management area standards.

Table A1. Access Management Tools (continued)

7) Regulate numbers of visitors	The National Park Service would establish quotas for visitor numbers in areas of the park additions and preserve when the volume of use is high enough that other mechanisms are unlikely to achieve standards. Visitors would be required to register and carry a permit, and the number of available permits would be limited. This is the mechanism presently used to manage overnight backcountry use in the Old Park and parts of the Kantishna Hills.
8) Temporal restrictions	The National Park Service would restrict access to particular times of day, days of the week, or other unit of time, or the duration of access could be limited.
9) Temporary and permanent closures	Using the appropriate authorities, the National Park Service would temporarily or permanently close areas of the park and preserve to all types of visitor use or to specific modes of access.
10) Management authorities of other agencies	The National Park Service would seek assistance from cooperating entities, such as the Federal Aviation Administration or State of Alaska, to apply regulatory or other measures to protect park resource values and achieve management area standards.

Appendix B. Decision Guide for Addressing Social Trail Formation

Table B1. Decision Guide for Addressing Social Trail Formation

Situation	Strategy	Application of Access Management Tools
No social trail formation; terrain allows dispersal or travel on durable surfaces (e.g., gravel river beds).	Keep use dispersed.	Provide Leave-No-Trace education for backcountry users to encourage continued dispersal and travel on durable surfaces.
No social trail formation at existing use levels, but terrain does not allow for dispersal or travel on durable surfaces.	Maintain use at level such that social trail formation does not begin.	Provide Leave-No-Trace education for backcountry users; manage guided groups to limit use; monitor level of use to detect increases; and limit number of visitors if necessary.
Social trails are present and are either stable or deteriorating, but additional dispersal is possible.	Encourage additional dispersal to lower levels of use on the social trail.	Provide Leave-No-Trace education for backcountry users and encourage voluntary dispersal coordinated through a social trails working group.
Social trails are present but stable at existing levels of use; little opportunity for dispersal.	Concentrate use on social trail and limit use sufficiently to prevent deterioration.	Educate visitors or restrict them to social trail, and limit numbers of visitors if necessary.
Social trails are present and are deteriorating; additional dispersal is not possible because of terrain.	Lower use levels until condition stabilizes.	Limit numbers of visitors or use temporary closures to restrict use.
<i>In addition, the National Park Service may temporarily close some areas around social trails to allow rehabilitation even if conditions are stable.</i>		

An option not listed in Table B1 and that has been used by the Park in the past is to harden a trail to protect park resources and limit overall IT impacts to the area.

Appendix C. Trail and Campsite Disturbance

Table C1. Trail and Campsite Disturbance

Descriptor	Description & Standard	Monitoring	Process for Evaluation
Medium	Visitors notice occasional social trails, campsites, or cut or broken vegetation.	Monitoring would occur at three levels. These include: 1) the use of an existing grid system of plots for monitoring changes in vegetation cover that are randomly distributed through the park and preserve, 2) a set of index sites where known social trail or campsite formation can be monitored, and 3) a random sample of additional locations selected each year. Variables to monitor would include bare ground, vegetation cover, soil compaction, physical damage to plants, and site characteristics, such as soil moisture and soil temperature.	The “Medium” descriptor is intended to match current conditions in the Old Park in areas accessible from the park road corridor. The first phase of the monitoring program would utilize existing data and new field observations to describe those conditions in more detail.
Low	Visitors notice few if any signs of social trails, campsites, or cut or broken vegetation.		
N/A	Identifies an alpine area that has very scarce or no vegetation or soil. Trails and campsites on snow are not monitored.		

