



Invasive Plant Management in Kenai Fjords National Park

2014 Summary Report

Natural Resource Data Series NPS/KEFJ/NRDS—2014/740



ON THE COVER

Clockwise from top: Kenai Fjords National Park Exotic Plant Management crew navigating to the outwash plain field site; ,
Student Conservation Association and Exotic Plant Management crew manually treating annual bluegrass along the trail at Exit
Glacier; common dandelion inflorescence

Photographs by: Nicholas Kainrath/NPS

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, 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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Contents

	Page
Figures.....	v
Tables.....	v
Appendices.....	v
Abstract.....	vi
Acknowledgments.....	vii
Acronyms.....	vii
Introduction.....	1
Methods.....	3
Control Methods.....	3
Manual Treatment	3
Chemical Treatment	3
Mapping.....	4
Personnel	4
Distribution of Invasive Plants	4
Results.....	6
2014 Season Overview	6
Exit Glacier Area.....	8
Herman Leirer Road.....	9
Campground	9
Exit Glacier Parking Lot.....	9
Employee Housing	10
SNOTEL.....	10
Nature Center Plaza and Main Trail.....	10
Trail to the Glacier View.....	11
Trail to the Edge of the Glacier	11
Harding Icefield Trail.....	11
Nike Stripe.....	12
Outwash Plain.....	12

Contents (continued)

	Page
Coastal Areas.....	13
Aialik Bay.....	13
Nuka Bay	14
McCarty Fjord	15
Seward	15
Outreach and Education	15
Gypsy Moth Monitoring.....	16
Restoration.....	16
Discussion and Recommendations	17
Literature Cited	19

Figures

	Page
Figure 1. View of Exit Glacier, the Harding Icefield, and outwash plain taken from the Harding Icefield Trail.	vi
Figure 2. Overview map of Kenai Fjords National Park.	2
Figure 3. Overview map of the Exit Glacier area.	8
Figure 4. Before and after shot of the KEFJ EPMT and SCA crew pulling annual bluegrass along the Main Trail.....	10
Figure 5. SCA crew hand pulling annual bluegrass along the Harding Icefield Trail.	11
Figure 6. NPS employee applying herbicide using a backpack sprayer on the Outwash Plain.	12
Figure 7. EPMT staff being picked up by the park’s Safeboat at Abra Cove in Aialik Bay.	13
Figure 7. EPMT staff being picked by the parks’ Safe Boat at Abra Cove in Aialik Bay.....	13
Figure 8. EPMT SCA Intern mapping in the North Arm of Nuka Bay.	14
Figure 9. Conducting chemical treatment and mapping at the Dinglestadt Glacier site.....	14
Figure 10. YCC crew member displaying a large root of a common dandelion.	15
Figure 12. NPS staff setting up a gypsy moth trap.	16
Figure 13. Before and after shot of a restoration site on the Trail to the Glacier View.....	17

Tables

	Page
Table 1. Three primary areas where invasive plants were controlled in 2014.	5
Table 2. Summary of Kenai Fjords National Park Exotic Plant Management Work from 2004 to 2014.	6
Table 3. Invasive plant species observed in the Exit Glacier area, coastal areas, and Maintenance Facility.....	7

Appendices

	Page
Appendix A: Site Specific Maps.....	20

Abstract

This report describes the work performed by the Exotic Plant Management Team (EPMT) in Kenai Fjords National Park (KEFJ) during the 2014 field season. 2014 marked the 11th season of manual treatment of invasive plants, and the fourth season of chemical treatment of common dandelion (*Taraxacum officinale*). There were a total of 14.38 acres surveyed, 7.05 acres infested, and 4.95 acres treated in KEFJ. A total of 633 pounds of invasive plants were hand pulled over 1.73 acres, and a total of 3.22 acres were chemically treated in KEFJ. A new invasive species, Smooth brome (*Bromus inermis*), was identified in the Exit Glacier area for the first time in 2014. A majority of the field work was conducted in the Exit Glacier area where nine different invasive species were surveyed and treated. There were a total of three trips to the coastal areas of the park where five invasive plant species were mapped and treated at seven sites within Aialik Bay, Nuka Bay, and McCarty Ford.



Figure 1. View of Exit Glacier, the Harding Icefield, and outwash plain taken from the Harding Icefield Trail.

Acknowledgments

The author would like to thank everyone who has contributed to the success of Kenai Fjords National Park EPMT 2014 field season; EPMT crewmembers including Student Conservation Association Intern Cory Smith, and Youth Conservation Corps members Jeremy Anderson and Kjell Nilsson; NPS employees Christina Kriedeman, Peter Frank, Chris Overbaugh, Travis Fulton, Mark Kansteiner, Sean LaHusen, Jordan Green, Sharon Kim, and Shannon Kovac; KEFJ trail crew members; the visiting Student Conservation Association crew; all groups and individuals that assisted with the Herman Leirer Road community weedpull event; and the NPS M/V *Serac* captain Mel Knight and deckhand Jennifer Pletz.

Acronyms

EPMT Exotic Plant Management Team

KEFJ Kenai Fjords National Park

M/V Motor Vessel

NPS National Park Service

PUC Public Use Cabin

SCA Student Conservation Association

SNOTEL Snowpack Telemetry

USFS United States Forest Service

YCC Youth Conservation Corps

Introduction

The Exotic Plant Management Teams (EPMT) were established in 2000 to control invasive plant species within the National Park Service (NPS) units. In 2014, the EPMT program consisted of 17 teams working in over 200 park units nationwide. Most of these programs consist of teams traveling between different NPS units over a wide area to treat invasive plants. However, the Alaska EPMT program does not have a centralized crew traveling between parks due to the remote locations and cost of travel between Alaska's NPS units. The Alaska Regional EPMT program cooperatively works with partner parks to manage and treat invasive plants in eight NPS units in Alaska. Kenai Fjords National Park (KEFJ) has been working as a part of the Alaska EPMT since 2004.

The KEFJ EPMT program has monitored and treated invasive plants in KEFJ for 11 years. The overall objective of KEFJ EPMT is to map and treat invasive plants while surveying new areas for infestations. The team has used an early detection rapid response approach to treat new or emerging infestations. The KEFJ EPMT has also prioritized field sites to contain and reduce infestations that can easily spread further into the park. The KEFJ EPMT has manually treated invasive plants since 2004, and has chemically treated at selected sites since 2011.

KEFJ is one of three NPS units in Alaska that is connected to the highway system (Catton 2010). Herman Leirer Road is the entrance road to KEFJ and allows for easy access to the Exit Glacier area from the city of Seward. The Exit Glacier area receives the highest visitor use compared to anywhere else in the park because a majority of the park is remote and only accessible by float plane or boat. The Exit Glacier area also has the highest concentration of invasive plant populations in the park. Herman Leirer Road acts as the main vector for invasive plants to spread into the Exit Glacier area. Vehicles and people traveling into the area transport invasive plant seeds and propagules into the park. Humans, wildlife, and wind have likely contributed to seed dispersal onto the trail systems and to locations outside the developed area.

