



Invasive Plant Management in Kenai Fjords National Park

2021 Summary Report

Natural Resource Report NPS/KEFJ/2021





ON THIS PAGE

KEFJ IPMT on the Harding Icefield Trail

ON THE COVER

Top: KEFJ IPMT spraying dandelions on Herman Leirer Road. Lower left: Biologist hand pulls dandelions in the middle of Glacier View Loop Trail. Lower right: Biological science technician and Serac logistics coordinator hand pull dandelions on the coast.

Invasive Plant Management in Kenai Fjords National Park

2021 Summary Report

Natural Resource Report NPS/2021

Hannah M. Gage and Christina L. Kriedeman

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

October 2021

U.S. Department of the Interior
National Park Service
Kenai Fjords National Park
Seward, Alaska

Please cite this publication as:

Gage, H. M., and C. L. Kriedeman. 2021. Invasive plant management in Kenai Fjords National Park: 2021 summery report. National Park Service Unpublished Report, Seward, AK.

Contents

	Page
Figures.....	vi
Tables.....	vi
Abstract.....	vii
Acknowledgments.....	viii
List of Terms.....	ix
Introduction.....	1
Methods.....	3
Prioritizing Treatment	3
Control Methods.....	3
Manual Treatment	3
Chemical Treatment	4
Data Collection and Analysis	4
Personnel	5
Results.....	6
2021 Season Overview	6
Notable Weather Conditions	8
Exit Glacier Area.....	8
Herman Leirer Road	8
Exit Glacier Parking Area	9
Campground	11
SNOTEL.....	11
Employee Housing	11
Nature Center Plaza.....	12
Picnic Area	12
Glacier View Loop Trail	12
Glacier Overlook Loop Trail	15

Harding Icefield Trail	15
Nike Stripe.....	16
Outwash Plain.....	16
Coastal Areas.....	20
Resurrection Bay	20
Aialik Bay.....	20
Northwestern Fjord.....	23
McCarty Fjord	24
Nuka Bay	25
Seward	27
Maintenance Facility	27
Prevention.....	28
Restoration.....	31
Outreach and Education	32
Partnerships	33
Defoliating Moth Monitoring	33
Discussion and Recommendations.....	34
Annual Bluegrass.....	34
Standardized Polygons	34
Re-treatment	34
Roadside Brushing.....	34
Coastal Priorities	34
Season Planning.....	35
Shea Parking Lot	35
The Nike Stripe and SNOTEL Successes.....	36
Prevention.....	36
Partners	37
Personnel	37

Literature Cited	38
Appendix A: Herman Leirer Road Standardized Polygons	39
Appendix B: Exit Glacier Parking Lot Standardized Polygons.....	40
Appendix C: Outwash Plain Standardized Polygons.....	41
Appendix D: Maintenance Standardized Polygon	42

Figures

	Page
Figure 1. Overview of Kenai Fjords National Park.	2
Figure 2. Location of oxeye daisy (pink) found in the Exit Glacier Parking Lot in 2021.	11
Figure 3. Common dandelion (yellow) populations along the Glacier View Loop Trail.	14
Figure 4. Common dandelion (yellow) populations northwest of the pumphouse.	15
Figure 5. Common dandelion (yellow) populations on the Harding Icefield Trail.....	16
Figure 6. Common dandelion (yellow) populations treated in five standardized polygons.....	17
Figure 7. Common dandelion (yellow) populations near Resurrection River Bridge.	19
Figure 8. Common dandelion (yellow) population near the Trail Builder’s Camp and Exit Creek.	20
Figure 9. Annual bluegrass (green) populations in Aialik Bay and Holgate Arm.	23
Figure 10. Common dandelion (yellow) south of the terminus of Dinglestadt Glacier.....	25
Figure 11. Common dandelion (yellow) populations treated on the beach at the head of North Arm in Nuka Bay.....	26
Figure 12. Narrowleaf hawksbeard (pink) found at the Maintenance Facility in 2021.	28

Tables

	Page
Table 1. KEFJ 2021 Project Areas.	3
Table 2. Summary of Kenai Fjords National Park Invasive Plant Work in 2021.	6
Table 3. Invasive plant species and locations 2021.....	7
Table 4. 2021 Monthly snow depths at the Exit Glacier Area compared to the previous 15-year averages.	8

Abstract

This report is an overview of Kenai Fjords National Park's (KEFJ) Invasive Plant Management Team's (IPMT) 2021 season. The KEFJ IPMT was made up of the biologist, two biological science technicians, and an SCA intern. We surveyed and treated a portion of known invasive plant populations in the park, focusing primarily on the Exit Glacier Area. We surveyed a total of 60.86 acres, chemically treated 0.65 acres with herbicide, and manually treated 0.06 acres (2,600 square feet). This season we spot sprayed 10.21 gallons of Milestone herbicide mix at a rate of 6 ounces per acre and 12.01 gallons of Roundup Custom herbicide mix at a rate of 48 ounces per acre on invasive plant populations in the Exit Glacier Area, at the Maintenance Facility, and coastal areas. While surveying we documented a total of 13 invasive plant species, and no new invasive plant species were documented in the park and on park properties outside the park boundary this season. We coordinated the Seward Community Weed Pull with Kenai Peninsula Cooperative Invasive Species Management Area (KP-CISMA) and worked with partners to install two boot brushes at the Seward Harbor. In addition to invasive plant work, the KEFJ IPMT completed two revegetation projects in the Exit Glacier Area. We also deployed five defoliating moth (*Lymantria dispar asiatica*) pheromone traps around the Exit Glacier Developed Area as part of the Alaska Division of Agriculture monitoring program. No invasive moths were detected in these traps.

Acknowledgments

We would like to thank the following individuals for their contributions to a successful 2021 field season: Nathan Bawtinheimer for logistical coordination and support on the Motor Vessel (M/V) Couloir, Jennifer Pletz and Isabel Barnwell for logistical support aboard the M/V Serac, Sara Lane for M/V Serac logistical support as well as assisting us with invasive plant work on the coast, Tyler Balstad and Student Conservation Association (SCA) intern Jaquelyn Titus for assistance with field work and data collection, Alaska Regional IPMT Liaison Anna O'Brien and Alaska Regional Geographic Information Services (GIS) Coordinator and Lead GIS Data Manager Angie Southwold for post-processing our data.

List of Terms

AKEPIC Alaska Exotic Plants Information Clearinghouse

AKISP Alaska Invasive Species Partnership

ACCS Alaska Center for Conservation Science

CUA Commercial Use Authorization

DNR Alaska Department of Natural Resources

EPMT Exotic Plant Management Team (historic name, used interchangeably with EPMT)

GIS Geospatial Information System

GPS Global Positioning System

IPMT Invasive Plant Management Team (new name replacing EPMT)

KEFJ Kenai Fjords

KP-CISMA Kenai Peninsula Cooperative Invasive Species Management Area

M/V Motor Vessel

NISIMS National Invasive Species Information Management System

NPS National Park Service

PUC Public Use Cabin

PUPS Pesticide Use Proposal System

RV Recreational Vehicle

SCA Student Conservation Association

SNOTEL Snow Telemetry Automated Weather and Climate Data Collection Station

VRP Visitor and Resource Protection

YCC Youth Conservation Corps

Introduction

The KEFJ Invasive Plant Management Team (IPMT) has monitored, mapped, and treated invasive plants in the park since 2004. A strategy of early detection rapid response (EDRR) is used to detect and control invasive plants. Invasive plant management within the park is divided into three primary areas: Exit Glacier Area, the coast, and the Seward area, which includes park property outside the park's boundary (Figure 1). The Exit Glacier Area is a high priority for the park since it includes the only road and established trails in the park and has the highest number of visitors each summer. This area has the largest populations and highest diversity of invasive plants found in the park. The coast has fewer visitors and no developed trails but is a high priority for the KEFJ IPMT. This is because the area is remote and access to the coastal areas of the park is limited to aircraft and boats making it difficult to survey for and treat invasive plant populations. Small and isolated invasive plant populations have been found in areas that are used by visitors. This highlights the importance of continued monitoring in the coastal areas of KEFJ. The Seward area includes the Maintenance Facility, Shea Parking Lot, and Visitor Center. These sites are located near roads and properties that are infested with invasive plants and are staging areas for park vehicles and equipment. Control efforts are focused on these areas to prevent park vehicles and employees from becoming vectors for the spread of invasive plants into the park.

Kenai Fjords National Park

Alaska Region
National Park Service
U.S. Department of the Interior

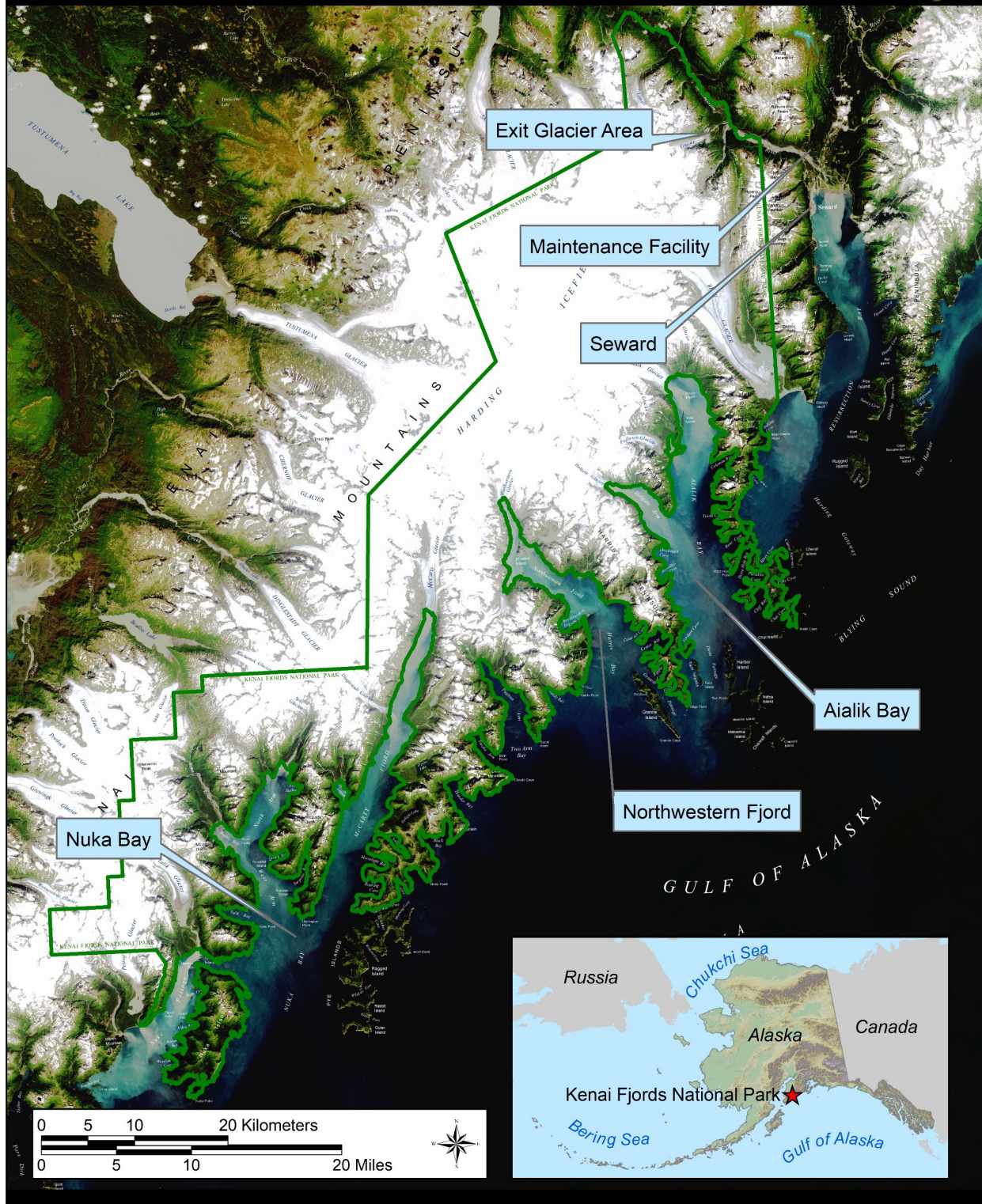


Figure 1. Overview of Kenai Fjords National Park.

