



Invasive Plant Management Team Treatment and Prevention in Denali National Park

2023 Summary Report



ON THE COVER

Left: Intern Kathryn Lee applying herbicide to *Taraxacum officinale* along the Teklanika Flats along the Denali Park Road.
Right: Revegetation Technician Wendy Mahovlic applying herbicide to *Lupinus polyphyllus* at Mile 7 on the Denali Park Road. (NPS/ELIZABETH MOUSSEAU)

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2023 Summary Report

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Abstract

The 2023 Invasive Plant Management Team (IPMT) had a successful season of invasive plant management, native seed collection and revegetation. In the first half of the season, Student Conservation Association (SCA) Interns Kathryn Lee and Elizabeth Mousseau joined Denali National Park's (DENA) Revegetation Technician, Wendy Maholvic, in the monitoring of invasive plant populations within the park, and along the George Parks Highway. Both chemical and manual control methods were used to treat and prevent invasive plants. In total, the IPMT manually removed 344 pounds of invasive plants, with the help of volunteers during the Dandelion Demolition volunteer event and an SCA crew in June. Using chemical treatment, the IPMT sprayed 62.25 gallons of herbicide through the season. In the second half of the season, the IPMT collected native seeds for the DENA's Native Seed Bank. These seeds are used for various revegetation projects in the park. The seeds collected and cleaned this season will be planted as part of the revegetation projects at Pretty Rocks Landslide at mile 43 of the Denali Park Road, and at a revegetation site at the DENA entrance area. In total, 32.58 pounds of native seeds were collected in the 2023 season, 39.86 pounds of which were cleaned and ready for planting (note: seeds were cleaned from previous years as well). Volunteers helped collect 4.5 pounds of these seeds during the Need for Seed volunteer event in August. 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 IMPTs is vital to the park ecosystems and the enjoyment of future generations of visitors.

Acknowledgments

The DENA IPMT would like to thank the following individuals and organizations, in no particular order, for their contributions to a successful 2023 season: Scott Richardson for being our eyes and ears on the park road this season: Jim Syvertsen for pulling Roxie out of a ditch: Kathleen Kelly and Ed Barnes for their volunteer coordination: Anna O'Brien, Joel Cusick, and Justin Fulkerson for providing regional IPMT training and all of their dedication and support through the season: Carl Roland: the five Student Conservation Association Alaska Corps crew members for all their hard work: all the volunteers who took the time to work alongside us: Roxie for all the miles she put in this season.

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 therefore a diversity of ecosystems and species that inhabit it. The Alaska Range divides the park creating a natural barrier and two climatic zones (Figure 1).