Appendix D. Maps of IT Survey by Backcountry Unit

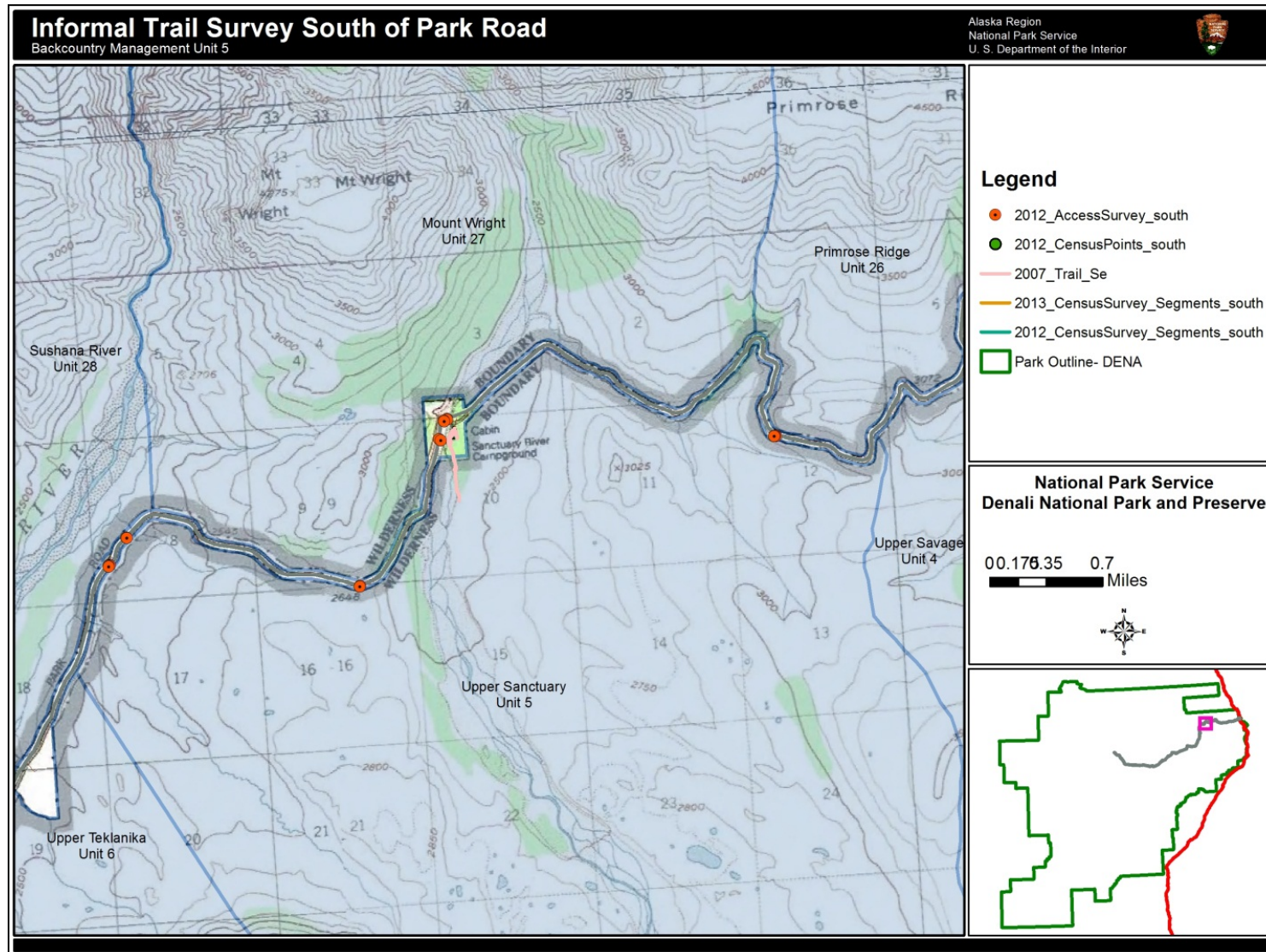


Figure D1. IT Survey, Backcountry Management Unit 5

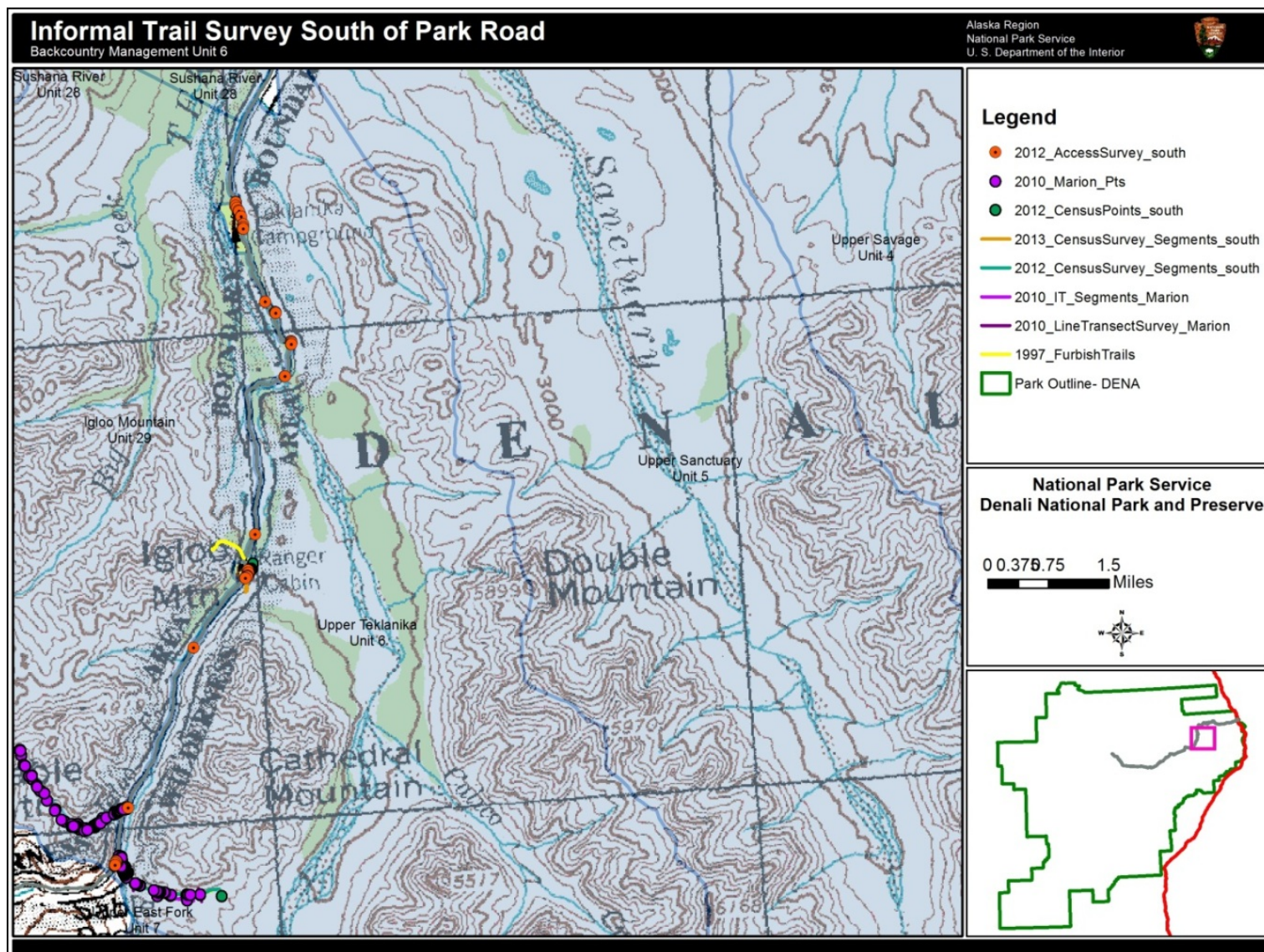


Figure D2. IT Survey, Backcountry Management Unit 6.

