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Backcountry Campsite Environmental Changes and Effective Monitoring Practices: A Case Study in Kenai Fjords National Park

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ON THE COVER
Campers in Kenai Fjords National Park at a backcountry campsite in Northwestern Fjord.
NPS Photo

Backcountry Campsite Environmental Changes and Effective Monitoring Practices

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Natural Resource Report NPS/KEFJ/NRR—2021/2289

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This report received informal peer review by subject-matter experts who were not directly involved in analysis or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

This report examines existing backcountry campsites' resource conditions over a five-year period in Kenai Fjords National Park (KEFJ), Alaska. Using campsite ecological monitoring techniques, 101 campsites were assessed for area size, vegetation cover loss, condition class assessments, as well as other indicator variable measurements. This research utilized parametric, non-parametric, robust linear regression, and principal component analysis statistical approaches to inform park managers of:

- Spatial and temporal patterns in changing campsite ecological variable conditions.
- Predicted annual variability of each ecological variable by campsite, beach, and bay.
- Opportunities for possible improvements in the efficiency of the current monitoring protocol by identifying:
    - An optimal sampling frequency.
    - Key ecological variables to sample.
    - Areas of concern to focus sampling efforts.

Patterns in changing campsites were difficult to discern until examined by park region (i.e., bay). Tree damage, mineral soil exposure, and root exposure were indicator variables sensitive to change while campsite area displayed changes in some locations. Future monitoring protocols should replace the rapid and complete assessments with a streamlined comprehensive protocol that reduces the number of indicator variables to include: rapid campsite area measurements, tree damage, vegetation cover loss, tent rock counts, trail counts, condition class ratings, and ghost tree damage. Campsite assessments should be conducted at a three to five-year sampling interval and revised if large significant changes occur or there is a significant change in the level of visitor use. As parks and protected areas continue to see increases in visitation and overnight use, the potential for recreational impacts increases without the appropriate management strategies. Our conclusions provide evidence to determine suitable management approaches and can be applied to future monitoring protocols to ease the burden of time intensive and expensive sampling.

Acknowledgments

We thank our field assistants including, K. Goonan, park officials, and park law enforcement, who helped to collect data in the field; Kenai Fjords National Park for the grant and overall opportunity to fulfill this research; C. Kriedeman, B. Pister, M. Hahr, L. Phillips, J. Cusick, and F. Klasner for their expertise, guidance, and support throughout the project.

List of Terms

Common acronyms:

- PPA - Park and Protected Area
- KEFJ - Kenai Fjords National Park
- GPS - Global Positioning System
- GIS – Geographic Information System

Ecological variables as defined by Monz et al. 2011 Coastal Campsite Monitoring Protocol:

- Azimuth – The compass heading or “bearing” used in the radial transect method to determine campsite area.
- Campsite – Backcountry areas of disturbed vegetation, surface litter, or soils caused by use during overnight stays.
- Condition Class – Numerical categorization of campsite condition that refers to several ecological variables simultaneously: vegetation cover, mineral soil and root exposure, tree damage, trails, etc. inside the campsite perimeter.
- Fire Rings – Manmade rock formations to contain a camping fire.
- Ghost Tree – Dead standing tree stumps left behind from the 1964 Good Friday earthquake.
- High Tide Line – Marked by vegetation or sea debris at its highest point on the beach indicating the water level at high tide.
- Human Waste – Sightings of human feces and/or toilet paper.
- Mineral Soil – Soil devoid of the obvious organic layer and by general observation to consist only of mineral components (i.e., sand, silt, and clay).
- Substrate – A general term used to describe the soil-vegetation types where campsites and control plots are found.
    - Bedrock – Shelf bedrock.
    - Cobble – Fist sized rocks, larger than gravel, that do not move when you walk on them.
    - Sand – Sandy beach soils that do not form a surface crust in trampled areas.
    - Sand/Cobble – Combination of sandy soils and cobble stones.
    - Soil – Includes clay and loamy soils. Soil is a mixture of minerals, organic matter (dead and alive), water and air.
    - Soil/Cobble – Combination of soil and cobble stones.
- Tent Rocks – Rocks used to stake out tents.
- Trails - Trampled vegetation or exposed soil leading to or from a campsite.

- Trash – All recreation litter seen when standing in the center of the campsite, does not include flotsam.
- Tree/Ghost Tree Damage – Presence of scars, nails, cuts, fire burns as signified by a fire pit/site nearby all identified as human caused. Not windfall or bear damage related.
- Root Exposure – Tree root exposed due to trampling and erosion caused by human impacts.
- Vegetation Cover – Estimate percentage of the amount of live non-woody plants within the campsite and control plot perimeter.

Introduction

Purpose and Goals

This assessment of the ecological condition of campsites from 2008 to 2012 in Kenai Fjords National Park combines several statistical applications to analyze changing conditions and attempts to optimize the monitoring protocol for the future.

Specific objectives for our research were:

- Determine the amount of change and annual variability by each campsite.
- Determine which ecological variables had the greatest amount of change during the sample period.
- Identify spatial patterns of change by campsite, beach, and park region.
- Enhance the current monitoring protocol by identifying key ecological indicators to sample and determine an optimized sampling frequency.

By analyzing a five-year dataset of coastal campsite assessments, we addressed the following questions:

- What is the magnitude of change of the sampled ecological variables over time in camping locations in Kenai Fjords National Park (KEFJ)?
- How can the monitoring protocol be optimized to reduce indicator redundancy, site observation intervals, and be more efficient in the field?

Scientific Background

Monitoring natural resource conditions is fundamental to park and protected area (PPA) management (Manning, 2011). Preserving the integrity of natural resources is the responsibility of PPA managers. With increasing demand for outdoor recreation (Machlis & Tichnell, 2019), limiting the amount of ecological impact associated with increased visitation rates to recreation sites has grown more challenging. An effective and commonly used practice to evaluate recreational impacts, is to set up longitudinal monitoring programs. These programs assess changes in conditions and determine areas of concern based on the level of anthropogenic impacts. Study areas are commonly confined to popular visitor areas such as trails and campsites (Leung & Marion, 2000).

Multiple studies have been conducted that suggest some generalizations of campsite effects on the environment (e.g. Twardock et al., 2010; Arredondo et al., 2018; Cole & Hall, 1992). Cole and Hall (1992) discovered that even with increases in campsite size, vegetation cover remained consistent over an 11-year study period in Eagle Cap Wilderness, Oregon. Monz et al. (2010) summarized this phenomenon by explaining that on established sites, changes in areal extent or surface area were more obvious than the changes in the impact intensity. Increases in site numbers (which imply increases in surface area disturbances) over time may be more of a concern for managers than the degradation at the individual site level. This type of impact opens up a popular discussion for managers in terms of planning strategies. More confined "designated camping areas" limit the formation of new sites and allow for more desirable well-maintained sites, which work well in locations with high volumes of visitors (Brame & Cole, 2011; Leung & Marion, 1999). Conversely, Cole et al. (2008) found in a study of Grand Canyon National Park that, over 20 years, informal sites were created even under a functioning confinement campsite plan, resulting in an increase in total disturbed area. These results led managers to believe that a more dispersed campsite strategy plan works in areas where visitor campsite demand is low.

Dispersing or concentrating visitors to certain areas are not the only management strategies to reduce the amount of anthropogenic impacts. Hammitt et al. (2011) present type of recreational use, visitor behavior, timing of use, site hardening or shielding, and recreational site location as factors that can be manipulated by managers to reduce ecological impacts. When considering the composition of the recreational site location, vegetation morphology may be a better predictor of the resilience of a location than the amount of use (Cole, 1995a; 1995b; Shrader-Frechette et al., 1995). Numerous studies suggest that in terms of vegetation, the most resilient landscapes are those with rocky surfaces and grasses. Vegetation that is flexible, with rapid growth, and few stems tend to be the most resilient (Monz et al., 2013; Cole, 1995a; 1995b). Given that the ecological composition of many coastal camping locations in our study site are rocky, it is possible that there is little landcover disturbance caused by campers.

Kenai Fjords National Park (KEFJ) is in the unique position of offering experiences with receding tidewater glaciers, endangered wildlife, and backcountry adventures within a three hour drive of Anchorage, Alaska. Given the dispersal of overnight backcountry visitors in KEFJ, our study aims to investigate the potential ecological changes of campsites over a five-year sampling period. Determining the extent of ecological changes due to recreational influences in KEFJ helps managers improve backcountry experiences and may change how visitors are educated on Leave No Trace Principles to minimize damage. Additionally, while long term monitoring practices are vital to understanding the conditions of natural resources and how they might change due to certain management strategies, they are often expensive and time intensive. The original protocol for this project was designed to examine the ecological changes at campsites in KEFJ to a high degree of accuracy and precision. However, data collection often exceeded the time and resource expectations managers prepared for. Therefore, our study objectives were to inform managers of potential areas of concern in the backcountry landscape and how best to assess campsite conditions in the future.

The implications of our research test the applicability of Leung and Marion's (1999) multiple-indicator monitoring system in a coastal Alaskan setting and are relevant to all campsite monitoring protocols. By investigating the rate and presence of ecological change and comparing the extent of change to each location we have a better understanding of appropriate monitoring intervals for park managers and the relationships between the variables at each campsite. Understanding visitor influence on the environment is integral for park managers to better establish guidelines to reduce the anthropogenic impacts on the environment. This analysis optimizes future monitoring programs by suggesting alternative data collection frequencies and establishing key indicators for observation to reduce cost and staffing needs.

Methods

Study Site

Located in south central coastal Alaska, KEFJ provides a sanctuary for marine and terrestrial wildlife, a productive environment for colorful flora, and a dynamic geological landscape. Spanning 1,685km^2, KEFJ is less remote than other protected areas of Alaska. The Seward visitor center is less than a three hour drive from the city of Anchorage, making it more accessible to visitors because of the road system layout of the state. Unlike other protected areas of the state, visitors do not have to charter a plane or a boat to get to KEFJ once they are on the main Alaskan road system. Nearly 51% of the park is covered in ice with 14 named glaciers within the park boundary (Nagorski et al., 2010). The dynamic landscape receives 203 to 381 centimeters of precipitation each year, establishing it as part of the temperate rainforest biome. Sitka spruce (*Picea sitchensis*) and Mountain hemlock (*Tsuga mertensiana*) are the dominant tree species in the region. While a majority of the tree species are coniferous, there are a few deciduous species including: black cottonwoods (*Populus trichocarpa),* Sitka alder (*Alnus viridis ssp. sinuate*), and several willow (*Salix sp.*) species (NPS, 2018; Boggs et al., 2008).

With harsh weather conditions from September to April, visitor use is typically confined to the summer months. Overnight visitors arrive at their campsites via kayak, motorized boats, or, on the rare occasion, sea planes. With the exception of the walk-in campground near Exit Glacier, there are no formal or designated campsites in the park. Most camping is confined to 15 beaches dispersed in the most popular three bays of KEFJ: Northwestern Fjord, Aialik Bay, and Resurrection Bay (Figure 1). These are the three most accessible bays due to their proximity to Seward and where most backcountry visitors camp and recreate in the park. Campsite substrate types on these beaches are classified as sand, soil, cobble, or some combination of the three. Soil/sandy beaches occur near a source of sediment deposition: rivers, eroding sea cliffs, and sand transported by wind or from the ocean shelf (Ritter, 1986). Above the high tide line, where visitors camp, the beach is dominated by grasses, forbs, and ferns. Species include: American dunegrass (*Leymus mollis*), beach pea (*Lathyrus maritimus*), lady fern (*Athyrium filix*), and alpine buckler fern (*Dryopteris expansa*). Further beyond the high tide line common graminoid vegetation species include: *Hordeum bracteosum*, *Poa eminens*, *Festuca rubra*, *Deschampsia spp*., and others. The graywacke (cobble) beaches are a result of erosion on rocky shorelines and cliffs and are often the remains of deglaciation. With exposure to wave action and storm swells common resilient species on these beaches include: American dune grass (*Leymus mollis*) and beach pea (*Lathyrus maritimus*), sea sandwort (*Honckenya peploides*), mountain hemlock (*Tsuga mertensiana*), Scottish licorice-root (*Ligusticum scoticum*), villous cinquefoil (*Potentilla villosa*), and lupine (*Lupinus nootkatensis*) (Boggs et al., 2008).

