National Park Service
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Natural Resource Stewardship and Science

Invasive Plant Management in Kenai Fjords National Park

2017 Summary Report

Natural Resource Report NPS/KEFJ/NRR—2018/1609





ON THIS PAGE
KEFJ EPMT chemically treating common dandelion in the Outwash Plain.
Photograph by Abigail Bobbette/NPS

ON THE COVER
Clockwise from the top-left: KEFJ EPMT and SCA crew at the park entrance sign at the Exit Glacier area; Common timothy on the Herman Leirer Road; SCA intern Abigail Bobbette mapping an Elodea survey line on Desire Lake; Biological Science Technician Geoffrey Geier and SCA Intern Abigail Bobbette surveying for invasive plants in Nuka Bay.
Photographs by Christina Kriedeman/NPS

Invasive Plant Management in Kenai Fjords National Park

2017 Summary Report

Natural Resource Report NPS/KEFJ/NRR—2018/1609

Geoffrey S. Geier and Christina L. Kriedeman

Kenai Fjords National Park
411 Washington Street
PO Box 1727
Seward, AK 99664

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Abstract

Invasive plant species have been documented and controlled in Kenai Fjords National Park (KEFJ) since the inception of the Alaska Exotic Plant Management Team (EMPT) program in 2004. In 2017, all known invasive plant infestations were revisited, mapped, and treated, with the exception of a common dandelion (*Taraxacum officinale*) population located on a nunatak near Petrof Glacier. In total, 58.72 acres were surveyed for invasive plants with 1.64 acres either chemically or manually treated. A total of 44.08 gallons of Milestone herbicide solution and 4.31 gallons of AquaMaster herbicide solution were used to chemically treat invasive plants in the Exit Glacier area, Maintenance Facility, and coastal fjords in 2017. Twelve invasive plant species were documented in KEFJ in 2017 with seven new invasive plant infestations found in the Exit Glacier area. A survey for the aquatic invasive plant Elodea (*Elodea spp.*) was performed on Desire Lake. Both a surface visual survey and environmental DNA (eDNA) sampling were completed. No Elodea was detected during the visual survey and eDNA sampling results have not been received yet. The park continued to participate in the gypsy moth (*Lymantria dispar*) monitoring program sponsored by the Alaska Division of Agriculture with no gypsy moths detected. In 2016, nearly one-mile of the park's segment of the Herman Leirer Road was reconstructed and this year, three sections of the roadside were reseeded. The KEFJ EMPT continued outreach and education efforts utilizing a variety of tools including community events, informative talks, social media posts, and interpretive displays. Continued efforts should be made to perform surveys for invasive plants, return to and treat known invasive plant infestations, identify areas that need restoration, monitor gypsy moths and Elodea, and provide outreach and education to the general public and park staff.

Acknowledgments

We would like to thank the following individuals for their contributions to a successful 2017 field season: Student Conservation Association (SCA) intern Abigail Bobbette and Youth Conservation Corps (YCC) employees Christopher Kingsland and Allison Rogers for their daily contributions as crew members; KEFJ employee Mark Kansteiner for logistical and technical support; National Park Service employees Christopher Overbaugh, Peter Frank, Wendy Mahovlic, and Joel Cusick along with University of Alaska Anchorage staff Justin Fulkerson and Dr. Matt Carlson, and volunteer Sue Salmons for their roles in Alaska Region Exotic Plant Management Team (EPMT) spring training and technical support throughout the season; KEFJ employees Ian Whittle, Nathaniel Charboneaux, and Amy Sherrow for operational and logistical support on the M/V Serac; KEFJ employees Philip Preti, Mark Dalpes, and Erik Johnson along with Student Conservation Association intern Lee Ayagarak for their help with a variety of EPMT projects including native seed collection, the Seward Community Weed Pull, and invasive plant surveys; members of the Kenai Peninsula Cooperative Weed Management Area for assistance in administering the Seward Community Weed Pull; KEFJ employee Sharon Kim for planning and administrative support; and KEFJ employee Aaron Vachowski along with the six-person SCA crew for their assistance with native plant restoration and invasive plant control.



NPS staff weighing annual bluegrass pulled on Exit Glacier area trails.

List of Terms

ABRS Aialik Bay Ranger Station

ADOT Alaska Department of Transportation

ANILCA Alaska National Interest Lands Conservation Act

AKEPIC Alaska Exotic Plants Information Clearinghouse

DNR Alaska Department of Natural Resources

eDNA Environmental DNA

EPMT Exotic Plant Management Team

GIS Geospatial Information System

GPS Global Positioning System

HIT Harding Icefield Trail

KEFJ Kenai Fjords National Park

M/V Motor Vessel

NISIMS National Park Service's National Invasive Species Information Management System

NPS National Park Service

PUC Public Use Cabin

SCA Student Conservation Association

SNOTEL Snowpack Telemetry

SWAN Southwest Alaska Inventory and Monitoring Network

WRST Wrangell-St. Elias National Park and Preserve

YCC Youth Conservation Corps

Introduction

Located on the southeastern coast of Alaska's Kenai Peninsula, Kenai Fjords National Park (KEFJ) is a unit of the National Park Service (NPS) established by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. The park's nearly 670,000 acres is noted for its rugged coastline, steep and dramatic ocean inlets, temperate rainforest and intertidal ecosystems, and the Harding Icefield, which feeds nearly 40 glaciers and covers over half of the park's land area (Figure 1).

Invasive plant species are of special concern due to their ability to outcompete native vegetation and form monotypic communities. The resulting loss of biodiversity threatens the capacity of an ecosystem to adapt to environmental changes over time. Invasive plants are often a less desirable and less nutritious food source for wildlife species. In most cases, invasive plants are established when native communities are disturbed, either through human development or natural disturbance. Due to the relatively low level of development at Kenai Fjords National Park, invasive plant populations are isolated to only a few areas within the boundary. This quality is of interest to the Kenai Fjords National Park Exotic Plant Management Team (KEFJ EPMT) because of the early detection and rapid response strategy adopted from protocols outlined by the Alaska Exotic Plant Management Team (EPMT) program. Emphasis is placed on surveying new areas and focused, repeated control efforts on known infestations in an effort to contain or eradicate them entirely.

Kenai Fjords National Park has inventoried and controlled invasive plants since the inception of the Alaska EPMT program in 2004. The park can be divided into three primary use areas: the Exit Glacier area, the outer coast, and the City of Seward and surrounding areas. With approximately 148,960 visitors between the months of June and September in 2017, the Exit Glacier area receives the majority of visitor use at Kenai Fjords National Park. This area contains the park's only road and trails system and is popular due to its ease of access to Exit Glacier and the Harding Icefield. The Exit Glacier area receives considerable attention from the EPMT due to the high level of visitor use, which is a primary vector for the spread of invasive plants. The coastal fjords, although less frequently utilized by visitors, also receives high priority from the KEFJ EPMT. Access to coastal areas is typically limited to boat or floatplane and the majority of invasive plant infestations can be found in concentrated areas of use such as public use cabins and camping areas. Due to the complexity of reaching these areas and the relatively intact nature of the KEFJ coastal ecosystems, great effort is made to eradicate these invasive plant populations before they spread further into the surrounding native plant communities. The primary focus in the Seward area is the Maintenance Facility, where a variety of invasive plant species exist. Park vehicles travel in and out of this area on a daily basis and can serve as vectors for the spread of invasive plants. To limit the spread of invasive plants into the park boundary, the Maintenance Facility received several chemical treatments throughout the 2017 field season.

In 2017, the KEFJ EMPT focused on mapping and treating all know invasive plant infestations. Inventories were also performed on new areas without known invasive plant populations. The EPMT continued to monitor for invasive gypsy moths and the aquatic invasive plant Elodea. Outreach and

education events were conducted to inform the general public and other park staff about threats invasive species pose on native communities and what they can do to mitigate those impacts.

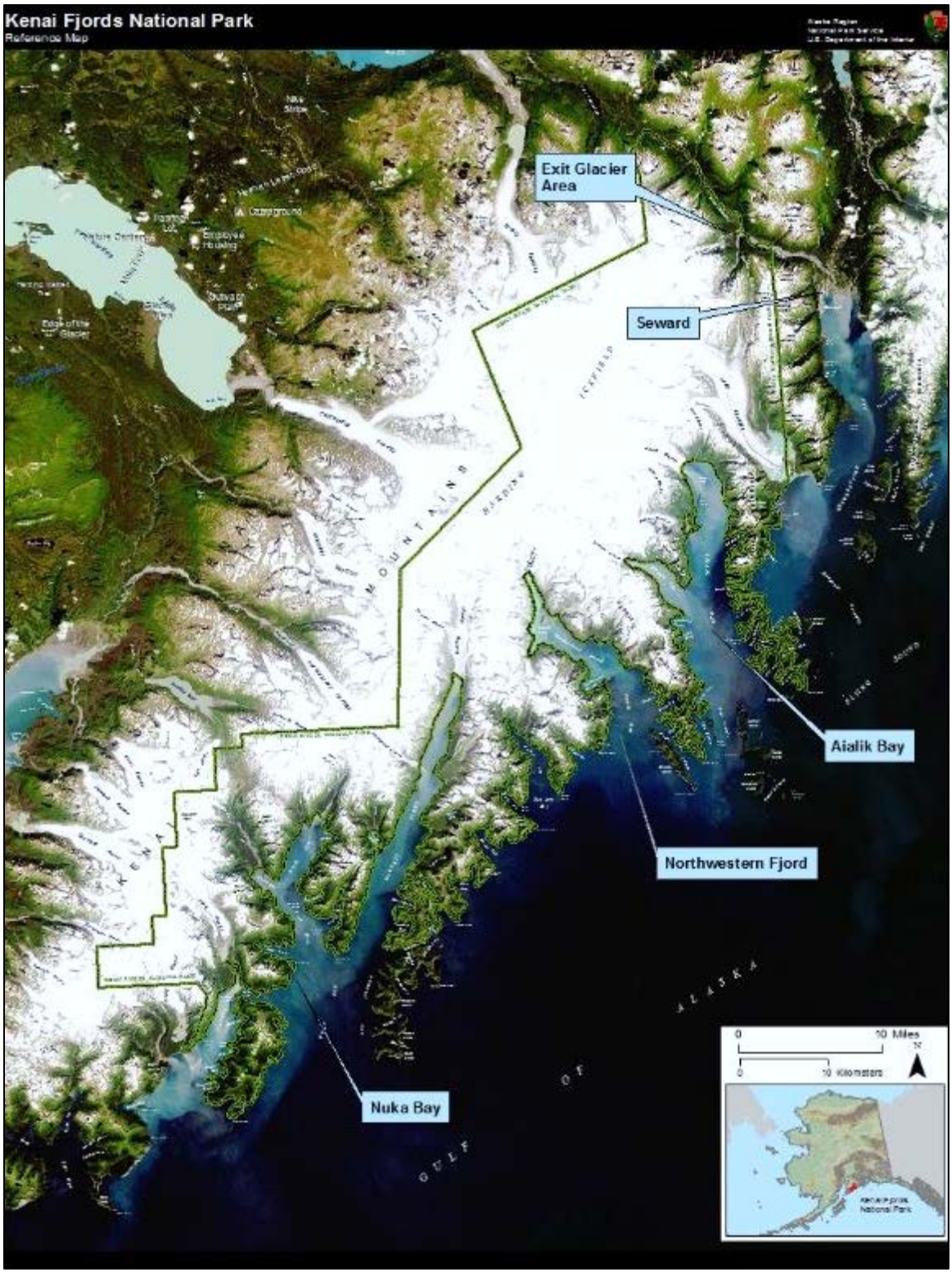


Figure 1. Overview of Kenai Fjords National Park.

Methods

All KEFJ EPMT fieldwork was performed in accordance with the Alaska EPMT 2017 Field Protocol (Overbaugh et al. 2017a). Planning for 2017 was conducted by reviewing data and recommendations from previous seasons. The KEFJ EPMT focused on revisiting and treating all known invasive plant infestations, surveying new areas for invasive plant populations, education and invasive plant awareness, and native plant restoration. Known invasive plant populations were navigated to using previously collected special data. Project sites were broken into three general areas based on geography: the Exit Glacier area, coastal areas, and the City of Seward and surrounding areas.

Table 1. 2017 Project areas.

Areas	Field Sites
Exit Glacier	Herman Leirer Road, Exit Glacier Parking Area, Campground, SNOTEL, Nature Center Plaza and Main Trail, Trail to the Glacier View, Trail to the Edge of the Glacier, Harding Icefield Trail, Nike Stripe and North Side of Road, Outwash Plain, Employee Housing
Coastal	Resurrection Bay, Aialik Bay, Northwestern Fjord, Nuka Bay, McCarty Fjord
Seward	Maintenance Facility, Visitor Center, Park Headquarters Building, Shea Parking Lot

The majority of field work was conducted in early June until mid-September. Several factors determined which projects received priority including weather, site accessibility, plant phenology, population size, project complexity, and availability of personnel. Cooler temperatures persisted throughout the 2017 field season. As a result, plant phenology returned to a somewhat normal rate when compared to previous seasons. Invasive plant treatments began in early June in 2017 as opposed to mid-to-late May in 2016 when warmer temperatures accelerated the development of common dandelion and other species. Cooler temperatures delayed native seed collection, with many seeds reaching maturation in late August to mid-September.

Table 2. Comparison of monthly snow depth (in inches) at Exit Glacier between the last 15 year average and the winter of 2016/2017.*

Time Period	December	January	February	March	April	May
2016-2017	11.00	N/A	42.00	60.40	54.70	25.40
Previous 15-year Average	N/A	25.50	35.45	44.40	51.75	29.95

* (NRCS SNOTEL Update Report downloaded on 9/18/2017)

The majority of chemical treatments in the Exit Glacier area were conducted early in the season based on plant phenology, site accessibility, and availability of additional personnel. Effort was made to control these infestations before seeds were produced. Treatment of larger common dandelion infestations in the Outwash Plain were conducted in early June to increase the likelihood of being able to cross Exit Creek safely. Cooler temperatures in the spring and lower snow levels at high elevations kept creek water levels low, which extended the window for safely crossing Exit Creek. Chemical treatments along the Herman Leirer Road also received early season priority. Due to the

logistical complexity of operations and close proximity to undisturbed backcountry areas, coastal sites received the next highest priority. Areas with the easiest access, such as those around the Exit Glacier Nature Center and trails system, were routinely surveyed and treated throughout the season. Small, outlier populations closer to intact native communities were prioritized over larger infestations near developed areas. KEFJ properties in Seward received the lowest priority due to their proximity to heavily developed areas with large invasive plant populations.