Methods

Methods for data collection and processing followed the Alaska Exotic Plant Management Team (EPMT) Field Protocol (Overbaugh and Frank 2020a) and the Alaska EPMT Office Protocol (Overbaugh and Frank 2020b) developed by the Alaska Regional IPMT program. These protocols outline methods for data collection and processing. We created a schedule for survey and treatment efforts for the season based on recommendations from the previous year's final summary report and from weekly field reports completed in 2020. See Table 1 for a list of project areas included in the 2021 field season schedule.

Table 1. KEFJ Project Areas.

Areas	Field Sites
Exit Glacier	Herman Leirer Road, Exit Glacier Parking Area, Campground, SNOTEL, Nature Center Plaza, Glacier View Loop Trail, Glacier Overlook Loop Trail, Harding Icefield Trail, Nike Stripe, Outwash Plain, Employee Housing, Pump House
Coastal	Resurrection Bay, Aialik Bay, Northwestern Fjord, Nuka Bay, McCarty Fjord
Seward	Maintenance Facility, Visitor Center, Park Headquarters Building, Shea Parking Lot

Prioritizing Treatment

Resources and staffing for managing invasive plants are limited. Therefore, planning and prioritizing invasive plant treatment is guided by a variety of factors including population size, invasiveness ranking, geographic location, and ease of access. The Alaska Center for Conservation Science (ACCS) in collaboration with land managers, biologists, and weed scientists across the state, developed an invasiveness ranking system including at least 170 known invasive plants within the state. This ranking system is based on a scale of 0 to 100, with a plant ranked as 0 being no threat to native ecosystems and a plant ranked at 100 having a very high threat to native ecosystems. The invasiveness ranking system for invasive plants in Alaska is based on an initial climate screening and an evaluation of ecological impacts, biological characteristics and dispersal ability, ecological amplitude and distribution, and feasibility of control (Carlson et al. 2008). Invasive plants with a medium to high invasiveness ranking (50 to 100) are a high priority for control efforts for KEFJ IPMT across the park. In the Exit Glacier Area, the primary goal is to reduce the populations of invasive plants in the developed areas and to prevent their spread to the undeveloped areas which have been naturally disturbed by the glacier-fed hydrology. These areas commonly have little native vegetative cover and invasive plants do not have to compete with native plants for space. Invasive plant populations in coastal and remote areas of the park are also a high priority for treatment. If invasive plant populations can be identified while they are small and easy to treat, there is a greater chance that they can be contained to reduce spread or completely eradicated.

Control Methods

Manual Treatment

Manual treatment involved removing a plant or plant parts by hand pulling or by using hand tools to dig up the plant. We used this method on invasive populations that were small and could be removed

easily and on species that did not have rhizomatous roots. Flower heads were removed from invasive plants before herbicide applications to prevent plants from developing viable seeds after treatment. All plant parts that were manually controlled were put in compostable bags and disposed of at the Seward Waste Transfer Facility.

Chemical Treatment

We used two types of herbicide to chemically treat invasive plants in 2021. Milestone (Aminopyralid) was applied to broadleaf plants at a rate of 6 ounces per acre and Roundup Custom (Glyphosate) was applied to grasses and some broadleaf plants at a rate of 48 ounces per acre. Herbicide was applied using backpack sprayers with at a calibrated rate of 30 gallons per acre using a spot spray method. The two biological science technicians and SCA intern applied herbicide under the Alaska pesticide applicator license of the KEFJ biologist. All herbicide use was approved and documented using the National Park Service (NPS) Pesticide Use Proposal System (PUPS).



Applying herbicide to common chickweed in the Maintenance Facility.

Data Collection and Analysis

Data collection and processing methods followed guidelines provided in the Alaska EPMT Field and Office Protocols. We collected data using a Trimble 7X and Trimble XT6000 Global Positioning System (GPS) using TerraSync software. We post-processed data using Pathfinder Office software and submitted it to the Alaska Region IPMT throughout the summer. Finalized data was post-processed into a Geospatial Information System (GIS) geodatabase by the Alaska Regional GIS Specialist and Alaska Region IPMT Liaison. The AK Regional IPMT submitted the data to both the Alaska Exotic Plants Information Clearinghouse (AKEPIC) and the National Park Services' National Invasive Species Information Management System (NISMS) databases.

We also documented all herbicide use in an Excel spreadsheet. Weekly field reports were completed to document invasive plant work and timing of control activities. All field notebook pages were scanned and stored on the KEFJ network drive.

The KEFJ IPMT utilized standardized polygons to collect herbicide treatment data on Herman Leirer Road, in the Exit Glacier Parking Lot, the Outwash Plain, and at the Maintenance Facility. This data collection method utilizes a standard boundary for a given treatment area that remains constant from year to year. The use of standardized polygons allows for the collection of a single GPS point with herbicide use information for each standardized polygon, instead of having to remap the entire perimeter of a population every year. This method allows for efficient data collection in the field. The amount of herbicide used each season within the standardized polygons can be compared to the previous years' data to determine efficacy of treatments and to track herbicide use more accurately over time.

The KEFJ IPMT used handheld tally counters to calculate the amount of herbicide used when we applied small amounts of herbicide in standardized polygons or treated small populations. We used a standard herbicide amount per squirt applied to each plant to calculate the number of gallons sprayed. Each squirt is equivalent to 0.001 gallons of herbicide mix. This number multiplied by the tally count gave us our total gallons of herbicide used.

Personnel

The KEFJ IPMT had four members in 2021. The KEFJ biologist managed the invasive program in the park including completing planning and herbicide applications, compliance requirements, and supervising the biological science technicians and SCA intern. One biological science technician planned field activities throughout the season, applied herbicide and pulled invasive plants, recorded and processed data, kept track of herbicide use totals, and completed weekly field reports. The other biological science technician applied herbicide and hand pulled plants throughout the summer and collected and processed data while completing additional Resource Management (RM) projects in the park. The SCA intern assisted in herbicide application and hand pulling as well as data collection and processing. There were no Youth Conservation Corps (YCC) employees in 2021 due to COVID-19 health and safety concerns.

Results

2021 Season Overview

The 2021 KEFJ IPMT completed several projects during the field season including invasive plant surveys and treatments, seed collection, revegetation, invasive defoliating moth (*Lymantria dispar asiatica*) monitoring, and collaborative work with Kenai Peninsula Cooperative Invasive Species Management Area (KP-CISMA) partners.

During the 2021 season, the KEFJ IPMT used manual and chemical methods to treat a total of 13 invasive plant species on park property. We treated 0.30 acres with 10.21 gallons of Milestone mix and 0.32 acres with 12.011 gallons of Roundup Custom mix. We also treated 0.06 acres (2600 square feet) using manual control efforts.

Table 2. Summary of Kenai Fjords National Park Invasive Plant Work in 2021.

Invasive Plant GPS Data			
NPS Lands			
Year	Species Acres Surveyed ¹	Species Acres Infested ²	Acres Treated ³
2021	60.86	0.71	0.62

The January 2018 NPS Land Status geodatabase was used to delineate NPS lands in acreage calculations.

¹Acres surveyed represent the total area mapped.

²Acres infested represent the area of a mapped infestation multiplied by the percent cover of invasive plants in that mapped area.

³Acres 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.

We focused our survey and treatment efforts in the Exit Glacier Developed Area, Maintenance Facility, and high use coastal areas of the park.

Treating common dandelion populations in the area known as the Outwash Plain was a high priority since none were treated in 2020 because of reduced staffing due to COVID-19. We were able to treat three of the large populations but were unable to treat all of them this summer because of rainy weather early in June and Exit Creek became too high to cross safely before we could complete herbicide applications.

The IPMT went on four coastal trips to complete surveys and treat invasive plant populations. We made two daytrips to Aialik Bay, and one to Resurrection Bay on-board the M/V Couloir. We spent six days on-board the M/V Serac surveying sites in Nuka Bay, McCarty Fjord, and Northwestern Fjord.

The IPMT found narrowleaf hawksbeard (*Crepis tectorum*) for the first time in the Maintenance Facility this summer.

Table 3. Invasive plant species and locations 2021. Key: X=Present, H=Historically Present

Species		AKNHP Ranking	Location			
Latin Name	Common Name		Exit Glacier	Coast	Shea Lot	Maintenance
<i>Alopecurus pratensis</i>	meadow foxtail	52	X	—	—	—
<i>Anthemis cotula</i>	stinking chamomile	41	H	—	—	—
<i>Bromus inermis</i>	smooth brome	62	X	—	—	—
<i>Capsella bursa-pastoris</i>	shepherd's purse	40	H	—	X	H
<i>Capsella rubella</i>	pink shepherd's purse	—	—	—	—	X
<i>Chenopodium album</i>	lambsquarters	37	H	—		
<i>Cerastium fontanum ssp. vulgare</i>	big chickweed	36	X	—	X	X
<i>Crepis tectorum</i>	narrowleaf hawksbeard	56	H	—	—	X
<i>Elymus repens</i>	quackgrass	59	—	—	X	—
<i>Galeopsis spp.</i>	hemp nettle	50	—	—	X	—
<i>Hordeum jubatum</i>	foxtail barley	63	X	—	—	—
<i>Leontodon autumnalis</i>	fall dandelion	51	H	—	—	—
<i>Leucanthemum vulgare</i>	oxeye daisy	61	X	—	X	H
<i>Linaria vulgaris</i>	yellow toadflax	69	H	—	—	—
<i>Matricaria discoidea</i>	pineapple weed	32	X	H	X	X
<i>Papaver croceum</i>	Icelandic poppy	39	H	—	—	—
<i>Phleum pratense</i>	common timothy	54	H	H	H	—
<i>Plantago major</i>	common plantain	44	X	H	X	X
<i>Poa annua</i>	annual bluegrass	46	X	X	X	X
<i>Poa pratensis</i>	Kentucky bluegrass	52	H	—		
<i>Polygonum aviculare</i>	prostrate knotweed	45	H	—	X	X
<i>Ranunculus acris</i>	tall buttercup	54	H	—	—	—
<i>Rumex acetosella</i>	common sheep sorrel	51	H	—	X	—
<i>Rumex crispis</i>	curly dock	48	H	H	X	—
<i>Stellaria media</i>	common chickweed	42	H		X	X
<i>Taraxacum officinale</i>	common dandelion	58	X	X	X	X
<i>Trifolium hybridum</i>	alsike clover	57	H	—	—	—
<i>Trifolium pratense</i>	red clover	53	H	—	—	—
<i>Trifolium repens</i>	white clover	59	X	—	X	X

The IPMT collected native seed to add to the park's seed bank and completed two restoration projects, one along the park road and another in the Exit Glacier housing area.