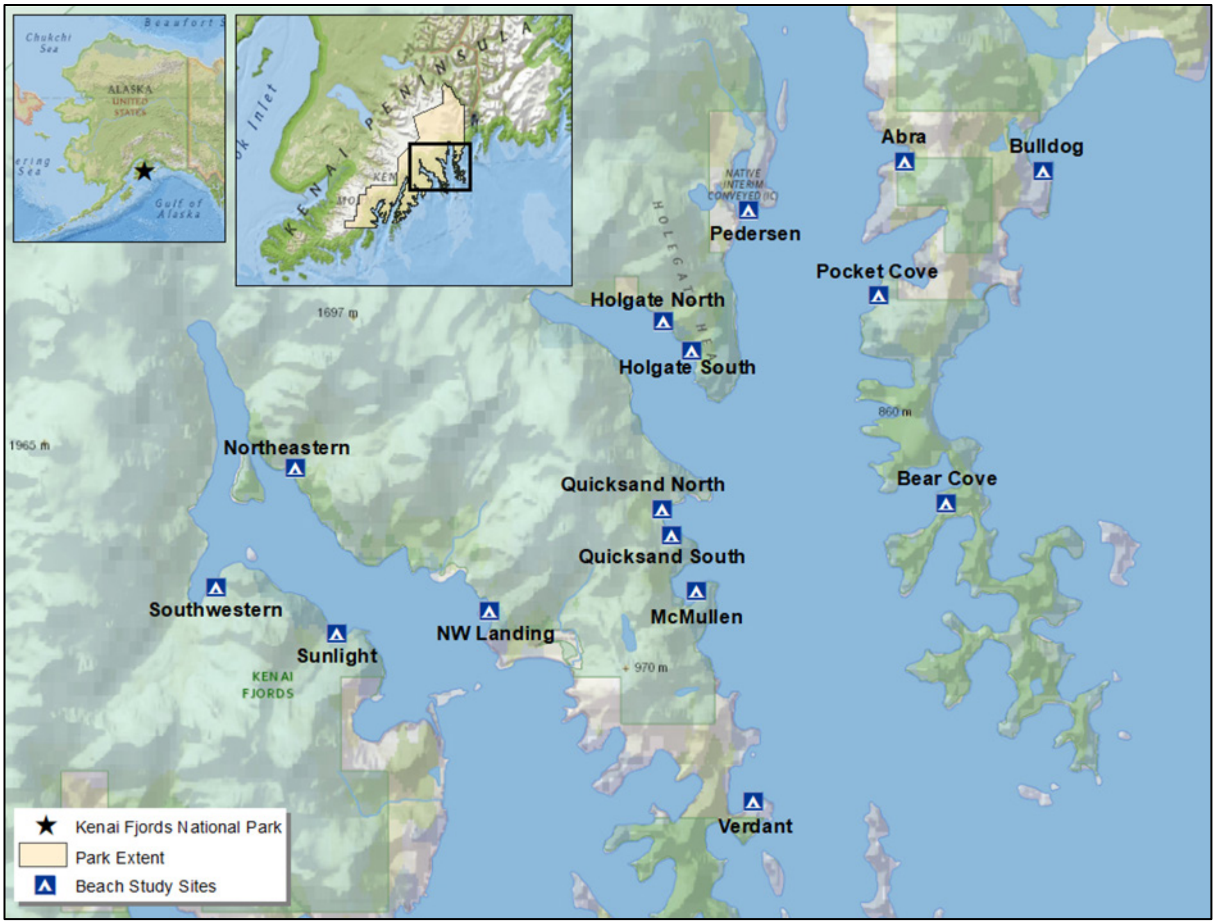

Figure 1. Beach locations of campsite study areas.

Data Collection

Monz et al. (2011) developed an Alaskan coast specific monitoring protocol following well established procedures created by Marion (1995), Leung and Marion (1999), Newsome et al. (2001), and previous work done by Monz and Twardock (2010). Data collection occurred from 2008 to 2012, with a sampling of 101 total observed campsites. To discern potential campsites, entire beaches feasible for camping were searched to find locations of flattened vegetation, surface layers, or soil disturbances that may indicate human influences. These search techniques occurred on the limited number of beaches able to accommodate camping. Combined with regular ranger patrols in most areas, this technique, provided a reasonable assurance that most camping locations were found and assessed.

Two types of campsite assessments were conducted as part of a long-term monitoring program for KEFJ: Rapid and Complete. Rapid assessments were designed to be done by one person and take approximately five minutes to complete per campsite. These quick assessments were intended to discover new sites not previously recorded and to check in on campsites the monitoring program was already aware of for large scale damages and severe ecological degradation. These assessments were planned to be performed in between regular monitoring field seasons to reduce the sampling burden

(Monz et al., 2011). However, due to staff changes and the desire to acquire a more comprehensive data set, rapid assessments only occurred in 2008 with complete assessments taking place in 2009 through 2012. Complete assessments were designed for two to three technicians to complete in about fifteen to twenty minutes. Using a Trimble Global Positioning System (GPS) unit, several observations of the campsite were noted and recorded (Tables 1 and 2). Campsite area measurements were captured following Marion's (1995) radial transect protocol (Monz et al., 2011 pg. 39). The perimeter of the campsite was flagged and a metal center point marker with a unique identification number was buried in the center of the campsite. With a technician standing on the center point, the azimuth, or compass bearing from magnetic north, was recorded and the distance from the center point to each established boundary flag was measured. This process allowed for the determination of parameter points that could be georeferenced and plotted as polygons in real space after the data was collected. Photographs were also taken of the exact location to assist with the identification of the campsite in the following sampling years. All data were then uploaded, stored, and analyzed in GPS Pathfinder Office to be reviewed and evaluated later (Marion, 1995; Monz et al., 2011). While the intentions and requirements were straightforward for each assessment protocol, technicians in the field found the protocols to be more cumbersome than expected. Relocating the metal campsite center point pins proved to be the most difficult and time intensive. Combined with setting up the boundary flags and establishing the compass bearings, complete assessments took 30 minutes per campsite.

Table 1. Impact assessment indicator variables, methods, and measurement scale.

Site Attribute	Method	Measurement Scale
Campsite Area	Radial transect	Square Meters
Distance from high tide	Measurement of campsite distance from high tide line marked by vegetation	Meters
Landing and campsite substrate type	Observation	Sand, Sand/Cobble, Cobble, Soil/Cobble, Soil, Bedrock
Tree Canopy	Observation	Presence/Absence
Vegetation cover onsite/control and mineral soil exposure onsite	Ocular estimation	Six level scale: 0-5%, 6-25%, 26-50%, 51-75%, 76-95%, 96-100%
Tree and ghost tree* damage and root exposure onsite	Ocular estimation	Four level scale: N/A, None/Slight, Moderate, Severe
Tree and ghost tree* stumps, fire rings, and trails	Counts	Total number present
Tent Rocks	Ocular estimation	Four level scale: 0, 1-5, 6-15, 16+
Trash	Ocular estimation	Three level scale: None to a handful, more than a handful to a gallon, greater than a gallon

* Ghost trees are the dead standing tree stumps left behind from the 1964 Good Friday earthquake. All three variables including root exposure, should only be assessed if trees are present.

Table 1 (continued). Impact assessment indicator variables, methods, and measurement scale.

Site Attribute	Method	Measurement Scale
Human Waste	Ocular estimation	Two level scale: None and Some
Condition Class	Ocular estimation	Six level classification scale

Table 2. Campsite condition class definitions (Monz et al. 2011, pg. 29).

Class	Description
Class 0:	• Describes a previously established site that has re-grown and is not showing current, observable disturbance. This class can only be used for re-measurement of an established site • Recreation site barely distinguishable • None or minimal disturbance of vegetation and/or organic liter • No observable vegetation loss in campsite as compared to off site
Class 1:	• Recreation site barely distinguishable • Slight loss of vegetation cover and/or minimal disturbance of organic liter • 6-25% vegetation loss in campsite as compared to off site
Class 2:	• Recreation site obvious • Vegetation cover lost and/or organic litter pulverized in primary use areas • 26-50% vegetation loss in campsite as compared to off site
Class 3:	• Vegetation cover lost and/or organic litter pulverized on much of the site • Some bare soil exposed in primary use areas • 51-75% vegetation loss in campsite as compared to off site
Class 4:	• Nearly complete or total loss of vegetation cover and organic liter • Bare soil widespread • 76-95% vegetation loss in campsite as compared to off site
Class 5:	• Soil erosion obvious, indicated by exposed tree roots and rocks and/or gullies formed • 96-100% vegetation loss in campsite as compared to off site

Data Processing and GIS Analysis

Polygons created from the radial transect measurements were imported into Esri's ArcMap 10.6.1 (2019, Environmental Systems Research Institute (ESRI), Redlands, CA, USA) and depicted campsite areas in meters squared. Center points, located in the center of each polygon, detailed the list of recorded variables (Monz et al., 2011). The polygons and center points were sorted by year of data collection and cleaned. Center points and polygons with notes indicating they were the new identification number for a center point marker that could not be found in the field were paired with the old center point marker number. For analysis purposes, campsites on beaches Verdant South and Verdant were combined due to their proximity to each other and to increase the sample size for a more accurate statistical analysis. Holgate Mid campsites were combined with Holgate South campsites for the same reason. While the majority of the indicator variables were recorded as numerical values or categories, vegetation cover loss needed to be calculated post hoc using vegetation cover estimates and the following equation (Monz & Twardock, 2010):

$$\text{Vegetation Cover Loss} = 1 - \frac{\text{\% cover in campsite}}{\text{\% cover in control plot}} \text{ X } 100\%$$

Statistical Analysis

Using a combination of parametric and non-parametric statistical analysis techniques, we determined which campsites, beaches, and regions had the most change during the study period, if there was redundancy in the observed indicator variables, and calculated more reasonable sampling intervals. A random coefficients model was used to estimate campsite ecological change by campsite, beach, and region over time. Campsites within a beach and beaches within a region were considered to be replicates. Each campsite, beach, and region was analyzed separately for each variable using a random coefficients model to estimate change per year as the linear slope coefficient. Random intercepts incorporated variance among campsites, however, there were too few repeated measures on campsites to estimate random slopes (Harrison et al., 2018). There were some limitations in definitively describing change by campsites due to smaller sample size, however, estimates for annual change were calculated. Since categorical variables used in this analysis were ordinal, they were recoded as integers. To determine which beach had the most ecological change, all estimated slopes for each indicator variable were ordered from most improved (negative integers) to most static (zero) or degrading (positive integers) and ranked. The data collection process was designed so each increase in category indicated progressive wear on the site. Positive values for change represented increased degradation and negative values for change indicated more recovery. Each variable ranking was added together to create one value to represent change rank amount for each beach. Each indictor held the same weight when being ranked to distinguish dynamic versus static beaches. This means, for example, campsite area had the same amount of pull in determining which beaches changed more as the amount of trash found on campsites.

Exploratory principal component analyses were conducted to visualize change occurring at campsites that were sampled more than once during the sampling period, using the estimated slopes data. Factor loadings were determined using varimax rotation and the results of the first two factors that describe the most variance were ordinated to illustrate patterns of change. A principal component analysis was used again using the cleaned raw data from each site, at each sampling year to determine if there was redundancy when measuring the independent indicator variables. This was an effort to determine if there were superfluous variables that could be excluded for a more efficient monitoring protocol (Monz & Twardock, 2010; Leung & Marion, 1999). Condition class rating assessments were not included in this analysis because of the covariance between these ratings and the other indicator variables. Condition class ratings were determined and provided as a generalization of all other indicator variables combined.

