



Invasive Plant Management and Prevention in Denali National Park and Preserve

2022 Summary Report



ON the Cover

Curious volunteers learn the proper manual technique for removing *Taraxacum officinale*.
(NPS/THERESA LEININGER-MILLER)

Invasive Plant Management and Prevention in Denali National Park and Preserve

2022 Summary Report

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Abstract

The 2022 DENA IPMT—consisting of NPS Revegetation Specialist Wendy Mahovlic and SCA Interns Isabella Pomeroy and Decker Sisk —monitored invasive plant populations within the boundaries of the park and surrounding entry points during the field season. Control strategies were established with the overall goal of limiting and eradicating present populations. In total, 1583 field hours (NPS Staff and 2 SCA interns) removed roughly 273 pounds of invasive plants and applied 142.1 gallons of mixed herbicide. The second half of the season was dedicated to seed collection and revegetation. 12.65 pounds of uncleaned native seeds were collected to replenish the DENA Native Seed Bank and 0.1 acres were revegetated. Invasive plant treatments and revegetation projects were conducted from June through August. Additionally two major volunteer events were hosted. Prolific concentrations of invasive species were seen along roadsides (increased encroachment into tundra areas), trails and transport areas. In future seasons, NPS personnel should continue monitoring in high visitation areas and disturbed sites and establish prevention strategies based on population dispersal trends. Restoration activities should be ongoing based on disturbances and revegetation project needs. The work of DENA IPMT is vital to the park ecosystems and the enjoyment of future generations of visitors.

Acknowledgments

The Denali National Park and Preserve Invasive Plant Management Team would like to thank the following individuals and organizations, in no particular order, for their contributions to a successful 2022 season: Anna O’Brien, and Joel Cusick for providing Regional IPMT training and lending their support and expertise throughout the season. Justin Fulkerson for providing extensive plant identification techniques, resources, and maintaining AKEPIC; Carl Roland for making this all possible; Kathleen Kelly for her volunteer coordination prowess; Theresa Leininger-Miller and Melanie Schefft for assistance with our Dandelion Demolition and Need for Seed events; and all volunteers who travelled great distances to help protect the vast wilderness of Denali National Park.

List of Terms and Acronyms

AKEPIC Alaska Invasive Plants Information Clearinghouse

AK IPMT Alaska Invasive Plant Management Team

DENA Denali National Park and Preserve

IPMT Invasive Plant Management Team

GIS Geographic Information System

GPS Global Positioning System

NPS National Park Service

SCA Student Conservation Association

Introduction

Denali National Park and Preserve (DENA) consists of six million acres of mostly intact wilderness in interior Alaska making it the third largest national park in the United States. The topography present creates a unique climate and diverse range of ecotones across the park. The Alaska Range divides the park creating a natural barrier and two climatic zones (Figure 1).

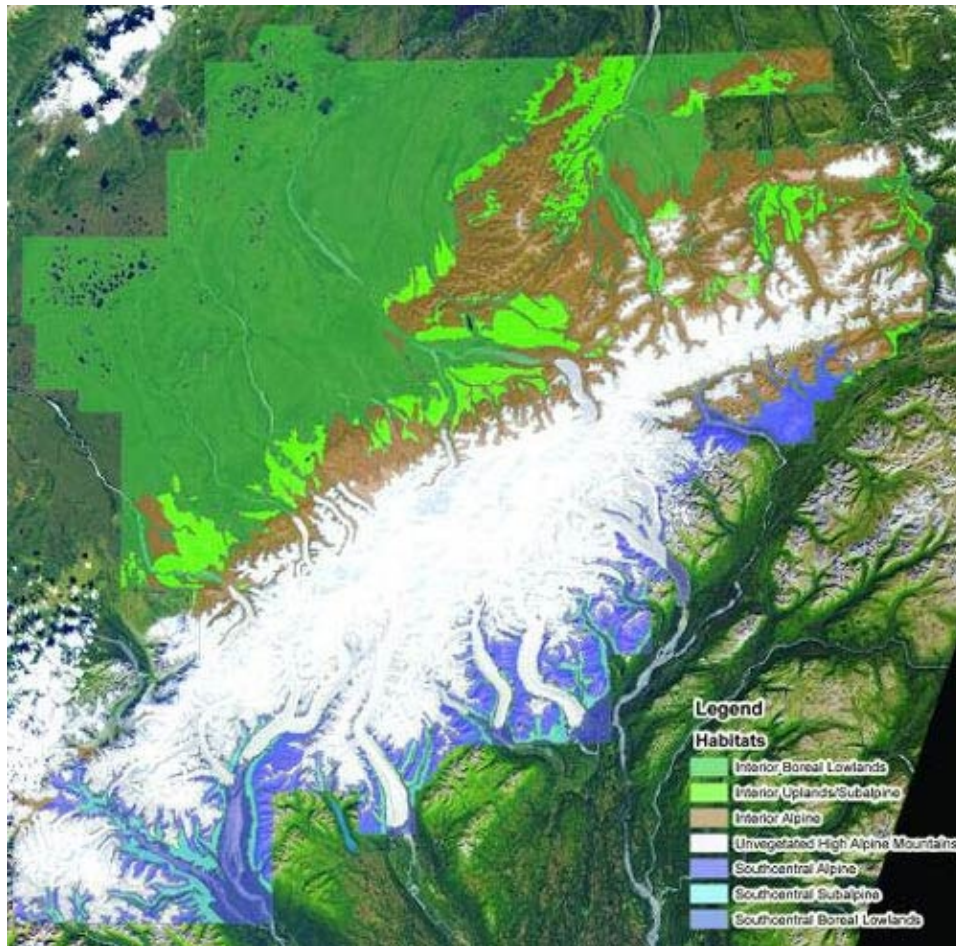


Figure 1. Satellite image of Denali National Park and Preserve with major habitats overlaid in color (NPS).