We deployed five traps to monitor for invasive defoliating moths around the Exit Glacier Developed Area as part of the Alaska Division of Agriculture's state-wide monitoring program. No defoliating moths were detected.

We were able to participate in several outreach activities this summer with the KP-CISMA. We assisted with the installation of two boots brushes and interpretive signs at the Seward Boat Harbor. We also coordinated a successful Seward community weed pull at the Seward Middle School. We had a total of 27 kids from the Seward Teen and Youth Center along with 15 volunteers and partners. We pulled 455 pounds of the invasive plant bird vetch (*Vicia cracca*) from the school grounds. Additionally, we helped remove white sweetclover (*Melilotus alba*) from an 8 mile stretch along the Seward Highway and around the parking lot of the Seward cruise ship terminal to help stop the spread of this invasive plant around the Kenai Peninsula.

Notable Weather Conditions

The snow depth was higher than average in the park during the winter of 2020/2021 (Table 4) and spring temperatures were cool, which caused snow to persist on the ground into the beginning of June. These conditions delayed the growth of invasive plant populations and we were unable to start survey and treatment efforts until the second week of June. This is two weeks later than when we typically start our field work in recent years.

Table 4. 2021 Monthly snow depths at the Exit Glacier Area compared to the previous 15-year averages.

Exit Glacier Course Data	December	January	February	March	April	May
2020/2021 monthly snow depth (in)	27.8	N/A	57.0	70.1	65.3	47.5
15-year monthly average snow depth (in) (2005-20)	11.66	N/A	31.56	41.92	45.59	20.80

Exit Glacier Area

Herman Leirer Road

Herman Leirer Road is divided into 8 standardized polygons (Appendix A), which we used to track herbicide use and efficacy. We treated all standardized polygons along the roadside. We used herbicide to spot spray common dandelion (*Taraxacum officinale*) with herbicide on June 7, 8, and 15. We treated standardized polygons near the Resurrection River Bridge first since the snow melted earlier on this part of the road and worked our way towards the parking lot. On June 28 we re-treated standardized polygons HLR_N4 and HLR_S4 because more plants had sprouted since the initial treatment. We applied a total of 2.046 gallons of Milestone herbicide mix to common dandelion, and a few small populations of big chickweed (*Cerastium fontanum spp.vulgare*) and white clover (*Trifolium repens*) .

We resurveyed the roadside for grasses flowering later in the summer on July 26 and August 3 and hand pulled five stems of foxtail barley (*Hordeum jubatum*). On August 4, we spot sprayed scattered populations of meadow foxtail (*Alopecurus pratensis*) and one population of smooth brome (*Bromus inermis*) on August 4 and used 0.048 gallons of Roundup Custom herbicide mix.



KEFJ biologist and biological science technician collect herbicide data on Herman Leirer Road.

The first 8 miles of Herman Leirer Road is located outside the park boundary. It begins at the Seward Highway and crosses Alaska Division of Natural Resources (DNR) and Chugach National Forest lands before reaching the park boundary at the Resurrection River Bridge. To reduce the spread of invasive plants along the road and into the park, we surveyed the roadsides and hand pulled high-ranking species outside the park boundary. We surveyed from the National Forest Service entrance sign to the Resurrection River Bridge and hand pulled oxeye daisy (*Leucanthemum vulgare*), yellow sweetclover (*Melilotus officinalis*), and yellow toadflax (*Linaria vulgaris*) on July 13 and August 9.

Exit Glacier Parking Area

The IPMT chemically and manually treated four invasive plant species in the parking area including common dandelion, white clover, oxeye daisy, and common plantain (*Plantago major*). We used nine standardized polygons to document and track infestation and treatments (Appendix B).

On June 8 and June 10 we manually treated common dandelions in all nine standardized polygons. We applied 0.085 gallons of Milestone herbicide mix on common dandelion on June 29 in polygons 1-4 and 6-9. On July 12, we resurveyed the parking area and manually retreated all standardized polygons. We returned on July 12 and manually treated common dandelion in polygon 5. A total of 289 common dandelions and one white clover were hand pulled in the parking area over the summer.



SCA intern and biological science technician hand pulling common dandelion in the Exit Glacier Parking Lot.

In addition to the dandelions and sweetclover the IPMT found two stems of oxeye daisy in the parking area and hand pulled them on June 8 and July 30. Common plantain was hand pulled on June 29 when 33 stems were found in the parking lot.



Figure 2. Location of oxeye daisy (pink) found in the Exit Glacier Parking Lot in 2021.

Campground

The IPMT surveyed and manually treated the Exit Glacier campground once during the summer. We hand pulled one common dandelion found in the parking lot on July 12. Annual bluegrass (*Poa annua*) is present in the parking lot, on the trails, and in some campsites, but was not treated this summer. The campground was busy throughout the summer, and it was difficult to find a time that herbicide application would not conflict with visitor use.

SNOTEL

Common dandelion was first found at the Snow Telemetry (SNOTEL) automated weather and climate data collection station in 2012 (Fulton 2013). During the 2021 season, we surveyed the SNOTEL site on June 22 and did not find any plants for the first time since this population was discovered.

Employee Housing

Employee Housing consists of the parking lot, Trail Builder's Camp, Willow Cabin, Spruce Cabin, and Alder Cabin. We surveyed the Trail Builder's Camp on July 16 and hand pulled two common dandelions on the path between the camp and the Employee Housing parking lot.

Pineapple weed (*Matricaria discoidea*), common plantain, and annual bluegrass continue to grow in the parking lot, however none were treated in the 2021 field season.

Nature Center Plaza

The Nature Center Plaza includes the area around the Nature Center, the picnic area behind the building, the pumphouse, and the Pavilion. We used Roundup Custom to treat annual bluegrass, common plantain, and common dandelion. We surveyed and treated the Nature Center Plaza on August 4 and used 1.75 gallons of herbicide mix to treat annual bluegrass at the pumphouse, and 0.25 gallons to treat annual bluegrass at the picnic area behind the building. We resurveyed the Nature Center Plaza on August 16 and applied 0.262 gallons of Roundup Custom herbicide mix on annual bluegrass, common plantain, and common dandelion.



KEFJ biological science technician applies herbicide to annual bluegrass at the Pumphouse.

The Pavilion has a population of annual bluegrass in front of it that did not get treated this summer. The return of regularly scheduled Ranger Talks in the Pavilion this year and an increase in visitors using the area made it difficult to close the area to apply herbicide.

Picnic Area

The picnic area is located on the south side of the RV parking lot. We did not treat the annual bluegrass population in the picnic area with herbicide during the summer. Visitation in the Exit Glacier Area was high this summer, which made it difficult to find a time to apply herbicide that did not conflict with visitor use.

Glacier View Loop Trail

We hand pulled invasive plant populations found along the Glacier View Loop Trail twice during the season. The first survey was completed on June 16 when we hand pulled 30 dandelions. We completed the second survey on July 12 and hand pulled one common dandelion.



SCA intern hand pulls common dandelion on the Glacier View Loop Trail.

We surveyed and manually treated the middle of the Glacier View Loop Trail on June 22 and found 13 dandelions. The area was resurveyed on August 3 and no common dandelion were found.



KEFJ biologist pulls common dandelion in the middle of the Glacier View Loop Trail.

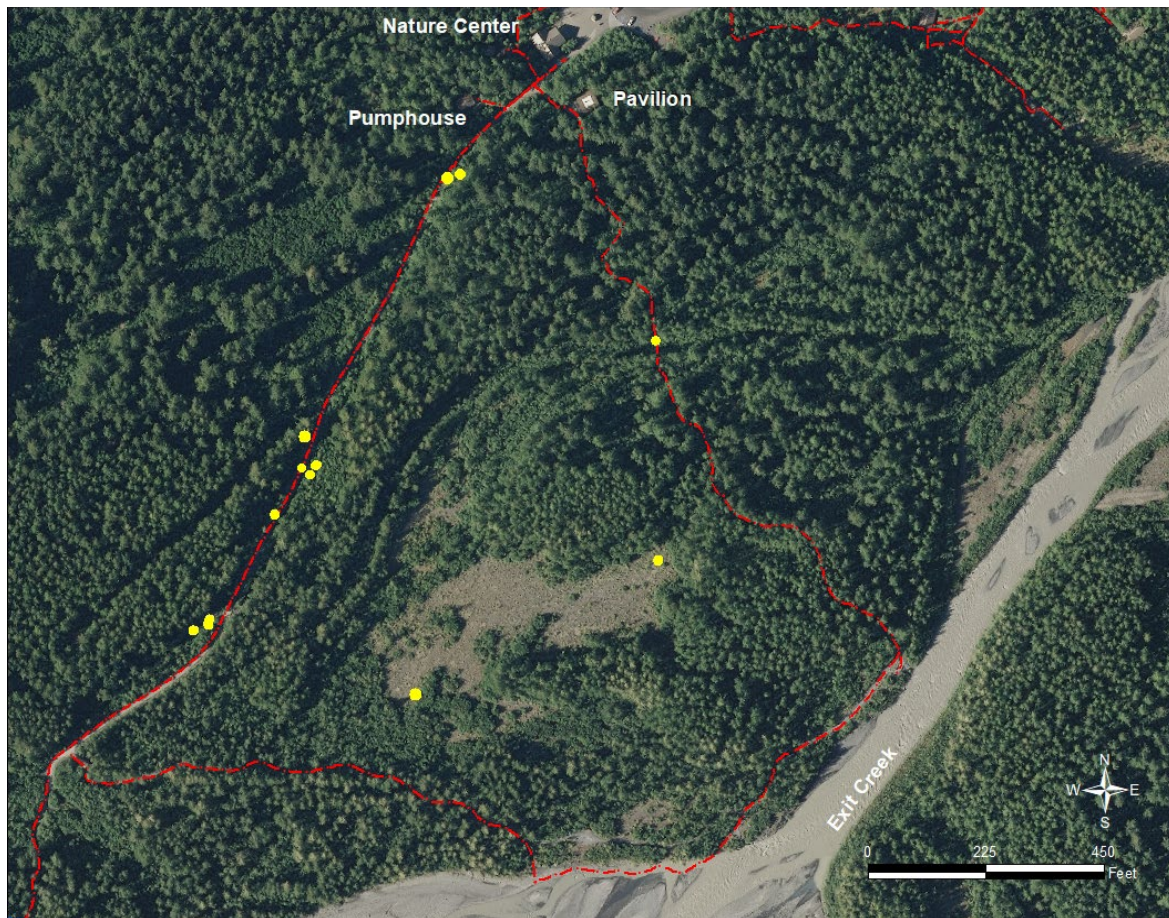


Figure 3. Common dandelion (yellow) populations along the Glacier View Loop Trail.