The data collection protocol specified intensive sampling measurements every other year at each campsite. The actual data collection sampling periods occurred more sporadically. Most sites were sampled in three-year increments (intensive sampling was completed three years apart). This proved to be beneficial for our study because it allowed us to determine a more appropriate intensive sampling interval. Paired student's T-tests were run on continuous variables, while Pearson's Chi-square tests were run for categorical data to determine which variables changed significantly over time (Twardock et al., 2010). Change significance of each indicator variable was conducted by interval sample group. Each campsite was assigned to one of four groups based on the time difference between its first sample and last. For example, if a site was first observed in 2008 and its last sample observation was in 2010, that site would be in the year 2 group. The sample number is often different for groups for each variable because there was missing data for some variables during sampling, but not all variables. By identifying when significant changes occurred for the variables, we determined a more efficient sampling interval.

Finally, to provide a more efficient method of measuring campsite area in the field, we compared the campsite area sizes that resulted from the radial transect method to estimated ellipses drawn around the polygons established by the radial transect method. To calculate the ellipse area, a major (a) and minor (b) axis of the campsite were drawn over the campsite polygon in ArcMap. The longest section from vertex to vertex was drawn as the major axis and the shortest section from vertex to vertex was drawn as the minor axis. Each axis aimed to cut the polygon in half trying to maintain equal parts on both sides (Figure 2). The estimated area was then calculated using the ellipse area equation:

$$Area = \pi \frac{\text{ab}}{2}$$

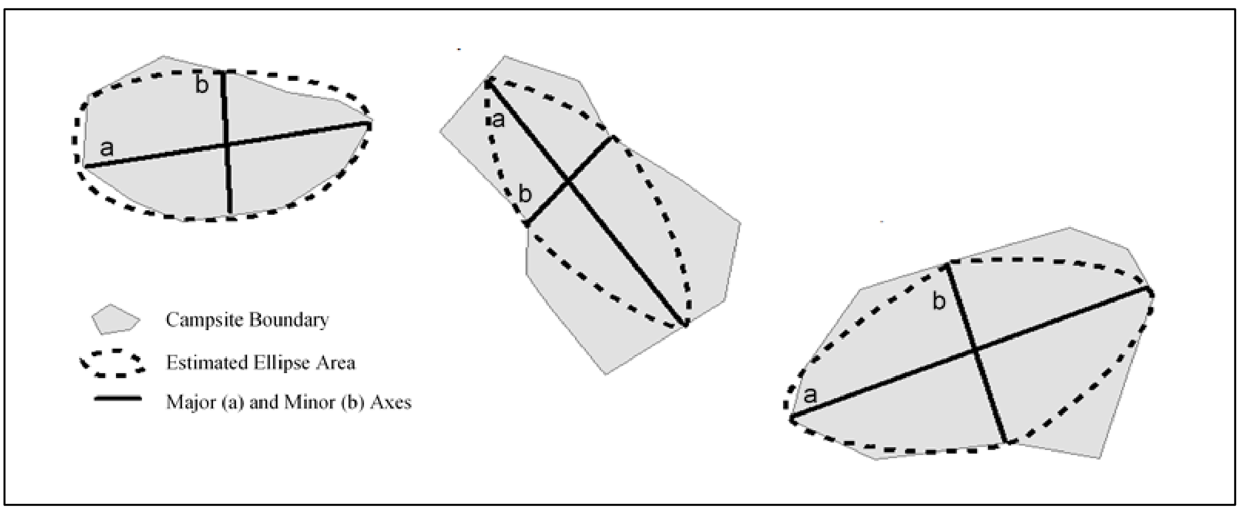

Figure 2. Drawn major and minor axes over theoretical campsite boundaries to create ellipse area estimations.

All 54 of the campsites measured in 2012 were used in the sample to determine if there was a significant difference in areas from the radial transect and ellipse methods. We calculated the means and standard deviations of both area measurements and compared the two with a paired T-Test to examine significant differences in the means. A simple linear regression analysis was also conducted in order to determine how well the ellipse areas could predict the true area determined by the radial transect. SPSS and R were used to summarize and conduct statistical analyses (v.25, IBM Corp., Armonk, NY, USA; v.1.1.456, R Foundation for Statistical Computing, Vienna, Austria).

Results

Descriptive Statistics

Over the five-year study period, measurable impacts were found on 101 campsites. Based on the data collected from every campsite for each year sampled, the mean area for campsites in KEFJ was 31.46m^2 (median = 19.52m^2). The mean condition class for all of the sites and their observations was two, indicating obvious recreational use. Vegetation loss and mineral soil exposure were both around 50%. There was a mean of 8.47 tent rocks found at each site (Table 3). It is possible that tent rock numbers were inflated, because tent rocks were not counted individually but rather in categories.

Table 3. Indicator variable summary for all sites in KEFJ. Values are mean ± SD for continuous variables and median ± range for ordinal variables.

Variable Type	Site Attribute	KEFJ Study Area	N
Continuous	Area (m^2)	31.46 ± 41.85	208
	Condition Class	2.14 ± 1.06	226
	Vegetation Loss (%)	55.66 ± 39.22	216
	Mineral Soil Exposure (%)	58.56 ± 37.15	213
	Tent Rocks	8.47 ± 5.98	221
	Trails	2.19 ± 1.63	230
	Fire Rings	0.18 ± 0.44	230
	Tree Stumps	0.19 ± 0.66	230
	Ghost Trees	0.19 ± 0.86	230
Ordinal	Tree Damage[a]	0 ± 2	170
	Ghost Tree Damage[a]	1 ± 2	61
	Root Exposure[a]	1 ± 2	173
	Trash[b]	1 ± 2	229
	Human Waste[c]	0 ± 1	229

[a] Categorical Variables: 0 = None/Slight, 1 = Moderate, 2 = Severe, NA = Not Applicable.

[b] Trash Variable: 0 = None to a handful 1 = Handful to a gallon, 2 = Greater than a gallon.

[c] Human Waste Variable: 0 = None and 1 = Some.

Campsite Change by Ecological Variable

A majority of variables were improving or remained static for each campsite. Trails and vegetation cover loss were the variables most likely to experience degradation. Number of tree stumps, fire rings, ghost tree damage, trash, and human waste predominately remained static. For these variables, if there was change, it was mostly improving. Campsites 93 (Pedersen) and 27 (Quicksand North) were the only two sampled sites that were degrading by four variables (area, vegetation loss, tent rocks, and mineral soil exposure), with the other variables remaining static. All other campsites either had a combination of recovering and static variables or a combination of recovering, static, and degrading variables (Tables 4a and 4b). Overall, 15 campsites recovered, and 14 new sites were found by the final year of sampling and no beaches experienced campsite proliferation.

Table 4a. Indicator variable baseline (intercept) and annual change (slope) estimates by beach. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Beach	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	# of Campsites
Abra	29.16	3.48	-64.06	16.80	1.88	0.00	0.00	0.00	7
	(-2.41)	(-0.27)[a]	(7.78)	(-0.91)	(0.04)	(0.00)	(0.00)	(0.00)	
Bear Cove	117.99	3.97	-40.29	8.05	3.82	1.22	-0.03	0.00	6
	(-19.27)[a]	(-0.42)[b]	(1.60)	(0.10)	(-0.29)	(0.00)	(0.25)[b]	(0.00)	
Bulldog	78.36	3.57	-44.10	13.72	1.52	0.105	0.37	0.00	5
	(-12.78)[a]	(-0.52)[a]	(-7.62)	(-1.22)	(0.03)	(-0.01)	(0.26)[a]	(0.00)	
Holgate North	53.59	4.09	-29.47	19.09	4.17	0.18	-0.10	0.00	6
	(-8.71)	(-0.78)[b]	(-7.33)[a]	(-3.15)[a]	(-0.83)[b]	(-0.04)	(0.26)[b]	(0.00)	
Holgate South	51.96	5.14	-13.26	7.02	1.89	0.42	0.00	0.00	3
	(-9.90)[a]	(-0.90)[a]	(-4.08)	(-0.75)	(-0.23)	(0.00)	(0.00)	(0.00)	
McMullen	26.48	1.54	-67.63	1.14	0.60	0.92	-0.11	0.28	4
	(-2.99)	(0.04)	(0.00)	(2.85)	(0.13)	(-0.13)	(0.25)[b]	(-0.06)	
Northeastern	99.82	2.92	-78.13	12.47	1.86	0.00	0.00	0.00	11
	(-10.35)[a]	(-0.13)	(6.25)	(-0.75)	(0.21)[a]	(0.00)	(0.00)	(0.00)	
NW Landing	14.89	0.25	-70.03	6.75	1.00	0.00	0.00	0.00	4
	(2.22)	(0.75)	(-1.77)	(-0.25)	(0.75)	(0.00)	(0.00)	(0.00)	
Pedersen	63.74	2.42	-57.68	4.22	2.79	0.64	0.00	0.00	13
	(-9.84)	(-0.04)	(0.23)	(-0.23)	(0.24)	(-0.11)	(0.00)	(0.00)	
Pocket Cove	62.30	4.16	-40.05	14.76	-0.55	1.39	0.00	0.00	2
	(-9.36)	(-0.58)	(7.83)	(-0.88)	(0.32)	(-0.17)	(0.00)	(0.00)	
Quicksand North	30.82	3.13	-40.17	0.56	3.50	0.63	0.00	0.00	4
	(-2.01)	(-0.13)	(6.75)	(0.56)	(-0.25)	(-0.13)	(0.00)	(0.00)	

[a] P-value < 0.05

[b] P-value <0.001

Table 4a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by beach. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Beach	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	# of Campsites
Quicksand South	45.98	4.65	-45.99	14.05	3.25	1.79	0.00	0.00	7
	(-7.69)[a]	(-0.80)[b]	(5.07)	(-2.33)[a]	(-0.37)	(-0.36)[a]	(0.00)	(0.00)	
Southwestern	14.12	2.02	-43.42	14.30	0.07	0.00	0.00	0.00	6
	(-0.76)	(0.00)	(5.74)	(0.06)	(0.31)	(0.00)	(0.00)	(0.00)	
Verdant	59.19	3.77	-18.48	17.08	1.19	1.41	0.00	-0.14	7
	(-9.19)[a]	(-0.58)[a]	(1.65)	(-2.07)[a]	(0.01)	(-0.15)	(0.00)	(0.05)	

[a] P-value < 0.05

[b] P-value <0.001

Table 4b. Indicator variable baseline (intercept) and annual change (slope) estimates by beach. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Beach	Mineral Soil Exposure (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	# of Campsites
Abra	67.53	0.00	0.00	1.05	0.84	7
	(-0.43)	(0.00)	(0.00)	(-0.17)	(-0.12)	
Bear Cove	65.63	0.11	0.69	1.00	1.06	6
	(-2.96)	(0.00)	(-0.08)	(0.00)	(0.00)	
Bulldog	82.62	0.68	0.00	1.53	1.52	5
	(-7.18)	(-0.10)	(0.00)	(-0.19)	(-0.25)[a]	
Holgate North	70.66	0.00	0.00	0.26	0.25	6
	(-4.26)	(0.00)	(0.00)	(0.01)	(0.12)	
Holgate South	124.29	0.00	0.00	1.30	1.30	3
	(-18.04)[a]	(0.00)	(0.00)	(-0.13)	(-0.13)	
McMullen	98.00	0.07	0.00	0.09	0.00	4
	(0.00)	(0.13)	(0.00)	(0.00)	(0.00)	
Northeastern	66.76	0.13	-0.08	1.68	1.47	11
	(-3.54)[a]	(0.00)	(0.03)	(-0.23)[a]	(-0.19)[b]	
NW Landing	-0.13	0.75	3.75	0.75	0.75	4
	(8.88)	(-0.25)	(-1.25)	(0.25)	(0.25)	
Pedersen	-11.08	0.29	-0.12	0.84	1.59	13
	(7.50)[a]	(0.01)	(0.21)[a]	(0.11)[a]	(0.03)	
Pocket Cove	93.92	0.50	-0.35	-0.35	0.33	2
	(-0.27)	(0.00)	(0.17)	(0.17)	(0.02)	
Quicksand North	66.63	0.00	0.00	1.00	1.00	4
	(1.50)	(0.00)	(0.00)	(0.00)	(0.00)	
Quicksand South	87.32	0.00	0.00	1.36	0.64	7
	(-3.34)	(0.00)	(0.00)	(-0.07)	(0.07)	
Southwestern	95.50	0.00	0.00	1.58	1.58	6
	(0.00)	(0.00)	(0.00)	(-0.24)[a]	(-0.24)[a]	
Verdant	94.72	0.51	0.38	1.22	0.69	7
	(-0.60)	(-0.05)	(-0.01)	(-0.07)	(0.06)	

[a] P-value < 0.05

[b] P-value <0.001

At the beach level, by summing all ranked values for each variable Bulldog, Holgate South and North, and Quicksand South recovered the most. NW Landing experienced the most degradation, followed by Pedersen and McMullen (Table 5). This was the same pattern for fully recovered campsites. NW Landing was the only beach to experience, on average, an increase in area size.