Table 3. Invasive plant species and locations

Species		AKNHP Ranking	Location*			
Latin Name	**Common Name**		**Exit Glacier**	**Coast**	**Shea Lot**	**Maintenance**
Alopecurus pratensis	meadow foxtail	52	X	–	–	–
Bromis inermis	smooth brome	62	X	–	–	–
Capsella bursa-pastoris	shepherd's purse	40	H	–	X	H
Cerastium fontanum	big chickweed	36	X	–	X	X
Crepis tectorum	narrowleaf hawksbeard	56	H	–	–	–
Elymus repens	quackgrass	59	–	–	X	–
Galeopsis spp.	hemp nettle	50	–	–	X	–
Hordeum jubatum	foxtail barley	63	H	–	–	–
Leucanthemum vulgare	oxeye daisy	61	H	–	X	–
Linaria vulgaris	yellow toadflax	69	H	–	–	–
Matricaria discoidea	pineapple weed	32	X	H	X	X
Papaver croceum	Icelandic poppy	39	H	–	–	–
Phleum pratense	common timothy	54	X	H	X	–
Plantago major	common plantain	44	X	H	X	X
Poa annua	annual bluegrass	46	X	X	X	X
Poa pratensis	Kentucky bluegrass	52	H	–	–	–
Polygonum aviculare	prostrate knotweed	45	–	–	X	H
Ranunculus acris	tall buttercup	54	H	–	–	–
Rumex acetosella	common sheep sorrel	51	H	–	X	–
Rumex crispis	curly dock	48	H	H	X	–
Stellaria media	common chickweed	42	X	–	X	X
Taraxacum officinale	common dandelion	58	X	X	X	X
Trifolium hybridum	alsike clover	57	H	–	–	–
Trifolium pratense	red clover	53	H	–	–	–
Trifolium repens	white clover	59	X	–	X	H

* Key: X=Present, H=Historically Present

Control Methods

Manual Treatment

Manual treatment involves physically removing a plant or plant parts from an area (Figure 2). Some invasive plant species have weak and shallow root systems and can be easily hand-pulled. Hand tools were used to dig out roots when hand-pulling was not effective. Flower heads were also removed from plants prior to chemical treatments to reduce the chance of seed dispersal. All materials that were manually treated were bagged and deposited in the KEFJ Maintenance Facility dumpster and were transported to the Seward Waste Transfer Facility.



Figure 2. Manual treatment at KEFJ Visitor Center.

Chemical Treatment

Milestone and AquaMaster were the two herbicides utilized by the KEFJ EPMT in 2017. Milestone (active ingredient aminopyralid) is a selective herbicide for use on broadleaf plants. AquaMaster (active ingredient glyphosate) is a non-selective herbicide utilized for control of invasive grasses. Concentrates of herbicides were applied at 6 ounces per acre for Milestone and 48 ounces per acre for AquaMaster. Both herbicide mixes were applied at a rate of 30 gallons per acre. Herbicide applications were performed with calibrated backpack sprayers using a spot-spray method. In 2017, an amendment was made to the Alaska Region Invasive Plant Management Plan. The amendment allows individuals that do not possess an Alaska or Federal Pesticide Applicator Certification to apply herbicide as long as someone who is a Certified Pesticide Applicator is present at the park and has approved the herbicide application (National Park Service). The KEFJ Biological Science Technician performed herbicide applications under the supervision of the Alaska Pesticide Applicator Certification of the KEFJ invasive plant program manager.



Chemical treatment on Herman Leirer Road.

Data Collection and Analysis

All KEFJ EPMT field data was collected in accordance with the Alaska Exotic Plant Management Team 2017 Field and Office Protocols (Overbaugh et al. 2017 a, b). Trimble Geo7X and Geo XT6000 Global Positioning System (GPS) units with TerraSync software were used to collect invasive plant and restoration data using a customized data dictionary. The data was uploaded, corrected, and edited using Trimble Pathfinder Office software. All GPS data was uploaded to the Alaska Region network drive on a biweekly basis and post-processed by the AK EPMT Data Manager into a Geospatial Information System (GIS). The data was submitted to the Alaska Exotic Plants Information Clearinghouse (AKEPIC) and NPS National Invasive Species Information Management System (NISIMS) databases.

Paper copies of the Alaska EPMT Herbicide Data Sheet were completed after every herbicide treatment in 2017. These data sheets were scanned and uploaded to the Alaska Region network drive on a biweekly basis along with photographs of project work and weekly field reports completed by the Biological Science Technician. A Microsoft Excel spreadsheet containing herbicide treatment records was created to more easily track herbicide use in the park.

Personnel

The KEFJ EPMT was comprised of five full-time staff members in 2017. The crew was supervised by KEFJ Environmental Protection Specialist Christina Kriedeman, who completed planning and compliance work for projects, led herbicide application efforts, assisted in field work, and supported daily operations. KEFJ GS-06 Biological Science Technician Geoffrey Geier performed herbicide application and lead day-to-day field operations performed by Student Conservation Association (SCA) intern Abigail Bobbette and two Youth Conservation Corps (YCC) high school employees Christopher Kingsland and Allison Rogers.



SCA intern Abigail Bobbette mapping an invasive plant infestation.

Alaska Region EPMT Liaison Chris Overbaugh co-led spring training efforts, assisted in herbicide application, and provided technical support. Wrangell-St. Elias National Park & Preserve (WRST) Field Crew Leader and EPMT Data Manager Peter Frank co-led spring training efforts and provided data collection and technical support throughout the season. The visiting SCA trail crew assisted in revegetation and manual control efforts between July 31st and August 4th.

Results

2017 Season Overview

The KEFJ EPMT accomplished several priorities in 2017 including invasive plant inventory and control, revegetation, Elodea monitoring, gypsy moth monitoring, and outreach and education. All known invasive plant populations were revisited, inventoried, and treated in 2017, with the exception of a common dandelion population discovered on a nunatak near Petrof Glacier in 2016. New infestations of mouse-eared chickweed (*Cerastium fontanum*) were identified, mapped and treated in the Maintenance Facility and behind the Exit Glacier Nature Center. New populations of common dandelion were mapped and treated in the Outwash Plain and in the trail builder's camp. New populations of common dandelion and annual bluegrass (*Poa annua*) were mapped and treated in the Exit Glacier campground. One common timothy (*Phleum pratense*) plant was hand pulled on the Trail to the Edge of the Glacier in an area where it has never been found before. Infestations of sheep sorrel (*Rumex acetosella*) and prostrate knotweed (*Polygonum aviculare*) controlled in 2016 were revisited, but none were found in 2017. In total, 8.82 ounces of Milestone herbicide concentrate and 44.08 gallons of herbicide solution, along with 6.89 ounces of AquaMaster herbicide concentrate and 4.31 gallons of herbicide solution were used to chemically treat 1.59 acres of invasive plant species in 2017. An additional 0.054 acres of invasive plants were manually treated in 2017.

Table 4. Summary of Kenai Fjords National Park Invasive Plant Work in 2017 using Invasive Plant GPS Data.

Year	Land Status[1]	Species Acres Surveyed[2]	Species Acres Infested[3]	Acres Treated[4]
2017	NPS Lands	58.72	2.13	1.64
	Non-NPS Lands	9.17	0.007	0.007

[1] The January 2015 NPS Land Status geodatabase was used to delineate NPS lands in acreage calculations.

[2] Acres surveyed represent the total area mapped.

[3] Acres infested represent the area of a mapped infestation multiplied by the percent cover of invasive plants in that mapped area.

[4] Acres treated represent the area of a mapped infestation multiplied by the percent cover of invasive plants in that mapped area and by the percent of the infestation treated.

Revegetation along the Herman Leirer Road began in 2017. 807.37 grams of native seeds were broadcasted on three sections of roadside totaling .01 acres with the help of a six-person SCA crew. Native seed collection continued in 2017 in the Exit Glacier developed area and along the Harding Icefield Trail.

No Elodea was visually detected during the survey conducted in Desire Lake in 2017. Three sites were sampled using environmental DNA (eDNA) protocol and sent for laboratory analysis. No gypsy moths were detected from five traps placed around the Exit Glacier developed area.

Outreach and education continued to be a high priority for the KEFJ EMPT in 2017. The Seward Community Weed Pull was held for the 13th year. It was held at the Seward Middle School on June

30th; with 12 participants, 266.5 pounds of bird vetch (*Vicia cracca*), yellow toadflax (*Linaria vulgaris*) and common dandelion were hand pulled. Three posts were made on the KEFJ Facebook page highlighting the Seward Community Weed Pull, Elodea monitoring, and seed collection events. The SCA intern completed a job-related and personal profile that was posted on the park Facebook page and in the online newspaper Seward City News. Informative talks concerning invasive plants were given to the visiting six-person SCA crew and interpretive staff. A boot brush and interpretive panel were reinstalled at the Exit Glacier Nature Center to provide information about the spread of invasive plants by hikers and for visitors to clean seeds from their shoes before hiking the trails.

Exit Glacier Area

Located twelve miles northwest of the town of Seward, the Exit Glacier area is the most developed region within Kenai Fjords National Park. This area contains the park's only road and trails system along with an employee housing area, campground, parking lot, nature center, bathroom facilities, interpretive displays, and picnic areas. This area experiences the highest visitor use in the park due to the ease of access to Exit Glacier and the Harding Icefield. Human activity is a primary vector for the spread of invasive plants; because of this, the Exit Glacier area receives considerable attention from the KEFJ EPMT.

Herman Leirer Road

The Herman Leirer Road begins at the Seward Highway and runs through private, State of Alaska Department of Natural Resources (DNR), and Chugach National Forest land before reaching the park. The roadside in this area is infested with dense populations of invasive plants including common dandelion, oxeye daisy (*Leucanthemum vulgare*), and yellow sweetclover (*Melilotus officinalis*). The remaining 1.3 miles of road is within the park boundary and ends at the Exit Glacier parking area. This section of road has been chemically treated by the KEFJ EPMT since 2015 to mitigate the spread of common dandelion into the backcountry in the Exit Glacier area.

In 2016, the park road grade was raised and five new culverts were installed below the roadbed to stop flooding across the road and to allow the flow of water through the adjacent wetlands (Figure 3).



Figure 3. Section of Herman Leirer Road where construction occurred in 2016.

This left 0.8 miles of roadside completely free of vegetation on the east end of the road closest to the Resurrection River Bridge.

Due to this construction project, many of the previously treated and surveyed invasive plant populations along the road were destroyed. Survey and control efforts were completed along the entire length of road in 2017.

Chemical treatment of common dandelion was performed on June 22nd and 23rd with the aid of the Alaska EMPT Regional Liaison. Because flowers can still produce seed after chemical treatment, common dandelion flower heads were manually removed prior and during spray operations. Three individuals applied 14.422 gallons of Milestone herbicide solution to common dandelion over a two day period (Figure 4).



Figure 4. NPS staff applying herbicide to common dandelion on Herman Leirer Road.

A few small infestations of invasive grasses were mapped and chemically treated on August 14th. Six common timothy plants, 51 smooth brome (*Bromus inermis*) plants, and 10 meadow foxtail (*Alopecurus pratensis*) plants were treated with 0.056 gallons of AquaMaster herbicide. Flowering heads were also removed from these plants to prevent the development and spread of seeds. Eight common timothy plants were manually treated on the same day.

On August 10th, foxtail barley (*Hordeum jubatum*) was observed and marked with flagging on the south side of the road near the exit of the parking lot. The plant and flagging were removed by unknown means before KEFJ EPMT staff could return to the site with a GPS unit to document the infestation.

Exit Glacier Parking Area

The Exit Glacier parking area is located at the end of the Herman Leirer Road. This area serves as the main parking area for all visitor activities in the Exit Glacier area. The parking area consists of parking spaces for tour buses, recreational vehicles, and passenger vehicles. These areas are

separated by several vegetated islands. Margins of the parking lot and vegetated islands were routinely surveyed by the KEFJ EPMT throughout the season. Common dandelion, common plantain (*Plantago major*), white clover (*Trifolium repens*), pineapple weed (*Matricaria discoidea*) and annual bluegrass were manually treated throughout the season. Infestations of sheep sorrel and common chickweed (*Stellaria media*) were found near the tour bus parking area and were documented and treated in 2016 (Sniegocki and Kriedeman 2016). No sheep sorrel or common chickweed were found in this location in 2017.

Campground

The park campground is located on the south side of Herman Leirer Road 0.3 miles from the Exit Glacier parking lot. This is a 12 site tent campground that contains a hand water pump, a food cooking and storage facility, vault toilet and parking lot. In previous years the campground was relatively weed free (Sniegocki and Kriedeman 2016). In 2017, two new invasive plant populations were discovered, mapped, and manually treated in the campground: two common dandelion plants at campsite 9 on June 20th and a larger annual bluegrass infestation on the path to campsite 8 on August 22nd. One half gallon of AquaMaster herbicide solution was used to chemically treat annual bluegrass in the campground parking lot on August 14th. This was the first chemical treatment performed at the campground by the KEFJ EPMT.

SNOTEL

The Snowpack Telemetry (SNOTEL) station records various forms of weather related data for the Exit Glacier area and is located in a clearing behind employee housing. This site has been chemically treated since 2015 where 45 common dandelions were controlled (Stover and Kriedeman 2015). Seventeen plants were chemically treated in 2016 (Sniegocki and Kriedeman 2016). On June 13th, nine common dandelion plants were chemically treated with Milestone herbicide. One plant was manually treated during a site revisit on July 20th. 2017 marks the second consecutive year of decline in the common dandelion population in the SNOTEL site.

Nature Center Plaza and Main Trail

The Nature Center Plaza is located at the west end of the Exit Glacier parking area. The plaza includes vault toilets used in the winter, restroom facilities, a picnic area, and the centrally-located Nature Center. Behind the Nature Center there is a small building that houses a search and rescue cache and a small picnic area. The Main Trail begins at the Nature Center and is a mostly paved 0.4 mile trail that connects visitors to all other trails in the area. The pump house is also located off the Main Trail and supplies water for the restroom facilities (Figure 5). Visitors must pass through this area to access all the trails in the Exit Glacier area, making it a prime location for invasive plant infestations.