The common dandelion populations that were discovered northwest of the pumphouse in 2020 were revisited on June 29 and July 12. We hand pulled a total of 12 plants from four populations found scattered in the woods.

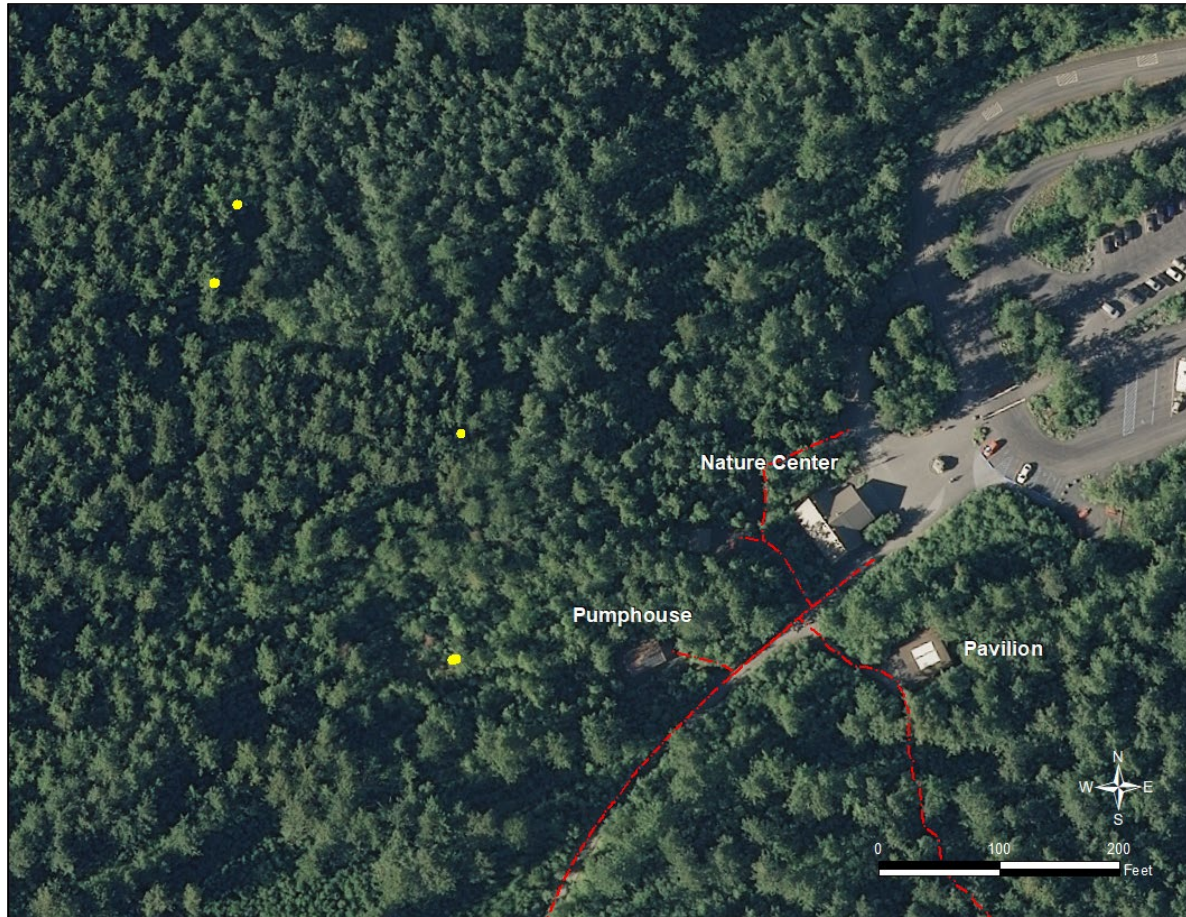


Figure 4. Common dandelion (yellow) populations northwest of the pumphouse.

Glacier Overlook Loop Trail

We hand pulled populations of common dandelion and common plantain on June 16 and July 12 on the Glacier Overlook Loop Trail. We manually treated nine dandelions and 13 common plantains along a switchback on the northwest side of the trail.

Harding Icefield Trail

The Harding Icefield Trail has several documented populations of common dandelion. There is a population found along an abandoned section of trail at mile 0.25, another is located between the bridge and Marmot Meadows at mile 1.1, and there is a small population in Marmot Meadows at mile 1.4. We treated these three populations with a total of 0.212 gallons of Milestone mix on June 21 and August 19.

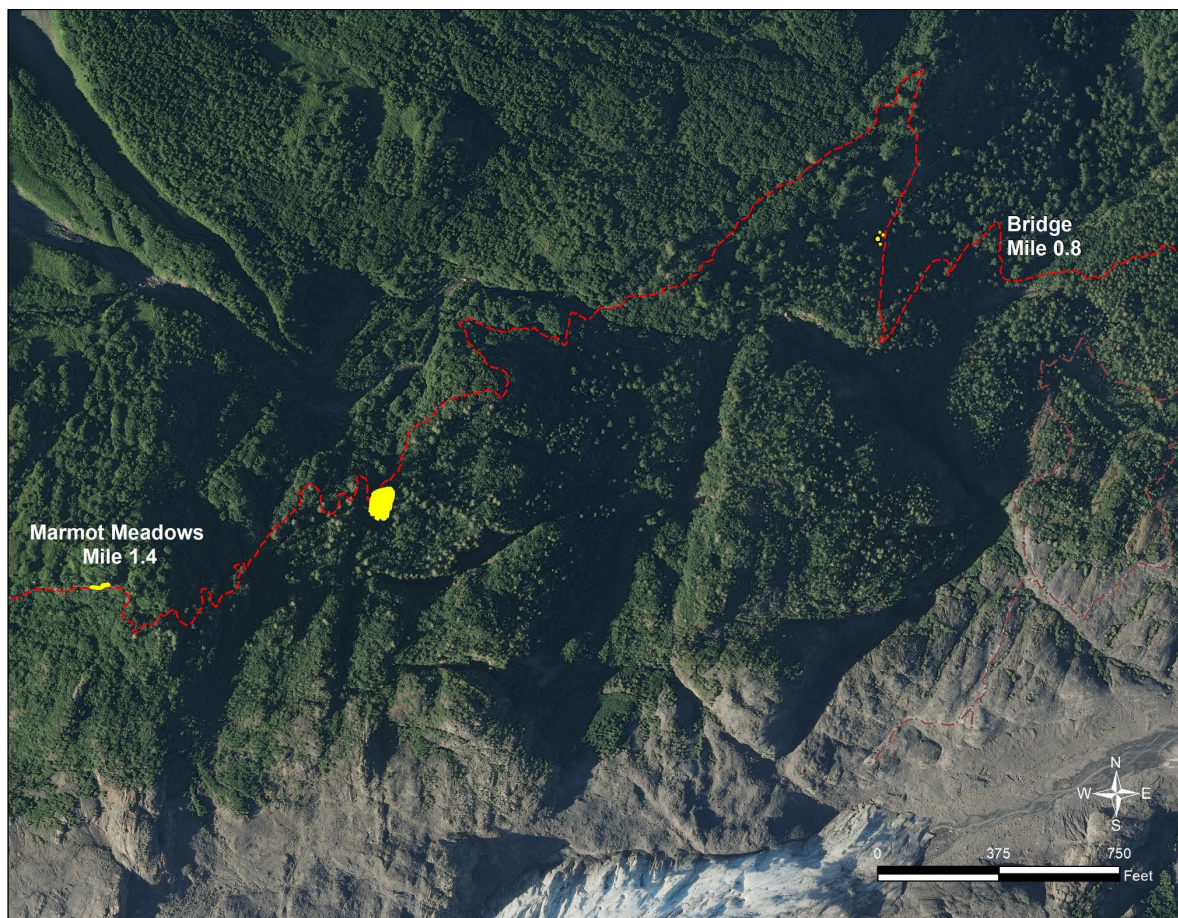


Figure 5. Common dandelion (yellow) populations on the Harding Icefield Trail.

Nike Stripe

The area locally known as the “Nike Stripe” is located about 0.4 miles north of the entrance sign on the park road. A large population of common dandelion was discovered in this area in 2004 and has been treated with herbicide since 2012 (Fulton 2013). Only 1 common dandelion was found during surveys in 2020. We surveyed the Nike Stripe on July 14 and found no common dandelion this year.

Outwash Plain

The Outwash Plain consists of 10 standardized polygons (Appendix C) on the south side of Exit Creek, the area on the south side of the road near the Resurrection River Bridge, and the area southwest of the trail builder’s camp next to Exit Creek. During the 2021 season, we were able to cross Exit Creek in June and spot spray herbicide in five of the ten standardized polygons in the Outwash Plain. We surveyed and treated common dandelions in Outwash_5, 6, 7, 8, and partially completed standardized polygon Outwash_9. We used a total of 3.19 gallons of Milestone herbicide mix on June 11, June 14, and June 17.