While all remaining beaches had a reduction in campsite area, on average, campsites on Bear Cove, Bulldog, Holgate North and South, Northeastern, Pedersen, Pocket Cove, Quicksand South, Sunlight, and Verdant had the most significant area decreases (Figure 3). Sunlight beach was not included in this ranked analysis at the beach level because only one campsite was sampled more than once over the course of the sampling period. Beaches in Aialik Bay had the most recovering campsites. Northwestern Fjord had less recovery and was the location for the most new sites found at the end of the study period. Bulldog beach was ranked the highest in terms of recovery but is the only beach sampled in Resurrection Bay. While we were able to rank the amount of change at each sampling level, change was still somewhat marginal for most variables. Change values for each indicator variable can be found by campsite and by region in the Appendix.

Table 5. Ranks of all indicator variables' change by beach.

Beach	Change Rank[a]
Bulldog	1
Holgate South	2
Holgate North	3
Quicksand South	4
Verdant	5
Bear Cove	6
Northeastern	7
Abra	8
Pocket Cove	9
Southwestern	10
Quicksand North	11
McMullen	12
Pedersen	13
NW Landing	14

[a] Change ranks are based on the amount of change occurring for each variable and their sum. By beach, each variable is ranked from most recovery to most degradation and all variable rank scores are summed.

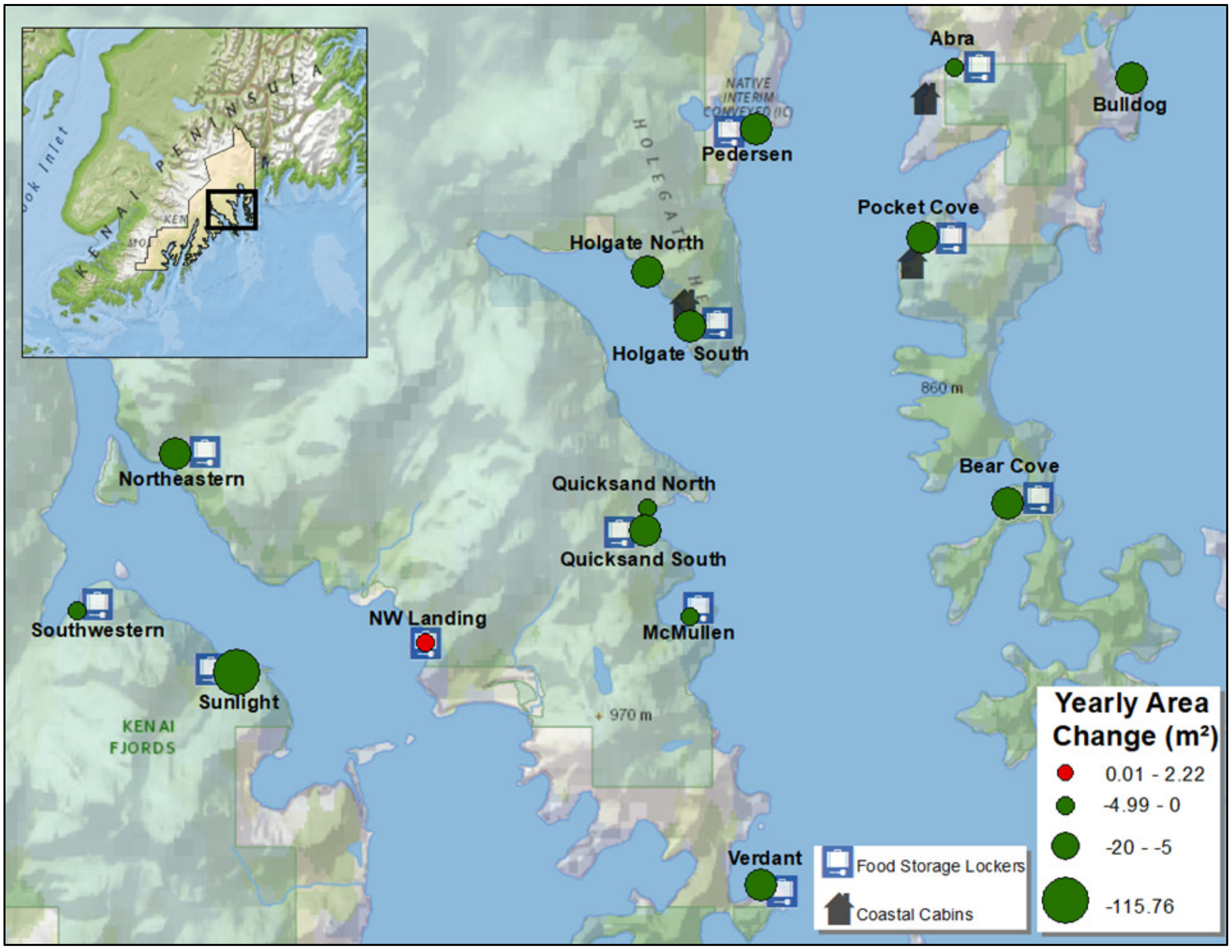

Figure 3. Yearly campsite area change by beach. Red campsite areas (NW Landing) depict area increases. Larger green circles depict greater area reductions.

Ecological Variable Change

Campsite area, tree damage, and root exposure are the most sensitive to change of all indicator variables. The data for this analysis includes the 70 campsites with at least two observation sample periods and no missing data. The exploratory principal component analysis revealed five factors that explained 64.6% of the variation in the change data. Campsite area, tree damage, and root exposure influence the first factor the most and account for 16.3% of the variance. The second factor explains 13.9% of the variability and includes variables: condition class, mineral soil exposure, trails, and trash (Table 6). For ease of interpretation, factor loadings between -0.4 and 0.4 are not listed. Factor loadings are reported as positive or negative because change occurs in either direction.

Table 6. Factor analysis of indicator variables' change of campsites in KEFJ.

	Rotated Factor Loadings[a]				
Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
Campsite Area	-.650	–	–	–	–
Condition Class	–	.755	–	–	–
Vegetation Cover Loss	–	–	-.708	–	–
Mineral Soil Exposure	–	.462	–	–	–
Tent Rocks	–	–	–	-.769	–
Trails	–	.708	–	–	–
Fire Rings	–	–	.764	–	–
Tree Stumps	–	–	.768	–	–
Tree Damage	.887	–	–	–	–
Ghost Tree Damage	–	–	–	–	.926
Root Exposure	.851	–	–	–	–
Trash	–	.654	–	–	–
Human Waste	–	–	–	.788	–
Cumulative Variation Explanation (Percent)	16.3	30.2	43.9	56.2	64.6

[a] Principal components extraction results with varimax rotation. Factors loadings above 0.4 are presented for ease of interpretation. N = 70.

The ordination visualizes which campsites are changing differently from other campsites, based on the variables that loaded the highest in factor one and two. There appears to be no pattern of a specific beach experiencing more exaggerated change than others (Figure 4). Campsite 66, the only campsite on Sunlight beach with more than one year of data, is varying from the clustering of campsites for the factor one variables. This particular campsite did experience a decrease in area size between sampling periods. Where a majority of campsites were observed to have a 10m^2 or less difference in area size per year, campsite 66 decreased in size by 115.76m^2 annually. Additionally, most campsites do not exhibit much change in tree damage or root exposure from year to year, but for this site, severity for both variables increased. Campsite 47 also presented itself as an outlier in the ordination plot. This site stood out as different from other sites because of its annual 10.25m^2 area growth, where the majority of sites were declining in size. Similar to campsite 66, this site's change in tree damage and root exposure changes drastically from year to year. For most sites, if there was a change in these variables, it is incremental. Unlike campsite 66, campsite 47 had severe tree damage and root exposure in the first year of sampling and improved by the final sample (Tables A1a and A1b in Appendix A).

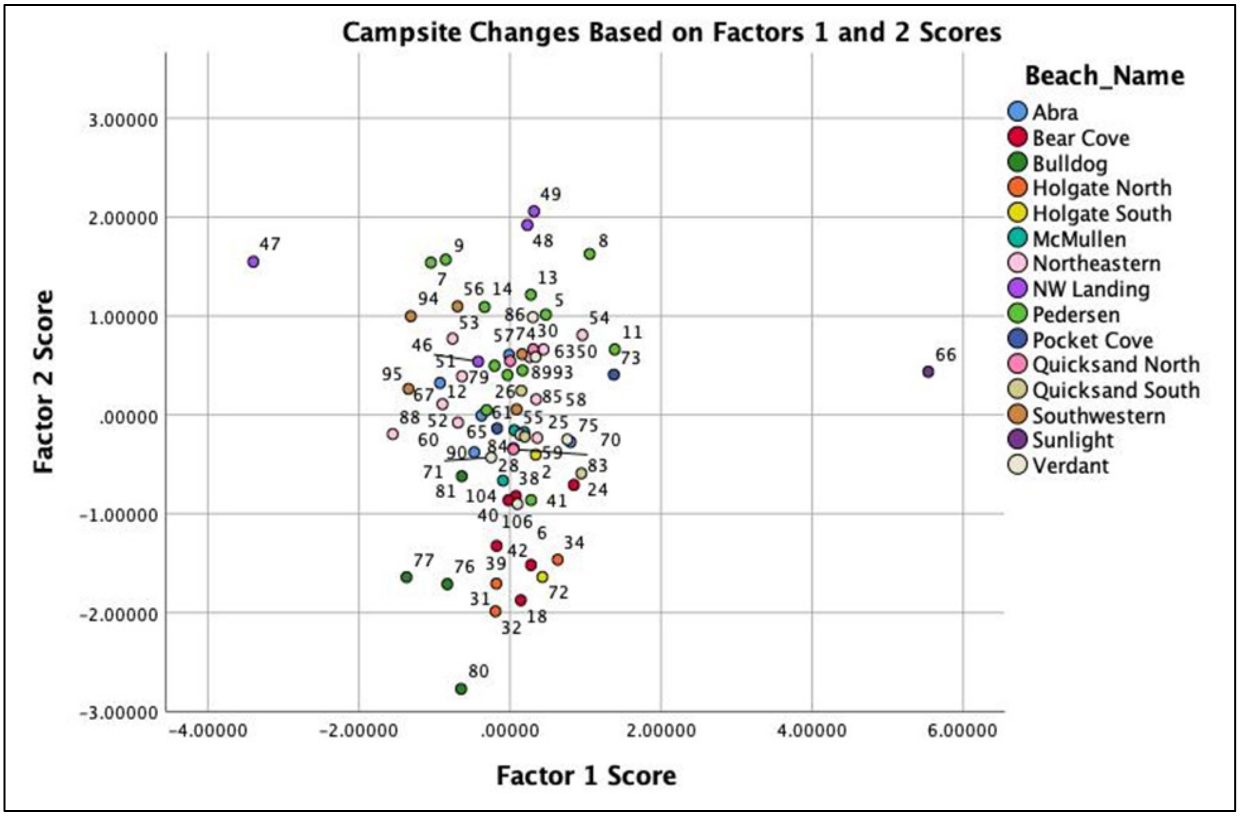

Figure 4. Scatterplot of campsites based on amount of change of variables in Factors 1 and 2. **Factor 1:** Area, Tree Damage, and Root Exposure. **Factor 2:** Condition Class, Mineral Soil Exposure, Trails, and Trash.