Figure 5. SCA crew pulling annual bluegrass at the pump house.

The Nature Center and Main Trail were routinely surveyed for invasive plants by the KEFJ EMPT. Scattered populations of common dandelion, common plantain, and pineapple weed were manually controlled throughout the summer. A previously undocumented infestation of mouse-eared chickweed was mapped and manually treated on July 26th in the gravel path behind the Nature Center. On July 31st and August 2nd and 3rd, the SCA crew assisted the KEFJ EPMT in manually removing 68.5 pounds of annual bluegrass along the Main Trail and pump house.

Trail to the Glacier View

Views of Exit Glacier, Exit Creek, and the Outwash Plain can be seen from the Trail to the Glacier View, which divides from the Main Trail at the Pavilion. This relatively flat, handicap accessible trail takes hikers through a tall cottonwood forest and then turns and follows Exit Creek until it joins the Trail to the Edge of the Glacier at an interpretive kiosk.

This trail was routinely surveyed throughout the season. Scattered populations of common dandelion and common plantain were found along the entire length of the trail, with the majority of plants being found in the section closest to the Pavilion and just off the trail behind the 1917 moraine sign. All invasive plants were manually controlled on this trail in 2017.

A population of common dandelions and common plantains were discovered in the drainage below and east of the last bridge on the way to Exit Creek from the Pavilion. Common dandelions had not been found in this location since 2011. This site was mapped and visited on four occasions, resulting in the manual removal of 223 common dandelion and 3 common plantain.



KEFJ EPMT mapping and hand pulling common dandelion along the Trail to the Glacier View.

An open clearing in the forest exists between the Main Trail and Trail to the Glacier View. Common dandelions were first documented in this location in 2014. Chemical treatment of common dandelions was performed in 2015 and 2016 (Sniegocki and Kriedeman 2016). Due to the low number of plants found in this area, the decision was made to manually control this infestation in 2017. Sixteen common dandelion plants were manually treated over three visits to this site.

Trail to the Edge of the Glacier

The Trail to the Edge of the Glacier begins at the intersection of the Main Trail and the Harding Icefield Trail (HIT) and allows visitors to climb to the top of an overlook on the north side of Exit Glacier. This 1.2 mile long trail was routinely surveyed by the KEFJ EPMT.



NPS employee holding a common plantain.

Common dandelion and common plantain were found primarily in a rocky outcrop on the lower section of the north side of the loop, although several small populations were found scattered throughout lower sections of the trail. No invasive plants were found on the spur trail at the top of the loop in 2017. The visiting six-person SCA crew assisted in manual treatment of small populations of annual bluegrass on the south side of the loop on August 7th. On August 14th, a new population of common timothy, consisting of one large plant, was mapped and manually treated on the north side of the loop before the wooden bridge.

Harding Icefield Trail

Branching away from the intersection of the Main Trail and Trail to the Edge of the Glacier, the HIT gains approximately 2500 feet of elevation over 4.1 miles before terminating at an overlook with panoramic views of the Harding Icefield. The trail meanders through alder and cottonwood communities before climbing through spruce and hemlock forests and eventually subalpine and alpine zones. The trail provides frequent views of Exit Glacier and the surrounding mountains. Steadily increasing use of the trail in recent years has escalated the potential for the spread of invasive species due to seed dispersal from boots and other hiking gear.

On June 14th, 87 common dandelions were chemically treated with Milestone herbicide on an old section of trail located 0.25 miles up the trail; 34 were manually treated during a follow up trip on July 27th. Other sporadic populations of common dandelion and common plantain were manually treated along the trail as far as 0.8 miles from the trailhead.

The KEFJ EMPT, along with the SCA crew, manually treated 374.6 square feet of annual bluegrass beginning at the trailhead and extending 1.8 miles up the trail (Figure 6). A total of 139 pounds of annual bluegrass were removed from the HIT in 2017.



Figure 6. The SCA crew pulling annual bluegrass on the Harding Icefield Trail.

Nike Stripe and North Side of Herman Leirer Road

North of Herman Leirer Road and west of the Resurrection River lies an area of cottonwood and alder forest, braided river channels, and marsh wetlands. The KEFJ EPMT has been visiting a clearing in this area locally referred to as the Nike Stripe since 2004. Common dandelions were manually treated in this location from 2004 to 2011. This area has been chemically treated since 2012. Nineteen common dandelions were spot sprayed with .02 gallons of Milestone herbicide solution on June 13th. Eight common dandelion plants were manually treated on a follow-up visit on August 10th. A total of 27 common dandelions were controlled in the Nike Stripe in 2017.

The area around the Nike Stripe was surveyed for invasive plant species on September 2nd with the help of one KEFJ backcountry ranger. The bank of Resurrection River was scouted until a braid in the river forced the survey inland. Clearings in the forest were identified and navigated to using aerial imagery on a Trimble GPS unit. Many of the clearings were marsh wetland communities that contained no invasive plant species. No invasive plant species were found during this survey.

Outwash Plain

The Outwash Plain is located east of the terminus of Exit Glacier and south of Exit Creek. This area contains glacial moraines, braided creek channels, large expanses of gravel and sand, and patchwork clearings among cottonwood (*Populus spp.*) and alder (*Alnus spp.*) forests. The sparse vegetation in this area is a result of the active meandering and braided nature of the drainage basin, which includes Exit Creek, Paradise Creek, and associated tributaries. Openings in the forest are created as water movement forms new creek channels, leaving behind areas of disturbance that are prone to invasive plant infestations. Wildlife also utilize these clearings, creating game trails that can help serve as a vector for the spread of invasive plant seeds.

The KEFJ EPMT has monitored and controlled common dandelion in the clearings of the Outwash Plain since 2006. Chemical treatment began in 2011 and continued in 2017. In past seasons, infestations were remapped each year during herbicide application. Beginning in 2016, standardized polygons of these infestations were created (Sniegocki and Kriedeman 2016). This method creates a standardized boundary around each infestation that is used for treatments from year to year. Herbicide use is documented by creating a GPS point including herbicide treatment data inside the standardized polygon instead of remapping infestations each year. This has simplified the data collection and herbicide application process and will allow for better tracking of herbicide efficacy over time. These standardized polygons will remain in place until the size of infestations necessitates remapping their boundary.

Most of the common dandelion infestations in the Outwash Plain can only be accessed by wading through Exit Creek. Access to this area is limited to early summer before winter snowmelt makes crossing unsafe due to high water levels. Low creek levels permitted the KEFJ EMPT, along with the Alaska EMPT Regional Liaison, to spend seven days treating this area between June 5th – 9th and on June 12th and 19th. The crew was able to retreat all 8 standardized polygons.



KEFJ EMPT walking through the Outwash Plain.

All of the small, outlying populations of common dandelion to the west of the standardized polygons were also revisited and treated. A large infestation of common dandelion located beyond the standardized polygons that had been mapped in 2013, but had never been treated, was remapped in 2017. Only about half of the 2.4 gross infested acre area was treated with herbicide due to time constraints. A total of 25.5 gallons of Milestone herbicide solution were used to treat 0.851 acres of common dandelion in the Outwash Plain in 2017.

Two smaller common dandelion infestations were visited in the Outwash Plain in 2017. On June 20th, 105 plants were manually removed from the bank of Exit Creek near employee housing. Thirty-one common dandelions were chemically treated across the creek on the south side of Herman Leirer Road near the bridge over Resurrection River.

On August 18th the KEFJ EPMT scouted an area of the Outwash Plain near the bridge over the Resurrection River for common dandelion and other invasive plant species. A new infestation of common dandelion was discovered near the confluence of Exit Creek and Resurrection River. The infestation was mapped and 501 plants were manually removed.



YCC Allison Rogers flags the boundary of a standardized polygon.

Employee Housing

Located southeast of the Nature Center parking lot, the employee housing area consists of three cabins, a maintenance tool shed, a vault toilet, an employee parking area, the Trail Builder's Camp, and footpaths between the cabins and the Nature Center.

Small, scattered populations of annual bluegrass, common dandelion, common plantain, and pineapple weed were manually treated throughout the season near the cabins and along the trails between facilities. New populations of common dandelion and annual bluegrass were mapped and manually controlled on the path to the Trail Builder's Camp and in the camping area inside the electric fence.

Coastal Areas

The majority of Kenai Fjords National Park's 585 miles of coastline is only accessible by boat and floatplane. Areas of visitor use are typically concentrated around public use cabins and camping areas with food storage lockers and beaches with landing areas for kayaks. Even in these remote areas, invasive plant species have been detected and treated by the KEFJ EPMT.



M/V Serac anchored in Nuka Bay.

In 2017, the KEFJ EPMT spent a total of seven days on two separate trips to the coast. Five days were spent working from the M/V Serac in Nuka Bay, McCarty Fjord, and Northwestern Fjord. Two days were spent working in Aialik Bay and Holgate Arm. A total of 14 sites were visited during both trips. No new infestations were found on the outer coast in 2017.

Resurrection Bay

In previous summers the beach at Bulldog Cove was surveyed for invasive plants with none found there as of 2016 (Sniegocki and Kriedeman 2016). Due to time and weather constraints this area was not surveyed in 2017.

Aialik Bay

The KEFJ EPMT visited five sites in Aialik Bay between July 24th and 25th. On July 24th a population of annual bluegrass was retreated at Aialik Public Use Cabin (PUC). A total of 0.828 square feet of annual bluegrass was manually treated. Abra Cove was also surveyed on this day and small, scattered patches of annual bluegrass were manually retreated around the camping areas.

On July 25th, the EPMT manually controlled annual bluegrass on the beach outside Pedersen Lagoon. This is a kayaking staging area for the Kenai Fjords Glacier Lodge. This land is a private inholding owned by Port Graham Corporation and leased to Alaska Wildland Adventures. Although this area is not park property, manual control of annual bluegrass is done as a courtesy to help ensure these invasive plants are not spread to adjacent park lands. Annual bluegrass has been manually controlled in this area since its discovery in 2011 (Fulton 2011). A total of 0.251 square feet were controlled along the road to Kenai Fjords Glacier Lodge and the kayak staging area. The beach in front of Aialik Bay Ranger Station (ABRS) was also surveyed on this day with no invasive plants found.



NPS staff pulling annual bluegrass at Pedersen Beach kayak staging area.

The Holgate Public Use Cabin (PUC) and camping beach located on the south side of the cabin were also visited on July 25th. A total of 0.697 square feet of annual bluegrass was manually controlled around the cabin and outhouse. The beach to the south of the PUC was surveyed for invasive plants with none found.

The beach at Verdant Cove was also surveyed for invasive plants with none found.

Northwestern Fjord

A new population of annual bluegrass was discovered at a camping site on a spit in Northwestern Fjord in 2016 (Sniegocki and Kriedeman 2016). The KEFJ EPMT returned to this site in 2017 and manually controlled 0.043 square feet of annual bluegrass found along social trails between the food storage locker and tent sites (Figure 7).



Figure 7. NPS staff pulling annual bluegrass in Northwestern Fjord.

Nuka Bay

Two known invasive plant infestations were surveyed in Nuka Bay on July 10th and 11th. The old airstrip site at the head of Beauty Bay was surveyed for common timothy and common dandelion on July 10th. Four common dandelion plants were manually removed near the beginning of the old airstrip. Common timothy, which has been found in the past on the old airstrip, was not found in 2017.

A small infestation of common dandelions, totaling less than 50 plants, was discovered in an undisturbed beach rye (*Leymus mollis*) meadow at the head of North Arm in 2013. Initial chemical treatment of this infestation began in 2014. Due to adverse weather conditions, this site was manually treated in 2015 and 2016. On July 11th, 0.25 gallons of Milestone herbicide solution were used to chemically treat 348.5 square feet of common dandelions in 2017.

A survey of the beach at Pilot Harbor was surveyed again in 2017 and no invasive plants were found.



KEFJ EPMT navigating to a common dandelion population at the head of North Arm.

McCarty Fjord

Five sites were surveyed in McCarty Fjord on July 11th, 12th, and 13th. The KEFJ EPMT revisited a population of common dandelion located on a rocky hillside south of the Dinglestadt Glacier and chemically treated 178 plants with 0.19 gallons of Milestone herbicide solution. The crew also performed invasive plant surveys on the outer beach of James Lagoon and on a spit north of James Lagoon. No invasive plants were found in these areas.



Chemically treating common dandelions at Dinglestadt Glacier.

On July 13th the KEFJ EPMT performed an Elodea monitoring survey on Desire Lake, which will be covered in a later section.

Seward

Aside from the land within Kenai Fjords National Park boundary, the park also owns three properties in the town of Seward, Alaska. These sites include the Visitor Center located near the Seward Small Boat Harbor, a storage building and park vehicle parking lot known as the Shea Lot, and Park Headquarters Building located in downtown Seward.

The Shea Lot was of particular interest to the KEFJ EPMT due to the presence of 15 known invasive plant species in the gravel parking lot for park vehicles. Some of these species have yet to be found inside the park boundary. Vehicles can act as vectors for the spread of invasive species, so every year effort is made to control plants in this area. KEFJ maintenance staff also routinely mowed this lot, which helped prevent many of these plants from going to seed. With the aid of a six-person SCA crew, a total of 142 pounds of invasive plants were manually pulled in the Shea Lot. Species hand-pulled included, common dandelion, pineapple weed, common plantain, white clover and common chickweed.



YCCs manually controlling invasive plants in the Shea Lot.

Located adjacent to the Seward Small Boat Harbor, the Visitor Center sits in a heavily developed area with minimal vegetation around the building and parking area. Common dandelion, common plantain, annual bluegrass, common chickweed, and pineapple weed were manually controlled in this area with the aid of the SCA crew. A total of 37.5 pounds were removed in 2017.

Maintenance Facility

Located on Old Exit Glacier Road, the Maintenance Facility houses the park's heavy equipment, boats, snowmachines, and other light duty vehicles. There is also a carpenter shop, mechanic shop, a meeting and lunchroom facility, equipment storage areas, and maintenance offices. This facility is located outside the park boundary, but because of the high volume of park vehicle traffic to and from the park at this location, it is of particular interest to the KEFJ EPMT. There has been an increase in the number and density of invasive plant species at the Maintenance Facility in the last few years, causing greater concern that park vehicles may be vectors for the spread of invasive plants into the park.