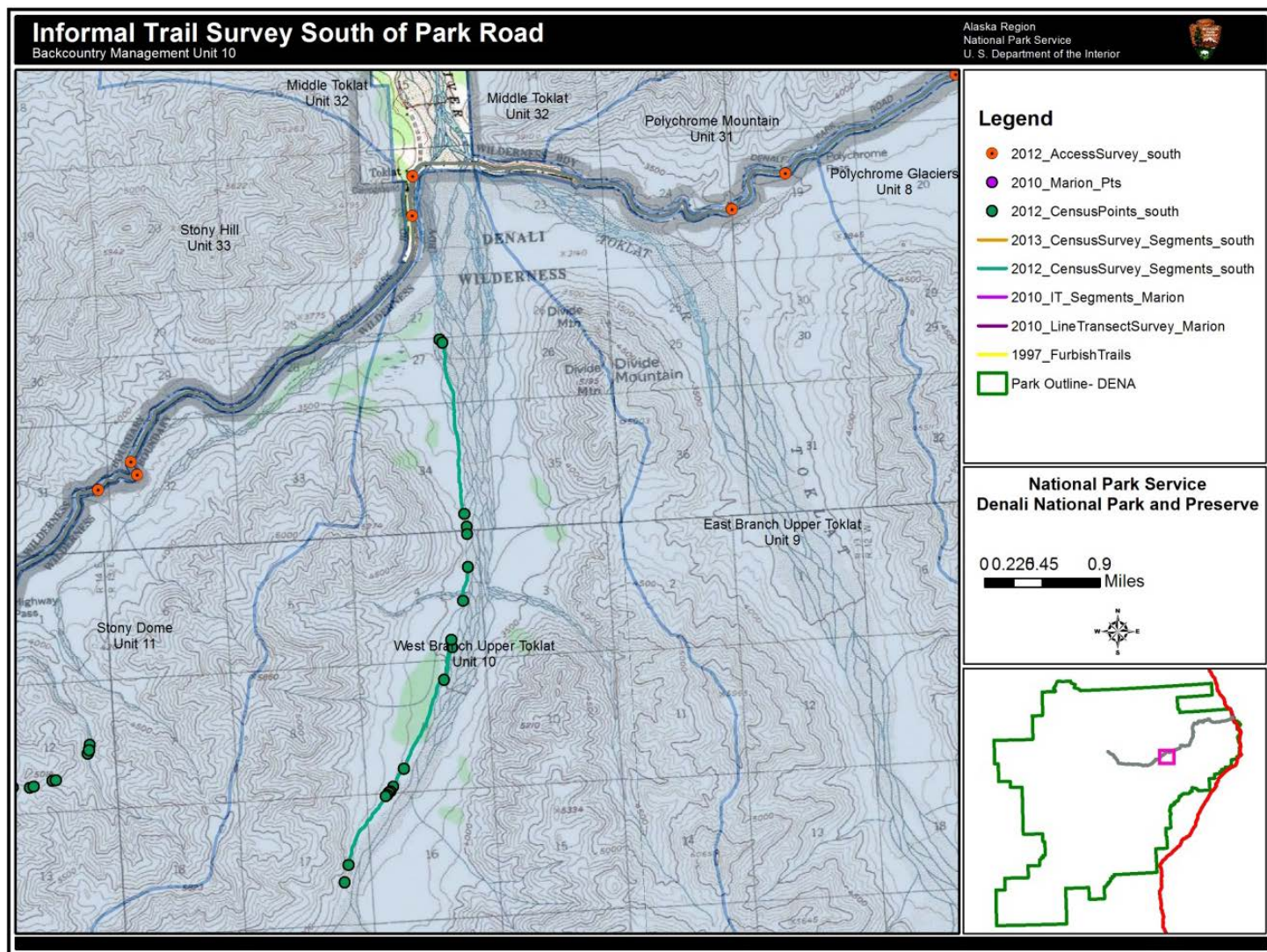


Figure D3. IT Survey, Backcountry Management Unit 10.