Factor two scores indicated some patterns by beach as all campsites on Bear Cove and Bulldog beach fell below zero on the Y axis while all of NW Landing and the majority of Pedersen campsites were above zero. This indicates there was a greater magnitude of change at these beaches for the variables condition class, mineral soil exposure, trails, and trash. Bear Cove and Bulldog campsites recovered more for all variables, while NW Landing and Pedersen campsites were degrading. This is evidenced when comparing Bulldog campsite 80 to NW Landing campsites 48 and 49. Campsite 80 improves by one condition class rating and decreases mineral soil exposure by 25% annually, ultimately recovering by the end of sampling. Both campsites 48 and 49 degraded by one condition class rating and gained a trail each year. Mineral soil exposure and trash observations remained static (Tables A1a and A1b in Appendix).

Optimizing the Monitoring Protocol

Redundant Ecological Variables

The data for this analysis included all 186 observations from the 101 campsites. Since this was the cleaned raw data, it included each sample made from all sampling periods for each campsite. Six equations were created to explain 74.1% of the variation in the data (Table 7). Variables loading similarly on the same factor accounted for similar characteristics in the data set. By eliminating one of the variables per factor, most of the variance could still be identified with less measurements. For example, factor two was most influenced by vegetation cover loss, mineral soil exposure, and tent rocks. A future protocol might suggest only measuring vegetation cover loss instead of mineral soil exposure, because it is easier to properly identify vegetation than it is mineral soil exposure with limited training. The elimination of the excessive variable measurement would still account for most of the variation in the data. Additionally, these results also suggest that removing trash, campsite area, and tent rocks as measured variables would yield a new protocol that would still capture 53.7% of the variance in the data.

Table 7. Factor analysis of indicator variables' campsites in KEFJ.

	Rotated Factor Loadings[a]					
Site Attribute	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Campsite Area	–	–	–	–	.799	–
Vegetation Cover Loss	–	.841	–	–	–	–
Mineral Soil Exposure	–	.890	–	–	–	–
Tent Rocks	–	.437	–	–	.643	–
Trails	–	–	–	.655	–	–
Fire Rings	–	–	–	.756	–	–
Tree Stumps	–	–	–	.502	–	–
Ghost Tree Stumps	–	–	.858	–	–	–
Tree Damage	.940	–	–	–	–	–
Ghost Tree Damage	–	–	.760	–	–	–
Root Exposure	.935	–	–	–	–	–
Trash	–	–	–	–	–	.882
Cumulative Variation Explanation (Percent)	16.6	31.5	42.7	53.7	64.0	74.1

[a] Principal components extraction results with varimax rotation. Factors loadings above 0.4 are presented for ease of interpretation. N = 186.

Sampling Interval

To determine a more appropriate sampling interval, paired Student's T-tests were run to compare the value of the first sample of the measured variable to the last and test for a significant change (Tables 8a and 8b). Our results indicated very little observable change occurred within one year. Significant changes did occur after at least two years. For the categorical variables root exposure, trash, and human waste there was no change detected between sampling years therefore, they were not included in Table 8b. Because ghost tree stumps are evidence of the 1964 Good Friday earthquake, the number of stumps at a campsite should not change as the stumps remain stationary. For this reason, the change in the number of ghost tree stumps was not evaluated, as there was no change. However, in campsites with ghost trees present, the level of damage to them was evaluated because this variable serves as an assessment of human impact when the damage can clearly be identified as human caused. Increased signs of damage such as scratches or cuts provided evidence of increased or irresponsible use.

Table 8a. Continuous indicator variable change significance by sampling interval.

Continuous Variable	Interval	Mean Difference	p-value	N
Area (m^2)	1 Year	-18.638	0.384	6
	2 Years*	-10.695	<0.001	30
	3 Years*	-20.96	<0.001	36
	4 Years	-64.452	0.078	6
Condition Class	1 Year	-0.429	0.120	7
	2 Years*	0.786	<0.001	28
	3 Years*	0.686	<0.001	35
	4 Years*	2.364	<0.001	11
Vegetation Loss	1 Year	26.112	0.232	9
	2 Years	-6.994	0.142	25
	3 Years	-9.911	0.057	32
	4 Years	0.500	0.965	12
Mineral Soil Exposure	1 Year	-1.857	0.736	7
	2 Years	-5.614	0.297	22
	3 Years	3.455	0.462	33
	4 Years	14.500	0.287	8
Tent Rocks	1 Year	0.143	0.928	7
	2 Years*	2.815	0.024	27
	3 Years*	1.280	0.042	34
	4 Years	3.100	0.451	10
Trails	1 Year*	-0.571	0.030	7
	2 Years	0.179	0.510	28
	3 Years	-0.400	0.124	35
	4 Years*	1.400	0.022	15

* Significant p-value <0.05

Table 8a (continued). Continuous indicator variable change significance by sampling interval.

Continuous Variable	Interval	Mean Difference	p-value	N
Fire Rings	1 Year	0.143	0.356	7
	2 Years	-0.072	0.161	28
	3 Years	0.057	0.624	35
	4 Years	-0.133	0.164	15
Tree Stumps	1 Year	0.714	0.253	7
	2 Years	0	1.000	28
	3 Years	-0.229	0.147	35
	4 Years	0.133	0.719	15

* Significant p-value <0.05

Table 8b. Categorical indicator variable change significance by sampling interval.

Categorical Variable	Interval	$\chi 2$	p-value	N
Tree Damage	1 Year	3.080	0.2144	7
	2 Years*	16.741	0.002	24
	3 Years	2.954	0.566	33
	4 Years*	11.123	<0.001	6
Ghost Tree Damage	1 Year	N/A	N/A	0
	2 Years*	6.412	0.041	11
	3 Years*	11.074	0.004	9
	4 Years	5.799	0.055	8

* Significant p-value <0.05

Ellipse Area Measurement

In 2012, campsite areas measured with the radial transect method were, on average, 20.58 m^2. On average, the same campsites measured using the ellipse estimation method were larger by a small margin at 21.02m^2 (Table 9). Radial transect and estimated area measurements were strongly and positively correlated ($r = 0.971$, $p < 0.001$). There was no significant difference between radial transect and estimated area measurements ($t_{53} = -0.93$, $p = 0.357$). On average, radial transect area measurements were 0.45m^2 smaller than estimated measurements (95% CI [-1.42, 0.52], Table 10). A simple linear regression analysis supported these results, explaining 94% of the variation across the two measures (Figure 5).

Table 9. Descriptive statistics of different campsite area measurement methods. N = 54.

Parameter	Mean	Standard Deviation
Radial Area (m^2)	20.58	14.66
Estimated Area (m^2)	21.02	14.57

Table 10. Paired samples correlations of radial versus estimated campsite area measurement methods. N = 54.

Correlation	Mean	Standard Deviation	Lower (95%)	Upper (95%)	t	df	Significance (2-tailed)
Radial - Estimated	-0.45	3.55	-1.42	0.52	-0.93	53	0.357

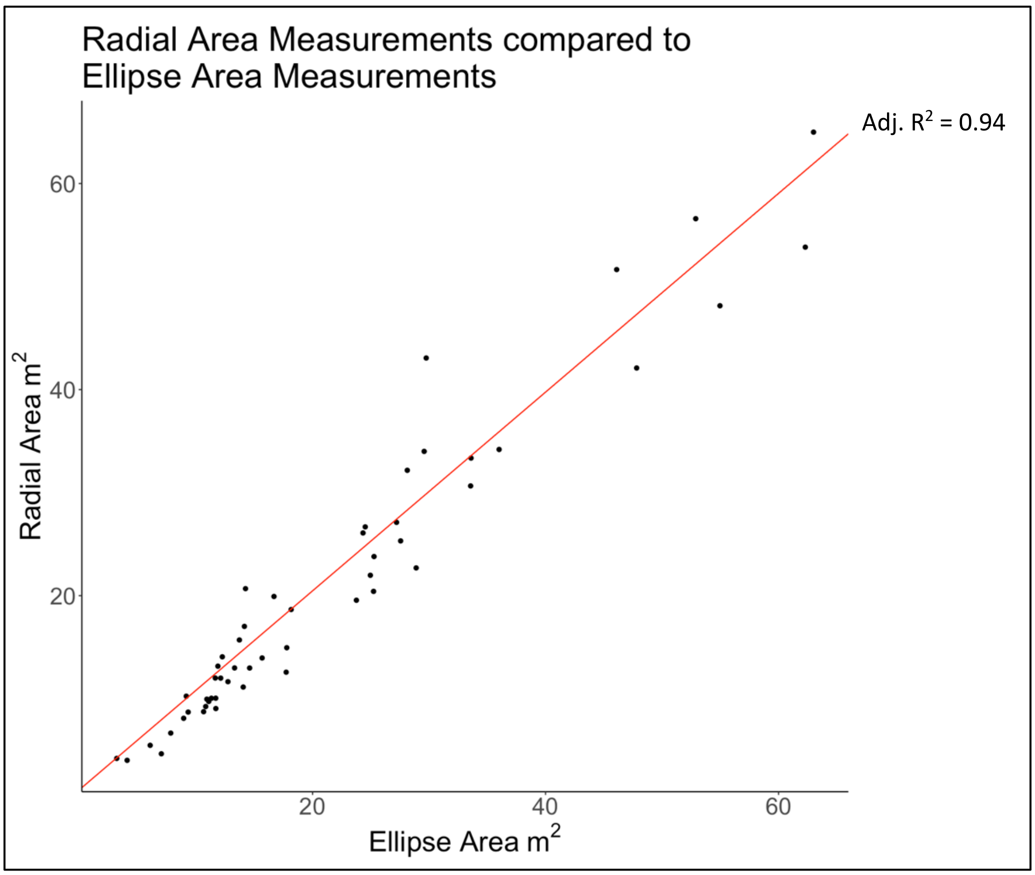

Figure 5. Simple linear regression model comparing radial area measurements to ellipse estimated area measurements. Regression line p-value <0.01, R^2 = 0.94.

Discussion

This assessment of campsite changes and the efficiency of current monitoring procedures is an important step in determining best natural resource management practices. Visitors notice ecological impacts on campsites (Farrell et al., 2001). Results from monitoring the conditions of visitor use areas provides the biophysical evidence to bridge the gap of what visitors find acceptable in terms of ecological impact and the reality of the condition they are in (D'Antonio et al., 2013; Goonan et al., 2012). Additionally, results from these assessments provide land managers evidence to justify restoration strategies if determined necessary. Confining visitors to certain designated camping areas (Reid & Marion, 2004), dispersing visitors to different areas (Cole et al., 2008), and closing campsites completely for restoration (Cole & Hall, 1992) are proven management strategies that have protected the natural resource (Hammitt et al., 2015).

Based on the results of our investigation, for our first objective, we have concluded that the majority of sites indicated recovery or remained static, but there was no spatial pattern in changing campsites at the individual or beach level. However, some spatial patterns were seen by park region. Resurrection Bay exhibited the most recovery, but only consisted of Bulldog beach. Given that Bulldog beach is exposed to high surf and weather from the Gulf of Alaska it is more dangerous to land a vessel there and may suggest fewer visitation levels. NW Landing beach, located in Northwestern Fjord, was a region of some concern. It was the only beach where campsites, on average, increased in size and variables were degrading more than recovering. Pedersen and McMullen beaches had slightly more degrading tendencies than other beaches as well and should continue to be monitored because of the new sites located in the later years of sampling. The same could be said for Abra, Sunlight, Southwestern, and Northeastern beaches. These are areas where new sites were discovered in the last two years of complete sampling assessments and there was little evidence of full recovery on older campsites. In comparison to the work by Twardock et al. (2010) in Prince William Sound, overall KEFJ campsites exhibited more recovery but appear to experience more degradation in terms of mineral soil exposure. While Twardock et al. (2010) presented findings that visitors were using multiple locations with less intensity, our results suggest a change in the overall pattern of use intensity. Visitors appear to be camping in completely different beach locations over time, allowing some beaches to recover while focusing use in other locations. Bulldog may have once been a popular destination, but Northwestern Fjord and areas of Aialik Bay seem to experience more use currently.