The work of DENA IPMT in the 2022 season occurred north of the Alaska range where an arctic high-pressure zone, and rain shadow effect increase seasonal temperature variability and limit precipitation. DENA sees a wide elevation range dividing the landscape into distinct habitats, with taiga forests below 2500 feet, spruce forests in the subalpine, low-shrub tundra above 3500 feet, and above that is mostly un-vegetated consisting of bare rock and glaciers.

Historically, the area of Denali has been explored and occupied for roughly 11,000 years. A variety of factors have kept human influence to a minimum. Native peoples were the sole travelers of this area in Alaska until the early 19th century, due likely to the lack of river access around the Alaska Range. Explorers and trappers were the first non-native peoples to the area, and shortly after, the gold

rush boom brought an influx of miners to Kantishna. With an increasing presence of humans in the area and fear of overhunting, Mount McKinley National Park (now Denali National Park and Preserve) was created. This conservation feat halted further development and limits impact within its boundaries still today (Hooge et al. 2006). At the time of conception in 1917, modes of transportation for visitors were limited to foot, horseback, and dog team (Bryant 2011). The instalment of the park road in 1972 was a pivotal moment in the park's history, making it possible for the mostly inaccessible landscape to now be accessed from mile 0 to mile 92. The introduction of a road did not bring a flood of visitors, and the park remained largely untraveled for decades. Today, DENA has seen an influx of visitors within its boundaries. In the past two decades park visitation rates have nearly doubled from 364,019 visitors in 2000 to 601,152 visitors in 2019 (NPS 2019). Due to the parks geographic isolation, policy implementations for road use, and heavy visitation confined to front country areas and along the park road, Denali continues to be a largely intact and pristine wilderness.

Unlike many National Parks, Denali National Park and Preserve has the unique capability to not only limit the spread of invasive plants but eradicate them altogether. The DENA IPMT works to maintain the integrity of the park from the impact of human visitation through monitoring, treatment, outreach and education, and restoration. The establishment of invasive plants is a concern to ecologists and land managers as the second greatest threat to global biodiversity (AKEPIC 2005).

Plants are considered invasive if they are a) growing outside their natural range due to accidental or intentional introduction by humans, and b) causing economic, environmental, or human harm. If an invasive species becomes established, it threatens the local flora and fauna and can change the structure and function of the ecosystem that it is introduced to. Invasive plants often reproduce and spread rapidly, especially after a disturbance, allowing these introduced species to outcompete native plants (Flagstad et al. 2017). Frequently traveled areas, such as, the entrance area, roadside, trails, and rest stops can be monitored and maintained regularly by IPMT to prevent further spread (Figure 2). Seasonal IPMT records indicate that these frequently traveled areas contain the largest and most diverse infestation of invasive species, while smaller, isolated plant populations have been found in other secluded sites—including social trails.