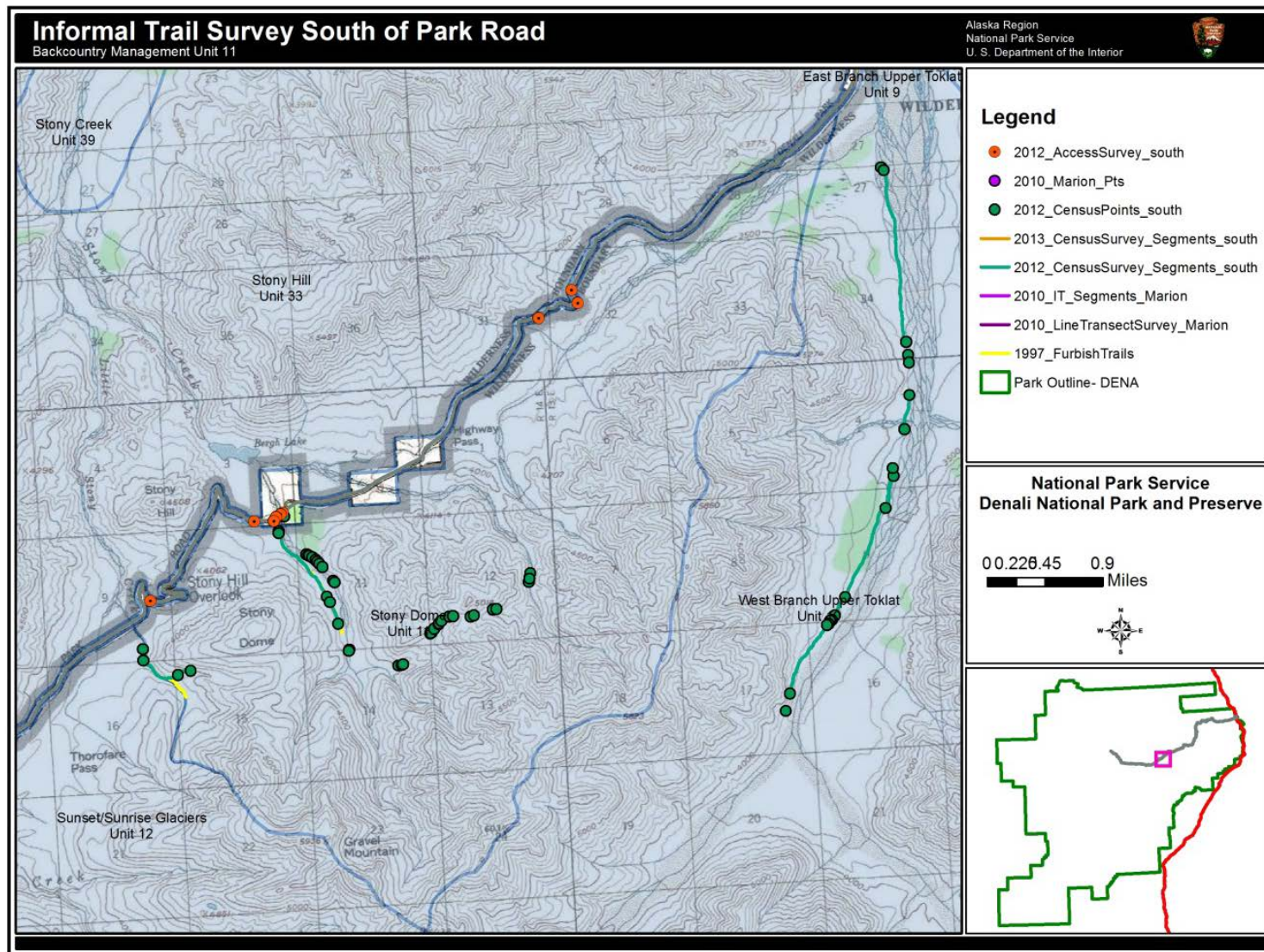


Figure D4. IT Survey, Backcountry Management Unit 11.

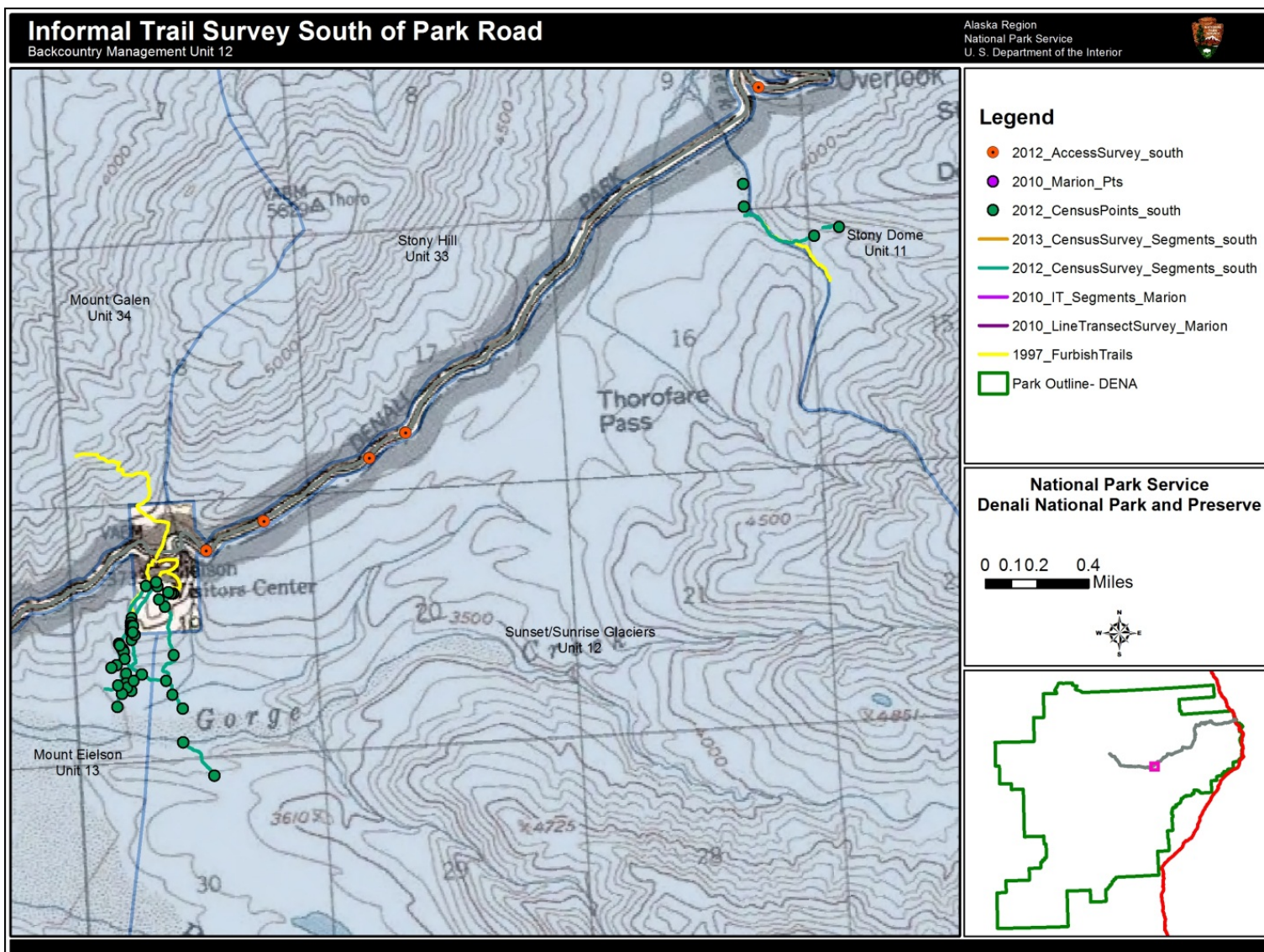


Figure D5. IT Survey, Backcountry Management Unit 12.