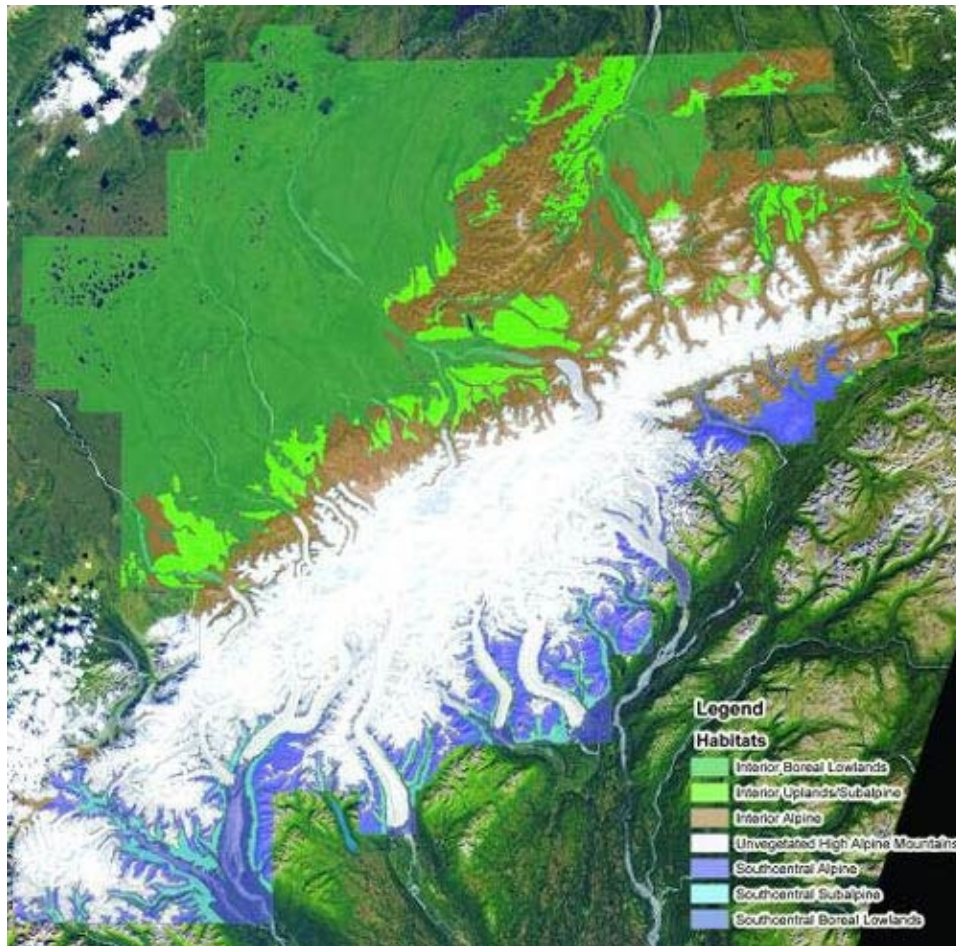


Figure 1. Satellite image of Denali National park and Preserve with major habitats overlaid in color (NPS).

The work of DENA IPMT in the 2023 season exists north of the 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 glaciated, or bare rock.

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 (i.e., 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 through the harsh subarctic climate were limited to foot, horseback, and dog team (Bryant 2011). The instalment of the park road in 1938 was a pivotal moment in the park's history, making it possible for previously virtually inaccessible landscape to now be accessed from mile 0 to mile 92; although, the introduction of a road did not bring a flood of visitors and the park remained largely untraveled for decades. 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 place of vast 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 non-native invasive plants is a concern to ecologist 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, Cortes-Burns, and Greenstein 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.