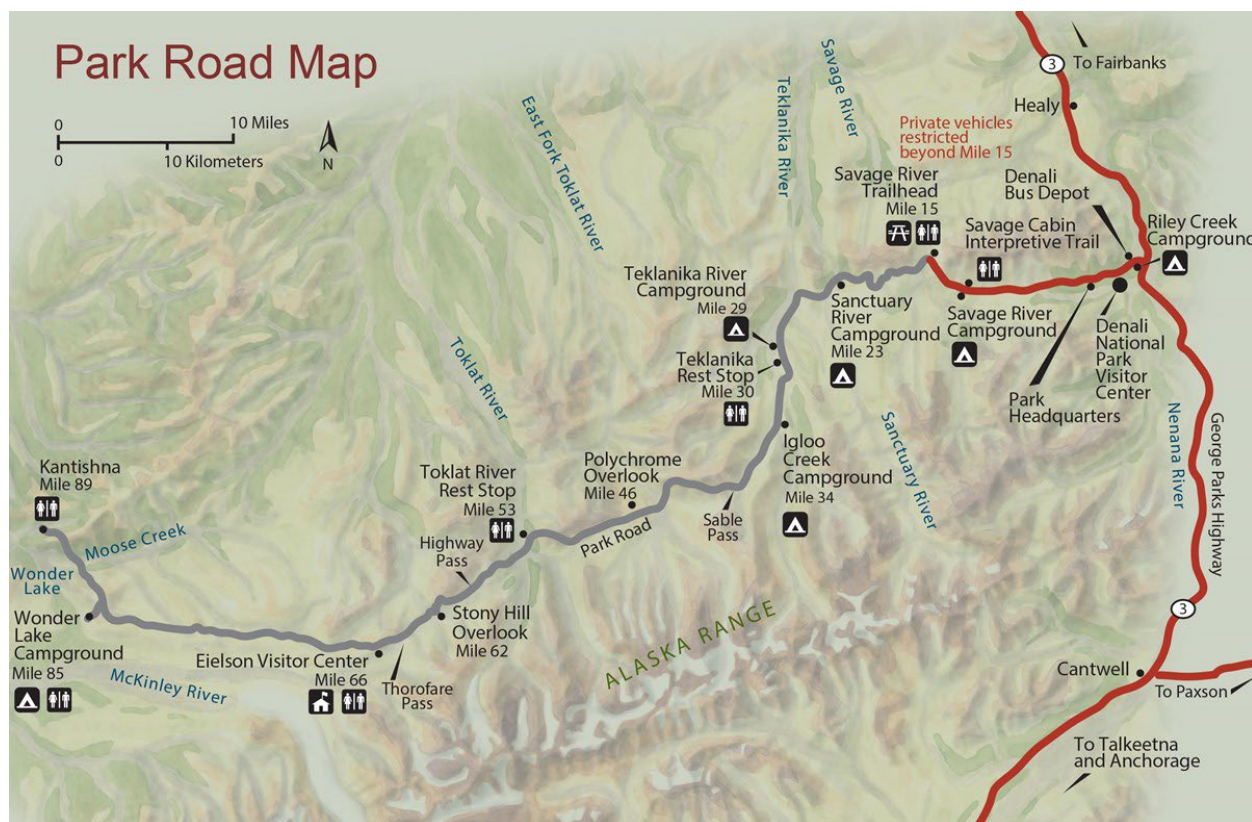


Figure 2. Map of the Park Road, Denali National Park and Preserve (NPS).

Due to the COVID-19 pandemic, no SCA interns joined DENA IPMT in the 2020 and 2021 seasons. Because of this, DENA staff were not able to treat as many far western end of the park road as they had in previous years. In addition to this, the Pretty Rocks road slump in late 2021 caused a closure of the park road at mile 43, so no road access is available to any part of the park beyond this point. Due to the closure, the team was unable to treat infestations between mile 43 and 92 during the 2022 season. No team will be able to tend to this part of the road until the bridge is built, which is expected to take at least 3 years. Because of this, the West end of the road will go at least 5 years (2020 – 2025) with minimal to no treatment, unless IPMT personnel are flown out to the west end of the park in future seasons. If left without treatment until 2025, the invasive plant populations on the West side of DENA will likely proliferate exponentially. Future IPMT participants should be prepared for this scenario and expect to find very large and expansive populations of invasive plants between mile 43 and 92 of the park road.

The DENA IPMT regularly monitors and treats for invasive plants in the entrance area. While for more remote sites, the team uses an early detection and rapid response approach by locating and treating infestations before establishment. Invasive species can grow rapidly, are extremely difficult to control once established and in-turn, removal and maintenance can be costly. The most effective and efficient means of invasive management is to prevent its introduction and dispersal. The purpose of this report is to summarize and discuss the methods and findings of the DENA IPMT 2022 field season and future considerations for the team.

Methods

The 2022 DENA IPMT conducted field work following the Alaska Invasive Plant Management Team: 2022 Field Protocol (O'Brien 2022). Field work was conducted from June 2 to August 19 and can be divided into two phases: Invasive plant treatment, and revegetation. These phases consisted of surveying and controlling invasive plant species, native seed collection, and reseeding disturbed sites.

Invasive Plant Treatment

After identifying an infestation of invasive plant species within the park suitable treatment methods are assessed based on key factors, e.g., identified species, phenology, site and size. The circumstances of infestation influence the guideline for treatment, either manual or chemical.

Work Prioritization

Prioritization must be established according to the Alaska Region IPMT guidelines. Target species, seasonal phenology, and infestation size and site must be considered when determining the field season strategy.

Target Species

The AK IPMT established a database that monitors all invasive plant species identified in Alaska, AKEPIC. The data collected provides an invasive ranking system—0 (non-invasive) to 100 (highly invasive)—based on impact potential, dispersal ability, and distribution within the three ecogeographic regions of Alaska (AKEPIC 2019).

Phenology

The IPMT considers phenology when determining appropriate timing of control methods. Plants are influenced by habitat factors and seasonal variations in climate conditions. Species that germinate early (e.g., *Taraxacum officinale*) must be targeted at the beginning of the field season in order to effectively control infestations. It is critical to treat an infestation before it goes to seed in order to minimize /or eliminate further spread. If treatment is warranted after it has gone to seed precautions must be taken to limit further spread. It is important to note that some plant species bloom multiple times within a field season, and multiple visits to a site may be justified.

Site

Treatment priority was given to infestations adjacent to potential vectors and sensitive habitats. Potential vectors—such as, campgrounds, trailheads, roads, and vehicle and equipment areas—are frequently traveled and have the potential to help the spread of seeds past the initial infestation area. These locations can aid invasive seeds in transport to sensitive areas—e.g., remote locations, recently disturbed sites, those with threatened /or endemic species—and must be given top priority. It is equally worth mentioning that sensitive areas are often remote and difficult to reach; therefore, suitable strategic planning is necessary to ensure effective treatment.