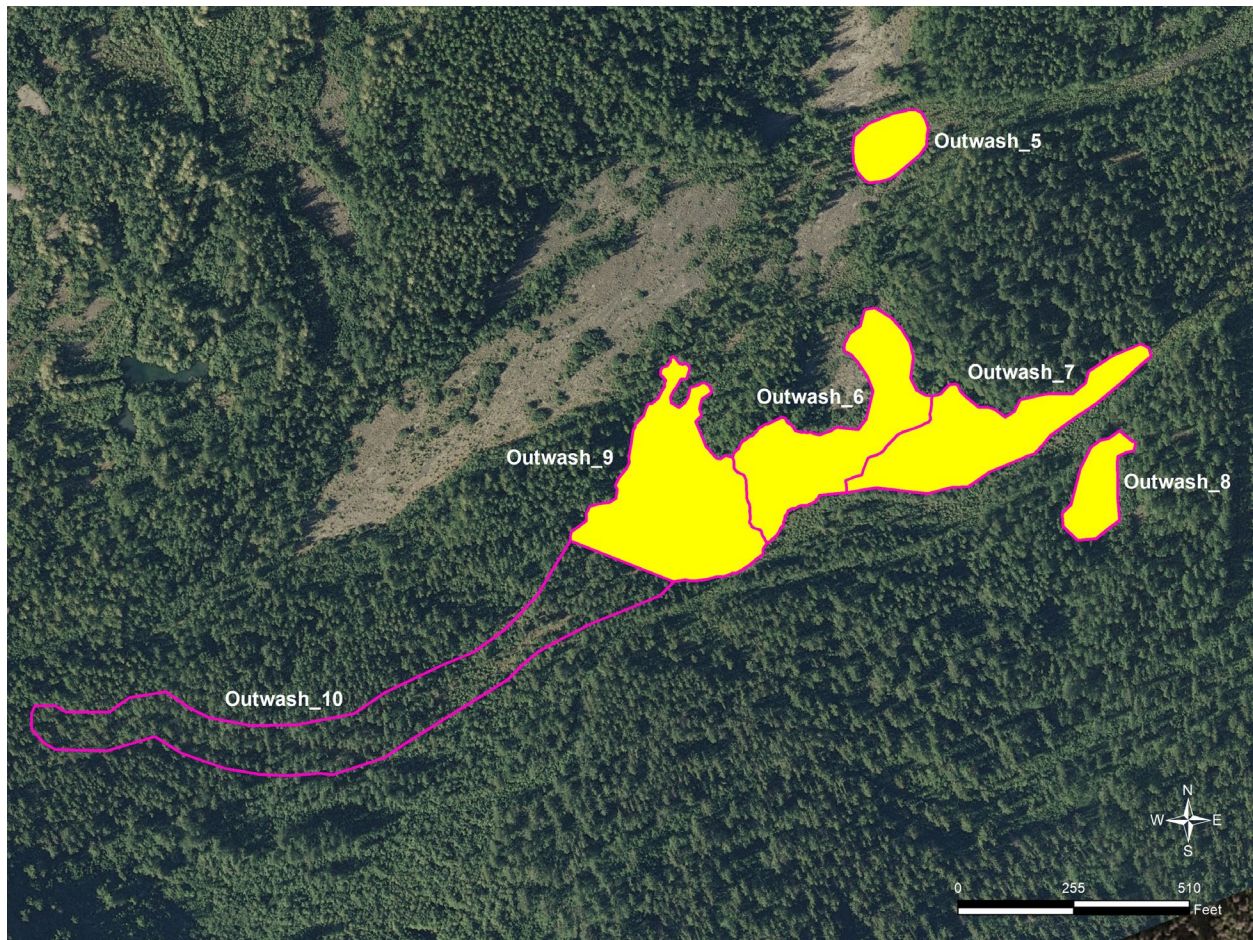


Figure 6. Common dandelion (yellow) populations treated in five Outwash Plain standardized polygons.

We were unable to treat common dandelion in all ten standardized polygons as well as other outlier populations in the area because of rainy weather conditions and because our coastal work had to be completed earlier than usual, due to boat scheduling conflicts. Doing coastal work in early July, instead of mid-July, kept us from being able to treat common dandelion populations across Exit Creek. By the time we got back from our coastal trip and were able to try to return to the Outwash Plain sites across Exit Creek in mid-July, the water was too high to safely cross.



KEFJ biological science technicians applying herbicide to common dandelion on the Outwash Plain.

We surveyed and hand pulled four common dandelions south of the park road near the Resurrection River Bridge on July 12. We returned and treated the rest of the populations with herbicide on July 14 and August 19. We used a total of 0.177 gallons of Milestone herbicide mix.

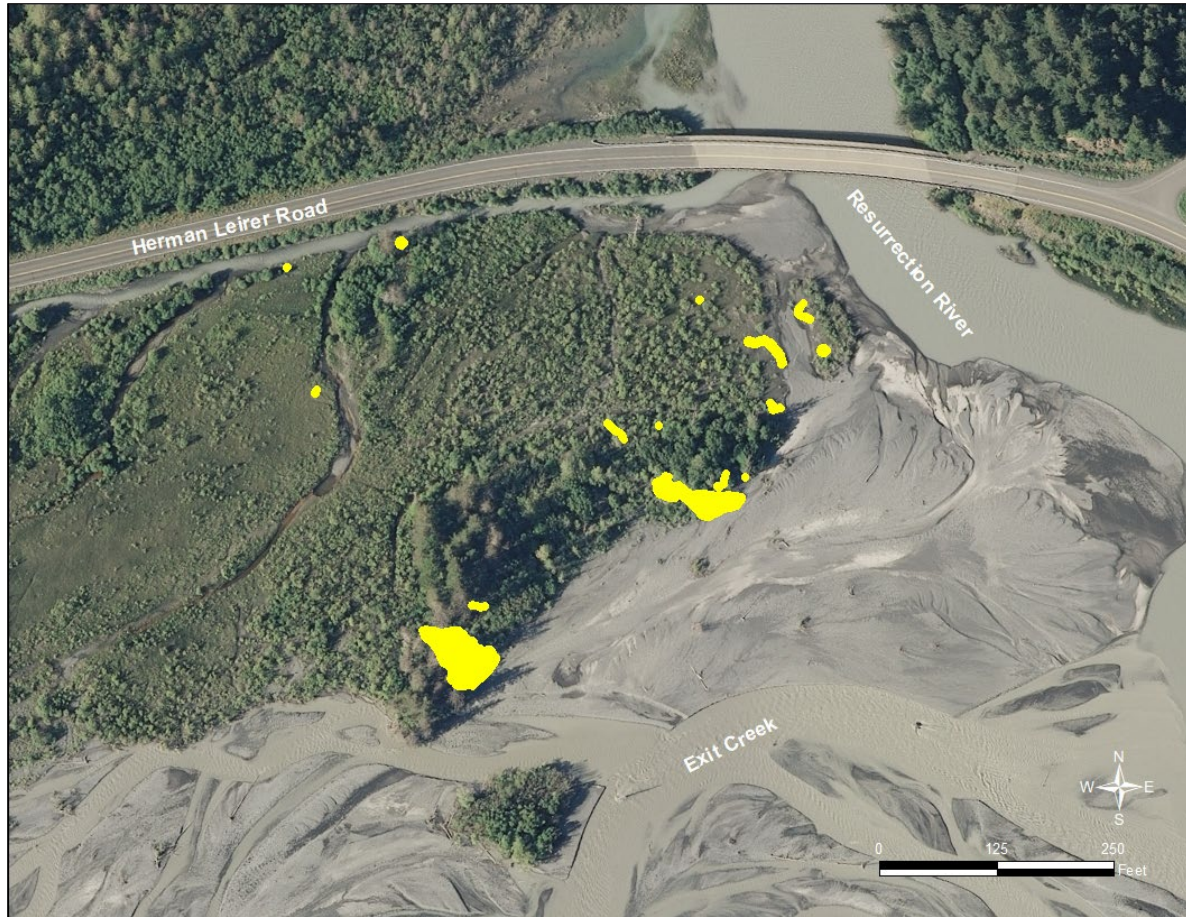


Figure 7. Common dandelion (yellow) populations near Resurrection River Bridge.

We surveyed and treated the population of common dandelion southwest of the Trail Builder's Camp near Exit Creek on July 16 with 0.019 gallons of Milestone herbicide mix.



Figure 8. Common dandelion (yellow) population near the Trail Builder's Camp and Exit Creek.

Coastal Areas

Resurrection Bay

We made one daytrip to Resurrection Bay on the park's landing craft, M/V Couloir on July 23. We surveyed Bulldog Cove and Porcupine Cove for invasive plants. No invasive plant populations have been discovered at these sites in the past and none were found this year.

Aialik Bay

In 2021, we made two daytrips to Aialik Bay on the M/V Couloir to survey eight different sites on June 29 and July 15.

The two Public Use Cabins (PUC) in Aialik Bay were closed during two different weeks of the summer for maintenance and not available for the public to reserve. During these closures, we were able to survey and spot spray annual bluegrass with herbicide. The first trip occurred on June 29 when the Holgate PUC was closed. We treated annual bluegrass with 0.546 gallons of Roundup Custom mix. We also surveyed the north and south beaches around the PUC and found no other invasive plants. We surveyed the campsite at Abra Cove where we hand pulled eight stems of annual bluegrass. We surveyed the campsite at McMullen Cove, an unnamed beach across from the PUC in Holgate Arm, and the campsite at Quicksand Cove and found no invasive plants.



KEFJ biological science technician applies herbicide to annual bluegrass at the Aialik PUC.

On July 15, we surveyed and treated the annual bluegrass at the Aialik PUC with 1 gallon of Roundup Custom solution. We resurveyed Abra Cove and hand pulled another seven stems of annual bluegrass. With permission from the Kenai Fjords Glacier Lodge manager, we surveyed the area on the outer beach at Pedersen Lagoon where the lodge stores their kayaks. This is not park property, but we have surveyed, and hand pulled annual blue grass and pineapple weed from this area as a courtesy and to prevent the spread into park lands around the upper lagoon. We found no invasive plants there, but we did find a patch of annual bluegrass at the Pedersen Lagoon camping easement. We hand pulled an area about half a meter in diameter. No other invasive plants were found in the vicinity. We also surveyed the campsite at Bear Cove and found no invasive plants.



KEFJ biological science technician hand pulls annual bluegrass at Abra Cove.

On July 6, at the end of our six-day trip aboard the M/V Serac we surveyed the Verdant Cove campsite for invasive plants and found none.