The Maintenance Facility was chemically treated for the first time in 2016 (Sniegocki and Kriedeman 2016) and was treated again in 2017. In 2017, a standardized polygon was used for the first time to collect herbicide data in the Maintenance Facility. Similar to the standardized polygons created in the Outwash Plain, this method creates a point inside the polygon that contains herbicide treatment data and removes the need to remap infestations each year. This method has simplified the data collection and herbicide application process and will allow for better tracking of the efficacy of herbicide treatments over time.

The initial chemical treatment was performed on June 28th. Common dandelion and common chickweed were treated with 0.625 gallons of Milestone herbicide solution. Common chickweed was retreated on July 28th with 2.625 gallons of Milestone herbicide solution. On August 4th, common dandelion, big chickweed, common chickweed, and pineapple weed were chemically treated with 0.35 gallons of Milestone herbicide solution. Two gallons of AquaMaster herbicide solution were

used to chemically treat annual bluegrass and common plantain on the same date. On August 14th, 2 gallons of AquaMaster herbicide solution were used to retreat annual bluegrass. In total, 0.25 acres were treated with 3.598 gallons of Milestone solution and 4 gallons of AquaMaster solution in the Maintenance Facility in 2017.

Elodea Monitoring

Elodea is the first aquatic invasive plant found in Alaska and was first discovered in Alaska in 1982 near Cordova (Alaska DNR 2017). Elodea has since been discovered in over 20 lakes and waterbodies around the state including Lake Hood in Anchorage, the largest float plane hub in the state. This plant has the ability to grow rapidly and reproduce from small segments of stem and other vegetative parts and can choke out lakes and slow moving rivers and streams. This is of significant concern to KEFJ since lakes and streams within the boundary are important spawning habitat for sockeye salmon (*Oncorhynchus nerka*) and other anadromous fish species.

Elodea is typically spread via boat and float plane where small segments of the plant become entangled in props and rudders. Three freshwater lakes within the park boundary were identified as vulnerable to the spread of Elodea due to float plane access in those locations. In 2016, Elodea detection and eDNA sampling surveys were completed at KEFJ on Delight Lake in McCarty Fjord (Sniegocki and Kriedeman 2016). No Elodea was detected during the visit. The park is still waiting for the eDNA results from the 2016 sampling.



Performing a visual Elodea survey with an underwater viewing scope at Desire Lake.

In 2017, the KEFJ EMPT hiked to Desire Lake, also located in McCarty Fjord, to perform a similar survey. The lake was surveyed using a modified version of the US Fish and Wildlife Service Aquatic Invasive Species Survey Protocol (Rich 2012). Due to time constraints, the entire perimeter of the lake was not surveyed. Pack rafts were paddled in an s-shaped “intuitive meander” pattern near the western shoreline of the lake where the lake bottom was visible. Underwater viewing scopes were used to aid in the visual survey. The water was clear and no aquatic vegetation was present. No Elodea was detected using this survey method.

Three replicate eDNA samples were taken at three locations along the lake (9 total samples) following the Central Alaska Network eDNA Field Sample Collection Protocol for use with the Mityvac hand pump (Simmons 2016, unpublished). These samples were collected by pumping lake water through a filter to capture and detect any elodea DNA that may be present (Figure 8). The filters were sent to the USGS Molecular Ecology Laboratory in Anchorage for analysis.



Figure 8. Collecting an Elodea eDNA sample at Desire Lake.

Outreach and Education

Part of an integrated approach to combating invasive plants is outreach and education. These efforts are intended to be a preventative measure aimed at mitigating the spread of invasive species before they become a major problem. Several tools are utilized to educate the public and other park personnel about the effects of invasive plants on native ecosystems.

On June 30th the KEFJ EPMT partnered with Chugach National Forest and Homer Soil and Water Conservation District for the annual Seward Community Weed Pull at Seward Middle School. A total of 12 people attended the event and 266.5 pounds of bird vetch, yellow toadflax (*Linaria vulgaris)*, and common dandelion were manually removed around the parking lot.

Social media is another way to educate the public about the impacts of invasive plants to the environment and several social media posts were utilized throughout the summer to inform the public of activities related to the EPMT program. These included Facebook posts about Elodea monitoring in the park, the Seward Community Weed Pull event, and native seed collection and restoration activities.



Participants from the Seward Community Weed Pull.

Youth engagement is another important part of education and outreach. The KEFJ EPMT hired two YCC local high school students and one college student from the SCA to round out the seasonal work staff. These positions give young people the chance to learn important job related skills as well as inform them about potential future career opportunities within Kenai Fjords National Park and the broader National Park Service system. The SCA intern also completed a personal and job-related profile that was posted on the park Facebook page and in the online newspaper Seward City News. The posting was aimed at both educating the public about EPMT functions and to engage young people who might be interested in pursuing a position in the National Park Service.

The KEFJ EPMT continued to reach out to other park personnel through presentations and informal talks in 2017. The EPMT Biological Science Technician gave an informal talk to the SCA trail crew working and living in the park over the summer. They learned basic invasive plant identification and awareness about how to reduce the spread of invasive plants into the park. Instructions on how and where to clean equipment were provided as well as suggestions on how to prioritize work projects so invasive plant seeds were not spread from more highly infested areas to areas further in the backcountry. Resource Management staff also gave informative presentations during seasonal interpretive training at the beginning of the season providing updates on the seasons operations and current successes.

An interpretive sign and boot brush were reinstalled at the front of the Exit Glacier Nature Center this summer. The interpretive sign located in this central location provides a great opportunity to teach visitors about how invasive plants are spread by humans. The sign informs visitors on how to prevent the spread of invasive plants by using the boot brush to remove any seeds or plant propagules hitchhiking on their shoes.

Restoration and Prevention

Native seed collection continued to be a late season priority for the EPMT in 2017. Native seeds were collected from several areas in late August and September around the Exit Glacier area and will be stored for future restoration projects. 2017 also marked the first year for revegetation efforts on the reconstructed section of the Herman Leirer Road that was completed in the fall of 2016.



KEFJ Visitor and Resource Protection staff assisting with native seed collection.

On July 31, 2017 Kenai Fjords National Park staff, along with the six person SCA crew, planted native seeds along three sections of the Herman Leirer Road. Seeding was performed to both aid in erosion control and also to help prevent infestations of invasive plants from growing into these unvegetated gravel shoulders of the road.



SCA crew and KEFJ EPMT raking in seeds along the Herman Leirer Road.

Three sections of the road were chosen for seeding, including a flat section of the road shoulder with bare gravel; a section covered with erosion control matting; and the steep side of an exposed glacial moraine. The results in each of these areas will provide information about the success of planting seeds in each of these conditions. The seeds utilized were collected from the Exit Glacier Area during previous seasons. Seeds from Merten's sedge (*Carex mertensii*), western columbine (*Aquilegia formosa*), lupine (*Lupinus nootkatensis*), alpine bluegrass (*Poa alpine*), alpine timothy (*Phleum alpinum*), meadow barley (*Hordeum brachyantherum*), spiked trisetum (*Trisetum spicatum*), blue-joint reedgrass (*Calamagrostis canadensis*), and goat's beard (*Aruncus diocus*) were mixed with sand

to aid in seed dispersal. Each section received a similar broadcast rate. A total of 807.37 grams of seeds were dispersed over .1 acres of roadside. Photo points were created to track the progress of each revegetation area and to help determine the efficacy of seeding efforts over time.

Gypsy Moth Monitoring

KEFJ EPMT has cooperated with the Alaska Division of Agriculture since 2009 to place pheromone glue traps in the Exit Glacier Area to provide an early detection method for invasive moth infestations. Monitoring efforts targeted both Asian and European gypsy moth (*Lymantria dispar asiatica & Lymantria dispar*). Five gypsy moth traps were placed around the Exit Glacier Area on June 6, 2017.



YCC Christopher Kingsland installs a gypsy moth trap.

Traps were placed near the campground parking lot, in the employee housing area, next to the Nature Center and in the parking lot. Traps sites were selected because of their exposure to common vectors for moth transport such as firewood, recreational vehicles and other camping equipment. The traps were monitored on July 18th and August 9th and removed on September 19th. No gypsy moths were detected in 2017.

Discussion and Recommendations

Exit Glacier Area

Areas with the highest visitor use, including developed areas and trails, should continue to be a high priority for monitoring and treatment in the Exit Glacier area, but areas that are undeveloped and mostly undisturbed by human use should continue to be a priority as well. Survey and monitoring efforts provide the opportunity to identify new invasive plant populations while they are small and take less time and resources to control as well as provide the opportunity to look at the effectiveness of treatment methods over time. Controlling all invasive plant populations in the Exit Glacier area should continue to be the primary goal, but emphasis should be placed on species with the highest invasiveness ranking and populations that are found in undeveloped backcountry areas.

Herman Leirer Road

Herman Leirer Road continues to be the main vector for the spread of invasive plants into the park. The population size and the diversity of invasive plant species continues to increase along the portion of the road that extends from the Seward Highway to the Resurrection River Bridge. This section of the road crosses private property, State of Alaska DNR and Chugach National Forest land. The roadside outside the park is a State of Alaska Department of Transportation (ADOT) right-of-way and there is no work being done to control the spread of invasive plants along this corridor. The KEFJ EPMT should continue to hand pull small populations of high priority species found outside the park including, yellow sweetclover (*Melilotus officinalis*), bird vetch (*Vicia cracca*), narrowleaf hawksbeard (C*repis tectorum*), and oxeye daisy (*Leucanthemum vulgare*) to prevent these populations from spreading down the road into the park.

The portion of Herman Leirer Road that is inside the park boundary has been a vector for the spread of common dandelion into the backcountry. The KEFJ EPMT began using herbicide to reduce the dandelion population along the road beginning in 2015 and has been applying herbicide every year since that time. A road construction project completed in the park in 2016 left approximately 0.8 miles of roadside, starting from the Resurrection River Bridge, devoid of vegetation and mostly free of invasive plants. Scattered populations of common dandelion were treated with herbicide on this portion of the road in 2017. Herbicide treatment along the roadside should continue in 2018.

Several small, scattered infestations of non-native grasses, including smooth brome, common timothy, and meadow foxtail were mapped and treated in 2017. Invasive grass species continue to occur sporadically along the Herman Leirer Road and should continue to be monitored and treated in 2018 to keep these populations. Surveys for these species should start in August when the development of inflorescences make identification easier.

One foxtail barley plant was documented and flagged by the EPMT on the south side of Herman Leirer Road near the parking lot, but the plant and flagging were removed by unknown means before it could be mapped with a GPS. Relocating this grass and mapping it should be a priority in 2018.

Coordination with maintenance staff should continue to ensure invasive grass species are treated before the roadside is brushed in late August.

Monitoring along the roadside should be a priority in the coming years to look for any new invasive plants species that may have been introduced during the construction project completed in 2016.

Campground

The Exit Glacier Campground has been relatively free of invasive plants in the past. It has had a small population of annual bluegrass and a few scattered common dandelion and common plantain found in the parking lot. In 2017, two common dandelion and a larger annual bluegrass population were found for the first time in the campground and the annual bluegrass population in the parking lot expanded in area from 2016. Because manual treatment was unsuccessful in reducing the population of annual bluegrass, it was treated with herbicide for the first time in 2017, and is a good candidate for continued herbicide application to stop its spread. The newly discovered population of annual bluegrass found on the path to campsite 8 should also be considered for herbicide treatment in 2018. Manual treatment has not always been effective on annual bluegrass populations that are larger and have an established seed bank in the soil. The common dandelion population found near campsite 9 included only two plants, so it is still a good candidate for manual treatment. Because these two new infestations were discovered this year, there should be an increased effort to survey and monitor the path and campsites more regularly to identify any new populations while they are still small.

Pump House

The section of bare gravel around the Pump House was manually treated again in 2017 with the aid of the SCA crew. Annual bluegrass has been hand pulled in this area since 2012 with the population continuing to increase over time. Chemical treatment of annual bluegrass in this area is recommended for 2018. Effort should be made to treat this population of annual bluegrass before seeds are produced to reduce the size of the seed bank in this area.

Nike Stripe

The population of common dandelion found in the area known as the Nike Stripe has been chemically treated since 2012. This population has responded very well to herbicide treatment and has been reduced in size and density each year. Only 19 common dandelions were treated with herbicide in 2017. This site should continue to be a priority for herbicide treatment and should be monitored and retreated if necessary later in the summer. This population continues to be an excellent candidate for eradication.

Outwash Plain

Beginning in 2016, standardized polygons were created around common dandelion populations in the Outwash Plain. Instead of remapping each population every year, a GPS point is collected inside the standardized polygon documenting the type and amount of herbicide used during the application. It is recommended to continue using standardized polygons as this technique has simplified the treatment process and has allowed more accurate tracking of the efficacy of herbicide treatments over time. These standardized polygons should be used until they no longer reflect the size of the population and then should be remapped. New standardized polygons should be created as new populations are identified and mapped.

The KEFJ EPMT has been focusing herbicide applications on the same populations of common dandelion for the last seven years and there has been a reduction in size and density. There are still populations that have not been mapped or treated on the southwest side of the existing standardized polygons. These populations should be a priority for mapping and treatment in 2018 since the full extent of these populations have not been documented and if they are not treated will continue to spread. Control efforts should start at sites that have not been mapped or treated at the far end of the Outwash Plain working back toward areas that have previously been treated. It is hoped that this strategy will help to better contain the total common dandelion population as it is treated over time and reduce the density and eventually the size of these populations.

Coastal Areas

The relatively pristine coastal fjords of the park continue to be a high priority for invasive plant control and survey efforts. Because the KEFJ EPMT accesses this area via boat, the area that can be surveyed and treated as well as the number of times a site can be revisited during the summer is limited. The highest priority survey locations should continue to be areas with known invasive plant populations. The KEFJ EPMT strives to revisits all of these sites each summer with the goal to eradicate these populations while they are still relatively small. Areas with high visitor use as well as areas that have less use, but have beaches that area accessible to visitors, should be a high priority as well. Invasive plant populations have been found in locations that were determined to be low risk in the past. These areas should be systematically surveyed, selecting a different group of these areas to survey each summer.