Size and Personnel Availability

The 2022 DENA IPMT consists of three members, NPS Revegetation Specialist Wendy Mahovlic and SCA Interns Isabella Pomeroy and Decker Sisk. The density, acreage, isolation and leading edge of an infestation determines personnel focus. More resources are needed to control infestations of greater area and density; consequently, the treatment schedule was based on when volunteer groups were scheduled and the number of personnel. The leading edge of these large, densely populated infestations—infestation encroaching on new areas—must be considered when planning a containment strategy. Small satellite infestations can be effectively controlled with less time and effort and should be prioritized when large crews are unavailable. These small—often remote—infestations threaten wilderness and backcountry areas.

Control Methods

Control work is the primary function of the IPMT. After a vulnerable site has become infested an effective management technique is the removal of these plant species through manual or chemical treatment.

Chemical Control

Unlike the previous years of IPMT, chemical control was the primary method of invasive plant control during the 2022 DENA IPMT field season. This is primarily due to a limited number of personnel available this season to work in invasive plant removal. In previous years, IPMT was aided by SCA crews to manually remove infestations. No SCA crews were available to assist the DENA IPMT in 2022. In addition to this, manual methods used in the past were less effective than chemical treatment of infestations, thus making chemical treatment the most efficient method for invasive plant removal. All chemical treatment was conducted with an herbicide, Milestone, and was applied using a backpack sprayer. Sprayer calibration and application to infestations was determined based on IPMT protocol (O'Brien 2022). Annual chemical training was conducted from May 8 to May 13 at the Alaska Regional Office.

Herbicide treatments are generally utilized when controlling particularly dense and broad infestations. Elements that were considered when deciding to applying herbicide include: identified invasive plant, weather conditions, surrounding habitat and species present, personal protective equipment (PPE), and risk-reward calculations relative to manual control. Chemical control was deemed to be more efficient and minimally intensive within the sites that it was applied and was also utilized based on number of personnel and field hours.

Manual control

Manual control methods—such as, hand pulling and digging—were used to remove invasive species in the 2022 season, primarily utilized during a trip assisting Yukon-Charley Rivers National Preserve treat their invasive plants. For the manual control of plants to be used the morphology of the target invasive must be considered. Notably, manual removal is effective on species without a substantial root system and those unable to vegetatively propagate. Species with deep tap roots and expansive underground systems are more laborious, requiring strict attention to fully removing all plant material. A hand tool with a curved metal shaft and sharpened V-shaped tip is a successful instrument in removing most or all a plant's root system. Manual removal is time and labor intensive

and should be utilized based on number of personnel and field hours. If full treatment is restricted based on time constraints or personnel, removing the flowering or seed head can be secondarily effective in preventing seed dispersal. As mentioned previously, if treatment is warranted once an infestation has gone to seed, removing the seed head is a necessary precaution to limit further dispersal. Properly dispose of the seed heads and then proceed to removal of vegetation if able. All removed plant materials were placed in sealed plastic garbage bags and will be burnt in winter by the DENA Fire Team.

Project Areas

The DENA IPMT invasive plant treatments in the 2022 field season can be divided into three project areas: the Entrance Area (mile 0-3 along the Park Rd.), the East End (mile 4-43 along the Park Rd.), and the George Parks Highway (mile 235 – 240.5 of the Parks Highway). Table 1 summarizes these areas, and what invasive species were found at different sites within them.

Table 1. Project sites and the invasive plant species controlled during the 2022 DENA field season.

Location	Work Sites	Invasive Plant Species
Entrance Area (mile 0-3)	Trail Crew Work Yard	<i>Taraxacum officinale</i>
	Bus Parking Lot	<i>Taraxacum officinale</i>
	Denali Visitor Center	<i>Taraxacum officinale</i>
	Rock Creek Bridge	<i>Taraxacum officinale</i>
	Park Headquarters	<i>Taraxacum officinale</i> , <i>Vicia cracca</i>
	Permanent Housing	<i>Taraxacum officinale</i> , <i>Galeopsis bifida</i> , <i>Vicia cracca</i>
	Seasonal Housing	<i>Taraxacum officinale</i>
	Park Road	<i>Taraxacum officinale</i> , <i>Crepis tectorum</i>
East End (mile 4-43)	Park Road	<i>Taraxacum officinale</i>
	Primrose Rest Stop (Park Rd Mile 17)	<i>Taraxacum officinale</i>
	Tek Flats (Park Rd Mile 29 - 27)	<i>Taraxacum officinale</i>
George Parks Highway	DENA Entrance (Parks Highway Mile 237.25)	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Melilotus albus</i>
	Creekside Cabins & Park Village (Parks Highway Mile 224 & Mile 231)	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Linaria vulgaris</i>
	Glitter gulch (Parks Highway Mile 238-239)	<i>Vicia cracca</i> , <i>Melilotus albus</i>
	South Entrance Triple Lakes Trailhead (Parks Highway Mile 231.25)	<i>Taraxacum officinale</i>

A detailed timeline of all Invasive Plant Treatments conducted in the 2022 field season is as follows:

- June 13-17: Decker Sisk, and Isabella Pomeroy chemically treated *Taraxacum officinale* around the park headquarters, trail crews' work yard, permanent housing, and the seasonal housing area.