Our second conclusion, is that while campsite area did change and is an important measure of campsite impact (Monz & Twardock, 2010; Cole & Hall, 1992), it did not account for much of the variation in the data (Table 7). These mixed results indicate that area change occurs in some places and remains static in others. The precise nature of conducting a radial transect area measurement allowed for determining more sensitive changes in area (Table 6), even though most changes in area were quite small. This suggests that perhaps future monitoring protocols may not require the precision that radial transect measurements offer. While exact campsite areas may be helpful to capture sensitive changes in the data, they can be quite cumbersome in the field. A revised protocol might include a more rapid area measurements such as our suggested ellipse area calculation. With no significant difference in the areas calculated from the radial transect method compared to the ellipse estimation and with 94% of the variance accounted for, the ellipse measurements still offer accurate area measurements with just slightly less precision. In the field, the campsite boundary would still be established, however only the length of the major and minor axis would be measured. With this type of measurement, managers will still be able to identify areas of concern and determine sites that are increasing in size at an alarming rate.

Finally, our results suggest a few modifications to the current rapid and complete assessment (Monz et al., 2011) techniques are necessary. With very little change occurring in one year and by campsite, change seems to occur more broadly by only a subset of campsites, and after at least two years. Based on the paired Student's T-test and Pearson Chi-Square results, suitable monitoring assessments could be completed at a three to five-year sampling interval. Simultaneously considering all our statistical analysis approaches, the high priority variables would include: tree damage, vegetation cover on and offsite, tent rocks, trails, condition class ratings, ghost tree damage, and campsite area. Mineral soil exposure, vegetation cover loss, and root exposure all loaded fairly high in the principal component analysis and accounted for most of the variance in the data. As these variables were correlated, vegetation cover loss was chosen as the most effective indicator variable. Identifying percent vegetation cover on the campsite and at a control plot requires less training than identifying percent mineral soil exposure accurately. Mineral soil exposure can be a complicated variable to measure. It requires correctly identifying mineral soil substances as opposed to the more commonly seen organic soil layer. Root exposure was thought to be less universally applicable because a tree would need to be present on the campsite. Properly identifying an appropriate control plot to compare to the amount of vegetation found on the campsite is imperative to the vegetation cover loss variable. Technicians should be trained on locating control plots within five meters of the campsite's perimeter with the same substrate type. Since the variables trash and human waste occurred so infrequently and except for severe cases, are fairly ephemeral, they do not need their own category to classify during each observation. However, they are important indicators of previous use and deviations from Leave No Trace principles and they should be noted if found. Campsite substrate and high tide line measurements should also be taken for future analysis purposes that may shed light on the causation of some campsite changes. Henceforth, our optimal monitoring protocol would replace the need for separate rapid and complete campsite assessments, opting for one streamlined comprehensive sampling program that provides a consistent set of variables measured each time. Campsite assessments would occur every three to five years and include: rapid campsite area measurements, tree damage (noting N/A if there are no trees), percent vegetation onsite and at a control plot, tent rock counts, trail counts, condition class ratings, ghost tree damage (noting N/A if there are no ghost trees), campsite substrate type, high tide measurements (meters), and noting any campsite abnormalities such as trash or human waste. Sampling intervals should be adjusted if large amounts of change are occurring or if visitor use levels change significantly. In these instances, a shorter interval period may be necessary.

A successful monitoring protocol inevitably comes down to feasibility. Some of the limitations in our study were brought on because not all campsites could be sampled more than twice in the five-year study period. Our variable model predictions would be more robust if each campsite had more samples. Additionally, because these are results from observations taken a decade ago, it might be in the best interest of the park to conduct another round of monitoring using the original protocol to compare to these results. If large scale changes have not occurred, the monitoring interval could be extended beyond the suggested three to five years. Important logistics to consider when determining an appropriate monitoring protocol depends on finances, time, and crew availability. Locating the metal pins used as the site identifiers seems to be the most time consuming part of the assessment process. The investment in sub-decimeter high accuracy GPS units could potentially mitigate this issue. By collecting center point data at each site with a higher degree of precision, returning to that exact location should be much easier in years to come. Considering the geographical location of Alaska and the effect of the magnetic field in KEFJ, a sub-decimeter level of GPS precision when relocating the campsites center point pin may not be achievable. With this in mind, having photographs of the campsites with the center points clearly identified with permanent landmarks in the photographs may cut down on the search time for the center point. Efforts to relocate the metal center points with a high accuracy GPS unit and reference photos should not exceed five to seven minutes. A new center point using a technician's best judgement should be created if the search time exceeds seven minutes. More thoughtfully organized record keeping protocols could also decrease assessment times. This would include providing drop down menus to select from a short list of options to reduce sampling times for variables such as substrate type, percent vegetation cover, and tree and ghost tree damage. Taking counts of most variables as opposed to ordinal ocular estimations for variables such as tent rocks and trails would also provide more precise results. Additionally, understanding intensity of use or tracking where visitors camp would improve this analysis. Future research might include providing visitors with a GPS unit to track their trip or asking visitors to document which beaches they camped on after returning from their trip (D'Antonio et al., 2013; Stamberger et al., 2018).

Results from research such as this, provide park managers the information they need to determine how best to mitigate recreation ecological damage and maintain a wilderness experience for visitors. This analysis has also garnered evidence to improve existing campsite monitoring protocols. Management suggestions might include: designating campsites, moving to a reservation system for use, or promoting camping use on more durable surfaces. Furthermore, we believe the ecological conclusions brought forth in this report can be extended to public land campsites, off a road system, in temperate coastal rainforests. Campsites in British Columbia, Canada and the Pacific Northwest region of the United States would likely prove suitable environments to test the suggested optimized protocol.

Conclusions

While patterns in campsites were hard to discern, looking more broadly at the park region level, beaches in Resurrection (Bulldog) and Aialik Bay (Holgate North and South and Quicksand South) recovered more than beaches in Northwestern Fjord (NW Landing and Sunlight) of KEFJ. Future research would include continued longitudinal monitoring of these campsites. To have data that spans decades and has consistent sampling periods would provide a more robust analysis. An alternative monitoring protocol would call for comprehensive sampling every three to five years focusing on: rapid campsite area measurements, tree damage, vegetation cover onsite and at a control plot, tent rock counts, trail counts, condition class ratings, and ghost tree damage. Research such as this should also expand to other locations. Conducting this study in areas with similar biomes could corroborate and support these results or provide new insight into ecological impacts of backcountry camping.

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Appendix A. Annual Ecological Variable Changes by Campsite and Park Region

Indicator variable baseline and annual change estimates are presented by campsite in Tables A1a and A1b and by park region in Tables A2a and A2b.

Table A1a. Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Abra	67	17.96	2.00	-226.20	16.00	2.00	1.00	0.00	0.00	59.8945
		(3.08)[a]	(0.00)[a]	(30.70)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6438
	68	44.78	3.67	-23.60	16.00	4.00	1.00	0.00	0.00	59.8944
		(-4.87)[a]	(-0.33)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6440
	69	NA	1.00	-34.23	16.00	-2.00	1.00	0.00	0.00	59.8942
			(1.00)[a]	(9.55)[a]	(0.00)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6447
	74	28.72	2.57	-69.11	13.00	1.43	1.00	0.00	0.00	59.8943
		(-4.15)	(-0.07)	(12.22)	(-2.00)	(0.07)	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6423
	75	42.61	4.43	4.27	16.00	2.57	1.00	0.00	0.00	59.8944
		(-1.98)	(-0.43)	(-6.19)	(0.00)[a]	(-0.07)	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6443
	90	24.47	2.00	-88.62	24.25	4.50	1.00	0.00	0.00	59.8944
		(-3.80)[a]	(0.00)[a]	(9.76)[a]	(-2.75)[a]	(-0.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6425
	91	NA	4.50	-15.13	24.25	1.00	1.00	0.00	0.00	59.8943
			(-0.50)[a]	(0.00)[a]	(-2.75)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6419
Bear Cove	18	67.50	4.83	-30.04	6.38	4.50	1.25	1.10	0.00	59.7907
		(-8.44)[a]	(-0.50)	(5.16)	(0.37)	(-0.50)[d]	(0.25)[a]	(-0.25)[a]	(0.00)[a]	149.6167
	38	73.78	4.83	-7.69	14.92	2.58	1.67	1.08	0.00	59.7896
		(-9.42)[a]	(-0.50)	(0.00)	(0.25)	(0.25)	(0.00)[a]	(-0.25)[a]	(0.00)[a]	149.6167
	39	48.86	4.83	-3.06	20.33	4.20	1.00	1.75	0.00	59.7897
		(-3.26)	(-0.50)	(0.26)	(-3.00)	(-0.50)	(0.00)[a]	(-0.25)[a]	(0.00)[a]	149.6167

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Bear Cove (continued)	40	61.55 (-10.30)[a]	3.42 (-0.25)	-44.10 (5.16)	7.67 (-0.50)	5.17 (-0.50)	0.92 (0.25)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.7898 149.6167
	41	287.99 (-46.28)[a]	3.42 (-0.25)	-62.12 (-0.99)	-1.00 (3.50)	2.92 (0.25)[a]	1.67 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.7903 149.6166
	42[b]	137.60 (-28.95)	2.50 (-0.50)[d]	-94.75 (0.00)	0.00 (0.00)[a]	3.58 (-0.75)	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.7905 149.6161
Bulldog	76	57.00 (-3.10)	4.43 (-0.43)	-39.58 (4.02)	20.71 (-1.96)	3.86 (-0.36)	1.00 (0.00)[a]	1.86 (-0.36)[a]	0.00 (0.00)[a]	59.8913 149.5580
	77[b]	40.01 (-8.25)	3.14 (-0.64)	191.32 (-145.16)[a]	27.00 (-5.50)[a]	5.00 (-1.00)[d]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8914 149.5577
	78	NA	3.00 (-1.00)[a]	-20.04 (-26.32)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8921 149.5632
	80[b]	120.67 (-24.12)[a]	5.57 (-1.07)	18.75 (-20.95)[c]	13.00 (-2.00)	0.29 (0.21)	1.57 (-0.07)[a]	1.86 (-0.36)[a]	0.00 (0.00)[a]	59.8912 149.5572
	81	123.10 (-21.73)	3.00 (0.00)	-15.32 (2.13)	16.00 (0.00)[a]	-0.29 (0.79)	1.00 (0.00)[a]	1.86 (-0.36)[a]	0.00 (0.00)[a]	59.8913 149.5572

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Holgate North	31[b]	28.23 (-5.65)[a]	3.92 (-0.75)	-52.64 (-6.68)[a]	28.09 (-6.25)	2.50 (-0.50)[d]	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.8456 149.7887
	32	14.78 (-0.73)[a]	4.58 (-0.75)	2.04 (-5.42)	15.25 (-2.25)	4.58 (-0.75)	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.8456 149.7889
	33	NA	3.92 (-0.75)	-15.24 (-5.67)	28.04 (-3.63)	7.50 (-1.50)	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.8455 149.7890
	34[b]	79.52 (-15.90)[a]	5.00 (-1.00)[d]	-15.51 (-8.10)[a]	12.75 (-0.75)[a]	2.50 (-0.50)[d]	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.8453 149.7888
	35[b]	NA	3.25 (-0.75)	-15.66 (-27.78)[a]	7.50 (-1.50)[a]	3.25 (-0.75)	1.00 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.8454 149.7888
	36	NA	3.50 (-0.50)[a]	-52.64 (-6.68)[a]	14.50 (0.50)[a]	5.50 (-1.50)[a]	2.50 (-0.50)[a]	1.50 (-0.50)[a]	0.00 (0.00)[a]	59.8457 149.7890
Holgate South	2	87.38 (-16.48)	4.50 (-0.50)[a]	-59.05 (7.09)[a]	10.50 (0.00)[a]	4.50 (-0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8318 149.7688
	64[b]	32.46 (-6.49)[a]	5.00 (-1.00)[a]	NA	5.00 (-1.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8365 149.7717
	72[b]	32.97 (-6.34)	5.00 (-1.00)[d]	35.49 (-26.31)[a]	3.86 (-0.86)	1.86 (-0.36)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8380 149.7740