The only invasive plant population found in the park that was not treated in 2017 was a population of common dandelion that was found in 2016 by the Southwest Alaska Network (SWAN) Inventory and Monitoring staff. The population of common dandelion was discovered during a vegetation survey on a nunatak located between Yalik and Petrof Glaciers at the south end of the park. The site is only accessible by helicopter and the park does not have the resources to access this area at this time. The park should look for creative ways to fund transportation or share transportation with other projects to reach this site in the future.

The KEFJ EPMT should reach out to VRP staff to help look for invasive plant populations while they are working in the coastal fjords. The KEFJ EPMT can only visit a limited number of areas each summer and VRP staff spends time on patrol in remote areas of the park. More eyes on the ground could help locate invasive plant populations while they are still small and take fewer resources to control.

Maintenance Facility

The Maintenance Facility was chemically treated for the second consecutive year in 2017. All invasive plant populations were treated with herbicide twice during the season. They were treated once early in the summer and then a follow up treatment was completed later to control any newly sprouted plants. This area should continue to be a high priority in 2018 due to the potential for the spread of invasive plants into the park via park vehicles and other equipment. These populations should continue to be treated with herbicide. Invasive plants should be treated before they go to seed

and follow up treatments should be completed at least once later in the summer to control plants that grow from seeds already in the soil.

A standardized polygon around the maintenance yard was used for the first time in 2017. The maintenance yard standardized polygon should continue to be used in 2018 to more easily document herbicide application and track changes in herbicide use and efficacy of treatments over time.

Seward

Shea Parking Lot

The Shea parking lot was surveyed in 2018 and contains 15 invasive plant species, a number of which are yet to be found in the park boundary. The Shea parking lot has been a low priority in the past, but since the gravel parking surface has become densely infested with invasive plants it has become a bigger concern. Park vehicles used by NPS employees working in Seward are staged in the parking lot and can be a potential vector for the spread of new invasive species into the Exit Glacier area. Maintenance staff should continue mowing the margins of the parking lot to help reduce the development of flowers and spread of seeds.

Chemical treatment of the Shea Lot is recommended for 2018 due to the proximity of park vehicles and their potential as vectors for the spread of invasive plants into the park. The use of a standardized polygon for the Shea Lot is recommended due to the complexities created by the treatment of multiple species in one location. This will provide an easier means of data collection and will allow herbicide efficacy to be more easily tracked over time.

Elodea

Elodea monitoring continued for the second consecutive year in 2017 and continues to be a high priority for the park. Visual and eDNA surveys were performed on Desire Lake - one of three lakes identified by park staff as being vulnerable to Elodea infestations due to floatplane access. Because of its large size, the KEFJ EMPT was able to survey only a portion of the lake using pack rafts. The survey was completed on the southwest end of the lake near the outlet stream. Since surveys completed in both 2016 at Delight Lake and in 2017 at Desire Lake did not cover the extent of the lake, it is recommended that in the future that the park try to partner with other agencies or park’s to complete Elodea monitoring at these two lakes.

Addison Lake should be prioritized for Elodea monitoring in 2018. This is the last remaining lake of the three considered vulnerable to Elodea due to float plane use and is an important spawning area for sockeye salmon. Although the northern portion of the lake is within the park boundary, it can only be accessed by crossing privately owned land from lower Pedersen Lagoon. Permission will need to be arranged with Kenai Fjords Glacier Lodge for access to the south end of the lake.

It is still unknown if eDNA sampling can replace the more time consuming visual and double-headed rake survey methods. There are some studies being conducted at this time looking at the efficacy of the eDNA sample method based on the size of the Elodea population in a waterbody, but the results are not yet available. eDNA sampling should continue to be part of the Elodea monitoring effort at

KEFJ since lakes in the park are too large to conduct a complete survey by pack raft. eDNA samples could identify Elodea infestations that cannot be seen during visual surveys.

Prevention

The easiest way to combat the spread of invasive plant species is by preventing their introduction in the first place. No major construction projects occurred in the park boundary in 2017, but stipulations should continue to be added to contracts, special use permits, and research permits issued by KEFJ to minimize the risk of spreading invasive plants into the park. As with the road construction project in 2016, language in contracts should specifically call for the inspection and cleaning of all heavy equipment and construction materials before they are brought onto park property to ensure new invasive plant infestations are not established.

The SCA crew was given an informative talk providing information about the impacts of invasive plants and how to plan work activities in the park to mitigate their spread. These talks should continue in future seasons with instructions on how to clean equipment and how to prioritize work projects so invasive plant seeds area not being spread from highly infested areas to more pristine areas.

Outreach and Education

Outreach and education activities are another cost effective way to help mitigate the spread of invasive plant species. The KEFJ EPMT should continue to provide invasive plant awareness information to park staff and the community through partnerships, information-sharing, and outreach events. Participating in local and statewide invasive plant partnerships as well as attending conferences and workshops are a great way to leverage resources and keep abreast of current invasive plant issues and strategies at the state level.

Participation in the Kenai Peninsula Cooperative Weed Management Area (KP-CWMA) should continue to be a priority. This is a volunteer group of non-profit groups, and state and federal agencies working together to manage invasive plants across all lands on the Kenai Peninsula. Participation in monthly conference calls and yearly conferences with the state-wide Committee for Noxious and Invasive Plant Management (CNIPM) is an important way to build partnerships and keep informed about the most current strategies and concerns about invasive plants around the state and in the nation.

The Seward Community Weed Pull was reestablished in 2017 in partnership with the Chugach National Forest and the Homer Soil and Water Conservation District. This collective group is part of the Kenai Peninsula Cooperative Weed Management Area (KP-CWMA). With numerous different property owners adjacent to park lands, interagency relationships and community outreach should continue to be fostered to promote invasive plant awareness throughout the region.

In the spring of 2017, the manager from Kenai Fjords Glacier Lodge requested information about how to reduce the spread of invasive plants during their operations. This lodge is located on private land within the Kenai Fjords National Park boundary and guides clients on daily hikes that access park lands. This is a very positive step and the KEFJ EPMT should continue to work with the lodge

managers to reduce the spread of invasive plants to the lodge and into the park. Maintaining open communications and providing updated information about priority invasive plant species and best management practices to reduce their spread should continue to be a high priority.

The KEFJ EPMT presented at the spring interpretive staff training on topics related to the invasive plant program. These efforts should be continued in 2018 and future seasons. Interpretive staff come in contact with visitors on a daily basis and have the opportunity to provide information about the negative impacts of invasive plants to a much wider audience. They can also help identify new populations of invasive plants since they regularly spend time roving trails in the Exit Glacier area.

Several online outlets were used to inform the general public about EPMT activities. Utilization of Facebook posts, Seward City News articles, and updates to the park website should continue in future seasons to promote invasive plant awareness in the local community.

A boot brush was reinstalled in front of the Exit Glacier Nature Center with and interpretive sign to both promote invasive plant awareness and to give visitors an opportunity to clean seeds from their boots before hiking into the park. There was discussion this summer about moving the boot brush to a location next to the trail that would intercept all hikers instead of only the ones that visit the Nature Center before they hike the trails. Planning should continue to include information about the spread of invasive plants and a boot brush in the updated orientation sign located in front of the Nature Center, so that all hikers will pass by it as they access the Exit Glacier trail system.

Youth Involvement

The KEFJ EPMT should continue to house the resource management division's youth program. The KEFJ EMPT is a perfect place for college and high school aged students to be introduced to the National Park Service and resource management. Introducing youth to the National Park Service, natural resource management and science can create lifelong natural resource stewards. They also play an important part in the ability of the KEFJ EPMT to complete its work goals. The KEFJ EPMT should continue to hire an SCA intern and two high school-aged YCC employees for the summer, and for an SCA crew to work for a week during the summer in 2018.

Restoration

Revegetation of the reconstructed area of the Herman Leirer Road began in 2017 with the reseeding of three sections of the gravel shoulder. Seeds collected from previous seasons were broadcasted along the roadside and photo points were taken of these areas to monitor the efficacy of restoration efforts. Reseeding should continue along the roadside in 2018. Seeds should continue to be collected from areas inside the park for use in future reseeding projects. Photo points collected in 2017 should be revisited and recollected around the same time of year in 2018. Newly impacted areas should continue to be monitored for possible restoration projects.

Personnel

The Biological Science Technician should continue starting earlier in the season before other EPMT personnel arrive to begin planning for the field season. This is also an ideal time to complete training

and allows for the individual to familiarize themselves with job responsibilities and other park personnel and operations.

A four person work crew proved to be an optimal number in 2017 and should be the goal for 2018. An SCA intern and two YCC members should continue to be hired to round out the seasonal workforce. These individuals were invaluable in data collection and labor intensive projects at the peak of the field season. The SCA crew should be utilized again for projects that require a larger workload including restoration of the Herman Leirer Road and pulling annual bluegrass.



SCA intern and YCCs pulling yellow sweetclover on Herman Leirer Road.

Literature Cited

Alaska Department of Natural Resources (DNR) Division of Agriculture. 2017. Elodea webpage. Available at: http://dnr.alaska.gov/ag/ag_Elodea.htm. (Accessed 28 September 2017).

Fulton, T. 2011. Invasive Plant Management in Kenai Fjords National Park: 2011 Summary Report. Natural Resource Data Series NPS/KEFJ/NRDS—2011/223. National Park Service, Fort Collins, Colorado.

National Park Service. 2017. Categorical exclusion form: amendments to best management practices appendix in Alaska region invasive plant management plan. National Park Service, Anchorage, Alaska.

Overbaugh, C. and P. Frank. 2017a. Alaska Exotic Plant Management Team 2017 Field Protocol. 2017. U.S. Department of the Interior, National Park Service, Anchorage, Alaska.

Overbaugh, C. and P. Frank. 2017b. Alaska Exotic Plant Management Team 2017 Office Protocol. 2017. U.S. Department of the Interior, National Park Service, Anchorage, Alaska.

Rich, Cecil F. 2012. Aquatic invasive species survey protocol: a rapid screening method for Alaska's lakes and slow rivers. US Fish and Wildlife Service, Alaska.

Simmons, Trey. 2016. Central Alaska network eDNA field sample collection protocol – mityvac hand pump version 1.0. National Park Service Unpublished Report, Anchorage, Alaska.

Sniegocki, R. and C.L. Kriedeman. 2016. Invasive Plant Management in Kenai Fjords National Park: 2016 Summary Report. Natural Resource Report NPS/KEFJ/NRR—2016/1351. National Park Service, Fort Collins, Colorado.

Stover, A. and C. L. Kriedeman. 2015. Invasive Plant Management in Kenai Fjords National Park: 2015 Summary Report. Natural Resource Report NPS/KEFJ/NRR—2015/1097. National Park Service, Fort Collins, Colorado.

Appendix A: Invasive Plant Surveys Site Specific Maps

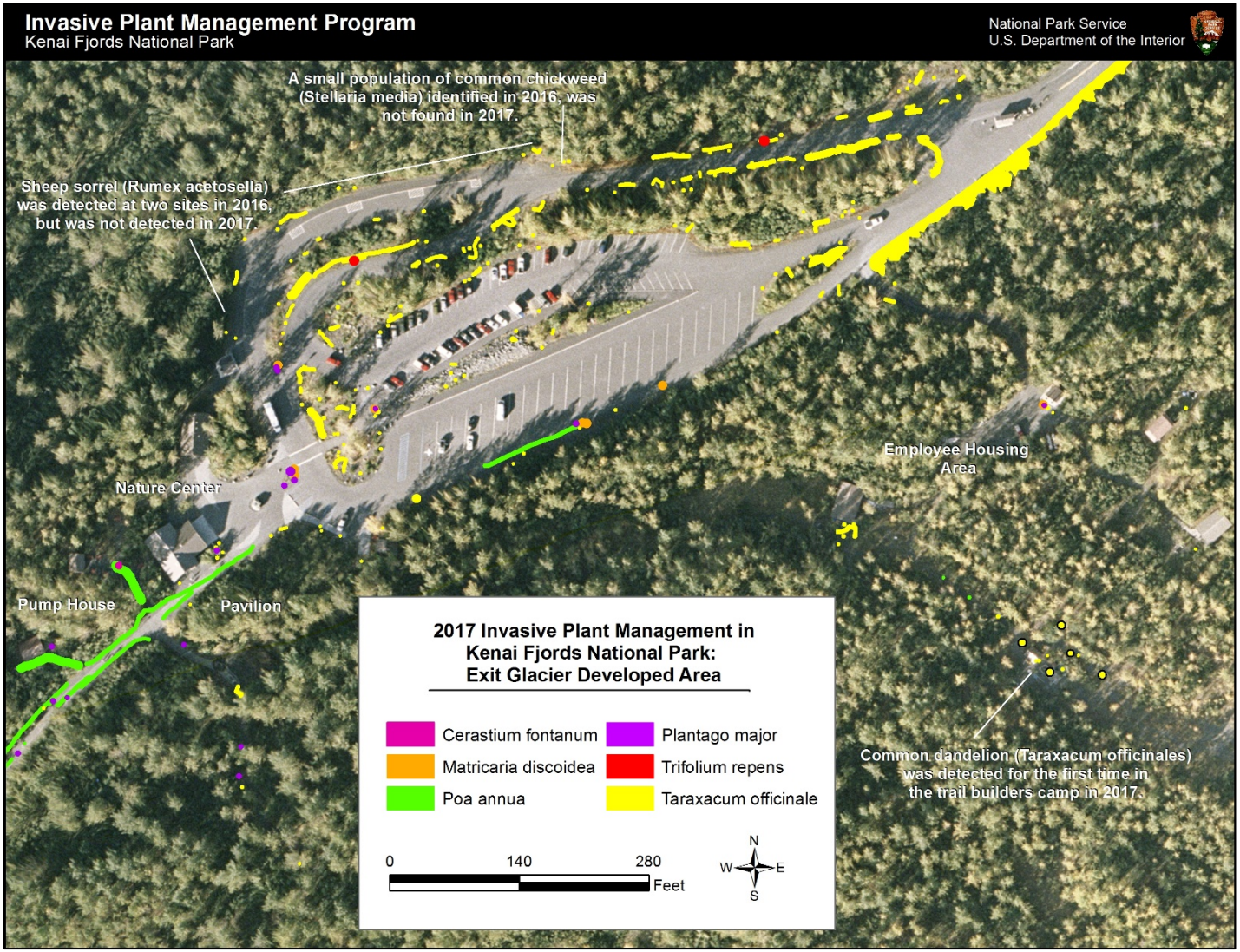


Figure A-1. Invasive plant surveys in the Exit Glacier developed area.