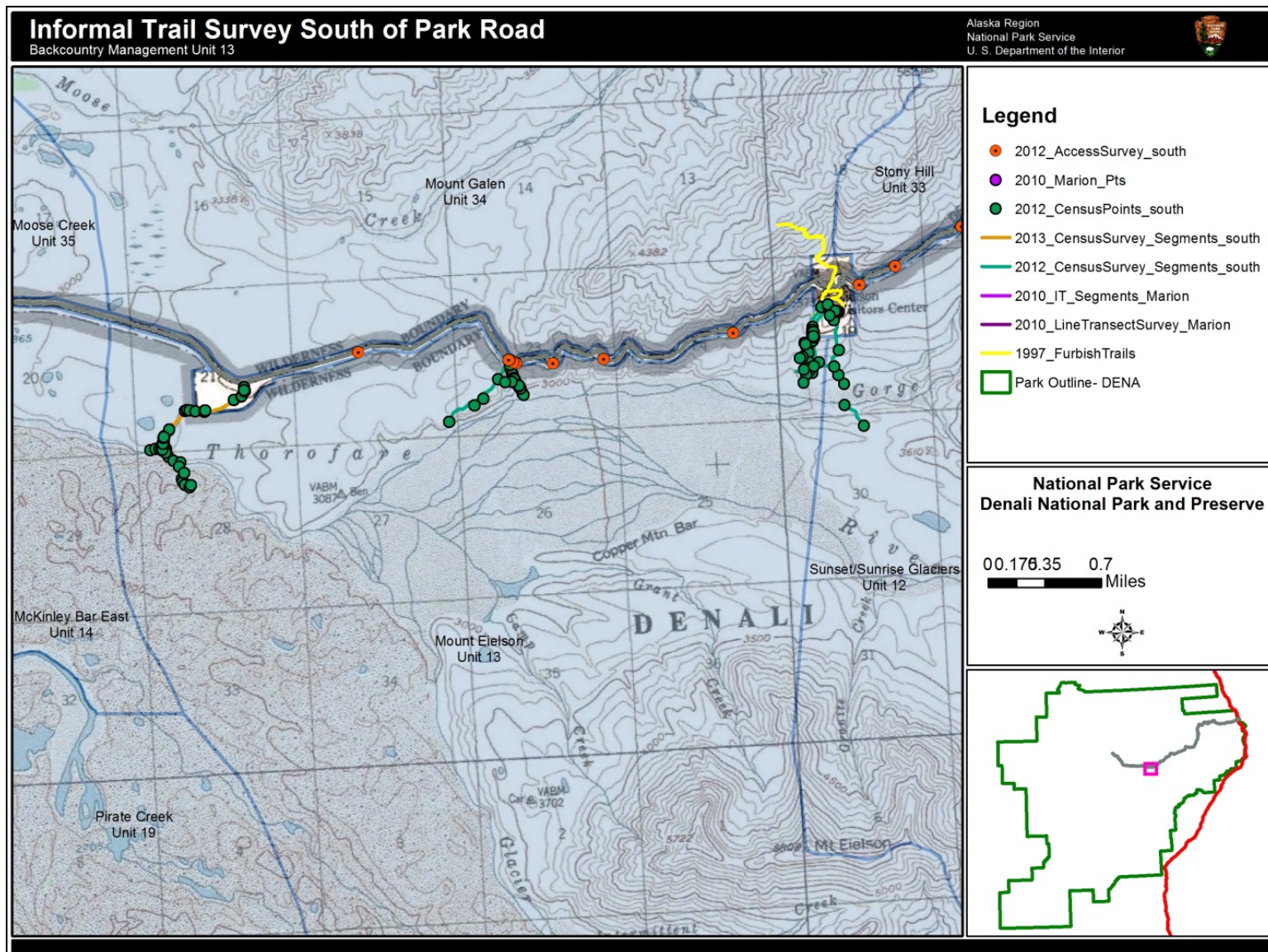


Figure D6. IT Survey, Backcountry Management Unit 13.