The coastal areas of KEFJ are mostly remote, rugged, and glacier-carved fjords. A majority of visitors to the coastal areas of KEFJ arrive by commercial tour boats and never set foot on land. However, there are some areas associated with public use which include public use cabins (PUC) and camp sites at beaches along the coast. There are seven sites along the coast with invasive plant populations, and most are associated with areas currently or historically used by visitors.

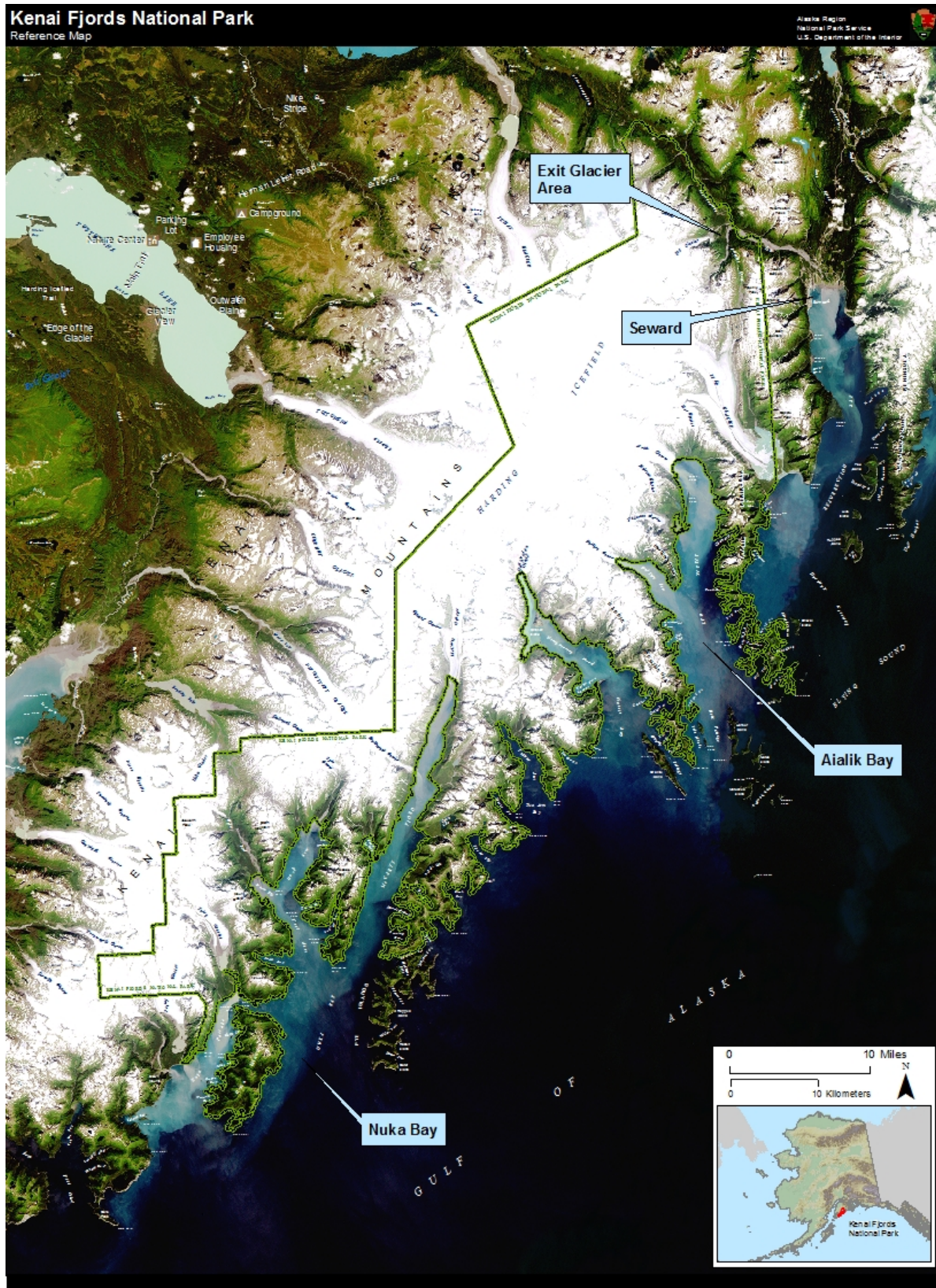


Figure 2. Overview map of Kenai Fjords National Park.

Methods

The KEFJ EPMT followed the regional Alaska Exotic Plant Management Team 2014 Field Protocol (Million et al. 2014) for the 2014 field season. The EPMT's overall goal focused on containing larger infestations within the park while completely removing smaller infestations. The majority of the field work was conducted between June and August of 2014, which included manually treating, chemically treating, and mapping invasive plant populations. The KEFJ EPMT used information such as historic infestations, geographic location, phenology, available personnel, weather, and whether the water level of Exit Creek was safe for crossing to prioritize field work throughout the season.

Throughout the season, geographic locations and phenology of the infestations determined where efforts were needed at what time. Legacy data was used to determine the extent of infestations as well as to navigate back to these populations. There was a strong emphasis on controlling invasive plants prior to them going to seed, so this helped prioritize when field work occurred at the different field sites.

The KEFJ EPMT started the season by treating and containing larger and denser infestations before they went to seed within the Exit Glacier area. The outwash plain invasive plant population was given priority at the beginning of the season because the KEFJ EPMT needed to cross Exit Creek to access the site before the water level became too deep. There was an emphasis on treating and removing all invasive plants on other backcountry sites and coastal sites to prevent infestations from spreading further into the park.

Control Methods

Manual Treatment

Manual treatment of invasive plants consisted of hand-pulling, digging, and flower head removal. When hand-pulling plants, the team tried to remove a majority, if not all, of the root structure. Flower heads were removed when time constraints did not allow for plants to be removed, and helped to prevent seed dispersal by inhibiting the flower from going to seed. All of the invasive plants removed were bagged, weighed, and disposed of at the Seward Transfer Facility where it is transported to the Kenai Peninsula landfill in Soldotna.

Chemical Treatment

Herbicide was used on less accessible populations of common dandelion (*Taraxacum officinale*) at two sites in the Exit Glacier area and two sites along the coast. Chemical treatment consisted of applying Milestone VM, a broadleaf herbicide with the active ingredient aminopyralid, to particular infestations using backpack sprayers. The herbicide solution consisted of 6 ml of Milestone VM per gallon of water, and blue marker dye. The blue dye distinguishes between treated and untreated plants, and fades away after exposure to the sun. A technique called spot spraying was used when applying herbicide from backpack sprayers. Spot spraying allows the applicator to selectively spray individual plants, reducing the impacts to non-target species. Flower heads from common dandelion were removed prior to spraying to reduce the risk of seed dispersal. All staff applying herbicide in

KEFJ are certified Pesticide Applicators through the Alaska Department of Environmental Conservation.