- June 18: The DENA IPMT coordinated a volunteer “Dandelion Demolition” event with the Volunteer Coordinator, Kathleen Kelly. Additional information on this event can be found in the Education and Outreach section of this report.
- June 22 to July 1: Decker Sisk, and Isabella Pomeroy chemically treated *Taraxacum officinale* from mile 21-43 of the park road.
- July 5-7: Wendy Mahovlic, Decker Sisk, and Isabella Pomeroy chemically treated *Vicia cracca* and *Taraxacum officinale*, and manually removed *Crepis tectorum* at Riley Creek and the park entrance.
- July 11- 18: Wendy Mahovlic, Decker Sisk, and Isabella Pomeroy traveled to the Yukon-Charley Rivers National Preserve (YUCH) and joined an effort to manually remove *Melilotus albus* along the Yukon River.
- July 27-28: Wendy Mahovlic, Decker Sisk, and Isabella Pomeroy applied herbicide to populations of *Vicia cracca* and *Melilotus albus* found on the George Parks Highway north of the park entrance, at Glitter Gulch (mile 237-239).
- August 2-3: Wendy Mahovlic, Decker Sisk, and Isabella Pomeroy chemically treated *Vicia cracca*, *Linaria vulgaris*, and *Melilotus albus* at the park village, as well as *Vicia cracca* and *Melilotus albus* along the Parks Highway in between the park entrance and park village, and at Glitter Gulch.

Construction

An ongoing infestation of *Melilotus albus* and *Crepis tectorum* has been identified at a construction site within DENA boundaries along the Parks Highway between miles 235 and 229. This area was not treated during the 2022 season due to active construction but should receive treatment during the following season.

Yukon-Charley Rivers National Preserve

In addition to the invasive plant work done in DENA, a trip was taken to YUCH to manually remove several infestations of *Melilotus albus* among various small islands along the Yukon River from July 11-18. The work was carried out by a seven-person crew, comprised of four NPS IPMT personnel, two Fish & Wildlife employees, and an NPS boat pilot. 155 pounds of *M. albus* was removed in total. The weeds were brought back to DENA to be burned during the winter by the DENA Fire Team.

Revegetation

A portion of the DENA 2022 field season was dedicated to revegetation efforts. Revegetation is the reintroduction of native plant species, restoring the ecological integrity of an environment after it is disturbed. This increases the areas resilience to invasive infestations. Disturbed sites are particularly vulnerable. Invasive species can outcompete native individuals, monopolizing sites before natives are able to revegetate. To minimize the risk of invasive plants inhabiting DENA’s disturbed sites revegetation is recommended.

DENA IPMT uses seed sowing, willow cuttings, tundra mats, and seed collection as methods for revegetating. For the purposes of this report, only methods utilized in the 2022 season will be described. Sowing seeds is the process of tilling the soil, scattering native seeds, and raking over the area to ensure a thin layer of soil has buried the seeds, roughly 1/8 in. Species of native seed are mixed with sand, annual rye and fertilizer, which temporarily revegetates vulnerable areas. Some seeds, e.g., *Oxytropis campestris*, requires scarifying before sowing. DENA utilizes a sanding machine to mimic the natural process of scarification, i.e., the process of weathering seeds experience to allow nutrients and sunlight to pass through their seed coat. The Denali National Park Service's policies requires native seeds to be planted within a 20-mile radius of where they were collected to maintain genetic diversity.

Project Areas

A detailed timeline of all revegetation conducted in the 2022 field season is as follows:

- August 17 - Anna O'Brien, Wendy Mahovlic, Decker Sisk, and Isabella Pomeroy revegetated an area of 4,350 ft² at mile 11.5 on the park road.

Native Seed Bank Preparation

The DENA IPMT maintains a seed bank on-site and collection occurs annually to ensure a steady supply of native seeds. It is important to keep a diverse stock of seeds from each major area of the park. Disturbance occurs regularly in high-traffic areas and revegetation projects are conducted each year. Replenishment needs for the seed bank, native species present in intended radius, and seasonal phenology must be considered when determining the field season collection strategy. It is important to note that first succession species—species that establish quickly and thrive in gravel locations—should be targeted for collection due to the proposed restoration sites.

DENA IPMT replenishes the park's seed bank of small, herbaceous perennials regularly; many of whom are from the family Fabaceae who maintain a mutualist relationship with nitrogen-fixing bacteria. Nitrogen is a key element in soil fertility, providing necessary nutrients for plant growth. Additionally, species with easy to clean and dispersible seeds are prioritized, while collection of some species in the Asteraceae family is minimal because of the pappus. While good for wind-dispersal, the pappus makes seed cleaning and proper storage difficult.

Seasonal weather conditions vary which directly effects the phenology timeline of native species intended for collection. If possible, surveying the morphology of species in intended collection sites before scheduling collection is vital. Seeds must be mature and ready for harvest.

Collection techniques vary based on plant structure; accordingly, volunteers must be instructed on proper methods. Examples methods of species commonly found in Denali:

1. *Hedysarum alpinum*, the seeds hang along an inflorescence allowing seeds to be gathered by hand in one swift motion.
2. *Elymus sp.*, scissors are required to snip the seed head from the stem.