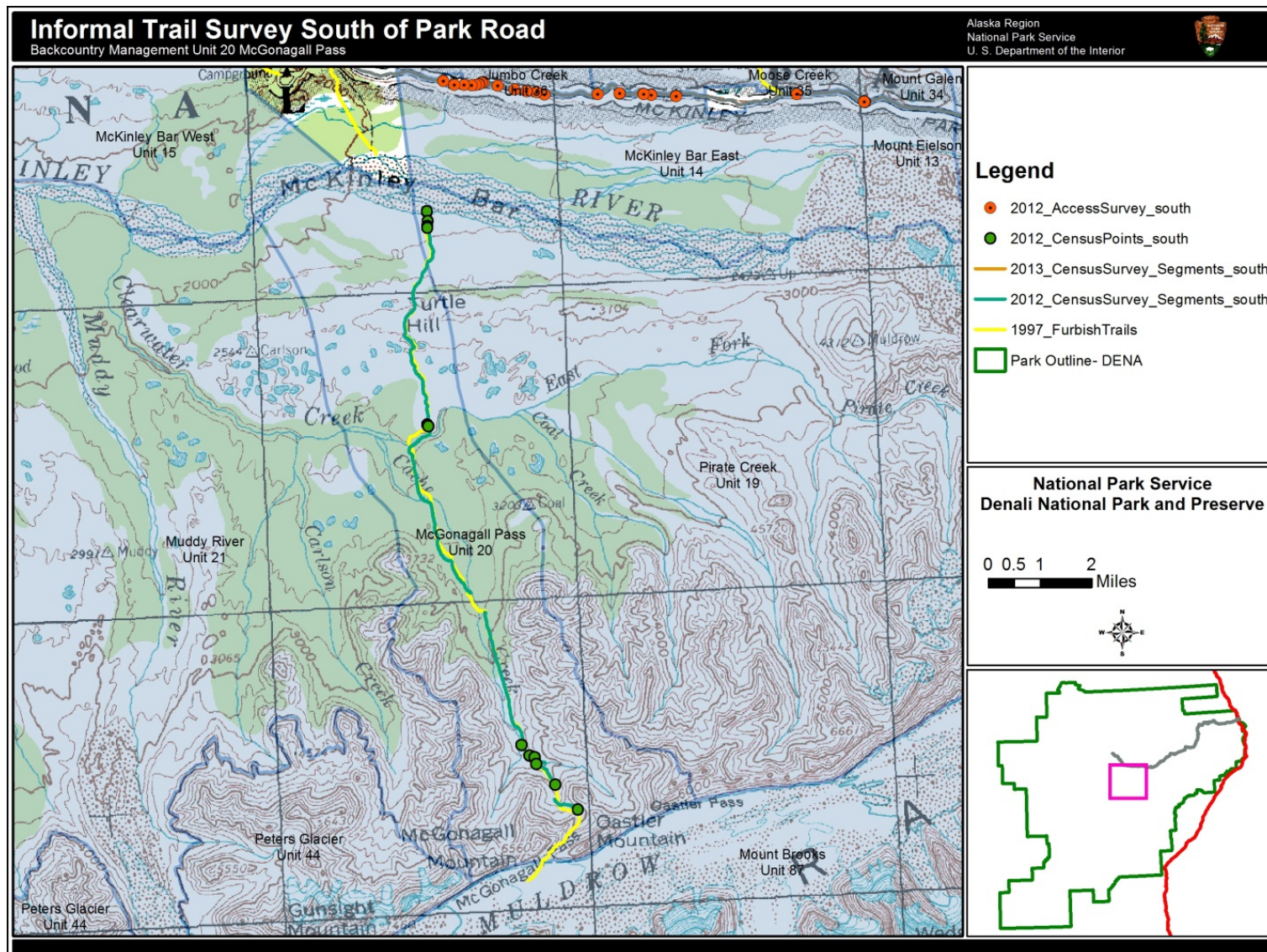


Figure D7. IT Survey, Backcountry Management Unit 20.

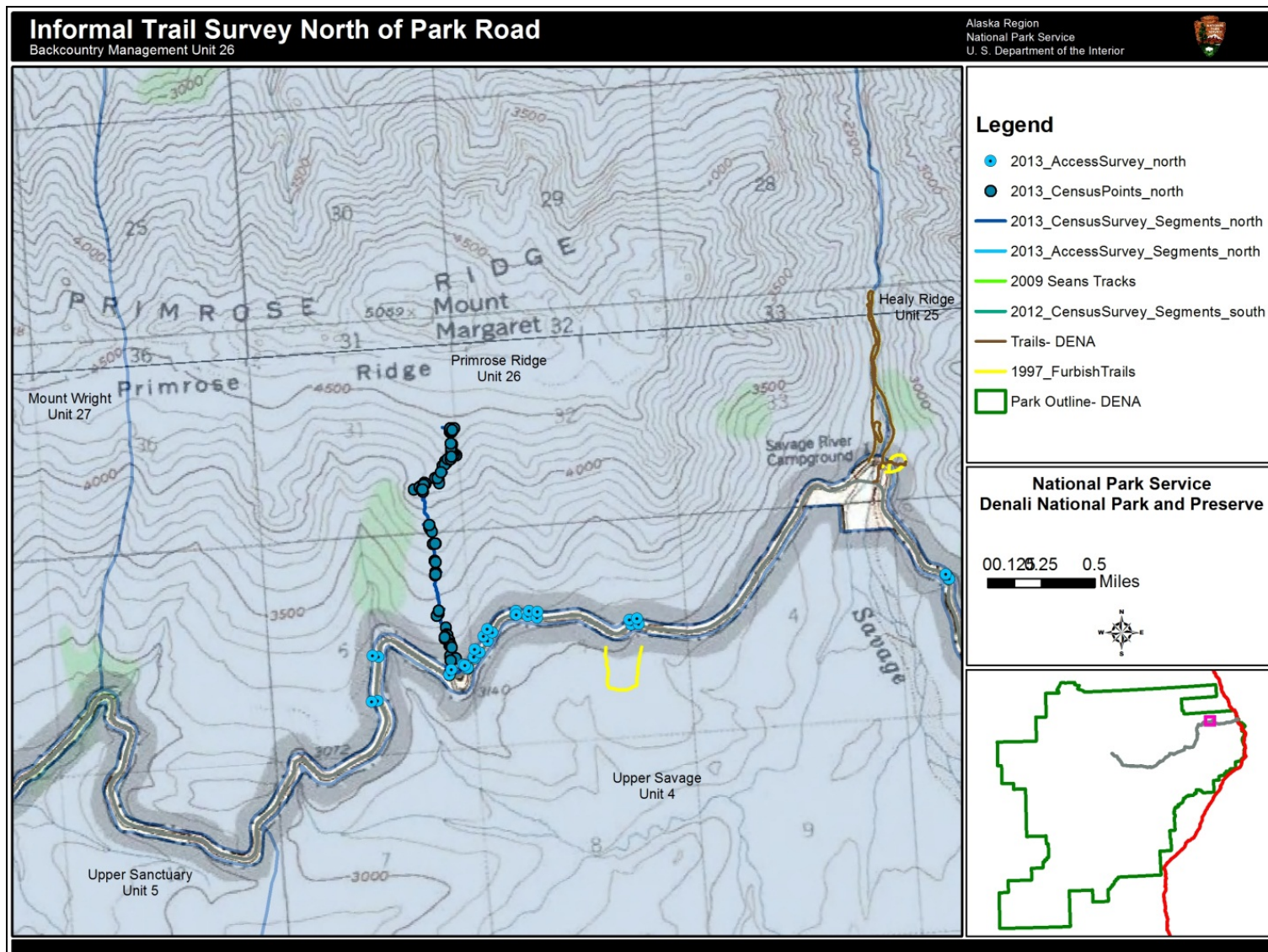


Figure D9. IT Survey, Backcountry Management Unit 29.