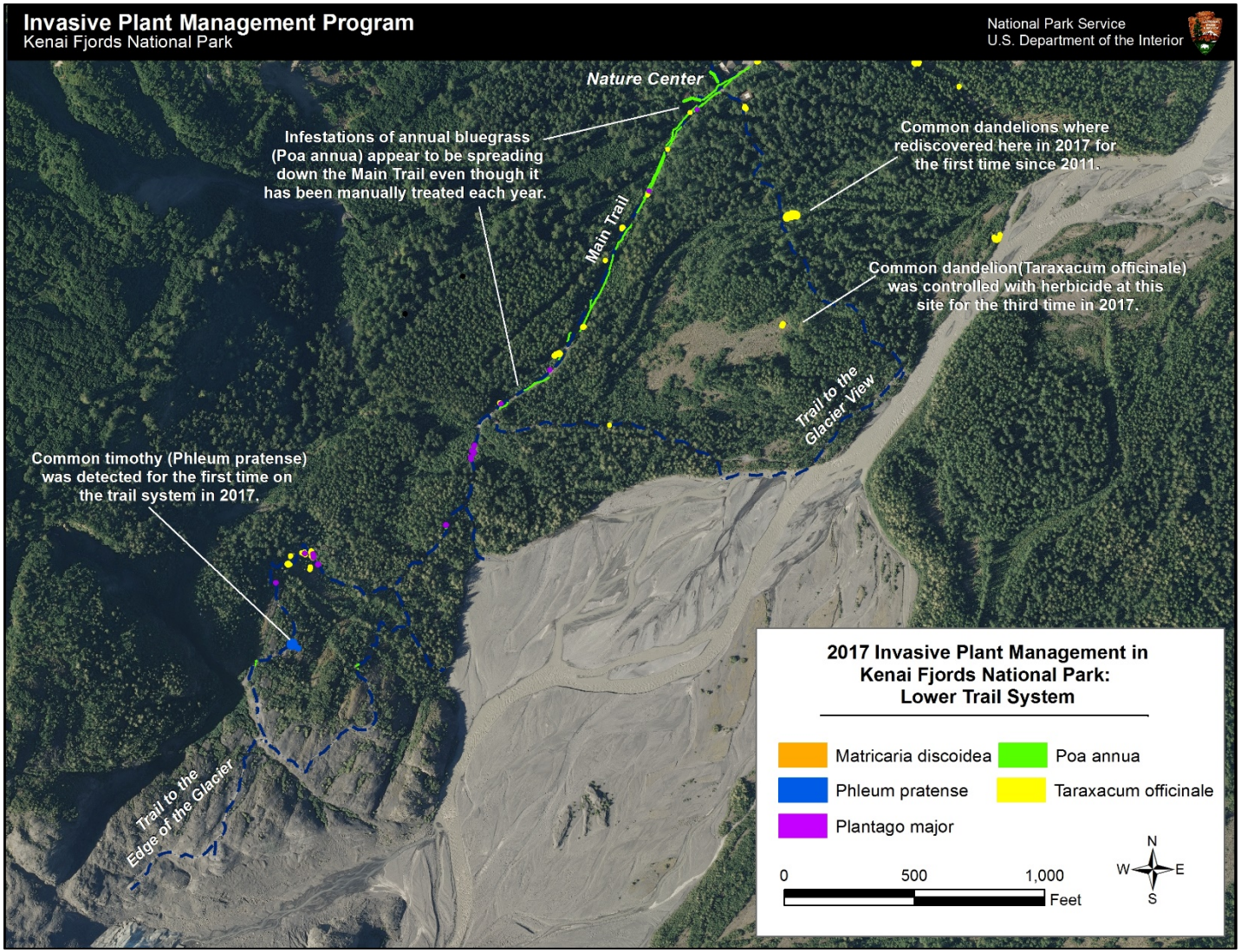


Figure A-2. Invasive plant surveys along the lower trail system.

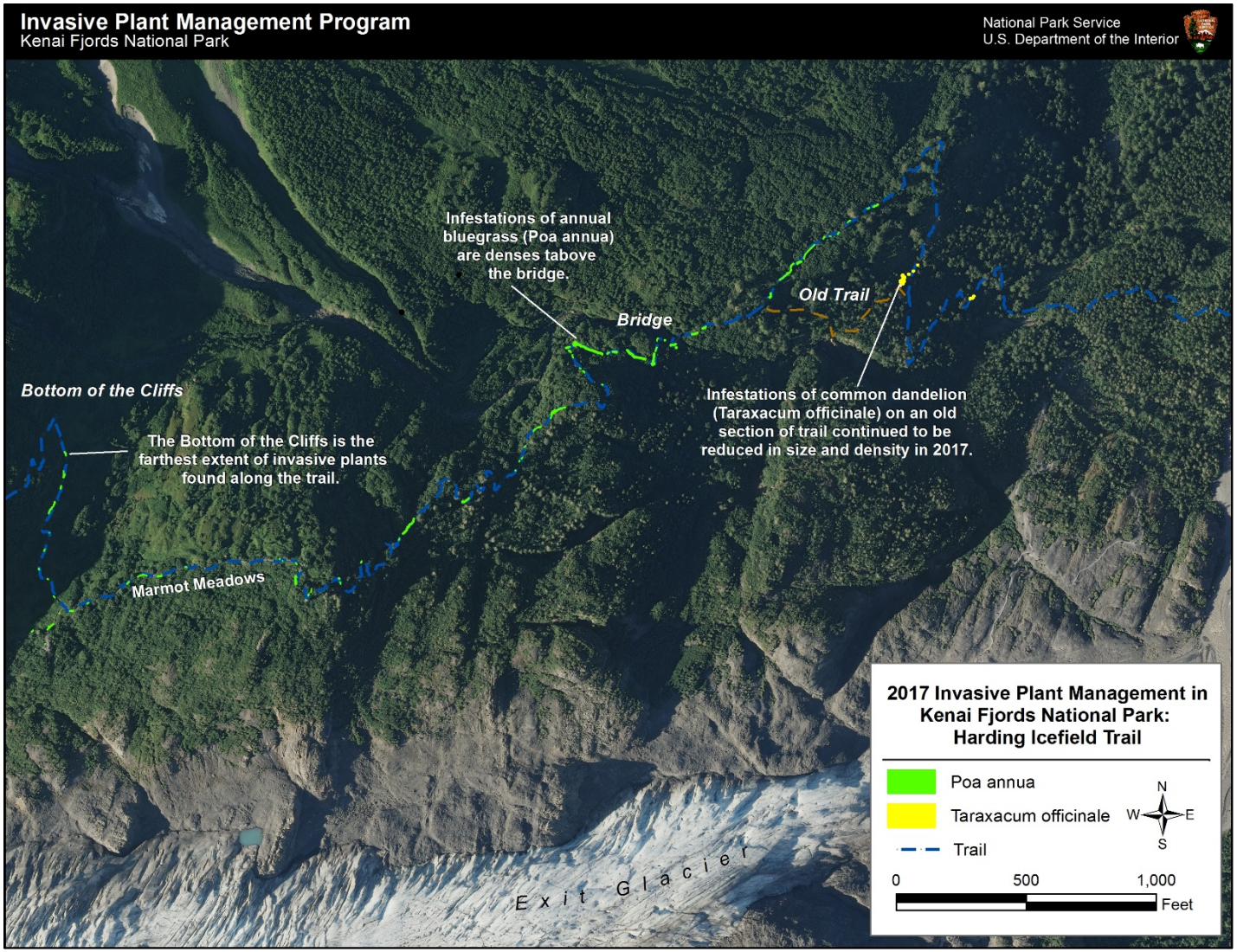


Figure A-3. Invasive plant surveys along the Harding Icefield Trail.

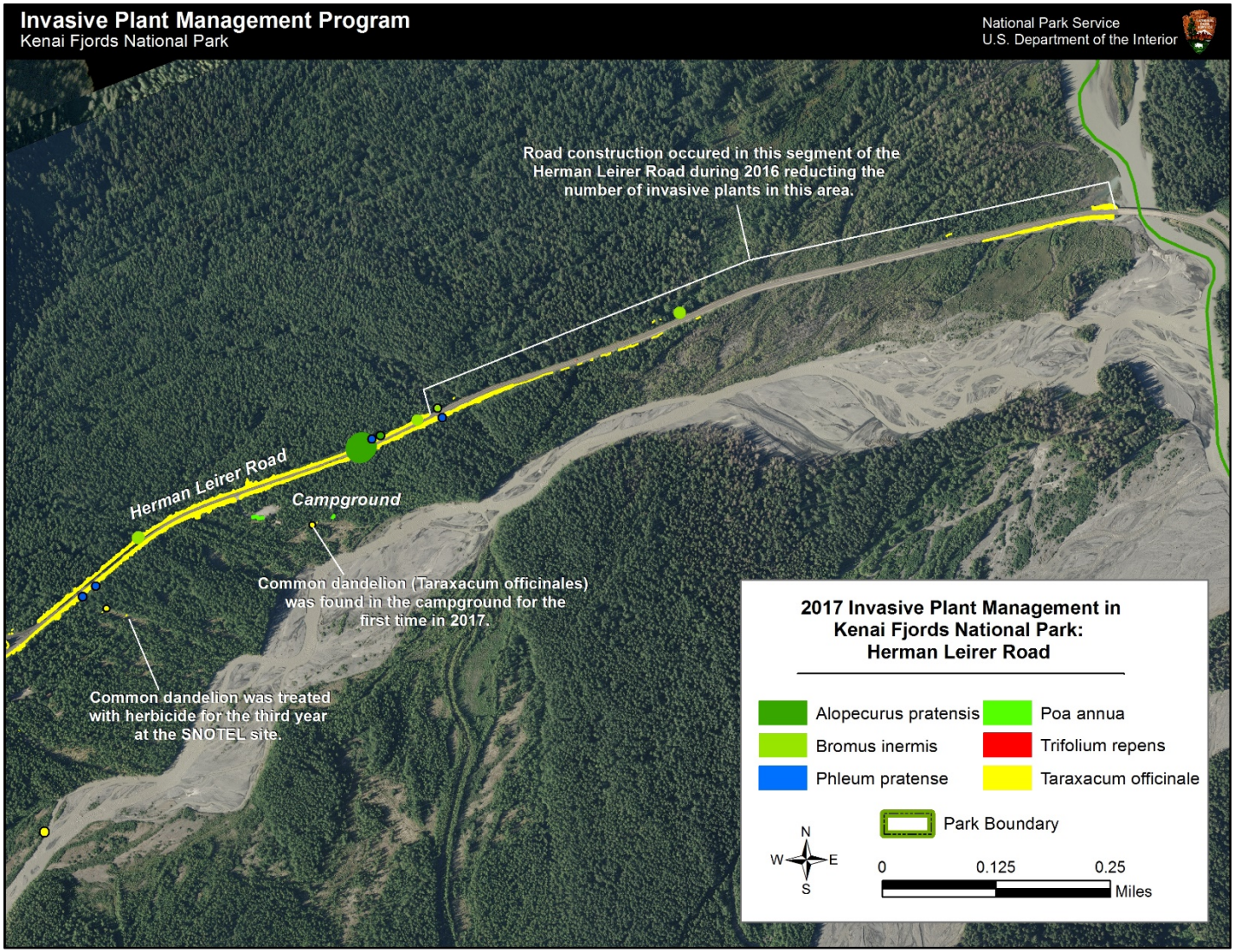


Figure A-4. Invasive plant surveys along Herman Leirer Road.

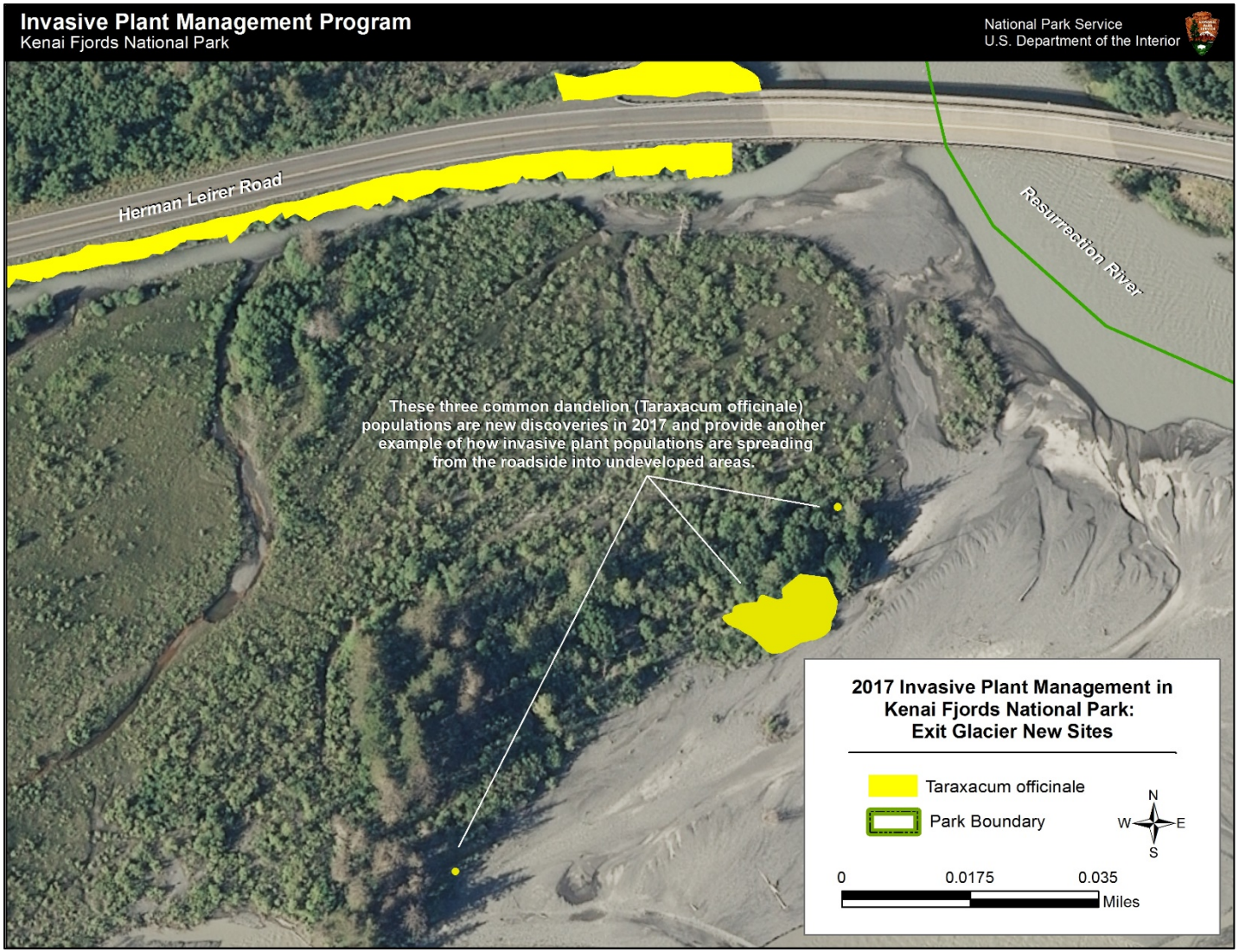


Figure A-5. New invasive plant infestations discovered in the Exit Glacier area in 2017.