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
McMullen	84	35.23 (-4.45)[a]	2.00 (0.00)[a]	-71.04 (0.00)	-0.25 (3.75)	-0.50 (0.50)[d]	1.33 (0.00)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.7634 149.7685
	85	-4.34 (2.68)[a]	-0.50 (0.50)[a]	-133.95 (20.97)	-16.50 (6.50)[a]	-0.42 (0.25)	2.42 (-0.25)[a]	1.08 (-0.25)[a]	1.08 (-0.25)[a]	59.7635 149.7684
	104	47.34 (-6.48)[a]	2.00 (0.00)[a]	23.00 (-20.97)	16.00 (0.00)[a]	2.00 (0.00)[a]	2.75 (-0.25)[a]	1.08 (-0.25)[a]	0.00 (0.00)[a]	59.7633 149.7686
	114	NA	NA	-99.00 (0.00)[a]	NA	1.25 (-0.25)[a]	1.00 (0.00)[a]	1.25 (-0.25)[a]	0.00 (0.00)[a]	59.7627 149.7684
Northeastern	50	414.34 (-57.82)	2.57 (-0.07)	-89.53 (2.01)	16.00 (0.00)[a]	0.43 (0.57)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8016 150.0138
	51	35.44 (-5.68)	2.00 (0.00)[a]	-144.91 (10.20)	0.86 (2.14)	1.57 (-0.07)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8018 150.0138
	52	44.46 (-6.87)[c]	2.57 (-0.07)	-80.05 (7.98)	7.29 (-0.54)	2.57 (-0.07)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8015 150.0137
	53	54.66 (-10.30)	0.71 (0.29)	-144.91 (10.20)	5.57 (-1.07)	0.14 (0.36)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8015 150.0135
	54	191.49 (-7.87)	3.00 (0.00)	-134.31 (20.25)	16.00 (0.00)[a]	1.36 (0.36)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.8007 150.0126

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Northeastern (continued)	55	47.19	3.90	6.39	10.50	3.00	1.00	0.00	0.00	59.8009
		(-1.02)[a]	(-0.40)	(-20.07)	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0126
	58	70.25	3.89	-5.98	17.57	-0.14	1.00	0.00	0.00	59.8004
		(-8.72)	(-0.36)	(-2.84)	(-1.57)	(0.64)	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0123
	59	71.83	3.67	-136.04	16.00	4.00	1.00	0.00	0.00	59.8006
		(-1.37)[a]	(-0.33)[a]	(18.52)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0125
	60	38.76	3.00	-28.13	17.65	4.70	1.00	0.00	0.00	59.8005
		(4.46)	(0.00)[a]	(1.67)	(-1.65)	(-0.20)	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0128
	88	29.25	4.50	-91.11	26.25	3.00	1.00	0.00	0.00	59.8004
		(-1.94)[a]	(-0.50)[a]	(17.11)[a]	(-5.25)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0125
	89	39.17	4.67	-10.46	25.50	-1.33	1.00	0.00	0.00	59.8004
		(-5.20)[a]	(-0.50)	(1.83)	(-5.25)	(1.00)	(0.00)[a]	(0.00)[a]	(0.00)[a]	150.0124
NW Landing	46	17.47	3.00	-262.74	27.00	3.00	1.00	0.00	0.00	59.7563
		(-1.04)[a]	(0.00)[a]	(81.87)[a]	(-5.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.8944
	47	10.89	0.00	101.68	-12.00	1.00	1.00	0.00	0.00	59.7564
		(10.25)[a]	(1.00)[a]	(-62.64)[a]	(7.50)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.8945
	48	12.78	-1.00	-20.04	9.00	0.00	1.00	0.00	0.00	59.7565
		(0.09)[a]	(1.00)[a]	(-26.32)[a]	(-3.00)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.8945
	49	18.45	-1.00	-99.00	3.00	0.00	1.00	0.00	0.00	59.7566
		(-0.41)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.8945

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Pedersen	5	303.71	3.00	-27.94	7.29	5.86	1.00	0.00	0.00	59.8796
		(-61.65)	(0.00)	(1.64)	(-0.54)	(0.14)	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7369
	6	149.98	2.57	-64.02	3.00	7.43	2.71	0.00	0.00	59.8797
		(-28.05)	(-0.07)	(-5.65)	(0.00)	(-1.43)	(-0.21)[a]	(0.00)[a]	(0.00)[a]	149.7370
	7	11.71	3.00	-37.78	21.75	4.50	1.00	0.00	0.00	59.8798
		(2.39)	(0.00)[a]	(0.00)[a]	(-3.75)[a]	(0.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7367
	8	15.94	3.00	-34.17	7.50	-0.50	1.00	0.00	0.00	59.8797
		(-0.32)	(0.00)[a]	(6.45)[a]	(-1.50)[a]	(1.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7366
	9	43.24	3.00	-29.29	21.75	2.00	1.00	0.00	0.00	59.8797
		(-0.06)	(0.00)[a]	(-2.83)[a]	(-3.75)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7366
	11[b]	100.25	0.00	-99.00	-4.50	0.00	-0.50	0.00	0.00	59.8796
		(-22.28)	(0.00)[a]	(0.00)[a]	(1.50)[a]	(0.00)[a]	(0.50)[a]	(0.00)[a]	(0.00)[a]	149.7373
	12	20.84	2.86	-86.24	0.00	2.14	2.86	0.00	0.00	59.8798
		(-1.09)	(-0.36)	(0.00)	(0.00)[a]	(0.36)	(-0.36)[a]	(0.00)[a]	(0.00)[a]	149.7370
	13	17.10	2.00	-57.03	5.00	-1.00	1.00	0.00	0.00	59.8797
		(-1.80)[a]	(0.00)[a]	(-3.13)[a]	(-1.00)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7369
	14	13.61	2.00	-55.24	5.57	0.29	1.00	0.00	0.00	59.8799
		(-0.78)	(0.00)[a]	(-3.35)	(-1.07)	(0.71)	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7367
	16	37.19	4.00	-15.81	0.14	5.86	2.86	0.00	0.00	59.8795
		(-1.77)	(0.00)[a]	(-0.16)	(2.61)	(-0.36)	(-0.36)[a]	(0.00)[a]	(0.00)[a]	149.7371

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Pedersen (continued)	79	15.61	0.43	-99.00	1.29	0.43	1.00	0.00	0.00	59.8799
		(-2.32)[a]	(0.07)	(0.00)	(0.21)	(0.07)	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7364
	92	NA	3.00	-93.07	3.00	0.00	1.00	0.00	0.00	59.8795
			(0.00)[a]	(9.93)[a]	(0.00)[a]	(1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7368
	93	9.90	2.00	-116.54	-4.50	3.00	1.00	0.00	0.00	59.8795
		(0.34)[a]	(0.00)[a]	(14.62)[a]	(1.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7367
Pocket Cove	65	52.92	5.29	-18.90	10.50	-1.14	2.86	0.00	0.00	59.8533
		(-7.03)	(-0.79)	(3.77)	(0.00)	(0.64)	(-0.36)[a]	(0.00)[a]	(0.00)[a]	149.6577
	73	73.81	2.67	-64.34	19.67	0.00	1.00	0.00	0.00	59.8535
		(-11.95)[a]	(-0.33)[a]	(12.27)[a]	(-1.83)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.6577
Quicksand North	27	34.98	3.00	-38.37	3.00	3.00	1.00	0.00	0.00	59.7886
		(3.77)[a]	(0.00)[a]	(7.08)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7885
	28	54.92	4.50	-20.13	-8.25	3.50	3.50	0.00	0.00	59.7888
		(-9.24)[a]	(-0.50)[a]	(1.00)[a]	(3.75)[a]	(-0.50)[a]	(-0.50)[a]	(0.00)[a]	(0.00)[a]	149.7884
	30	7.96	2.00	-96.60	0.00	1.50	1.00	0.00	0.00	59.7880
		(-0.06)[a]	(0.00)[a]	(18.94)[a]	(0.00)[a]	(0.50)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7894
	83	25.41	3.00	-5.58	7.50	6.00	1.00	0.00	0.00	59.7884
		(-2.49)[a]	(0.00)[a]	(0.00)[a]	(-1.50)[a]	(-1.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	149.7889

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Quicksand South	19[b]	107.77 (-21.55)[a]	5.00 (-1.00)[a]	NA	NA	3.50 (-0.50)[a]	3.50 (-0.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7841 149.7897
	21[b]	36.34 (-7.27)[a]	2.50 (-0.50)[a]	NA	7.50 (-1.50)[a]	1.00 (0.00)[a]	-0.50 (0.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7840 149.7896
	22	NA	7.50 (-1.50)[a]	NA	7.50 (-1.50)[a]	4.50 (-0.50)	3.50 (-0.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7835 149.7895
	23[b]	25.13 (-5.03)[a]	5.00 (-1.00)[a]	NA	26.25 (-5.25)[a]	5.00 (-1.00)[a]	3.50 (-0.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7831 149.7891
	24	24.46 (-3.04)[a]	3.50 (-0.50)[a]	-72.68 (0.00)[a]	21.75 (-3.75)[a]	3.50 (-0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7827 149.7889
	25	68.70 (-11.17)[a]	4.50 (-0.50)[a]	-95.02 (18.41)[a]	3.00 (0.00)[a]	4.50 (-0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7826 149.7889
	26	27.50 (-0.74)[a]	4.50 (-0.50)[a]	-33.31 (3.24)[a]	24.25 (-2.75)[a]	0.50 (0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7828 149.7891
Southwestern	56	9.32 (1.45)	1.36 (0.36)	-22.95 (4.34)	16.00 (0.00)[a]	-1.29 (0.71)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7641 150.0605
	57	10.85 (0.46)	2.00 (0.00)[a]	-15.13 (0.00)[a]	16.00 (0.00)[a]	-0.67 (0.33)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7643 150.0605
	61	8.28 (0.71)	3.67 (-0.33)[a]	-23.24 (4.05)[a]	19.67 (-1.83)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7640 150.0608

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Southwestern (continued)	94	18.50 (-1.93)[a]	0.50 (0.50)[a]	-29.46 (4.78)[a]	2.25 (2.75)[a]	0.50 (0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7644 150.0602
	95	19.32 (-2.38)[a]	2.00 (0.00)[a]	-187.82 (29.61)[a]	2.25 (2.75)[a]	2.00 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7644 150.0604
	107[b]	39.51 (-7.90)[a]	NA	NA	NA	NA	NA	NA	NA	59.7643 150.0606
Sunlight	66	355.90 (-115.76)[a]	1.00 (0.00)[a]	20.04 (-39.68)[a]	10.50 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.7493 149.9845
Verdant	63	95.52 (-13.58)	2.14 (-0.14)	-9.67 (-0.68)	20.71 (-1.96)	-1.71 (0.71)	2.86 (-0.36)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6986 149.7329
	70	54.92 (-10.08)[c]	4.71 (-0.71)	-59.30 (11.91)	10.50 (0.00)	3.86 (-0.36)	1.29 (0.21)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6968 149.7387
	71	72.43 (-10.35)	4.71 (-0.71)	-10.96 (1.35)	16.93 (-2.68)	1.57 (-0.07)	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6967 149.7388
	86	38.41 (-4.54)[a]	1.57 (-0.07)	-15.13 (0.00)	13.64 (-0.39)	-1.71 (0.71)	1.43 (0.07)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6986 149.7331
	87[b]	31.52 (-6.30)[a]	5.00 (-1.00)[a]	NA	26.25 (-5.25)[a]	5.00 (-1.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6982 149.7340