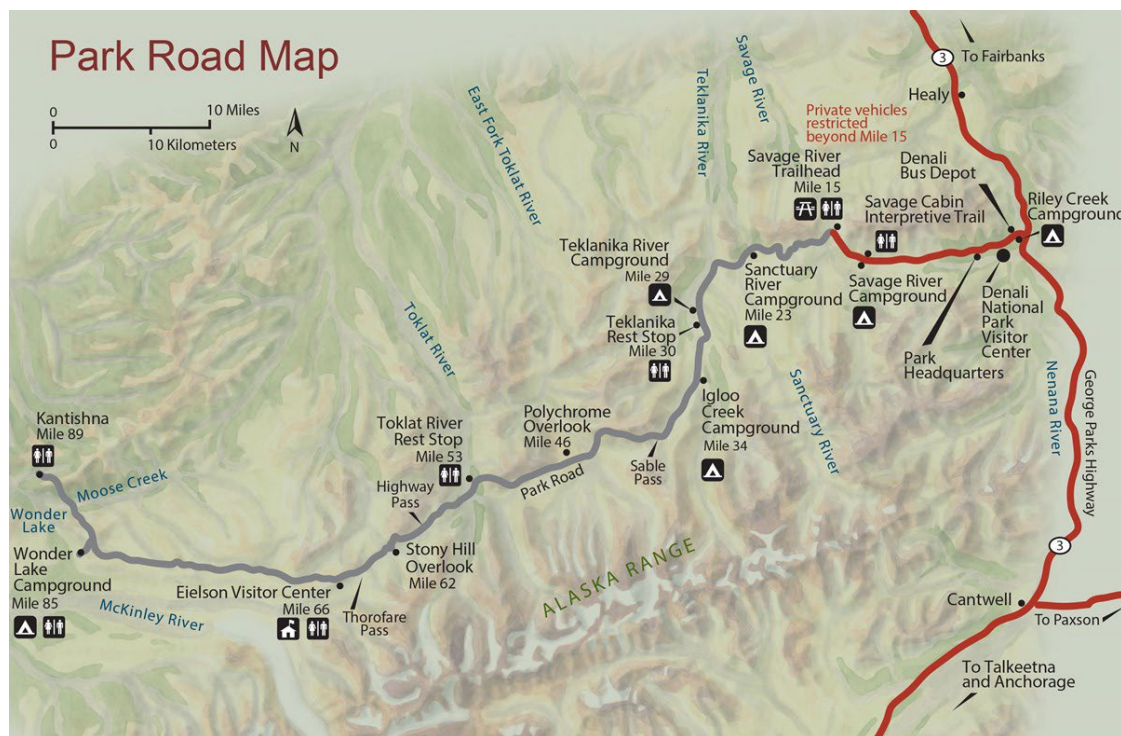


Figure 2. Map of the Park Road, Denali National Park and Preserve (NPS).

Due to the COVID-19 pandemic, no SCA interns joined DENA IPMT in the 2020 and 2021 seasons. Because of this, Mahovlic was not able to treat as many infestations on the far (West) side of the park road as she had in previous years. In addition to this, the Pretty Rocks landslide 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 2023 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 6 years (2020 – 2026) with minimal to no treatment, unless IPMT personnel are flown out to the west end of the park in future seasons. Mahovlic was able to fly out to Kantishna this season and chemically treated *Taraxacum officinale* and *Vicia cracca* on the west end. Mahovlic has stated that left without treatment until 2026, the invasive plant populations on the west side of DENA will proliferate exponentially and are already well on their way. 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 2023 field season and future considerations for the team.

Methods

The 2023 DENA IPMT conducted field work according to the Alaska Invasive Plant Management Team: 2023 Field Protocol (O'Brien 2023). Field work was conducted from May 30 to August 23, and can be divided into two phases: Invasive Plant Management and Revegetation. These phases consisted of monitoring and treating invasive plants, collecting native seeds, and revegetating a site near the DENA entrance area.

Invasive Plant Management

Work Prioritization

Target Species and Phenology

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). 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 to effectively control infestations. It is critical to treat an infestation before it goes to seed 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 Location

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. Infestations in these locations spreads invasive seeds to sensitive areas—e.g., remote locations, recently disturbed sites, those with threatened /or endemic species—and must be given top priority. Sensitive areas are often remote and difficult to reach; therefore, suitable strategic planning is necessary to ensure effective treatment.

Size of Infestation and Personnel Availability

The 2023 DENA IPMT consists of three members. Accordingly, 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

Manual Control

Manual control methods—such as, hand pulling and digging—were used to remove invasive species in the 2023 season, primarily along the Denali Park Road. An SCA Crew helped remove *Taraxacum officinale* June 19 – 23 on the Park Road, miles 17-43. All removed plant materials were placed in sealed plastic garbage bags and will be burnt in winter by the DENA Fire Team.

Manual removal is more effective on species without a substantial root system or those unable to vegetatively propagate. Species with deep tap roots and expansive underground systems require particular care to fully removing all plant material. Hand tools with a curved metal shaft and sharpened V-shaped tip help to remove a plant's root system. After the invasive plants go to seed, one should pick the seed heads before digging out the rest of the plant to limit further seed dispersal. Because manual treatment is more time and labor intensive, this control method should be considered when larger numbers of personnel and field hours are available. When the IPMT is limited by time or personnel, the team should prioritize chemical control or simplify treatment by removing seed heads.