Techniques described can be applied to species of similar structure. Collected seeds are segregated into paper bags if multiple species are collected; and labeled with species name, date collected, and location. Species are then laid out on drying racks (i.e., muslin cloth laid on a wood-framed mesh screen) consolidated by site location, date, and species. The seeds are left to dry in a warm, dry location for several days until fully dry and ready to be cleaned. Not all species need to be cleaned, e.g., *Hedysarum alpinum*. For those that do, cleaning consists of separating the seeds from the chaff. All seeds are sealed in freezer bags, labelled, and stored in the DENA Seed Bank freezers.

Surveying and Geospatial Data

All projects conducted in the 2022 season were surveyed using a handheld Trimble Geo7X GPS unit. Attributes of invasive infestation and restoration were recorded including location, disturbance type, action taken, plant phenology (de-vegetation), personnel hours, and species. The DENA data dictionary provided by AK IPMT annually provides a framework for collecting GIS data. Data is recorded in the form of a rover file based on the features of the location, either as a point to buffer, line to buffer, or polygon. A point to buffer (Figure 3) maps a circular area with its radius recorded as a buffer distance and should never be larger than three meters.

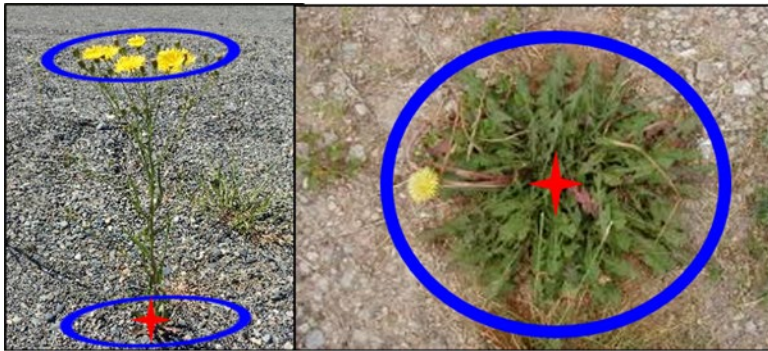


Figure 3. Example of a single plant that should be recorded as a point to buffer (NPS).

A line to buffer (Figure 4) maps a linear area with the buffer distance equal to half the total width and should never be larger than five meters. A polygon (Figure 5) maps the shape of an area if the site does not fit into the previous requirements. Standard polygons are created and maintained by regional IPMT for known infestations and defined perimeters. Data collected must be differentially corrected and edited in GPS Pathfinder Office. Edited data is submitted weekly to the AK IPMT data manager. Final files are reviewed and made available in the AKEPIC database.



Figure 4. Example of a linear infestation that should be recorded as a line to buffer (NPS).



Figure 5. Example of irregularly shaped infestation that has a large buffer distance and should be recorded as a polygon (NPS).

Education and Outreach

Education and outreach are mechanisms for engaging the local community in the work their local park is doing; inspiring the next generation to participate in conservation practices and teaching the community about native and invasive plants and the prevention and revegetation DENA is conducting. Volunteers and visitors can become knowledgeable about the surrounding ecosystems and the threats invasive species pose. Citizen scientists are an invaluable tool to conservation efforts.

Education

The most effective and efficient means of invasive management is to prevent its introduction and dispersal. Seeds from travel locations can be lodged in gear, clothes and on boot treads and vehicles. Cleaning gear before and after use and washing off tire treads before entering the park are useful practices. With 43 miles of the park easily accessible to traffic, educating visitors and employees about prevention practices can minimize spread of non-native species into the park.

Field work conducted in populated areas were channels for providing information to the public, as were outreach events. Hikers and bikers along the park road would often approach the IPMT, providing in-field examples of plant management practices and how they can aid in park efforts as citizen scientists. Buses would occasionally stop to inquire what IPMT workers were doing and Mahovlic provided informal plant talks to bus passengers.

Volunteer Events

DENA IPMT coordinated two volunteer events— “Dandelion Demolition” and “Need for Seed”— with the Volunteer Coordinator, Kathleen Kelly, and volunteers, Theresa Leininger-Miller and Melanie Schefft. These events aimed to provide outreach and education to the surrounding community about the work of the IPMT within DENA and utilize volunteer work to bolster project needs.

Dandelion Demolition

This event took place in the entrance area of the park on June 18 from 9 a.m. to 1p.m. Manual removal of *Taraxacum officinale* occurred at the Denali Visitor Center campus, dog kennels, the adjacent park road, bus service road, and the traffic circle. Location coordinating, volunteer forms and vouchers, and snacks and wildlife safety information was provided by Kelly. Decker Sisk and Isabella Pomeroy provided tools, training on general ecology, and *Taraxacum officinale* identification and removal techniques. Prizes were awarded to the volunteers with the longest root, biggest flowering head, and most collected. Collected dandelions were bagged and weighed. In total, 28 volunteers participated from the surrounding community and 117.5 pounds of dandelions were removed.