Mapping

All invasive plant populations within the park were mapped using Trimble GPS units, as specified in the Alaska Exotic Plant Management Team 2014 Field Protocol. Invasive plant populations were mapped as precisely as possible in order to prevent overestimating infested acreage. After the data was collected in the field, it was post-processed and sent to the Alaska Regional EPMT staff, where it is entered into the NPS's servicewide Alien Plant Control and Management (APCAM) database. The GPS data is converted into ArcMap feature classes and put into the Alaska Regional invasive plant geodatabase.

Personnel

The EPMT field crew consisted of a NPS Biological Science Technician Nicholas Kainrath, one Student Conservation Association (SCA) intern Cory Smith, and two Youth Conservation Corps (YCC) members Jeremy Anderson and Kjell Nilsson. KEFJ Environmental Protection Specialist Christina Kriedeman managed the KEFJ EPMT program which included providing guidance, applying herbicide, conducting field work, and completing all planning and compliance work. KEFJ Backcountry Ranger Travis Fulton, also a certified pesticide applicator, assisted with herbicide treatments. Alaska Region EPMT Liaison Chris Overbaugh provided technical support and assisted with herbicide application projects. EPMT Biological Science Technician Peter Frank based out of Wrangell-St. Elias National Park and Preserve, provided technical and data management support. A six person SCA crew also worked with the KEFJ EPMT from August 4th to August 8th.

Distribution of Invasive Plants

The Exit Glacier area has been the most visited and accessible area of KEFJ causing it to be susceptible to infestation by invasive plants. Herman Leirer Road allows a majority of visitors' easy access to the Exit Glacier area and is heavily infested with invasive plants and acts as a vector for seed dispersal into the park. A variety of seed dispersal mechanisms such as humans, automobiles, wildlife, and wind, have transported seeds and propagules onto the road, and into the Exit Glacier area.

The City of Seward is highly infested with invasive species and likely contributes to the establishment and spread of invasive plants within the park. The KEFJ EPMT went to three Seward locations owned by KEFJ to hand pull invasive plants. These sites were the Maintenance Facility, the Headquarters building, and the Information Center. It is important to control invasive plants in these sites to prevent NPS vehicles and staff from spreading seeds and propagules to other locations and into the park.

Coastal areas in KEFJ have fewer invasive plant infestations than the Exit Glacier area because they are inaccessible by road and receive fewer visitors. A majority of coastal visitors access the fjords by commercial tour boat and never step foot on land. Infestations along the coast are all associated with current or past human use.

Table 1. Three primary areas where invasive plants were controlled in 2014.

Areas	Field Sites
Exit Glacier	Herman Leirer Road, Campground, Employee Housing, Exit Glacier Parking Lot, SNOTEL, Nature Center, Main Trail, Trail to the Glacier View, Trail to the Edge of the Glacier, Harding Icefield Trail, Nike Stripe, Outwash Plain.
Coastal	Aialik Bay Public Use Cabin, Holgate Public Use Cabin, Abra Cove Camping Beach, Beauty Bay, North Arm of Nuka Bay, Dinglestadt Glacier.
Seward	Maintenance Facility, Information Center, Park Headquarters.

Results

2014 Season Overview

The KEFJ EPMT conducted a majority of its invasive plant field work between June and August of 2014. A total of 14.38 acres were surveyed, 7.05 acres were infested, and 4.95 acres were manually and chemically treated within KEFJ; these numbers reflect acreage calculations as specified in Table 2. The 2014 data has been adjusted in an attempt to more accurately estimate acres surveyed, acres infested, and acres treated. All acres surveyed, acres infested, and acres treated mentioned in this report will incorporate these adjustments.

Table 2. Summary of Kenai Fjords National Park Exotic Plant Management Work from 2004 to 2014.

Year	Invasive GPS Data NPS Lands (non-NPS lands)		
	Species Acres Surveyed*	Species Acres Infested*	Acres Treated**
2004	2.8 (0.5)	1.7 (0.5)	0.5 (0.5)
2005	9.7 (0.1)	2.8 (0.01)	2.3 (0.01)
2006	42.7 (0.3)	5.4 (0.3)	4.8 (0.2)
2007	23.5 (1.8)	5.2 (0.01)	1.9 (0.01)
2008	24.0 (0.2)	3.4 (0)	1.7 (0)
2009	26.1 (3.2)	2.7 (0.01)	2.3 (0.01)
2010	55.9 (5.9)	5.5 (0.01)	3.4 (0.01)
2011	27.6 (9.3)	7.5 (0.8)	6.1 (0.8)
2012	21.4 (5.5)	7.1 (0.2)	5.5 (0.2)
2013	13.4 (0.4)	3.4 (0.1)	3.2 (0.1)
2014	14.38 (1.9)	7.05 (0.1)	4.95 (0.1)

The March 2014 NPS Land Status geodatabase was used to delineate NPS lands in acreage calculations.

* Acres Surveyed and Acres Infested are calculated by multiplying acres mapped by the percent cover in areas greater than 0.5 acres. In mapped areas under 0.5 acres, infestations are counted as 100% cover.

**Acres Treated are calculated by multiplying acres mapped by the percent cover and percent treated in areas greater than 0.5 acres. In mapped areas under 0.5 acres, infestations are counted as 100% cover.

In 2014, a total of 12 invasive plant species were identified during the season. A total of nine invasive plant species were identified in the Exit Glacier area, five species were identified in the coastal areas, and seven species were identified at the Maintenance Facility. Throughout the season a total of 633 pounds were hand pulled within KEFJ including the three NPS properties in Seward. A total of 1.73 acres were manually treated within KEFJ and primarily consisted of common dandelion and annual bluegrass (*Poa annua*).

Four sites were chemically treated including: the Outwash Plain, Nike Stripe, a site south of Dinglestadt Glacier, and the beach at the head of North Arm in Nuka Bay. A total of 61 gallons of herbicide solution was applied to treat common dandelion on all sites treated. A total of 12.37 ounces of Milestone VM herbicide was applied in KEFJ in 2014 at a rate of 0.203 ounces (6 ml) per gallon as recommended by the product label. A majority of the herbicide applied occurred in the Exit Glacier area, where 58.25 gallons of solution was applied. 2.75 gallons of herbicide solution was applied at the site south of Dinglestadt Glacier and at the beach at the head of North Arm in Nuka Bay.

Table 3. Invasive plant species observed in the Exit Glacier area, coastal areas, and Maintenance Facility. X = present in 2014, H = historically present.