Chemical Control

Chemical control was the primary method of invasive plant control during the 2023 DENA IPMT field season, due to limited personnel. Though manual treatment was previously used on species with rhizomatous root systems like *Vicia cracca*, infestations continued to worsen. The IPMT now uses chemical treatment on species with extensive and difficult to remove root systems. All chemical treatment includes the herbicide, Milestone, and was applied using a backpack sprayer. Sprayer calibration and application to infestations was determined based on IPMT protocol (O'Brien 2023). Annual chemical training was conducted from May 22-26 at the Alaska Regional Office.

Herbicide treatment should be utilized when controlling particularly dense and broad infestations. Elements to consider when 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 is more efficient with fewer personnel and field work hours.

Project Areas

The DENA IPMT de-vegetation work in the 2023 field season can be divided into three project areas: the Entrance Area (mile 0-3 Park Rd.), the East End (mile 4-43 Park Rd.), and the George Parks Highway (mile 232 – 240.5 Parks Highway). Table 1.

Table 1. Project sites and invasive plant species in the 2023 DENA IPMT field season.

Location	Work Sites	Invasive Plant Species
Entrance Area (mile 0-3)	Denali Visitor Center	<i>Taraxacum officinale</i>
	Murie Science and Learning Center	<i>Taraxacum officinale</i>
	Airstrip	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Melilotus albus</i> , <i>Linaria vulgaris</i>
	Power Plant	<i>Vicia cracca</i>
	Post Office & Riley Creek Campground	<i>Crepis tectorum</i> , <i>Taraxacum officinale</i> , <i>Vicia cracca</i>
	Park Headquarters	<i>Taraxacum officinale</i> , <i>Vicia cracca</i>
	Permanent Housing	<i>Taraxacum officinale</i> , <i>Vicia cracca</i>
	Park Road	<i>Taraxacum officinale</i> , <i>Crepis tectorum</i> , <i>Vicia cracca</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>
West End (mile 52-92)	Park Road	<i>Taraxacum officinale</i> , <i>Vicia cracca</i>
George Parks Highway	Creekside Cabins (Parks Highway Mile 224)	<i>Vicia cracca</i> , <i>Crepis tectorum</i>
	Parks Highway Mile 229	<i>Vicia cracca</i>
	New Wayside Construction Area (Parks Highway Mile 230-232)	<i>Crepis tectorum</i> , <i>Melilotus albus</i>
	Denali Park Entrance (Parks Highway Mile 237.25)	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Melilotus albus</i>
	Glitter Gulch (Parks Highway Mile 238-239)	<i>Vicia cracca</i> , <i>Melilotus albus</i>
	Old Campground (Parks Highway Mile 240.5)	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Melilotus albus</i>
	Highway road edge gravel (Parks Highway Mile 232 – 240.4)	<i>Vicia cracca</i> , <i>Crepis tectorum</i> , <i>Melilotus albus</i>

A detailed timeline of all de-vegetation conducted in the 2023 field season is as follows:

- June 12: Lee & Mousseau chemically treated *Taraxacum officinale* around the Trail Crew yard (next to Auto Shop).
- June 17: 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.
- June 19 – 23: SCA Crew, Lee, Mahovlic, & Mousseau manually treated *Taraxacum officinale* on mile 17 and miles 30 – 43 of the park road.
- June 27-29: Lee, Mahovlic, & Mousseau chemically treated *Taraxacum officinale* on mile 15 and miles 22-29 of the park road.

- July 5: Lee, Mahovlic, & Mousseau chemically treated *Taraxacum officinale* from mile 19-22 on the park road.
- July 11-12: Lee & Mahovlic took an inventory of the new wayside construction area from mile 230-232. See more in the Construction section below.
- July 13-14: Lee & Mousseau chemically and manually treated *Vicia cracca*, *Crepis tectorum*, and *Melilotus albus* in the Riley Creek Standard Polygons 1-4.
- July 18-21: Lee & Mousseau chemically and manually treated *Vicia cracca*, *Crepis tectorum*, and *Melilotus albus* in the Riley Creek Standard Polygons 4-5, Park Road mile 1, and the 240.5 Old Campground standard polygon. Mahovlic took an inventory of *Taraxacum officinale* on the Park Road mile 50-92 and chemically treated *Vicia cracca*.
- July 24-26: Lee, Mousseau, & Mahovlic chemically and manually treated *Vicia cracca*, *Crepis tectorum*, and *Melilotus albus* along the Parks Highway mile 233-240.
- July 31- August 4: Lee, Mousseau, & Mahovlic chemically and manually treated *Vicia cracca*, *Crepis tectorum*, and *Melilotus albus* on the Parks Highway mile 232-235, Park Road mile 1 & 7, Airstrip, Park Headquarters, Post Office, Permanent Housing, and Creekside Cabins (Mile 224).