Need for Seed

On August 6, a public seed collection event took place in Park Headquarters and along the Rock Creek Bridge. Location coordinating, volunteer forms and vouchers, and snacks; as well as wildlife safety information was provided by Kelly and Schefft. Isabella Pomeroy and Decker Sisk provided tools, training on general ecology, and native seed identification and collection techniques. In total,

51 volunteers participated from the surrounding community and collected 5.5 pounds of uncleaned seeds.

Results

In the 2022 field season the DENA IPMT conducted manual and chemical removal within and around DENA; revegetation at mile 11.5 on the park road; and seed collection around the entrance area, mile 12 of the park road, Igloo (mile 33 Park Rd), and Sable Pass (mile 39 Park Rd). Projects and seed collection were aided with the help of volunteers. Total field hours, acres surveyed, acres infested, and acres treated since the IPMT 2004 season can be found in table 2.

Table 2. Annual overview of field work (i.e., re-vegetation, devegetation) conducted by the DENA IPMT from 2004 to 2022.

Year	IPMT Personnel		Volunteer Crews		Total Person Field Hours	Invasive GPS Data NPS Lands(non-NPS lands)		
	# pers.	Field Hours	# pers.	Field hours		Species Acres Surveyed	Species Acres Infested ^A	Acres Treated ^B
2004	1	39	1	25	64	2.553 (6.557)	0.934 (6.557)	0.450 (0.035)
2005	1	224	8	544	768	16.713 (2.321)	12.877 (1.531)	3.261 (0.186)
2006	1	454	8	679	1,133	750.313 ^C (2.958)	16.866 (0.349)	10.211 (0.121)
2007	2	743	16	1,173	1,916	805.951 ^C (7.826)	11.329 (0.301)	8.368 (0.289)
2008	2	626	10	454	1,080	741.687 ^C (11.982)	12.750 (7.968)	11.051 (0.649)
2009	2	571	5	385	956	749.459 ^C (4.210)	20.437 (0.317)	11.370 (0.317)
2010	3	1,893	16	2,560	4,453	159.034 (35.245)	16.766 (2.616)	14.125 (2.586)
2011	3	764	3	143	907	290.592 (23.395)	29.348 (7.228)	10.290 (2.010)
2012	2	478	35	912	1,390	61.872 (6.397)	19.108 (2.366)	10.519
2013	2	500	27	980	1,480	118.85 (8.3)	5.783 (1.89)	4.56 (.461)
2014	2	443	14	337	780	80.33 (0.23)	6.24 (0.04)	0.84 (0.03)
2015	3	1,040	14	1,350	2,390	73.55 (0.41)	5.66 (0.03)	4.71 (0.03)
2016	2	1,288	159	2,338	3,626	3.28 (0.18)	0.80 (0.07)	0.80 (0.07)
2017	2	580	79	894	1,474	13.16 (3.77)	0.95 (0.19)	0.89 (0.19)
2018	2	1,280	133	932.5	2,212.5	42.57 (.08)	1.182 (.03)	1.07 (.007)
2019	2	1080.75	170	1712	2792.75	140.48 (0.002)	3.28 (0.001)	3.19 (0.001)
2022	3	1583	79	316	1899	59.90 (1.68)	59.90 (1.68)	59.74 (1.68)

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

^B Acres treated represent the area of a mapped infestation multiplied by the percent cover of invasive plants in that mapped area and by the percent of the infestation treated.

Invasive Plant Control

Chemical control was applied to populations of seven invasive species found in DENA. *Taraxacum officinale* was targeted for herbicide application. Dense populations were found in high-traffic areas throughout the park and 142.1 gallons of mixed herbicide was applied to populations found by DENA IPMT. Approximately one month after chemical treatment, all infestations of *Vicia cracca* along the George Parks Highway appeared to be brown and completely dead. However, *Melilotus*

albus appeared to be more resistant to the herbicide and most large plants that were surveyed remained standing and alive, albeit with a sickly yellow appearance.

Manual control was utilized for *Taraxacum officinale* infestations in DENA during Dandelion Demolition, as well as for infestations of *Melilotus albus* in YUCH. In total 272.5 pounds of invasive plants were manually removed. *Taraxacum officinale* is the most populous invasive found in the park and its removal was the IPMT primary priority at the beginning of the season. A breakdown of manual removal in the DENA 2022 field season can be found in table 3.

Table 3. Species breakdown of estimated IPMT manual removal work in the 2022 field season.

Invasive Species	Pounds Removed	Person Hours
<i>Taraxacum officinale</i>	117.5	112
<i>Melilotus albus</i>	155	240
Total	272.5	352

Revegetation Projects

DENA conducted one revegetation project in the 2022 field season which was located on the mound at mile 11.5 park rd., investing a total of 6 hours. A breakdown of revegetation projects in the DENA 2022 field season can be found in table 4.

Table 4. Breakdown of estimated DENA IPMT revegetation work in the 2022 field season.