Species		Location		
Latin Name	Common Name	Exit Glacier	Coast	Maintenance
<i>Alopecurus pratensis</i>	meadow foxtail	X		
<i>Bromus inermis</i>	smooth brome	X		
<i>Capsella bursa-pastoris</i>	shepherd's purse	H		X
<i>Cerastium fontanum</i>	mouse-ear chickweed	H		
<i>Crepis tectorum</i>	narrowleaf hawksbeard	H		
<i>Hordeum jubatum</i>	foxtail barley	H		
<i>Leucanthemum vulgare</i>	oxeye daisy	H		
<i>Linaria vulgaris</i>	yellow toadflax	H		
<i>Matricaria discoidea</i>	pineapple weed	X	X	X
<i>Papaver nudicaule</i>	Icelandic poppy	H		
<i>Phleum pratense</i>	common timothy	X	X	
<i>Plantago major</i>	common plantain	X	X	X
<i>Poa annua</i>	annual bluegrass	X	X	X
<i>Poa pratensis</i>	Kentucky bluegrass	H		
<i>Polygonum aviculare</i>	prostrate knotweed			X
<i>Ranunculus acris</i>	tall buttercup	H		
<i>Rumex acetosella</i>	common sheep sorrel	X		
<i>Rumex crispus</i>	curly dock	H	H	
<i>Stellaria media</i>	common chickweed			X
<i>Taraxacum officinale</i>	common dandelion	X	X	X
<i>Trifolium hybridum</i>	alsike clover	H		
<i>Trifolium pratense</i>	red clover	H		
<i>Trifolium repens</i>	white clover	X		H

Exit Glacier Area

A majority of the field season was spent in the Exit Glacier area hand pulling common dandelion and annual bluegrass. A total of 478 pounds of invasive plants were pulled over 1.58 acres from the Exit Glacier area. Other invasive plant species identified in 2014 include: common plantain (*Plantago major*), pineapple weed (*Matricaria discoidea*), common timothy (*Phleum pretense*), white clover (*Trifolium repens*), meadow foxtail (*Alopecurus pratensis*), common sheep sorrel (*Rumex acetosella*), and smooth brome (*Bromus inermis*).

The KEFJ EPMT controlled all historically mapped and treated infestations. Work was prioritized by controlling infestations that were relatively small in size, which could be easily controlled, and had the potential of spreading further into the park. Sites that were furthest away from the road were given higher priority than the road itself. The aim was to completely control all invasive plants in the Nike Stripe, the Harding Icefield Trail (HIT), the lower trails, the Nature Center, the Exit Glacier parking lot, employee housing, and campground to limit infestations within the Exit Glacier area to the road system.

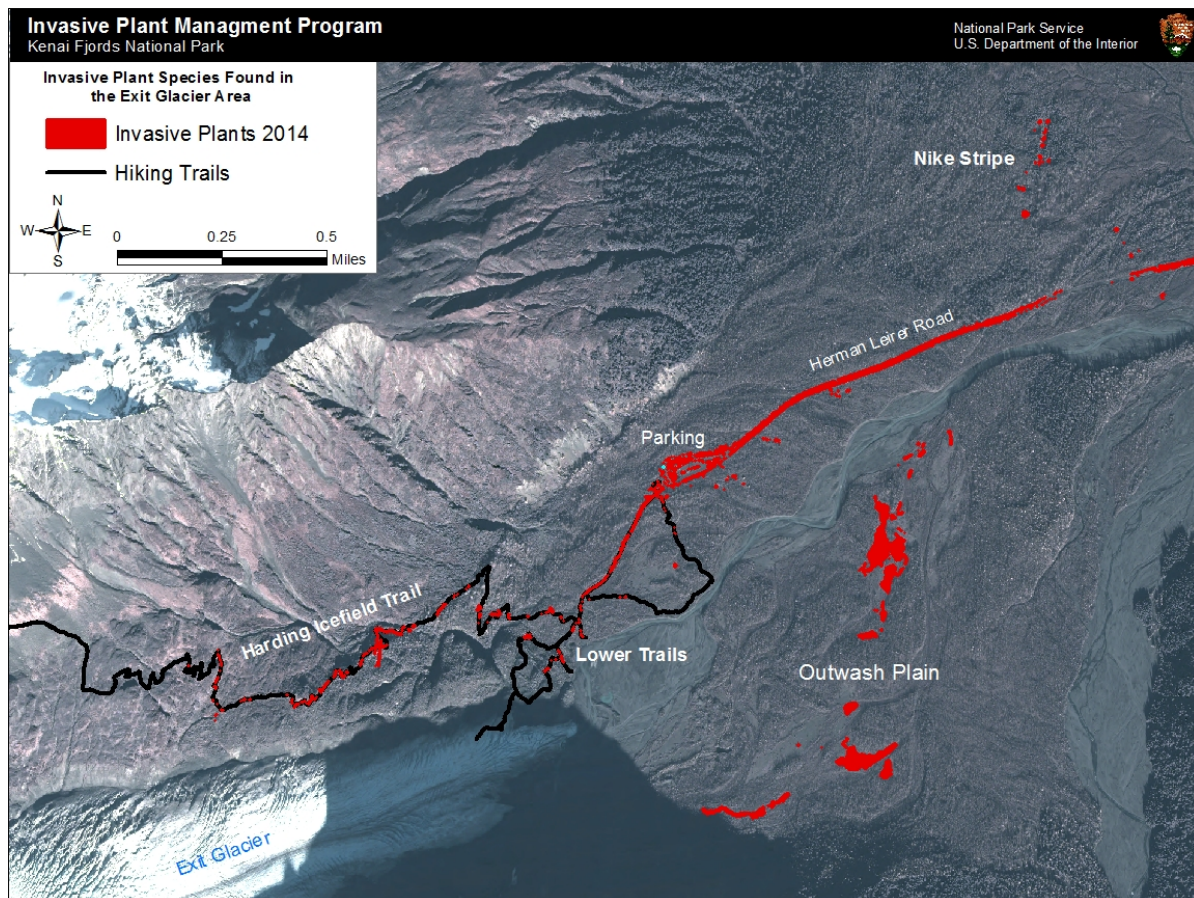


Figure 3. Overview map of the Exit Glacier area.

Herman Leirer Road

This one-mile stretch of road is the main vector for invasive plants to establish themselves in the Exit Glacier area. The KEFJ EPMT surveyed the entire extent of the road twice throughout the season. Invasive plant species identified were: common dandelion, common plantain, pineapple weed, meadow foxtail, white clover, and smooth brome. The section of Herman Leirer Road inside the park boundary is heavily infested with common dandelion, and because of the high number of person hours needed to manually treat the entire road, it was not attempted. Instead, a total of 119 pounds of common dandelion flower heads were removed to reduce seed dispersal rates and to try to contain the established infestation.

Common plantain and pineapple weed had small, scattered populations along the road system and all identified plants were mapped and hand pulled. Historic populations of meadow foxtail and white clover were relocated using GPS and manually treated. This year, there were six small populations of meadow foxtail and seven small populations of white clover mapped and removed.

In 2013, the KEFJ EPMT suspected two patches of grass along the road of being smooth brome, but was unable to verify this because the grass never went to flower. In 2014 this suspected invasive grass went to flower and was successfully identified as smooth brome, which would mark the first time this species was documented in the park. The two patches of smooth brome were not manually treated. It is difficult to successfully remove it through manual treatment because of its rhizomatous root structure, and instead is a candidate for herbicide treatment in 2015.