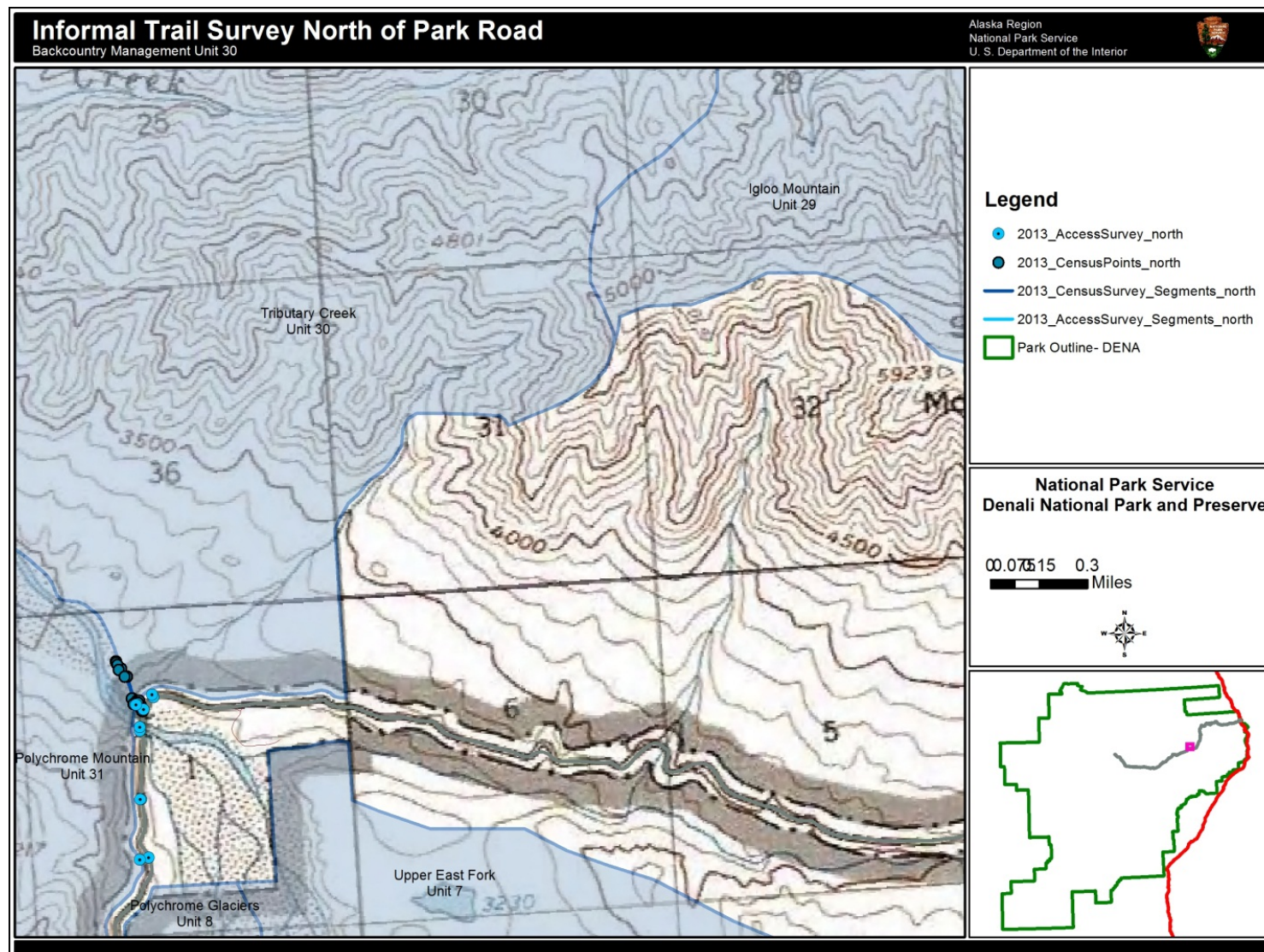


Figure D10. IT Survey, Backcountry Management Unit 30.