Site	Date Planted	Seed Species	Acres Revegetated	Person Hours
Mile 11.5	August 17	<i>Hedysarum alpinum</i> , <i>Oxytropis campestris</i> , <i>Elymus sp.</i> , <i>Poa alpina</i> , annual rye, fertilizer	0.1	6
Total			0.1	6

Native Seed Bank

The beginning of the 2022 season was spent creating a new seed inventory using Microsoft Excel. The previous inventory before this was created in 2010 and did not accurately reflect the current park inventory. Hopefully the new 2022 inventory will continue to be updated in future seasons as new seeds are collected and more area is revegetated. DENA IPMT collected the seeds of seven native plant species in the 2022 field season. Multiple sites along the park road were surveyed for collection. *Elymus sp.* was found to be the most prolific and at the correct stage of maturation for collecting. In total 4.67 pounds (uncleaned) of this species were collected. A breakdown of native species collected can be found in table 5.

Table 5. Species breakdown of estimated DENA IPMT seed collection work in the 2022 field season.

Native Species	Pounds Collected^A	Pounds Cleaned^B
<i>Oxytropis campestris</i>	4.42	0
<i>Elymus sp.</i>	4.67	2.08
<i>Hedysarum alpinum</i>	3.04	3.04
<i>Leymus innovatus</i>	0.22	0.19
<i>Poa alpina</i>	0.12	0
<i>Solidago multiradiata</i>	0.09	0
<i>Aster sibericus</i>	0.09	0
Total	12.65	5.31

^A Includes cleaned and uncleaned seeds.

^B Not all seeds collected this season were cleaned and some seeds cleaned this season were collected in previous seasons.

Conclusions

During the 2022 field season DENA IPMT successfully treated populations of invasive species with chemical and manual methods, revegetated project areas, and collected native species for the DENA seed bank. Yet, with the DENA team unable to treat all populations of invasive plants surveyed this season, the increasing visitor presence in the park and traffic along the park road, and annual construction projects, more field hours dedicated to IPMT work is foreseen. Field work conducted was limited by a lack of personnel. Unlike previous seasons, there were no SCA crew teams working in the park. This is due to the fact that there weren't enough SCA crew teams in Alaska to be sent to Denali. Additional employees and volunteers are recommended for DENA to effectively manage infestations within the park and conduct revegetation plans to minimize the likelihood of non-native establishment at those sites, and to maintain the aesthetic value of DENA wilderness for visitors.

Further, a recommendation for management needs is the installation of boot brushes at frequently travelled locations. National Parks in the Alaska region, namely Kenai Fjords and Klondike Gold Rush National Historic Park have established this invasive control mechanism. Strategically placing these stations around the park is an inexpensive and effective way of minimizing seed dispersal further along the road and into the back country. Invasive species grow rapidly and are difficult to control if established. The most effective and efficient means of management is to prevent its introduction and dispersal.

Based on personnel hours, more time was logged in chemical treatment this season than any previous season. The vast majority of the time spent treating invasive plants involved chemical treatment. More time was spent spraying *Taraxacum officinale* than any other invasive plant species. The month of July has previously been dedicated to pulling *Crepis tectorum*, however, this season July was spent chemically treating other plants, leaving a very narrow window for treating *Crepis tectorum*. The population of *Crepis tectorum* found in the usual "Crepis Sweep" area (mile 0 – 2 Park Rd) is expanding and chemical treatment is recommended. If spraying time and identification is not possible to coordinate, pulling should be coordinated with volunteers to allow for Mahovlic and her intern to chemically treat other species in July. The large population now found within the "Crepis Sweep" is large and time-consuming to pull, extra hands are needed for efficiency. If scheduling a volunteer crew is not possible, interns and co-workers from other departments may be interested in scheduling time to assist with pulling. *Taraxacum officinale* is the most populous invasive found in the park. It was found encroaching on the tundra along the park road, through social trails, animal trails, and around culverts. The park road should be surveyed in future seasons for additional populations, and populations found this season should be monitored closely. *Vicia cracca* cannot be fully eradicated by manual control. DENA IPMT sprayed populations found on the Parks Highway and in DENA Permanent Housing and Headquarters. This species sends out branched tendrils, expanding overtop of the surrounding vegetation and fastening itself. In order to effectively treat infestations and avoid spraying surrounding native plants pull the leaflets—including tendrils—off the surrounding plants, bunch all plant material together and wind it down to the base of its stem. Once the whole plant is in a ball on the ground it is ready to be sprayed. This appeared to be an efficient spray technique this season. Due to construction work on mile 229 – 235 Parks Highway,

DENA IPMT were unable to remove *Vicia cracca*, *Crepis tectorum*, and *Melilotus albus* along the Parks Highway. It is recommended that next year's team prioritize these areas.

Seed collection was limited by finding populations of the correct phenology to be harvested in August. Populations that were found ready to harvest were of former revegetation sites; thereby, ideal plant species for seed collection and revegetation could be found in those areas around the same time in future seasons. Seasonal weather changes should be monitored closely in order to plan collection efficiently. In the DENA seed bank, there are several pounds of uncleaned native seeds. Time towards cleaning should be coordinated throughout the field season. If there are enough personnel on site for the Need for Seed event, an employee could take volunteers to the seed bank to assist with cleaning. Other volunteer groups or IPMT personnel could be coordinated for seed cleaning.

Additionally, in future seasons it is recommended that the DENA IPMT include a discussion section within the end of season report. Examining seasonal changes of species, population distribution and number, and phenology would aid seasonal strategic planning and management. It would also be a way of quantifying DENA management successes over-time.

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