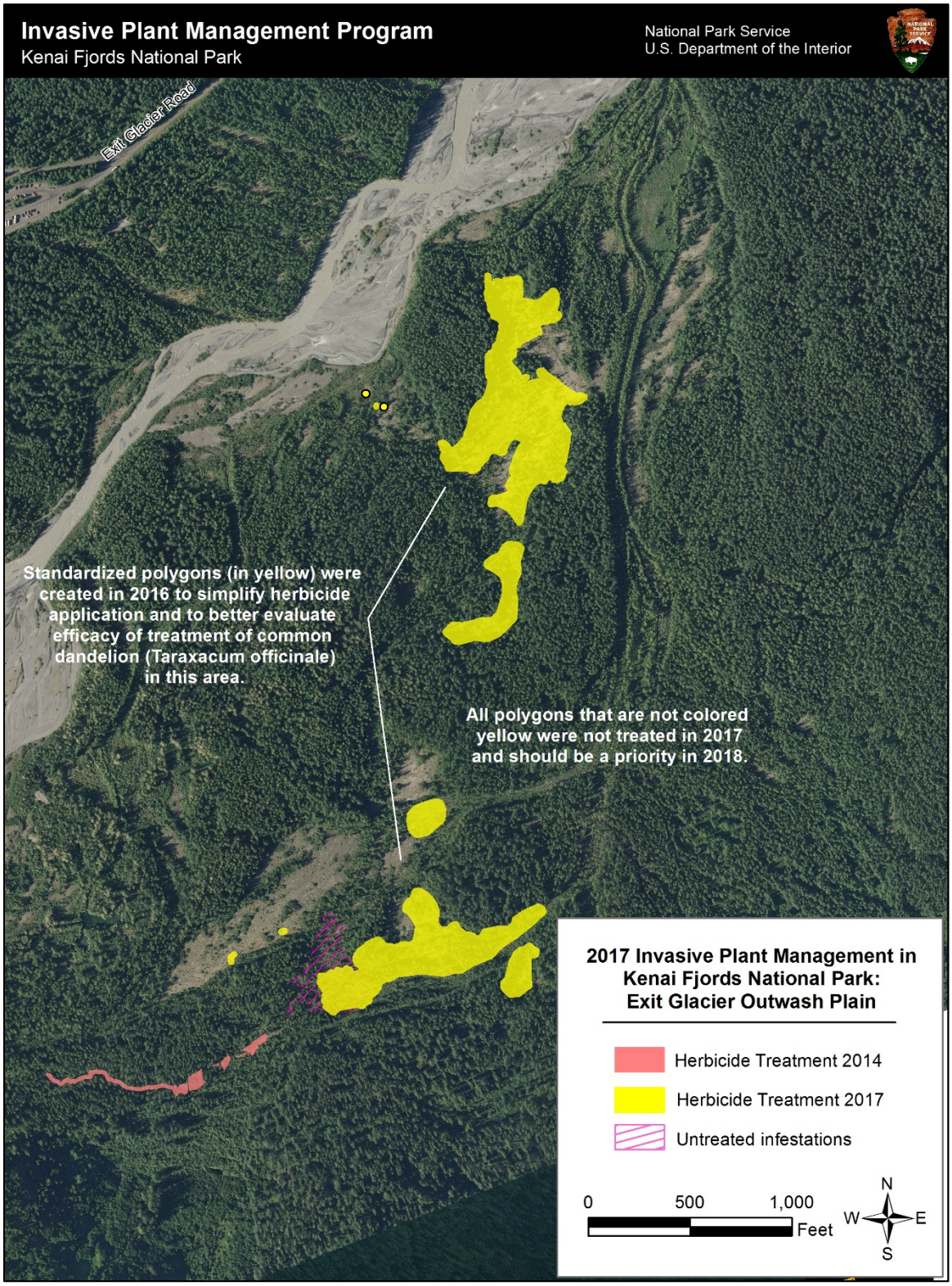


Figure A-6. Invasive plant surveys in the Exit Glacier Outwash plain.

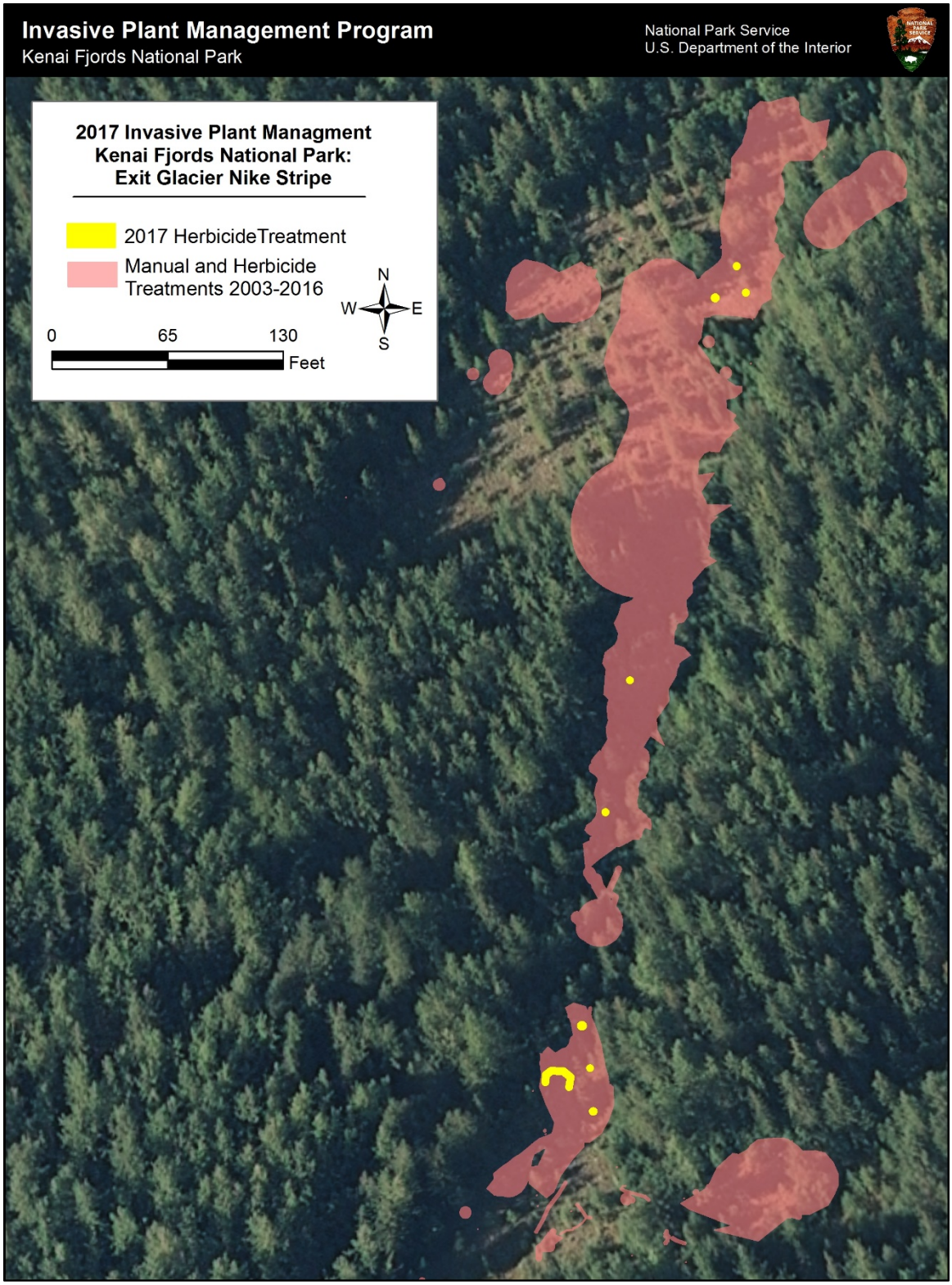


Figure A-7. Invasive plant surveys in the Nike Stripe.



Figure A-8. Invasive plant surveys in the Maintenance Facility.

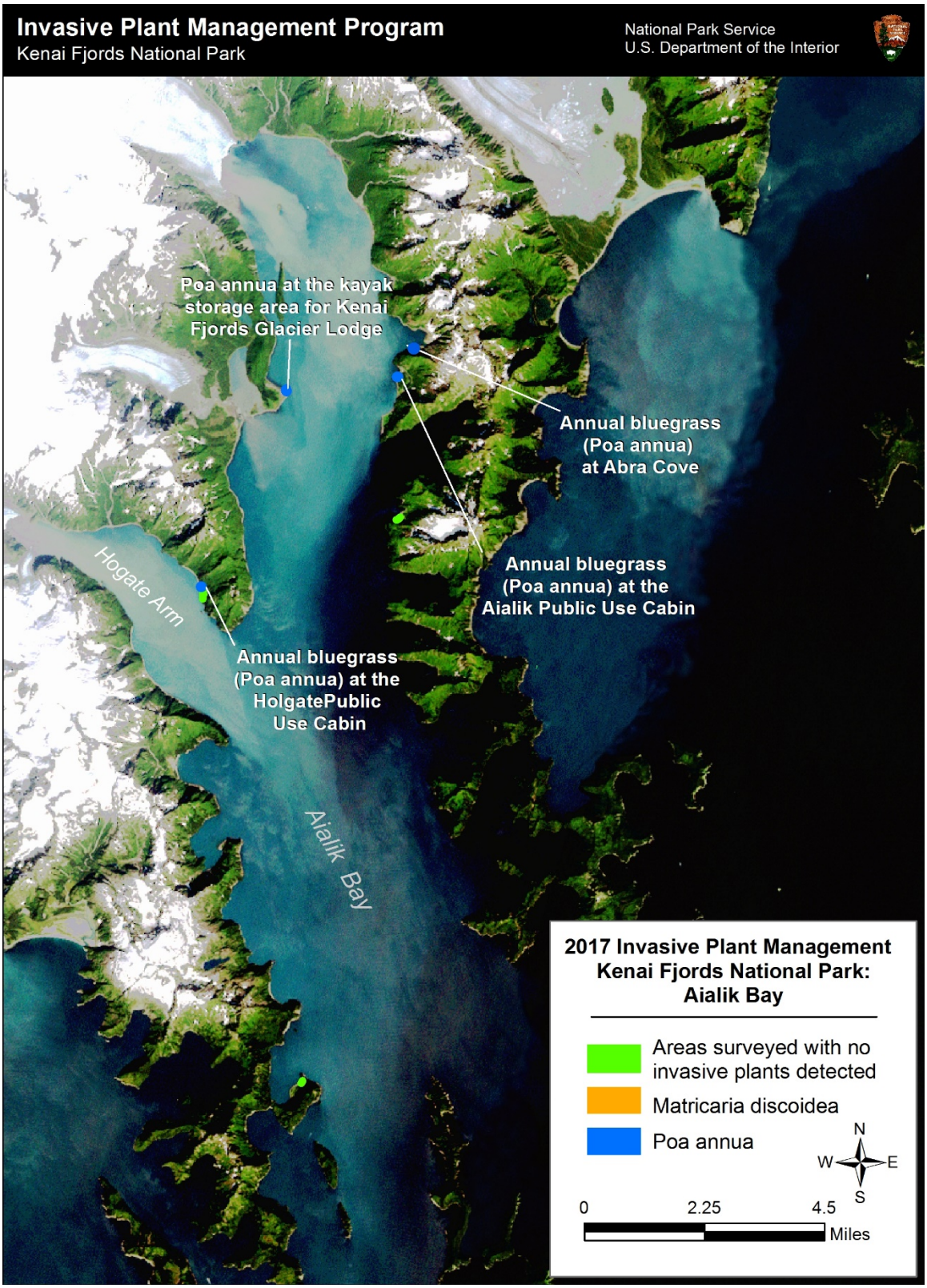


Figure A-9. Invasive plant surveys in Aialik Bay.



Figure A-10. Invasive plant surveys in Northwestern Fjord.