Campground

The Exit Glacier campground has 12 walk-in campsites and is located east of the Exit Glacier parking area off Herman Leirer Road. The KEFJ EPMT surveyed this area several times throughout the season and did not observe any invasive plant species along the trails and at campsites. Scattered populations of common dandelion were mapped and manually treated in the parking area and near the bathroom. Only one common plantain was mapped and treated in the parking area.

Exit Glacier Parking Lot

KEFJ EPMT spent 11 days manually treating infestations in the parking lot and pulled a total of 161 pounds of invasive plants. The parking lot was treated for the first time for six days in June, and again for 5 days in late July and early August. This was by far the most time consuming field site controlled this season due to large populations of common dandelion and annual bluegrass. Invasive species identified and controlled include: common dandelion, common plantain, pineapple weed, annual bluegrass, common sheep sorrel, and common timothy. Approximately 30 pounds of common dandelions were hand pulled throughout the season, and was the largest extent of any other invasive plant species found in the parking lot. A visiting six-person SCA crew assisted the EPMT in hand pulling 122 pounds of a dense patch of annual bluegrass in one day along the south side of the parking lot. Common plantain and pineapple weed both have small, but scattered populations throughout the parking lot area. A single population of common sheep sorrel was located in the north-west corner of the parking lot and a single population of common timothy was located in the south-west corner of the parking lot. All invasive plant populations encountered were mapped and removed.

Employee Housing

There are three employee cabins, an employee parking lot, and a maintenance tool shed that are located on the south-east side of the Exit Glacier parking lot. This area was surveyed a number of times throughout the season to ensure all invasive plant populations were discovered and removed. A few small scattered populations of common dandelion were mapped and treated in the employee housing parking lot. A few patches of dense annual bluegrass were hand pulled in the parking lot. One single common plantain and pineapple weed were mapped and pulled.

SNOTEL

The snowpack telemetry (SNOTEL) site is located near the Employee Housing area and was constructed in 2010 by the Natural Resource Conservation Service (NRCS). This site has also been used for snow surveys for the last 27 winters and is situated in a natural opening in the forest. In 2013 one common dandelion was mapped and pulled while in 2014 over 50 individual common dandelions were mapped and pulled at this site. A larger dense patch of common dandelion was located near the equipment at the SNOTEL site along with a scattered populations extending westward towards the road. From 2013 to 2014 there was a significant increase in mapped population of common dandelion and therefore this site should be a high priority site next year to contain the infestation from expanding further.

Nature Center Plaza and Main Trail

The Nature Center Plaza and Main Trail were monitored frequently throughout the 2014 field season. Small patches of common dandelion, common plantain and pineapple weed were in scattered populations around the Nature Center Plaza and along the Main Trail. Annual bluegrass was densely concentrated along the beginning of the Main Trail and near the pump house, and becomes less dense towards the end of the Main Trail. Most of the annual bluegrass was controlled over the course of several days in early August with the help of a visiting SCA crew.



Figure 4. Before and after shot of the KEFJ EPMT and SCA crew pulling annual bluegrass along the Main Trail.

Trail to the Glacier View

There were only a few invasive plant infestations documented along the wheelchair accessible trail to the Glacier View. There were two small but dense patches of annual bluegrass, and a few pineapple weed and common plantain plants next to the Pavilion that were mapped and treated. A few small patches of annual bluegrass and a few individual common plantains were located within 600 feet of the Pavilion and within 500 feet of the Kiosk along the trail. A patch of common dandelions was discovered this year in a forest clearing between the trail to the Glacier View and the Main Trail. This forest clearing had been surveyed in the past but had always been free of invasive plants. There are several game and social trails leading to this opening. This area should be monitored closely in future seasons because it is not heavily vegetated and the infestation could easily spread throughout the entire clearing.

Trail to the Edge of the Glacier

The Trail to the Edge of the Glacier is a popular trail and remains minimally infested with invasive plants. There is one area located just off trail on the northern loop that has a historic population of common dandelion; this patch was mapped and treated several times throughout the field season. Along the southern loop of the trail a few small patches of annual bluegrass, one common dandelion, and one common plantain were mapped and controlled. A few patches of annual bluegrass were observed at the intersection of the trail to the Edge of the Glacier and the Outwash Plain spur. All invasive species encountered were mapped and manually treated.

Harding Icefield Trail

This 4.1 mile hiking trail allows access to the Harding Icefield. Annual bluegrass was mapped in patches from the trailhead to approximately 1.5 miles up the trail just past Marmot Meadows. The upper section of trail from approximately 1.5 miles to the end of the trail was surveyed several times and remains free of invasive plants. An SCA crew assisted the KEFJ EPMT in pulling 106 pounds of annual bluegrass on the trail on August 5th and 6th. The SCA crew and the KEFJ EPMT split into two groups and started working from opposite ends of the infestation along the Harding Icefield Trail (HIT), and met in the middle while manually treating all annual bluegrass. Since 2010 the entire extent of annual bluegrass along the trail has been mapped and hand pulled on an annual basis. In 2010 annual bluegrass only extended to the far end of Marmot Meadows, and in 2014 has expanded a few hundred yards further up the trail. In 2010 over 900 pounds of annual bluegrass was manually pulled, which included dense mats of vegetation with heavy soil attached. This year the patches of annual bluegrass encountered were not in thick vegetation mats, so it appears the density of the patches has decreased while the extent has increased slightly.



Figure 5. SCA crew hand pulling annual bluegrass along the Harding Icefield Trail.

Four common plantain plants found scattered along the trail from the trailhead to about a quarter mile from Marmot Meadows were mapped and treated. There were very few common dandelions pulled along the trail, with the largest population (< 20) manually treated along a section of the trail that was abandoned when the trail was rerouted approximately a quarter mile up from the trailhead.

Nike Stripe

There is a clearing north of Herman Leirer Road, locally referred to as the Nike Stripe, that contains several populations of common dandelion. South of the Nike Stripe clearing there were a few scattered small populations of common dandelion found north of the park road in a forested area. Bushwhacking through dense vegetation while wearing hip boots and crossing streams is necessary to access this area. This site was manually treated from 2004 to 2011, but control methods were changed to chemical treatment in 2012. The common dandelion population was chemically treated on June 12th with 1 gallon of herbicide solution, and chemically retreated again on August 20th with 0.25 gallons. Since this site was first chemically treated in 2012 there has been a reduction in the overall extent of the infestation (refer to site specific map in Appendix A).

Outwash Plain

The Outwash Plain is a large area located south of Herman Leirer Road and east of the terminus of Exit Glacier. The water level of Exit Creek varies with the amount of snowmelt and rain, and can only be safely crossed during low water. The Outwash Plain was first inventoried and manually controlled for common dandelion in 2006 (Wetherbee 2006). After a few years of hand pulling, the infestation was determined to be too extensive for manual treatment and determined to be an appropriate site for chemical treated in 2011.