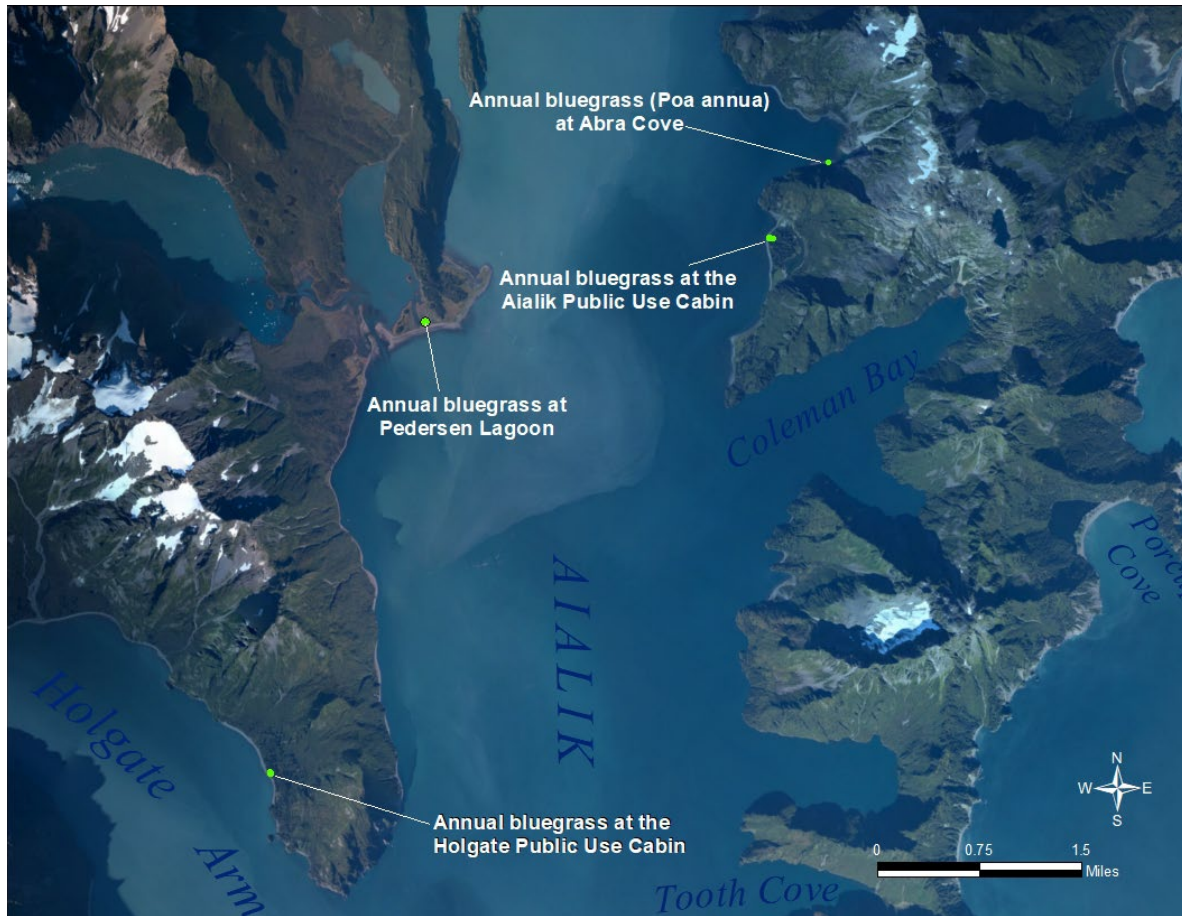


Figure 9. Annual bluegrass (green) populations in Aialik Bay and Holgate Arm.

Northwestern Fjord

We surveyed five beaches for invasive plants in Northwestern Fjord on July 5. We focused the surveys on areas that are popular for camping and that have food storage lockers. We surveyed Southwestern Beach, Northeastern Beach, Sunlight Beach, and Long Beach and found no invasive plants. We treated the known population of annual bluegrass at the camping spit north of the moraine. We hand pulled a total area of one square foot of annual bluegrass around the food storage locker and along the path to the beach.



KEFJ biological science technician collects data at the camping spit in Northwestern Fjord.

McCarty Fjord

On July 2 and 3 we surveyed two sites in McCarty Fjord: the rock ridge south of Dinglestadt Glacier, and the outer beach at James Lagoon. The population of common dandelion at Dinglestadt Glacier was first discovered in 2006 (Wetherbee 2006). Initially this population was hand pulled, but because of the large size of the population and its remote location, we began using herbicide to treat this population starting in 2013. The area was treated both chemically and manually due to less-than-ideal weather conditions for herbicide treatment on the day we surveyed the population. We mapped each population we found inside the known extent. We hand pulled a total of 93 dandelions and we spot sprayed a total of 0.243 gallons of Milestone mix.

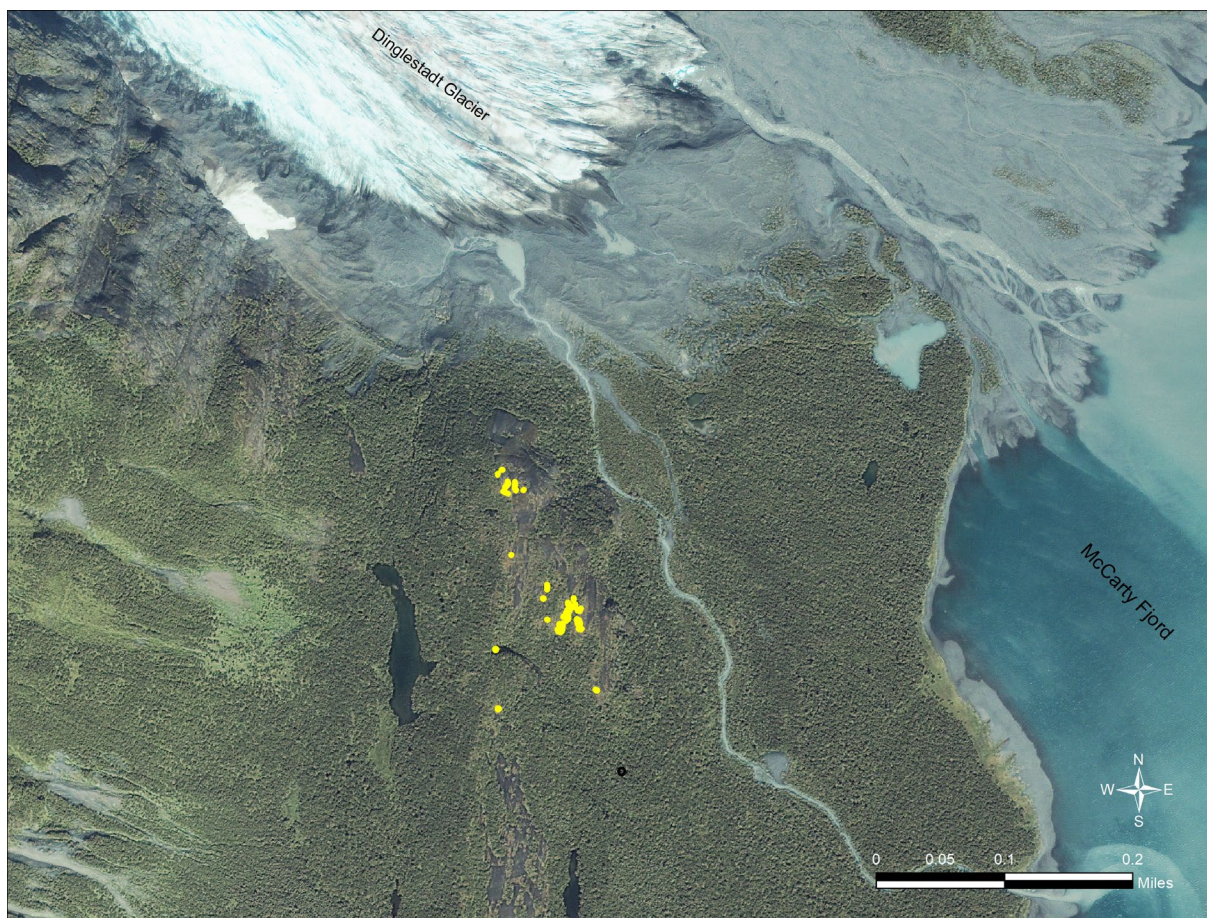


Figure 10. Common dandelion (yellow) south of the terminus of Dinglestad Glacier.

We surveyed James Lagoon outer beach for invasive plants in conjunction with a bird mortality survey and no invasive plants were found.

Nuka Bay

We surveyed a total of three sites in Beauty Bay and North Arm. We surveyed the old airstrip at the head of Beauty Bay on July 1 and found that a creek was now flowing through the south end of the old airstrip closest to the beach. The soil and plants where common dandelion and common timothy (*Phleum pratense*) had previously been found had been washed away by the stream. Common dandelion and common timothy had not been found in recent years in this area and since the creek is running through the site, this location is no longer a priority for resurveying.

We manually treated two small populations of common dandelion on July 2 at the head of North Arm. We planned to treat these populations with herbicide, but rainy weather did not allow for application, so we had to manually control them instead. We hand pulled a total of 101 dandelions at this site.

We surveyed Pilot Harbor in North Arm on July 2 and found no invasive plants.



Figure 11. Common dandelion (yellow) populations treated on the beach at the head of North Arm in Nuka Bay.



KEFJ biological science technician and M/V Serac logistics coordinator hand pull common dandelion at the head of North Arm.

Seward

Unlike in previous years, the IPMT did not survey and treat invasive plant populations at the Visitor Center or Shea Parking Lot located in the City of Seward.

Maintenance Facility

We completed five herbicide spot treatments in the Maintenance Facility between June and August. We used a standardized polygon that includes the entire maintenance yard to document and track herbicide use (Appendix D). We spot sprayed common dandelion, common chickweed (*Stellaria media*), big chickweed, and pineapple weed for the first time on June 22, and we used 1.161 gallons of Milestone herbicide mix. We applied Milestone a second time on July 20 and used 1.7 gallons of herbicide mix. We completed a third and final treatment with Milestone on August 16 and treated the same species, with the addition of prostrate knotweed (*Polygonum aviculare*) with 1.375 gallons of herbicide mix.

The first treatment with Roundup Custom occurred over two days on July 20 and July 27 and we spot sprayed 6 gallons of herbicide mix on annual bluegrass and common plantain. We applied Roundup Custom a second time on August 16 using 2.155 gallons of herbicide mix.

We hand pulled one stem of narrowleaf hawksbeard next to a building on the northwest corner of the Maintenance Facility on August 17. This was the first time this species has been found at the Maintenance Facility. The site where this plant was discovered should be resurveyed next year to ensure it does not become established.



Figure 12. Narrowleaf hawksbeard (pink) found at the Maintenance Facility in 2021.

Prevention

Using boot brushes to reduce the spread of invasive plants and encouraging other park staff to use them, continued to be a priority for the IPMT. We distributed small handheld brushes to employees in the Resource Management and Visitor and Resource Protection (VRP) divisions that regularly worked off trail in the park.



A handheld boot brush being used to clean shoes before heading out into the park.

On June 2, we installed two boot brushes with interpretive information with KP-CISMA partners at the Seward Harbor. Each sign explains why it's important to reduce the spread of invasive plants and to clean your shoes before heading out into the park or to other recreation areas. We installed these brushes at the north ramp where many boats pick up kayakers for trips out to the fjords, and at the south boat ramp next to the park's Visitor Center. We also replaced worn parts of the boot brush at the trailhead of the Harding Icefield Trail on July 26.



SCA intern and KEFJ biological science technician installing a boot brush at the north ramp at the Seward Harbor.



KEFJ staff and KP-CISMA partners next to the boot brush at the south ramp of the Seward Harbor.

Restoration

Native seed collection began on August 10 and continued through the rest of the month. We collected meadow barley (*Hordeum brachyantherum*), alpine timothy (*Phleum alpinum*), spiked trisetum (*Trisetum spicatum*), western columbine (*Aquilegia formosa*), goat's beard (*Aruncus diocus*), and lupine (*Lupinus nootkatensis*). We sent the seeds to the Alaska Department of Agriculture Plant Material Center in Palmer for cleaning.