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1a (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste	Latitude (°N) Longitude (°W)
Verdant (continued)	105[b]	64.59 (-12.92)[a]	7.50 (-1.50)[a]	NA	40.00 (-8.00)[a]	3.50 (-0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	1.50 (-0.25)[a]	59.6984 149.7334
	106	-13.84 (9.20)[a]	3.50 (-0.50)[a]	27.98 (-10.32)[a]	-8.25 (3.75)[a]	2.50 (-0.50)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	59.6981 149.7343

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

[d] P-value <0.001

Table A1b. Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (°N) Longitude (°W)
Abra	67	38.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	2.67 (-0.33)[a]	2.67 (-0.33)[a]	59.8945 149.6438
	68	85.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	2.67 (-0.33)[a]	1.00 (0.00)[a]	59.8944 149.6440
	69	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8942 149.6447
	74	29.43 (9.82)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.57 (-0.07)[a]	59.8943 149.6423
	75	120.86 (-11.61)[c]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.43 (0.07)[a]	0.71 (0.29)[a]	59.8944 149.6443
	90	71.75 (-11.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	3.50 (-0.50)[a]	59.8944 149.6425
	91	-52.00 (30.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8943 149.6419
Bear Cove	18	120.08 (-20.75)	0.00 (0.00)[a]	5.42 (-1.25)	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7907 149.6167
	38	85.50 (0.00)	0.33 (0.00)	-0.42 (0.25)	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7896 149.6167
	39	84.46 (3.12)	0.00 (0.00)[a]	-0.42 (0.25)	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7897 149.6167
	40	48.42 (8.75)	0.00 (0.00)[a]	-0.42 (0.25)	1.00 (0.00)[a]	1.67 (0.00)[a]	59.7898 149.6167
	41	52.79 (-8.88)	0.33 (0.00)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7903 149.6166
	42[b]	2.5 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7905 149.6161
Bulldog	76	92.64 (-0.89)	0.00 (0.00)[a]	0.00 (0.00)[a]	2.86 (-0.36)[a]	1.00 (0.00)[a]	59.8913 149.5580
	77[b]	63.00 (0.00)[a]	-0.86 (0.36)	0.00 (0.00)[a]	2.86 (-0.36)[a]	2.86 (-0.36)[a]	59.8914 149.5577

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A1b (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (°N) Longitude (°W)
Bulldog (continued)	78	2.50 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8921 149.5632
	80[b]	145.50 (-25.00)	1.29 (-0.29)	0.00 (0.00)[a]	2.86 (-0.36)[a]	2.29 (-0.29)[a]	59.8912 149.5572
	81	85.50 (0.00)	1.29 (-0.29)	0.00 (0.00)[a]	2.71 (-0.21)[a]	2.86 (-0.36)[a]	59.8913 149.5572
Holgate North	31[b]	38.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.33 (0.00)[a]	1.33 (0.00)[a]	59.8456 149.7887
	32	94.88 (-5.63)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.33 (0.00)[a]	1.33 (0.00)[a]	59.8456 149.7889
	33	87.38 (-5.63)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.33 (0.00)[a]	1.33 (0.00)[a]	59.8455 149.7890
	34[b]	51.75 (11.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	0.50 (0.50)[a]	59.8453 149.7888
	35[b]	75.50 (-12.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.33 (0.00)[a]	1.33 (0.00)[a]	59.8454 149.7888
	36	75.50 (-12.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	0.50 (0.50)[a]	1.00 (0.00)[a]	59.8457 149.7890
Holgate South	2	63.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8318 149.7688
	64[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	2.67 (-0.33)[a]	2.67 (-0.33)[a]	59.8365 149.7717
	72[b]	156.64 (-29.64)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8380 149.7740
McMullen	84	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.33 (0.00)[a]	1.00 (0.00)[a]	59.7634 149.7685
	85	98.00 (0.00)[a]	-0.42 (0.25)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7635 149.7684
	104	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7633 149.7686
	114	NA	0.75 (0.25)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7627 149.7684

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A1b (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (ºN) Longitude (ºW)
Northeastern	50	57.29 (-8.04)[a]	-0.86 (0.36)	-0.86 (0.36)	2.71 (-0.21)[a]	2.86 (-0.36)[a]	59.8016 150.0138
	51	2.50 (0.00)	-0.86 (0.36)	0.00 (0.00)[a]	2.71 (-0.21)[a]	2.86 (-0.36)[a]	59.8018 150.0138
	52	15.50 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	2.86 (-0.36)[a]	2.86 (-0.36)[a]	59.8015 150.0137
	53	2.50 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	2.86 (-0.36)[a]	2.86 (-0.36)[a]	59.8015 150.0135
	54	63.00 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	0.36 (0.36)[a]	1.00 (0.00)[a]	59.8007 150.0126
	55	79.00 (-4.75)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8009 150.0126
	58	101.57 (-3.57)	2.57 (-0.57)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8004 150.0123
	59	117.17 (-15.83)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8006 150.0125
	60	103.50 (-6.75)	0.00 (0.00)[a]	0.00 (0.00)[a]	2.20 (-0.20)[a]	2.80 (-0.30)[a]	59.8005 150.0128
	88	66.75 (6.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	3.50 (-0.50)[a]	3.50 (-0.50)[a]	59.8004 150.0125
	89	98.00 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8004 150.0124
NW Landing	46	18.00 (22.50)[a]	3.00 (-1.00)[a]	12.00 (-4.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7563 149.8944
	47	-23.50 (13.00)[a]	0.00 (0.00)[a]	3.00 (-1.00)[a]	4.00 (-1.00)[a]	4.00 (-1.00)[a]	59.7564 149.8945
	48	2.50 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7565 149.8945
	49	2.50 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7566 149.8945

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A1b (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (°N) Longitude (°W)
Pedersen	5	-41.93 (20.68)	1.00 (0.00)[a]	1.57 (-0.07)	2.29 (-0.29)[a]	1.00 (0.00)[a]	59.8796 149.7369
	6	2.50 (0.00)	1.29 (-0.29)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.57 (-0.07)[a]	59.8797 149.7370
	7	-88.25 (30.25)[a]	-1.50 (0.50)[a]	-1.50 (0.50)[a]	3.50 (-0.50)[a]	1.00 (0.00)[a]	59.8798 149.7367
	8	2.50 (0.00)[a]	1.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	-0.50 (0.50)[a]	59.8797 149.7366
	9	-50.75 (17.75)[a]	-1.50 (0.50)[a]	0.00 (0.00)[a]	3.50 (-0.50)[a]	1.00 (0.00)[a]	59.8797 149.7366
	11[b]	2.50 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	-0.50 (0.50)[a]	59.8796 149.7373
	12	2.50 (0.00)	1.29 (-0.29)	-0.86 (0.36)	1.00 (0.00)[a]	2.29 (-0.29)[a]	59.8798 149.7370
	13	-6.17 (4.33)[a]	0.00 (0.00)[a]	-1.33 (0.67)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8797 149.7369
	14	-27.93 (12.68)	0.00 (0.00)[a]	-0.86 (0.36)	1.00 (0.00)[a]	2.29 (-0.29)[a]	59.8799 149.7367
	16	43.71 (8.04)	-0.29 (0.29)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8795 149.7371
	79	2.50 (0.00)	0.00 (0.00)[a]	0.43 (0.71)	2.67 (-0.33)[a]	1.43 (0.07)[a]	59.8799 149.7364
	92	-50.75 (17.75)[a]	0.00 (0.00)[a]	3.50 (-0.50)[a]	1.00 (0.00)[a]	-0.50 (0.50)[a]	59.8795 149.7368
	93	2.50 (0.00)[a]	0.00 (0.00)[a]	3.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.8795 149.7367
Pocket Cove	65	108.71 (-4.46)	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	2.29 (-0.29)[a]	59.8533 149.6577
	73	77.17 (4.17)[a]	1.00 (0.00)[a]	-0.67 (0.33)[a]	0.33 (0.33)[a]	0.33 (0.33)[a]	59.8535 149.6577

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A1b (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (ºN) Longitude (ºW)
Quicksand North	27	66.75 (6.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7886 149.7885
	28	66.75 (6.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7888 149.7884
	30	35.00 (-6.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7880 149.7894
	83	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7884 149.7889
Quicksand South	19[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7841 149.7897
	21[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	-0.50 (0.50)[a]	1.00 (0.00)[a]	59.7840 149.7896
	22	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7835 149.7895
	23[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7831 149.7891
	24	71.75 (-11.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	-0.50 (0.50)[a]	59.7827 149.7889
	25	66.75 (6.25)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7826 149.7889
	26	63.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7828 149.7891
Southwestern	56	98.00 (0.00)	0.00 (0.00)[a]	0.00 (0.00)[a]	2.71 (-0.29)[a]	2.71 (-0.29)[a]	59.7641 150.0605
	57	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7643 150.0605
	61	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.7640 150.0608
	94	98.00 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	3.50 (-0.50)[a]	3.50 (-0.50)[a]	59.7644 150.0602

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A1b (continued). Indicator variable baseline (intercept) and annual change (slope) estimates by campsite. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Site	Tag Number	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure	Latitude (°N) Longitude (°W)
Southwestern (continued)	95	85.50 (0.00)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	3.50 (-0.50)[a]	3.50 (-0.50)[a]	59.7644 150.0604
	107[b]	NA	NA	NA	NA	NA	59.7643 150.0606
Sunlight	66	83.00 (-22.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (1.00)[a]	1.00 (1.00)[a]	59.7493 149.9845
Verdant	63	98.00 (0.00)	1.29 (-0.29)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.6986 149.7329
	70	74.79 (4.46)	0.29 (0.21)	3.86 (-0.86)	0.14 (0.36)[a]	1.00 (0.00)[a]	59.6968 149.7387
	71	74.79 (4.46)	1.29 (-0.29)	-2.57 (1.07)	1.00 (0.00)[a]	2.86 (-0.36)[a]	59.6967 149.7388
	86	98.00 (0.00)	-0.86 (0.36)	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.6986 149.7331
	87[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.6982 149.7340
	105[b]	NA	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.6984 149.7334
	106	150.50 (-17.50)[a]	0.00 (0.00)[a]	0.00 (0.00)[a]	1.00 (0.00)[a]	1.00 (0.00)[a]	59.6981 149.7343

[a] Sample size of 2. P-value is not attainable.

[b] Recovered campsite

[c] P-value < 0.05

Table A2a. Indicator variable baseline (intercept) and annual change (slope) estimates by park region. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Region	Area (m^2)	Condition Class	Vegetation Loss (%)	Tent Rocks	Trails	Ghost Tree Damage	Trash	Human Waste
Aialik Bay	66.79 (-11.05)[a]	3.64 (-0.44)[a]	-42.31 (1.42)	10.55 (-0.85)[b]	2.64 (-0.14)[b]	0.72 (-0.09)[b]	0.44 (0.13)[a]	0.02 (0.00)
Northwestern Fjord	66.99 (-7.61)[b]	2.43 (-0.06)	-74.96 (6.70)	11.47 (-0.37)	1.40 (0.23)[b]	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Resurrection Bay	78.36 (-12.78)[b]	3.41 (-0.48)[b]	-56.19 (-4.30)	16.80 (-2.04)	2.00 (-0.07)	0.18 (-0.03)	0.34 (0.27)[b]	0.00 (0.00)

[a] P-value < 0.05

[b] P-value <0.001

Table A2b. Indicator variable baseline (intercept) and annual change (slope) estimates by park region. Variable baseline of predicted 2008 value (Yearly Change). For all variables, a negative yearly change indicates improvement, 0 is no change, positive yearly change indicates degradation.

Region	Mineral Soil (%)	Fire Rings	Tree Stumps	Tree Damage	Root Exposure
Aialik Bay	62.35 (-0.28)	0.14 (0.01)	0.13 (0.03)	0.81 (0.00)	0.82 (0.03)
Northwestern Fjord	63.90 (-2.17)	0.13 (-0.01)	0.34 (-0.07)	1.66 (-0.23)[b]	1.54 (-0.20)[b]
Resurrection Bay	74.59 (-5.05)	0.46 (-0.04)	0.00 (0.00)	1.57 (-0.20)	1.44 (-0.23)[a]

[a] P-value < 0.05

[b] P-value <0.001

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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