Kantishna Assessment

Because of COVID-related reduced work capacity in 2020 and the Denali Park Road closure in 2021, the DENA IPMT has not been able to monitor or treat invasive species on the west end of the park for three seasons. From July 17-20, Wendy Mahovlic assessed the state of untreated invasive species from Mile 52-92.5 on the Park Road. Mahovlic inventoried 83.84 acres of invasive infestations of *Taraxacum officinale* and chemically treated one location of *Vicia cracca* (at Fannie Quigley's cabin – Mile 91). To control the invasives past the road closure, we recommend that DENA IPMT allocate the resources to fly to Kantishna on a yearly basis.

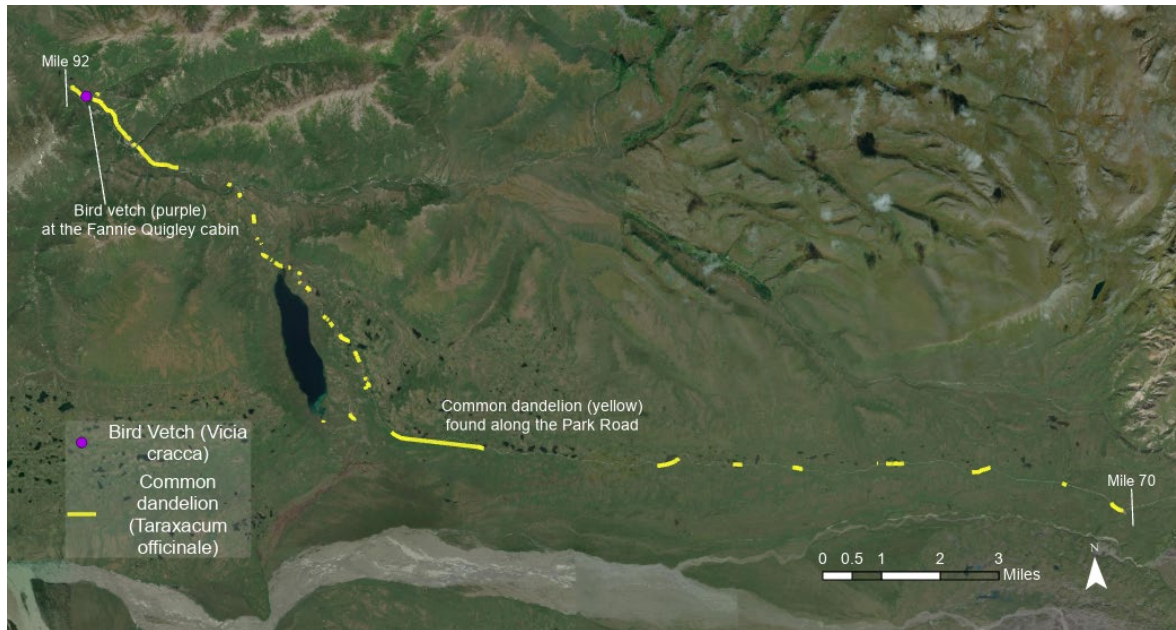


Figure 3. Infestations of *Taraxacum officinale* and *Vicia cracca* along Mile 70-92 of the Park Road.