This year the KEFJ EPMT was able to cross Exit Creek and chemically treat the area from June 2nd to June 6th. This year marked the fourth consecutive year that common dandelion in the Outwash Plain were chemically treated using herbicide. There were a total of four people applying herbicide and three people assisting for the first three days. The people assisting in the control efforts delineated patches of the infestation with flagging and mapped the area; they also carried food, water, and gear for the people carrying backpack sprayers and applying herbicide. There were a total of three sprayers and three people assisting on the fourth day, and two sprayers and two people assisting on the last day. A total of 57 gallons of herbicide solution was applied over the area using a spot spraying technique to selectively spray individual plants. The KEFJ EPMT was able to chemically retreat all historically treated populations but did not finish spraying the entire extent of the infestation in the Outwash Plain. There was a new site in the Outwash Plain that was mapped and chemically treated this year, which



Figure 6. NPS employee applying herbicide using a backpack sprayer on the Outwash Plain.

increases the southern extent of the infestation. The amount of herbicide solution applied to the Outwash Plain increased from 28 gallons in 2013 to 57 gallons in 2014. Even with the increase of chemical treatment, there still remain several infested acres that have not been controlled yet due to time and resource constraints.

Coastal Areas

The KEFJ EPMT traveled to seven infested sites within Aialik Bay, Nuka Bay, and McCarty Fjord. 4,834.46 square feet (0.11 acres) were collectively treated, which includes all historically mapped invasive plants. The KEFJ EPMT surveyed 7.33 acres while visiting over 15 coastal sites. Invasive species encountered include: annual bluegrass, common dandelion, common plantain, pineapple weed, and common timothy.

Aialik Bay

The KEFJ EPMT surveyed and manually treated invasive plants found at four different sites within Aialik Bay. A total of 13 pounds of invasive plants were hand pulled on July 8th and 9th. A three-person team traveled to Aialik Bay in the park's 19-foot Safeboat. There were two people dropped off at each site surveying, mapping, and manually treating invasive plants. One person operated and stayed on the boat to most efficiently and safely get the other two crewmembers on and off beaches. 604.6 square feet (0.014 acres) of annual bluegrass were manually treated in about two hours at the Aialik Bay Public Use Cabin (PUC). The annual bluegrass was concentrated around the cabin and no other invasive species were observed at the Aialik PUC. A total of 330.8 square feet (0.008 acres) of annual bluegrass were manually treated in about an hour at the Holgate PUC; the infestation was concentrated around the cabin. At Abra Cove, a relatively popular camping beach during the summer months, 299.7 square feet (0.007 acres) of annual bluegrass were manually treated in about an hour. The annual bluegrass was scattered in a few small population along the beach where visitors camp. One common plantain was also found, and was mapped and pulled.

Kenai Fjords Glacier Lodge is a private inholding leased by Alaska Wildland Adventures from Port Graham Corporation. The lodge is located in Aialik Bay near Pederson Lagoon. Permission was granted from the lodge manager to access and manually retreat invasive plants at the landing beach and treat a new site located near the lodge's employee housing. There was a trip scheduled to survey around upper Pederson Lagoon, but was cancelled due to weather constraints. The area in upper Pederson Lagoon has not been surveyed since 2012, and should be surveyed in future seasons because it is a destination for park visitors and lodge guests.



Figure 7. EPMT staff being picked up by the park's Safeboat at Abra Cove in Aialik Bay.

Nuka Bay

From July 14th to July 17th, the KEFJ EPMT visited two sites in Nuka Bay and conducted field work from the M/V Serac. Three KEFJ EPMT staff conducted all of the invasive plant field work and was assisted at times by two other KEFJ staff.

Historically mapped populations of invasive plants were revisited and retreated. Invasive species controlled include common dandelion and common timothy. The KEFJ EPMT also accompanied the Cultural Resource Program Manager to five historic sites including: Rosness Larson Mine, Waterfield-Goyne Mine, Kinney/Sonny Fox Mine, Glass-Heifner Mine, and the Hatch Cabin; no invasive plant species were observed at these sites.

Beauty Bay is located in the West Arm of Nuka Bay. A population of common timothy was relocated and hand pulled at this site. This population is located within a historic airstrip, which is now beginning to fill in with small trees and shrubs. This population of common timothy has been drastically reduced in size since 2006 when control first began. 150 pounds were manually controlled in 2006 and only one pound was pulled in 2014 (Wetherbee 2007). A small population of common dandelion was relocated south of the historic airstrip and two plants were mapped and pulled this year. The KEFJ EPMT and two additional NPS staff surveyed along the beach at the head of Beauty Bay, throughout the historic airstrip, and at the Glass-Heifner mine, and found no new populations of invasive plants.

In 2013, a population of common dandelions was discovered on the beach at the head of North Arm in Nuka Bay. The population consisted of fewer than 50 plants and was manually controlled (Frank 2013). In 2014, this population of common dandelions was revisited and chemically controlled for the first time. A total of one gallon of herbicide solution was applied by spot treatment. The rest of the beach was surveyed but no new infestations were discovered.



Figure 8. EPMT SCA Intern mapping in the North Arm of Nuka Bay.



Figure 9. Conducting chemical treatment and mapping at the Dinglestadt Glacier site.

McCarty Fjord

A site located south of the Dinglestadt Glacier terminus in McCarty Fjord was revisited, surveyed, and chemically retreated for the second consecutive season. This area was manually treated from 2006-2012, and chemically treated in 2013. This site is remote, rugged, and requires bushwhacking through dense vegetation and up steep terrain to access the area. It contains a scattered population of common dandelion. A total of 1.75 gallons of herbicide solution was applied to this site. A few new populations of common dandelion were surveyed and treated, but because of time constraints all sites that were historically treated could not be retreated. A population of common dandelions still remains on a rocky outcrop that has been observed but never controlled due the danger of access.

Seward

Over the course of two days, the visiting SCA crew and the KEFJ EPMT manually pulled 155 pounds of invasive plants at three locations owned by the NPS within or near the city of Seward. The Maintenance Facility is located off Herman Leirer Road and is infested with seven different invasive species including: shepherd's purse, common dandelion, common plantain, pineapple weed, annual bluegrass, common chickweed and prostrate knotweed. The entire maintenance yard was surveyed and treated and a total of 62 pounds of invasive plants were pulled in about six hours. 72 pounds of invasive species were pulled from the Information Center, adjacent to the small boat harbor, in about two hours. The crew spent an hour manually treating a portion of the invasive plants located along the ally adjacent to the Park Headquarters building in downtown Seward; a total of 21 pounds of invasive plants were pulled here.



Figure 10. YCC crew member displaying a large root of a common dandelion.