The area disturbed next to Spruce Cabin during the cabin's construction in the employee housing area was reseeded for a second time this season. The area was initially planted with native seed in 2019, but much of the seed did not germinate because there was very little organic soil to hold moisture. We noticed seeds had germinated in low areas in the gravel where water pooled, so we created depressions randomly around the disturbed area and spread the seed in them. The area was then lightly raked over. The area was reseeded with bluejoint reedgrass (*Calamagrostis canadensis*), meadow barley, alpine timothy, spiked trisetum, and lupine. Photos were taken to monitor the success of this project and a revegetation sign was placed in the area to discourage trampling.

Another revegetation project we completed during the field season was at the 1889 moraine on Herman Leirer Road. Native seed was spread at this site in 2019, but there were still some bare gravel areas. We used the same revegetation technique we used at the Spruce Cabin site to improve the likelihood that the seeds would germinate. We spread native seeds from meadow barley, alpine timothy, spiked trisetum, bluejoint reedgrass, Merten's sedge (*Carex mertensii*), western columbine, and lupine at this site.

Outreach and Education

Outreach and education are important aspects of the invasive plant management program. During the season, we communicated the invasive plant program goals and accomplishments with park staff and the public through a variety of methods.

We shared information about the invasive plant program with park staff and the public through presentations, field reports, social media, and informal talks. We provided updates and accomplishments in a presentation to interpretation staff during spring training. A field report was sent out to KEFJ park staff, providing an update on what we accomplished during our coastal field work. We shared information about invasive species work the park is doing during National Invasive Species Awareness Week through five Facebook posts during the week. The IPMT shared four more Facebook posts throughout the summer highlighting invasive plant work and other natural resource topics.

The IPMT submitted a blog post to the KP-CISMA website highlighting the partnership's efforts this summer to control white sweetclover on the Kenai Peninsula. The IPMT summer work accomplishments were shared with NPS Alaska Regional staff through a submission to the summer edition of High Latitude Highlights.

We coordinated the 16th Seward Community Weed Pull on June 25 at the Seward Middle School. The event was held in partnership with KP-CISMA partners, including Chugach National Forest, Homer Soil and Water Conservation District, and the Kenai Watershed Forum. We had a total of 15 adult volunteers and partners as well as 27 kids and 3 adults from the Seward Teen and Youth Center participate in the event. We hand pulled a total of 455 pounds of the invasive plant bird vetch from the Seward Middle School grounds.



KEFJ staff, KP-CISMA partners, and volunteers at the Seward Community Weed Pull.

We were also frequently asked questions by park visitors, and we used the opportunity to inform them about the impacts of invasive plants in the park and encouraged them to use boot brushes before hiking the trails.

Partnerships

Along with installing the boot brushes at the Seward Harbor, we also coordinated with KP-CISMA partners to pull white sweetclover along eight miles of road on the side of the Seward Highway at milepost 71 through 79. The KP-CISMA has been working to keep white sweetclover from spreading onto the Kenai Peninsula and the population was located at the entrance to the peninsula on Turnagain Arm. This was a great team effort with over six different agencies and organizations represented. Six dumpsters were filled with bags of white sweetclover by the end of the day. Additionally, we pulled a newly discovered population of white sweetclover found around the parking lot of the Seward cruise ship terminal.



KEFJ staff and KP-CISMA partners pulling white sweetclover on the Seward Highway.

Defoliating Moth Monitoring

During the summer, we deployed five defoliating moth traps in the Exit Glacier Developed Area for the 11th year (Fulton 2011). We received these traps from the Alaska Division of Agriculture, as part of their invasive moth monitoring program for the State of Alaska. We deployed traps near the Nature Center, by the picnic area, in the parking lot, by employee housing, and at the campground parking lot. We installed traps in June, checked them twice during the season, and removed them in September. We found no invasive moths in the traps. The Alaska Division of Agriculture provided data sheets that we filled out and sent back to our DNR contact.

Discussion and Recommendations

Annual Bluegrass

The treatment of populations of annual bluegrass at KEFJ continues to be a topic for consideration. Annual bluegrass is a low-ranking invasive plant and tends to spread into continuously disturbed areas such as along trails or on the edge of parking lots. We have not seen it spread into undisturbed areas that have healthy native plant populations, but it is spreading up trails and into some coastal campsites. Coastal populations are still relatively small, and they should continue to get high priority for treatment to reduce the populations and keep them from spreading. The populations at the PUCs should continue to be sprayed with herbicide when there is an opportunity to close them to the public during applications. The large population in front of the pumphouse in the Exit Glacier Area should also continue to be treated with herbicide to reduce the spread along the paved trail. Applying herbicide is a much more efficient way of treating annual bluegrass and is much more effective than hand pulling. However, efficacy of herbicide use should be monitored in these areas to determine if there is a reduction in the size and density of the populations treated with the herbicide Roundup Custom. The use of other types of herbicides that might be more effective at controlling annual bluegrass should be explored. Populations that are found around the park's developed area should continue to be monitored.

Standardized Polygons

The use of standardized polygons continues to be an efficient way to track herbicide use and to determine efficacy of treatments. The KEFJ IPMT should continue to use the current standardized polygons and create them in other areas in the park as they make sense in the future. The KEFJ data dictionary needs to be updated in 2022 for standardized polygons to include the nine parking lot standardized polygons in the drop-down menu for Location Name.

Re-treatment

Re-treating invasive plant populations multiple times in the summer is a useful strategy to reduce the density of a population over time in one summer. Retreating a population for a second time using a spot treatment of herbicide or manual treatment is an opportunity to treat plants that sprouted after the first treatment. There is not always enough time or resources to treat all populations multiple times in a summer, but this strategy should be considered for high priority populations such as the maintenance facility, the roadside and along trails.

Roadside Brushing

There can be conflicts with the timing of brushing on Herman Leirer Road by maintenance staff and herbicide treatment of invasive grasses along the roadside. It is important to coordinate with the trail crew lead early in July to identify areas that we plan to treat later in the summer and want them to avoid cutting. To accomplish both projects and avoid conflicts, coordinating early is essential to have time for identifying and flagging invasive grasses before brushing begins.

Coastal Priorities

Although the Exit Glacier Area gets the most visitor use and has a majority of the invasive plant populations in the park, coastal areas should be a high priority for survey and treatment efforts as

well. Visitor use in coastal areas is mostly confined to Aialik Bay and Northwestern Fjord, but invasive plant populations have been discovered in remote and unlikely places in the past. It is important to continue to focus on treating existing populations of invasive plants to keep them from being spread to other areas of the park, but systematic surveys across the park's coastline should be a part of our yearly coastal work plan.

Understanding visitor use in coastal areas of the park has always been a challenge because of its remoteness and the difficulty of counting visitors accessing this part of the park. Most of the visitor use in coastal areas of the park seem to be through commercial guides, but because this data has been difficult to compile, we do not know how many visitors are on guided trips to the coast. We also don't have a full understanding of where guides are taking clients on the ground. In the next fiscal year, the Alaska Region Commercial Services program will be finalizing a new reporting system for companies with Commercial Use Authorizations (CUA). This new system uses an online data entry platform instead of allowing CUA-holders to report client numbers on a paper form. This new system will not only collect client numbers but will also require commercial users to report the areas where they went and what activities they were doing at those locations. The new database will allow us to easily calculate the number of visitors and where they are going in the park. The IPMT will be able to use the location data to focus survey efforts on places that guides are taking visitors and where invasive plants are more likely to be spread.

During the summer of 2022, there will be three clean-up projects occurring at historic mines in Nuka Bay. Stipulations were put in the contracts for these projects to mitigate the spread of invasive plants, but there is still a possibility that invasive plants could be spread to these areas. Although this will not affect the IPMT field season in 2022, these areas should be surveyed after the projects are completed during 2023 and 2024 to ensure any new invasive plant infestations are treated quickly before they can become established.

Season Planning

This summer there was a timing conflict with another coastal project and the IPMT six-day coastal trip on the M/V Serac was scheduled two weeks earlier than usual. While some dandelion flowers had gone to seed when we were treating populations on the coast, going on our coastal trip in the middle of July gives us more time to finish up with treatments on the Outwash Plain. We have to cross Exit Creek to access the Outwash Plain and the water typically gets higher later in the summer as temperatures warm up and more snow melts in the mountains. By the time we returned from our coastal trips in mid- July, the creek was too high to cross safely, and we had to abandon our treatments in this area for the summer. This limited the amount of time we spent across the creek, and we were unable to treat a large portion of this population of common dandelion. If it's possible next summer, the week-long coastal trip aboard the M/V Serac should be scheduled for the week of July 11 rather than late June/early July.

Shea Parking Lot

The Shea Parking Lot is in downtown Seward and is infested with over 15 invasive plants, including several that are not found in the park. Invasive plants are growing on the parking surface where park vehicles, as well as employees, are exposed to seeds. Invasive plant seeds can be easily carried from

the parking lot on vehicle tires and on employee's shoes into the park. A weed-free path could be created from the alley into the parking lot. Herbicide has never been applied on the park's properties located in the City of Seward. This will require a commitment to applying herbicide each year to keep the surface clear of invasive plants. Since there is a continuous source of invasive plant seeds around the parking lot, it will continue to be reinfested. Ideally, a long-term plan of paving the lot would be put into place. However, this would be expensive to do and would require maintenance into the future.

The Nike Stripe and SNOTEL Successes

The area known as the Nike Stripe and the SNOTEL automated weather station site both have had known populations of common dandelion that have been treated for years. For the first time since their discovery, there were no common dandelions found at either location. While the populations appear to be eradicated, these areas should continue to be prioritized for monitoring since invasive plants could still sprout from an existing seed bank in the soil and become reestablished in future years.

Prevention

Long term efforts to prevent the spread of invasive plants into the park during administrative activities needs to be a continuous and long-term commitment. The cost of time and money to treat new invasive plant infestations is high and continuing to consistently incorporate preventative measures into the park's day to day activities can help reduce or eliminate the introduction of new invasive plant populations.

The KEFJ IPMT should continue to maintain the boot brushes at the Exit Glacier Nature Center Plaza and at the Harding Icefield Trail register. Additionally, we should provide input on new interpretive signs and products and suggest that additional information about invasive plants be included.

Providing small hand-held boot brushes to park staff should continue to be priority. We should give these to all employees that work in the backcountry areas in the park, including but not limited to all resource management staff and backcountry rangers. We should also explain the importance of their use to decrease the spread of invasive plants in the park and educate staff about the role park staff play in the spread of invasive plants.

Continued efforts to mitigate the introduction of new invasive plants to the park during construction projects should also be a high priority. Measures are currently incorporated into contracts, and contractors are required to clean equipment before work is done in the park. The KEFJ IPMT inspects equipment being used by looking for soil and plant materials that have not been removed before equipment is brought into the park. Continuing to incorporate these measures into all construction projects will help reduce the introduction of new invasive species.

Partners

Partnerships are an important component of outreach and community engagement and should continue to be a priority. Attending monthly conference calls with the state-wide Alaska Invasive Species Partnership (AKISP) provides opportunities to network and learn about invasive species issues across the state. As a member of the Kenai Peninsula Cooperative Invasive Species Management Area (KP-CISMA) we participated in quarterly meetings, assisted with updating strategic plans and priorities, partnered in hosting the Seward community weed pull, participated in invasive plant control efforts on partner agency lands, and worked with partners to install boot brushes and interpretive signs at the Seward Harbor. Partnerships are a great opportunity to learn from other agencies and organizations and it gives us an opportunity to share resources, as well as participate in state-wide planning efforts.