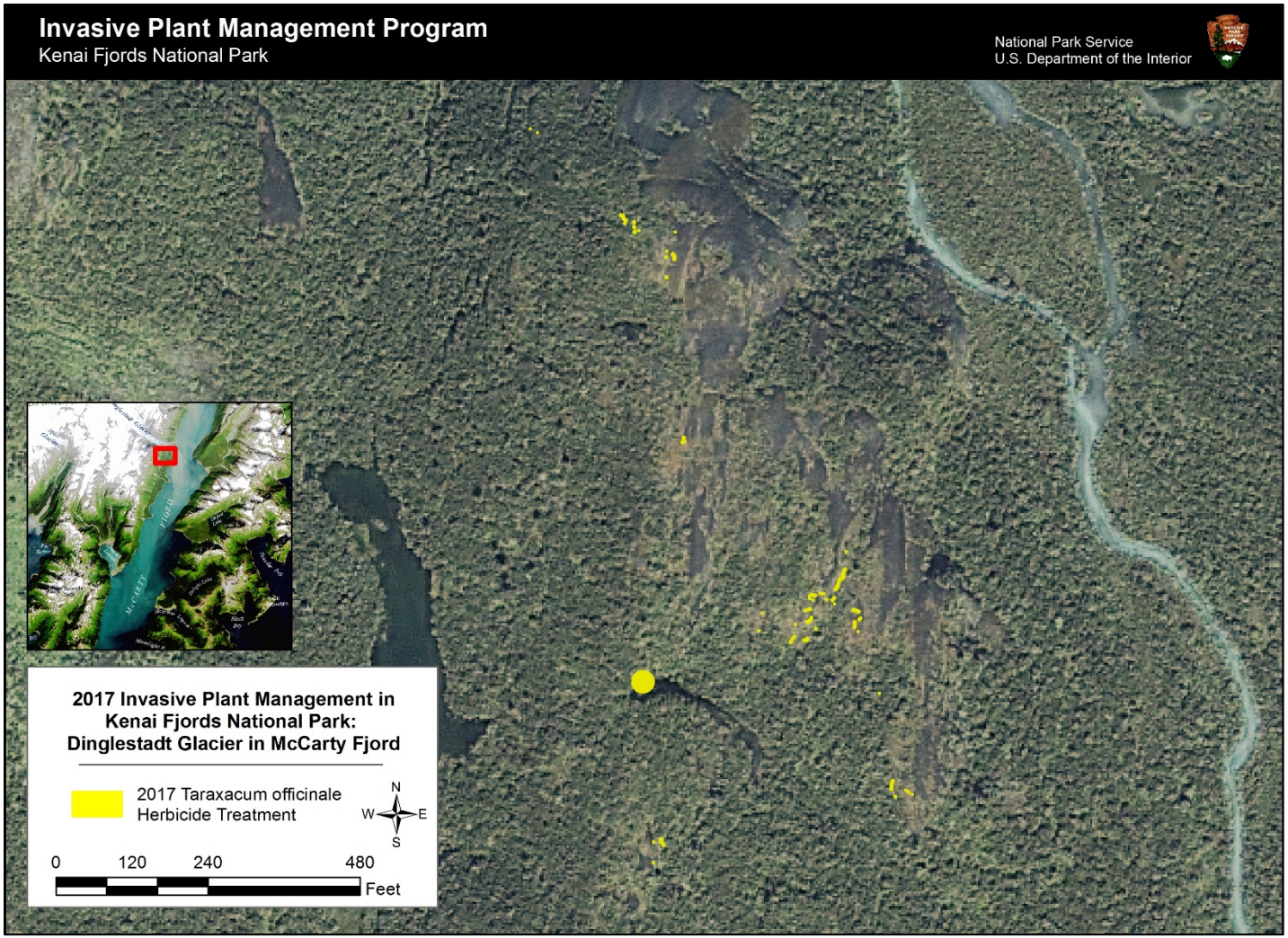


Figure A-11. Invasive plant surveys in McCarty Fjord.

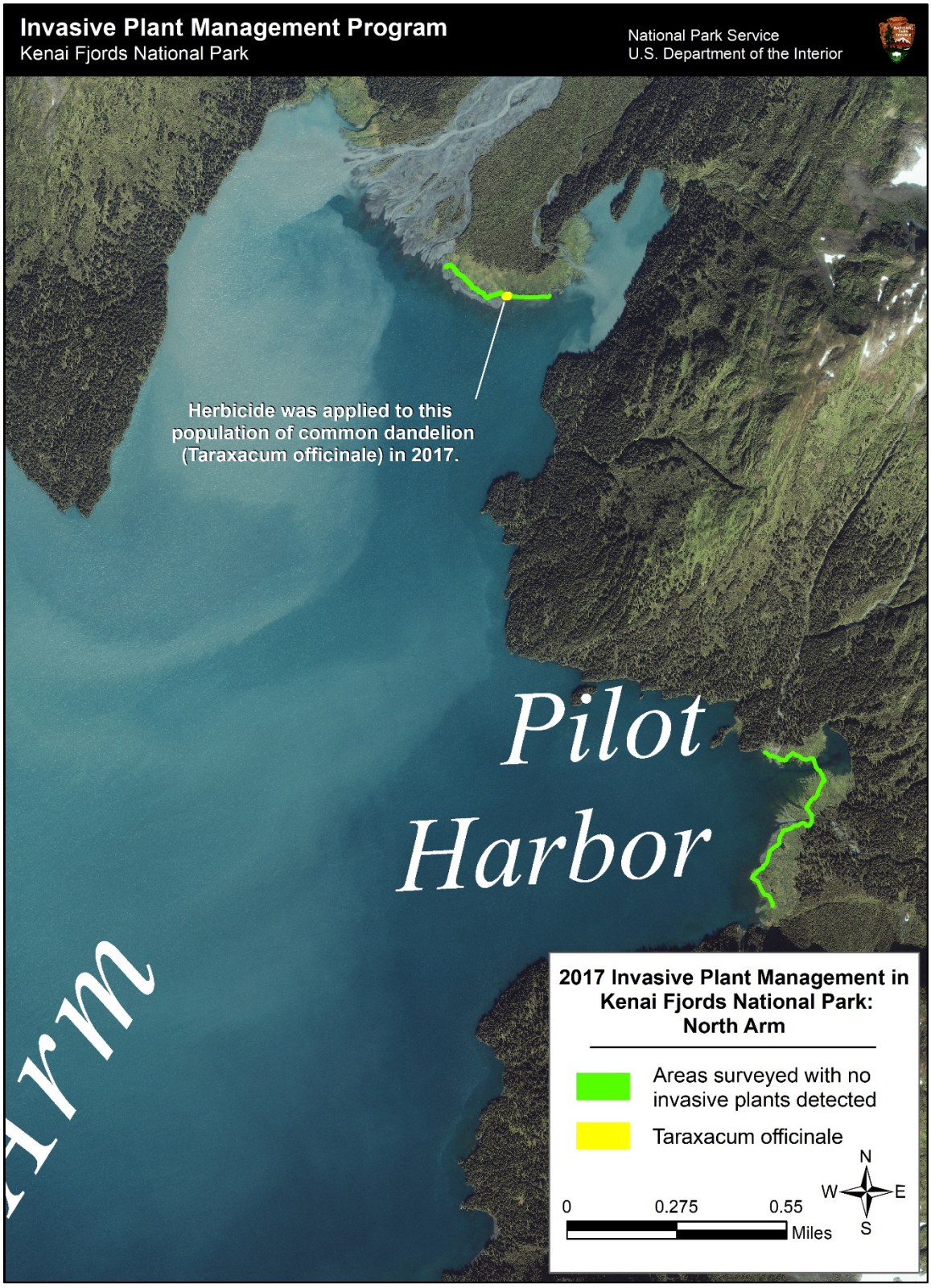


Figure A-12. Invasive plant surveys in North Arm.

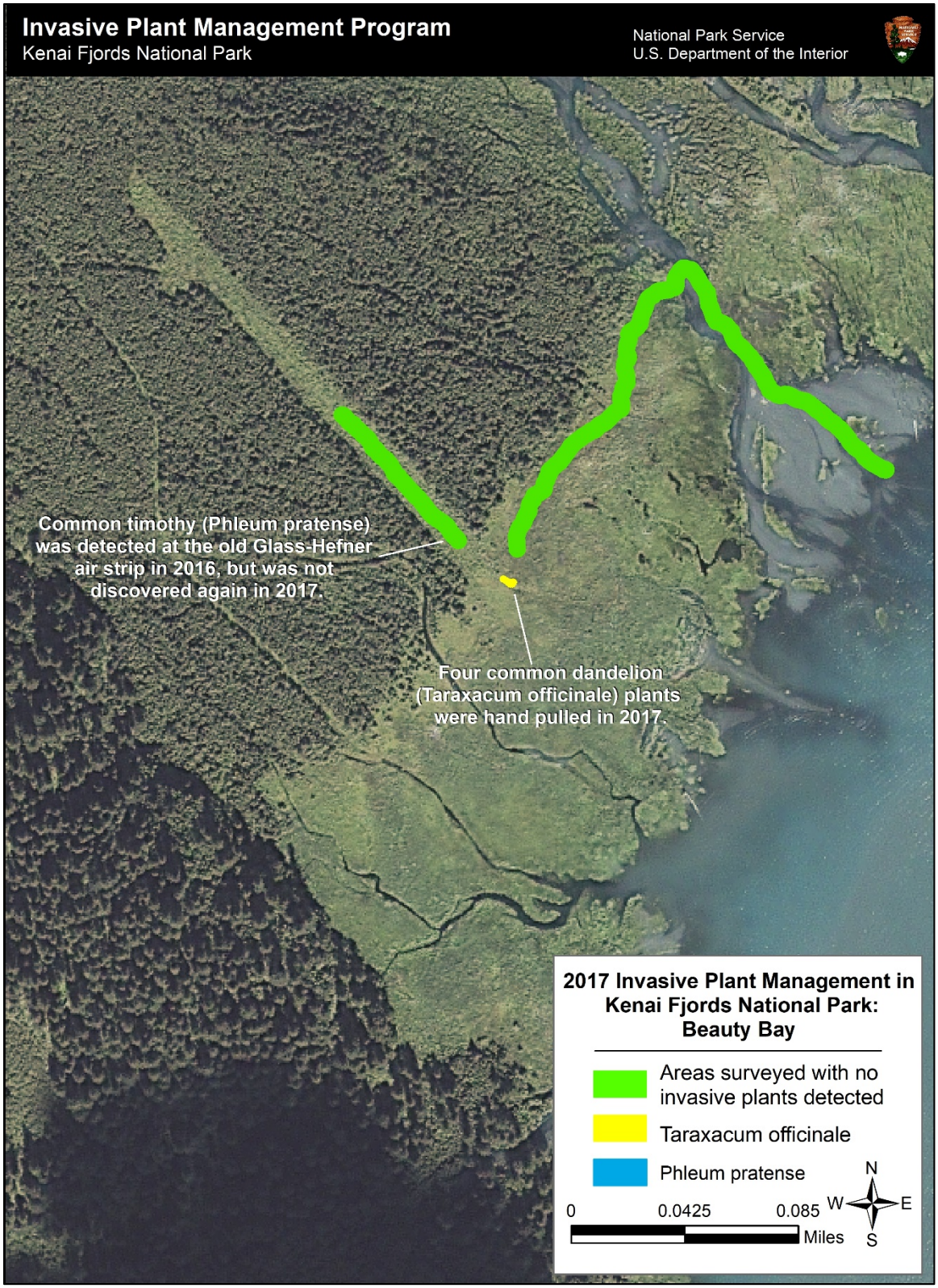


Figure A-13. Invasive plant surveys in Beauty Bay.

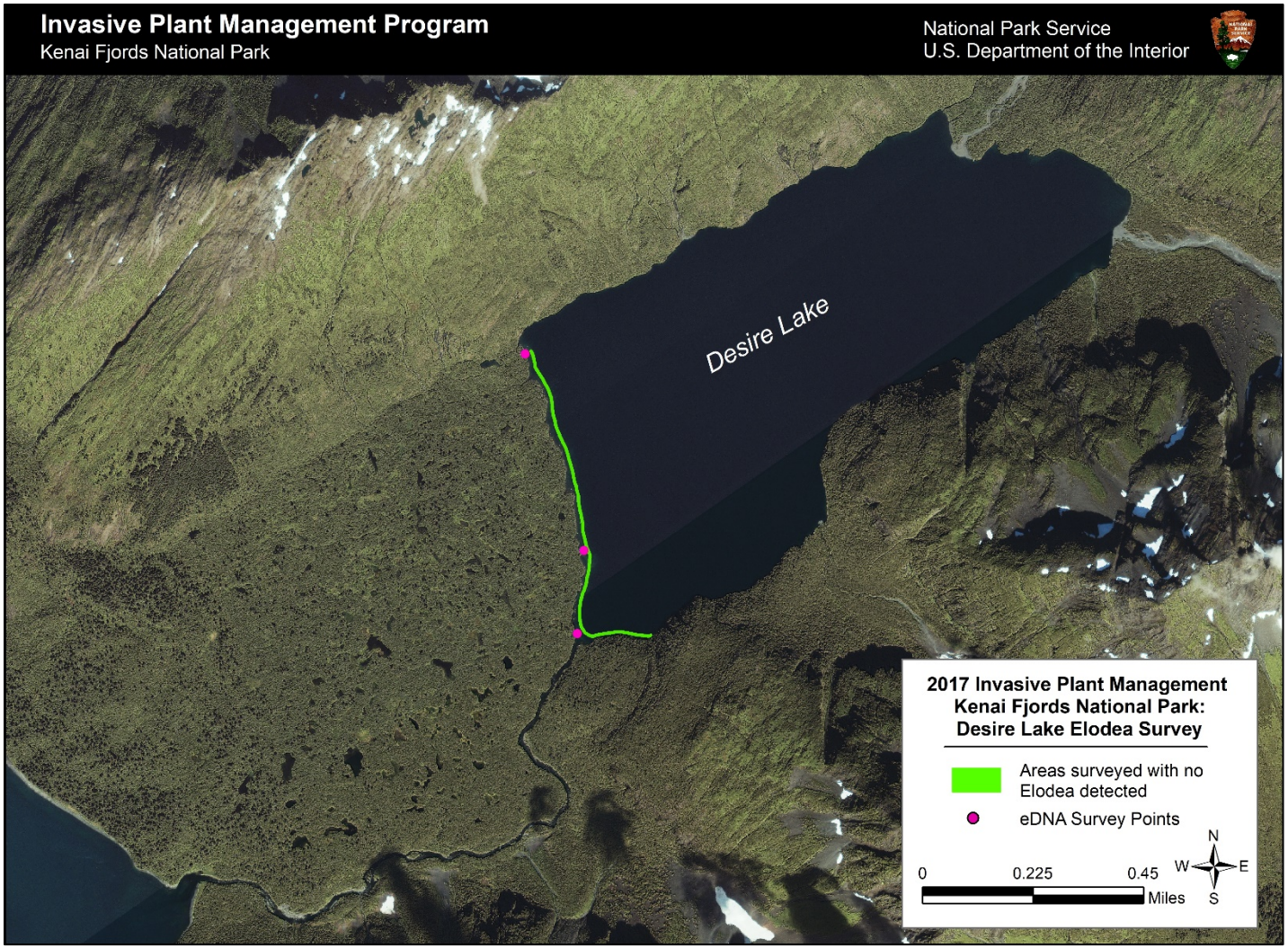


Figure A-14. Elodea surveys in Desire Lake.

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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Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525