Outreach and Education

Throughout the season, KEFJ EPMT participated in outreach and education activities. Presentations about invasive plants were given to visiting trail crews to educate the groups on minimizing risks of spreading invasive seeds, plants, and propagules while working in the park. Informational materials, identification booklets, and educational brochures were also provided to the trail crews. Two invasive plant blogs were posted on the Resource Management blog located on the park website. A boot brush was reinstalled at the Nature Center with a sign educating visitors on how to prevent the spread of invasive plants on shoes and boots.

On June 27th the KEFJ EPMT joined with the U.S. Forest Service (USFS) for the 11th annual community weed pull event on Herman Leirer Road in Chugach National Forest. A total of 22 people participated from the USFS, NPS, Alaska Association of Conservation Districts, and the Seward Teen and Youth Center. A total of 85.5 pounds of weeds were pulled from the following species: bird vetch (*Vicia cracca*), common timothy, common dandelion, oxeye daisy (*Leucanthemum vulgare*), and alfalfa (*Medicago sativa*).

Gypsy Moth Monitoring

The KEFJ EPMT participated in a gypsy moth (*Lymantria dispar* & *Lymantria dispar* spp. *japonica*) monitoring project for the fourth consecutive summer. The traps were baited with a string covered in female gypsy moth pheromones to attract male moths, and had a sticky substance on the inside walls of the trap to capture the moths. Five gypsy moth traps were placed around the Exit Glacier area and were installed June 17th and taken down September 5th, which coincided with the moths' flight period. The traps were checked three times throughout the season, but no gypsy moths were detected in any of the traps in 2014.



Figure 12. NPS staff setting up a gypsy moth trap.

Restoration

A variety of native plant seeds were collected in the Exit Glacier area in August and September included the following species: meadow barley (*Hordeum brachyantherum*), bluejoint reedgrass (*Calamagrostis canadensis*), spike trisetum (*Trisetum spicatum*), Merten's sedge (*Carex mertensii*), alpine timothy (*Phleum alpinum*), goat's beard (*Aruncus sylvestris*), and arctic lupine (*Lupinus arctica*). The seeds collected were dried and sent to Alaska Department of Agriculture, Plant Material Center in Palmer, Alaska to be processed and cleaned.

On September 23rd a variety of native seeds were planted at five different restoration sites. A mixture of alpine timothy, arctic lupine, goat's beard, bluejoint reedgrass, meadow barley, and spike trisetum was spread in a small unvegetated area in front of the Nature Center near the flag pole. Four sites along the trail to the Glacier View had a mixture of seeds scattered within them including: columbine (*Aquilegia formosa*), arctic lupine, goat's beard, bluejoint reedgrass, alpine timothy, meadow barley, and spike trisetum.

During the summer, a portion of the viewing area along the trail was washed away by Exit Creek. The trail was rerouted and the viewing area was moved further north away from Exit Creek and the outwash plain. On August 4th the KEFJ EPMT and a six person SCA crew worked together to restore two sections of the abandoned trail leading to the old viewing area. Compacted soil on the old sections of trail were loosened up using rakes and McLeods. Duff, branches, and any vegetative material that was cleared away from the newly constructed trail and from the surrounding area was transferred to the old trail. On September 23rd a variety of native seeds were planted at the restoration sites in hopes that next year the revegetation process will be accelerated.

Discussion and Recommendations

Over the last 11 years, manual and chemical treatment of invasive species has been an ongoing effort at KEFJ. This effort will need to continue on an annual basis to reduce and eradicate existing populations while preventing new infestations from developing. Since 2004, the KEFJ EPMT has grown as a program, eradicated a number of invasive plant species, and reduced the extent of infestations. Continuing to precisely map infestations on an annual basis is an important tool to analyze the progress and success of the KEFJ EPMT program over time.

In the Exit Glacier area, manual treatment has shown positive results with a reduction in density and extent of established infestations within the parking lot, lower trails, and Harding Icefield Trail. Continuing to survey and treat historic populations of invasive plants on an annual basis should reduce the extent of larger infestations while eradicating smaller infestations. Less common species that have been identified and mapped in the past, including meadow foxtail, common sheep sorrel, prostrate knotweed, and white clover, should be revisited to be sure these populations, if present, are retreated.

A different approach may be needed to fully treat larger infestations like common dandelion along Herman Leirer Road. The entire extent of the road has never been fully treated by hand pulling due to limited resources and the large size of the infestation. The only effort being made along the road to control common dandelion at this time is by pulling flower heads off plants in an effort to reduce the number of seeds dispersed. This site should be evaluated further as a candidate for chemical treatment because it would enable the entire road to be fully treated.

The Nike Stripe and Outwash Plain have seen reductions in the extent and density of all previously chemically treated areas. The entire extent and infestation within the Outwash Plain, however, has not been fully mapped and chemically treated. For the entire infestation within the Outwash Plain to be fully treated, more time, money, personnel, and resources will need to be allocated to the task; along with good weather and several days in a row where the water level in Exit Creek will be low enough to safely cross.



Figure 13. Before and after shot of a restoration site on the Trail to the Glacier View

The infestations along the coast so far appear to be limited to seven sites, five invasive plant species, and relatively small area. It is important to survey all areas used by visitors and treat previously mapped infestations along the coast to reduce the risk of invasive plant species spreading further into the park. There is still a good chance to eliminate all invasive plants along the coast since populations are still small and isolated, so control efforts there should remain a priority to maintain and preserve areas free of invasive plants in remote and coastal areas in the park. The common dandelion infestation near Dinglestad Glacier poses a threat; a population of common dandelion still remains that has not been treated and is located along a cliff band that is dangerous to access. More time, planning, and equipment is necessary to safely access and treat this area.