Safety

Safety is the highest priority when completing field work and the IPMT crew completes daily safety talks to identify potential safety concerns before heading out in the field each day. During the summer of 2021, a new hazardous event occurred in June while the team was working in the Outwash Plain standard polygons south of Exit Creek. We were made aware of a glacier outburst flood coming from the terminus of Exit Glacier and moving down Exit Creek from an announcement over the park radio. A large volume of water moved down Exit Creek carrying large quantities of glacier ice with it. It was very similar to a flash flooding event. We were not near the creek at the time and did not see it occur, but on our return from our field work we had to cross the creek to get back to the north side and we saw glacier ice deposited on the bank high above the creek level. The creek level was back to the level it has been at previously during the day and was again safe for us to cross. This type of event cannot be forecasted but is a good reminder that the glacier creates a very dynamic and sometimes hazardous worksite. This type of event should be considered during planning for future work near Exit Creek and recognized as a potential hazard to consider.

Personnel

This summer was the second summer that we did not have teenage Youth Conservation Corp (YCC) employees due to COVID-19 safety concerns. The KEFJ IPMT was made up of the biologist, two biological science technicians and a Student Conservation Association (SCA) intern. We recommend continuing to find funding to hire a biological science technician as a crew lead, an SCA intern, and two YCCs to round out the team and provide the resources we need for a successful invasive plant program. A minimum of four people on the team is essential for spraying the standardized polygons across Exit Creek on the Outwash Plain as well as completing other invasive plant projects.

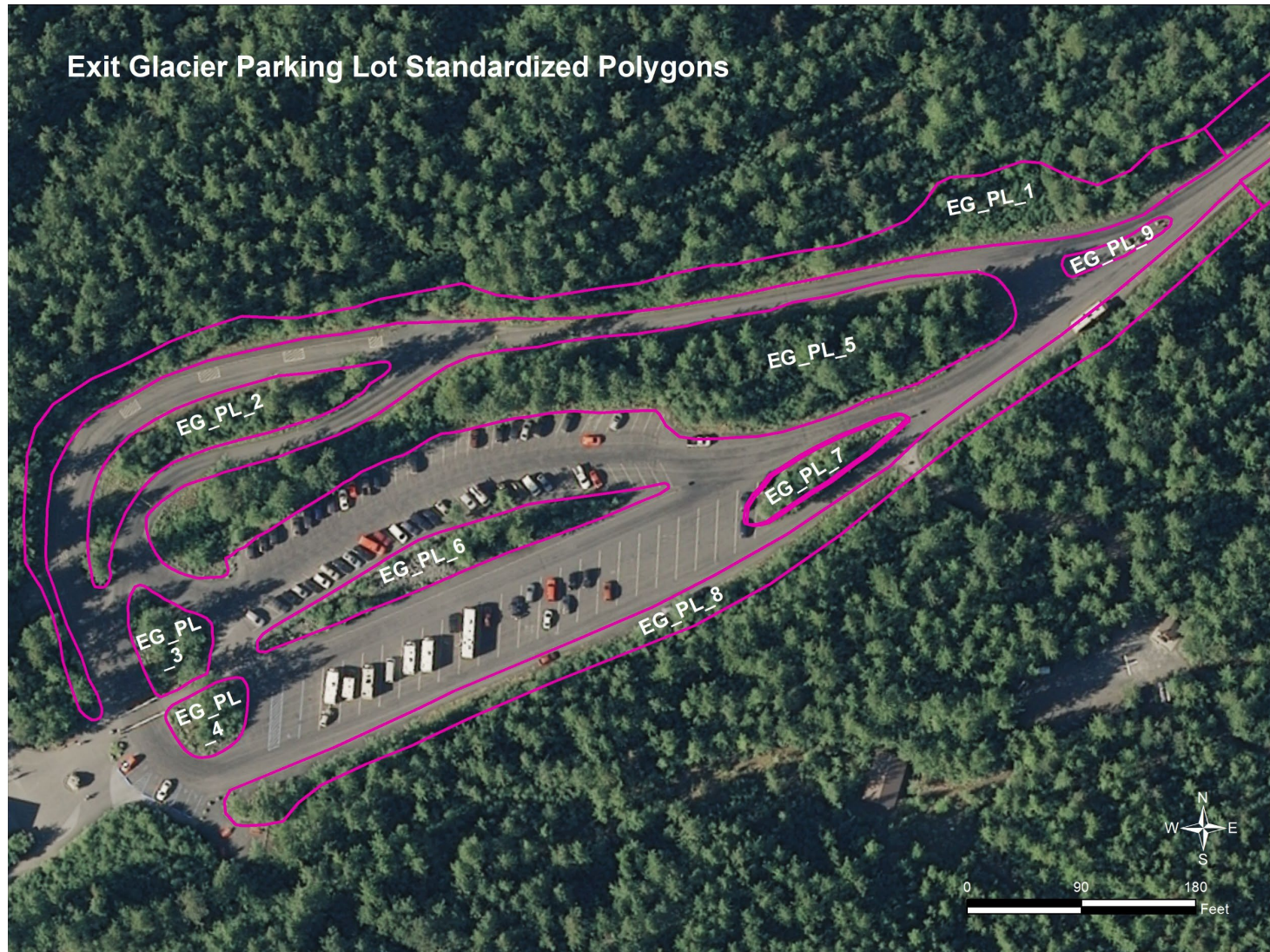
Literature Cited

- Carlson, M. L., I. V. Lapina, M. Shephard, J. S. Conn, R. Densmore, P. Spencer, J. Heys, J. Riley, and J. Nielsen. 2008. Invasiveness ranking system for non-native plants of Alaska. USDA Forest Service, R10, R10-TP-143.
- 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.
- Fulton, T. 2013. Invasive plant management in Kenai Fjords National Park: 2012 summary report. Natural Resource Data Series NPS/KEFJ/NRDS—2013/430. National Park Service, Fort Collins, Colorado.
- Overbaugh, C. and P. Frank. 2020 a. Alaska exotic plant management team 2020 field protocol. 2020. U.S. Department of the Interior, National Park Service, Anchorage, Alaska.
- Overbaugh, C. and P. Frank. 2020 b. Alaska exotic plant management team 2020 office protocol. 2020. U.S. Department of the Interior, National Park Service, Anchorage, Alaska.
- Wetherbee, H. 2006. Invasive plant management in Kenai Fjords National Park: Summer 2006 field season report. National Park Service Unpublished Report, Seward, Alaska.

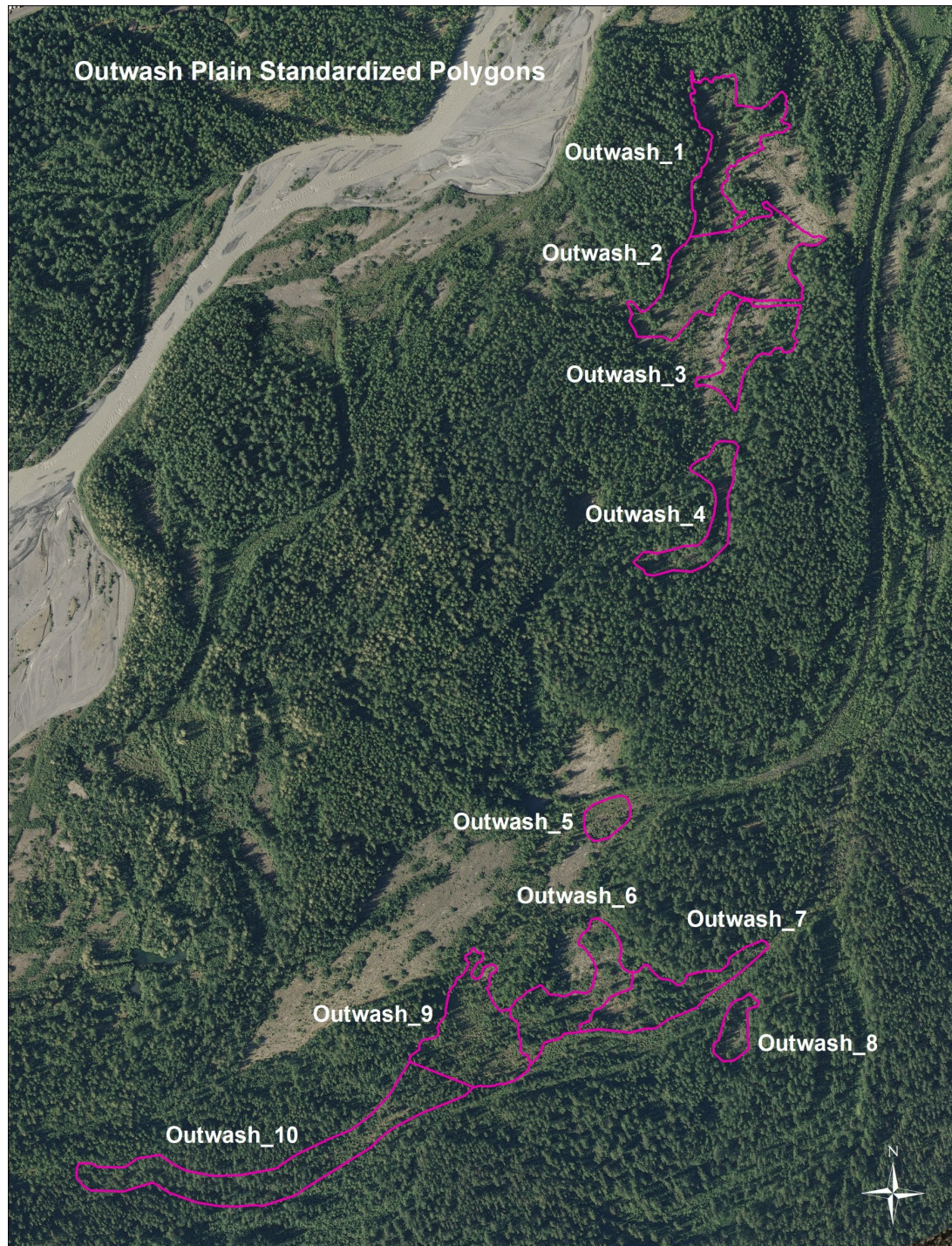
Appendix A: Herman Leirer Road Standardized Polygons



Appendix B: Exit Glacier Parking Lot Standardized Polygons



Appendix C: Outwash Plain Standardized Polygons



Appendix D: Maintenance Standardized Polygon



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.

NPS KEFJ, October 2021

National Park Service
U.S. Department of the Interior



Kenai Fjords National Park
PO Box 1727
Seward, AK 99664

EXPERIENCE YOUR AMERICA™