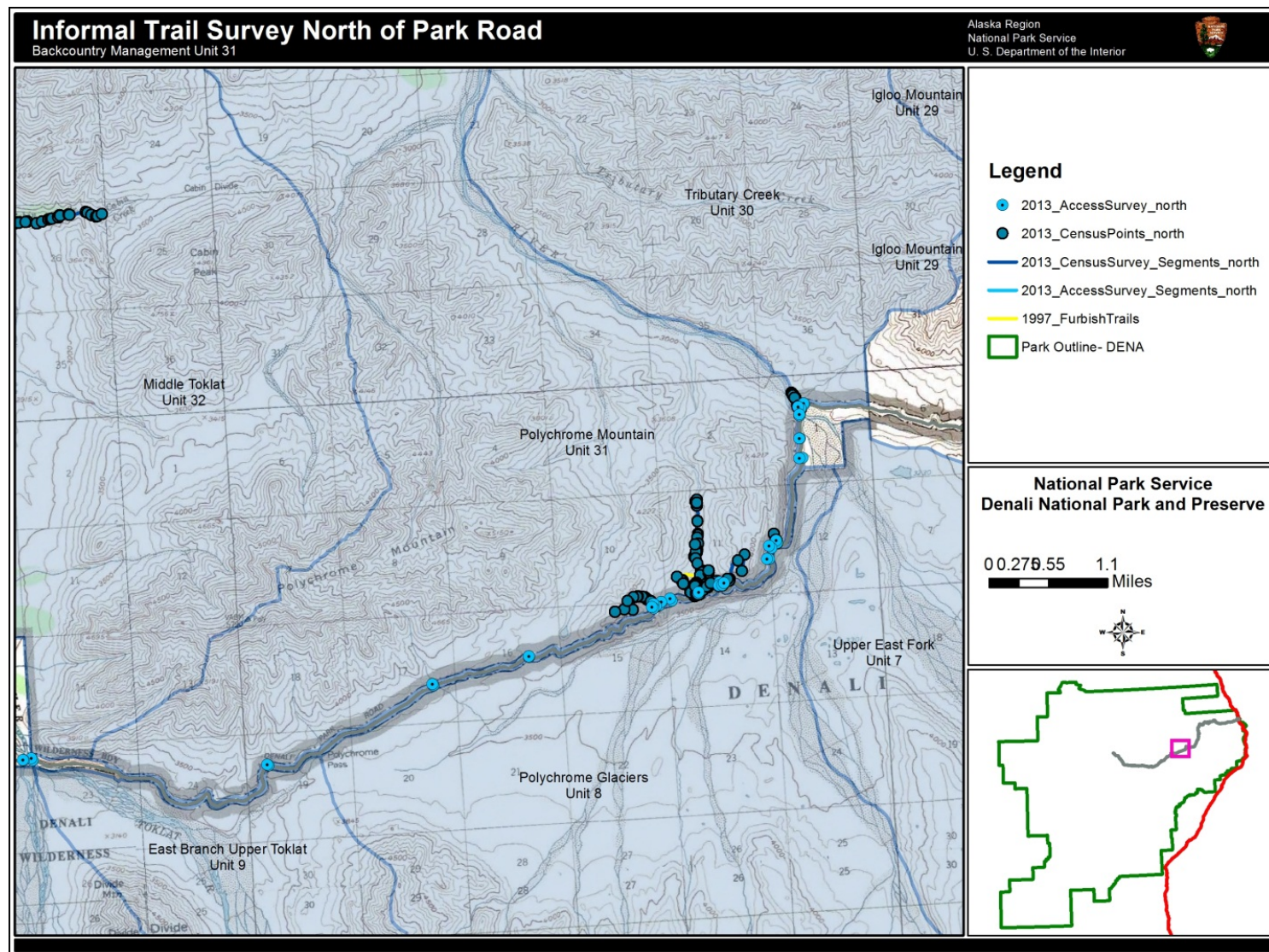


Figure D11. IT Survey, Backcountry Management Unit 31.

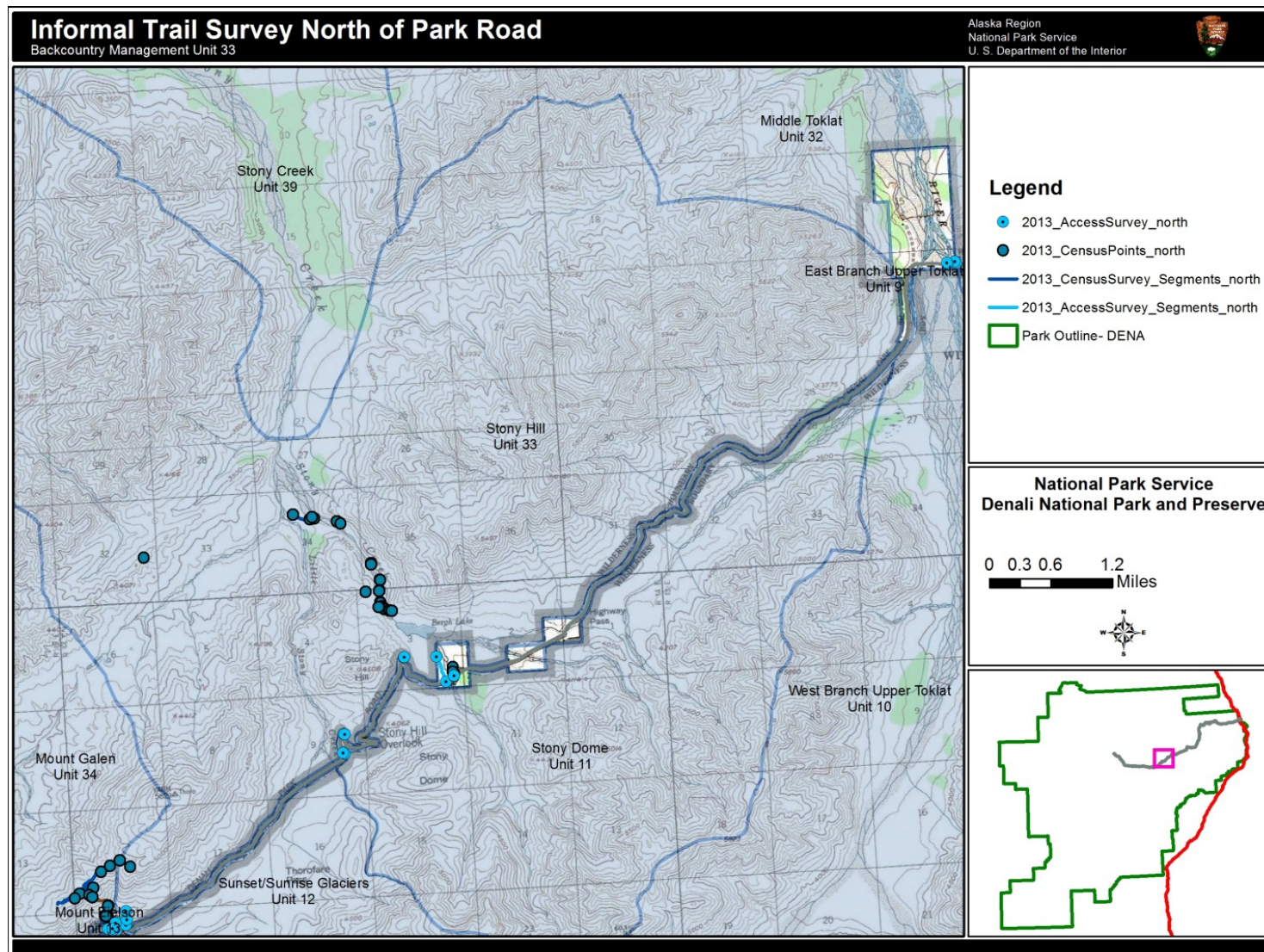


Figure D13. IT Survey, Backcountry Management Unit 33.

Figure D14. IT Survey, Backcountry Management Unit 34