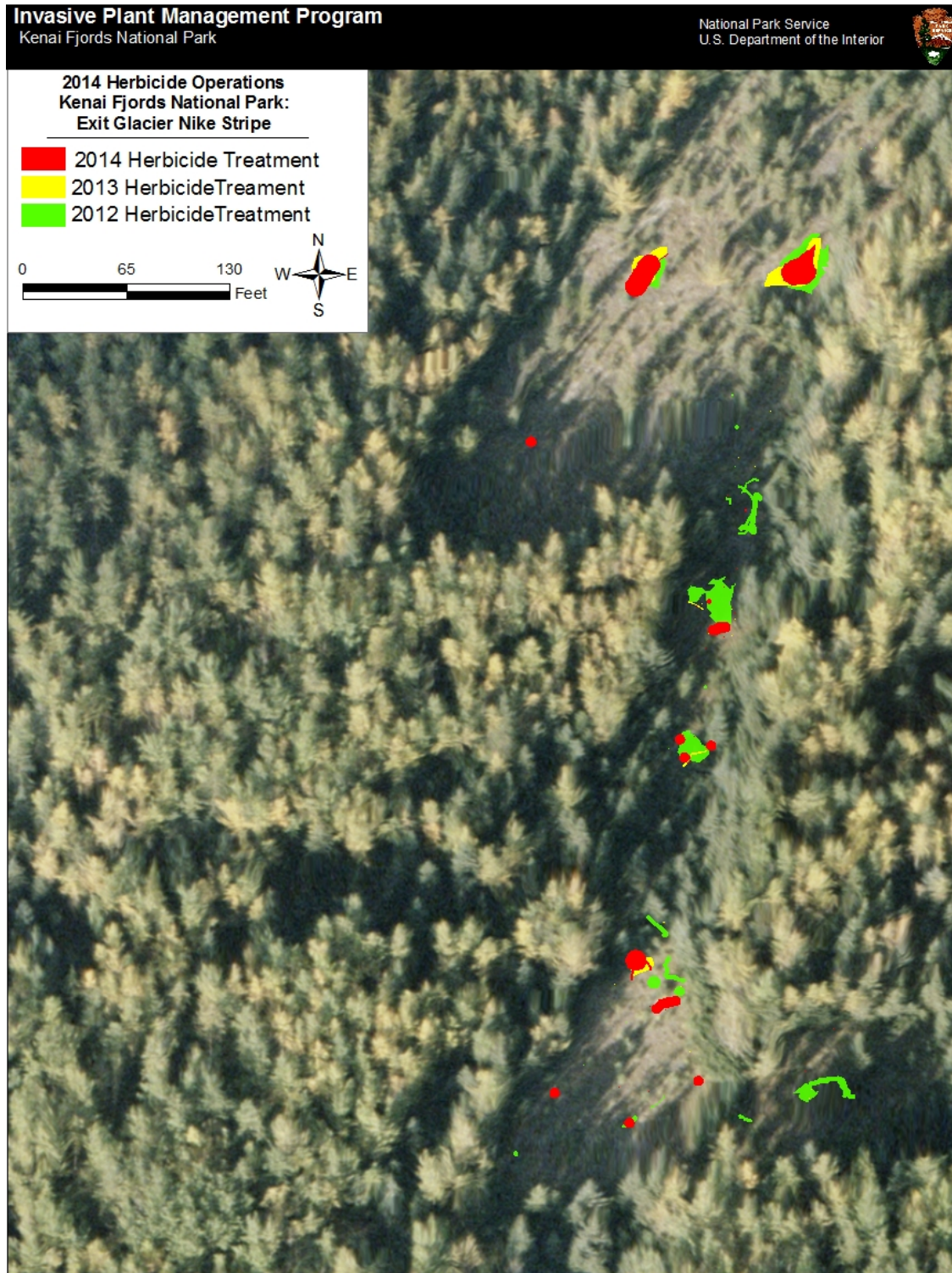
Outreach and education should continue to be a part of the invasive plant program. The annual community weed pull event has been successful, but a stronger emphasis on advertising could increase community member and visitor participation. Suggestions include posting more flyers around town, putting multiple posts on KEFJ Facebook page, and advertising in the on-line newspaper Seward City News leading up to the event. When opportunities arise, KEFJ EPMT should participate in community events to build relationships with other local agencies and organizations.

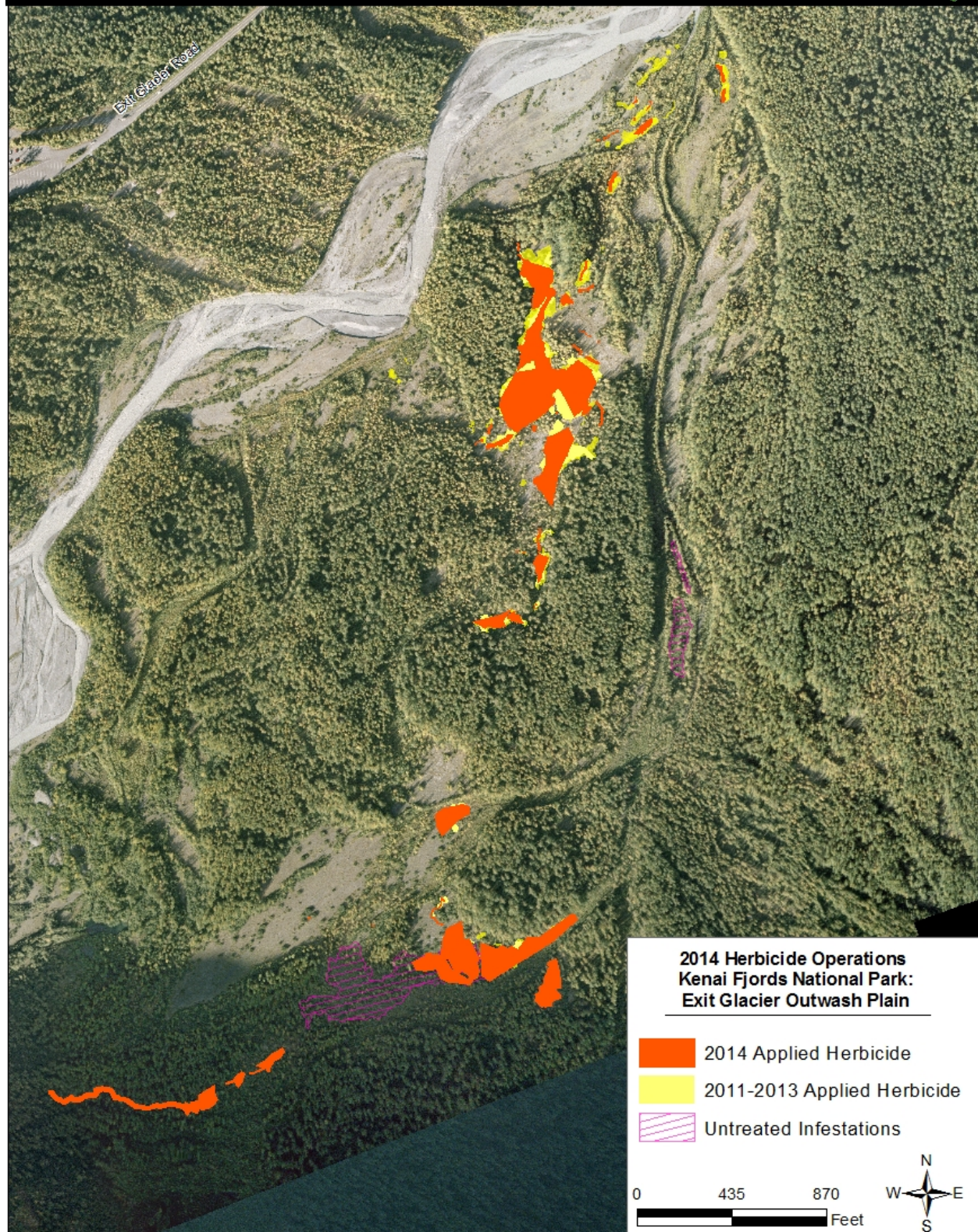
It is important to continue collecting native plant seeds in the park to have a seed bank available for future restoration needs. Seeding disturbed areas helps to accelerate the return of native plant communities, and reduce the chance of invasive plant species being introduced. Current and past restoration projects should continue to be monitored over time to assure success.

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Appendix A: Site Specific Maps





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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