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 230-232. DENA IPMT took an inventory of the 34.5 acres of infested area. Revegetation Technician, Wendy Mahovlic, estimated that the area would take around 160 hours of labor to remove the invasive plants through a combination of manual and chemical treatment. Additionally, an SCA Crew would need to be properly trained in herbicide use for one week. The total yearly estimated cost is \$26,900: \$20,000 for two weeks of an SCA Crew, \$6,400 for supervision, and \$500 for herbicide supplies. This process would need to be repeated over several summers for successful management of this area.



Recent construction site with *Crepis tectorum* on the George Parks Highway Mile 231. (NPS/WENDY MAHOVLIC)



Figure 4. Infestations of *Crepis tectorum* (Narrowleaf Hawksbeard) along Mile 230-232 on the George Parks Highway.

Revegetation

Revegetation is the process of restoring the ecological integrity of an environment after some disturbance has taken place. This can be done by reintroducing native plant species, which increases ecological resilience against invasive species infestations. It has been found that disturbed sites are particularly vulnerable to invasive species. These tenacious plants can outcompete native individuals, monopolizing sites before natives are able to revegetate. To minimize the risk of invasive encroachment, artificial revegetation is recommended.

DENA IPMT uses seed collection, seed sowing, willow cuttings, and tundra mats as methods for revegetating. For the purposes of this report, only methods utilized in the 2023 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*, require scarifying before sowing. DENA utilizes a sanding machine to mimic the natural process of scarification, i.e., the process of weathering seeds to allow nutrients and sunlight to pass through their seed coat. The Denali National Park Service 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 2023 field season is as follows:

- July 14: Lee & Mousseau collected *Arnica* seeds along the Parks Highway just past Otto Lake Road (Mile 243 Parks Hwy).
- July 17: Lee & Mousseau collected *Arnica* seeds at Sable Pass and *Lupine* seeds at the Mountain Vista rest stop.
- August 5: DENA IPMT coordinated a volunteer “Need for Seed” event with the Volunteer Coordinator, Kathleen Kelly, and volunteer, Ed Barns. Species collected: *Oxytropis campestris*, *Elymus sp.*, *Hedysarum alpinum*. Additional information on this event can be found in the Education and Outreach section.
- August 7-10, SCA Crew, Lee, Mahovlic, & Mousseau collected seeds at Parks Highway Mile 240.5 and Denali Park Road Mile 1. Species collected: *Oxytropis campestris*, *Hedysarum mackenzii*.
- August 14-15, 17: SCA Crew, Lee, Mahovlic, & Mousseau collected seeds along the Teklanika Riverbed at Denali Park Road Mile 31. Species collected: *Oxytropis campestris*, *Elymus sp.*, *Hedysarum alpinum*.
- August 18, SCA Crew, Lee, Mahovlic, & Mousseau revegetated an area of 0.13 acres at the Denali Park entrance along the George Parks Highway (Mile 237.25).
- August 21, SCA Crew collected seeds along the Teklanika Riverbed at Denali Park Road Mile 31. Species collected: *Oxytropis campestris*, *Elymus sp.*, *Hedysarum alpinum*.

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. First succession species—species that establish quickly and thrive in gravel locations—are targeted for collection.

DENA IPMT replenishes small, herbaceous perennials regularly; many of whom are from the family Fabaceae that has 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 should be targeted, while collection of species in the Asteraceae family is minimal because of its pappus. While good for wind-dispersal, the pappus makes seed cleaning and proper storage difficult.

Seasonal weather conditions effect 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 separated into paper bags based on species 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, labeled, and stored in the DENA Seed Bank freezers.

Surveying and Geospatial Data

The 2023 field season was the first year to use ESRI products to record GPS data, instead of the handheld Trimble Geo 7X GPS units. All projects conducted in the 2023 season were surveyed using ESRI Field Maps on a Samsung Tab Active 3 Tablet. Attributes of invasive infestation and restoration were recorded including location, disturbance type, action taken, chemical mix applied (if applicable), plant phenology (de-vegetation), personnel hours, and species.

Points to buffer, lines to buffer, and polygons are recorded on a downloaded base map. A point to buffer maps a circular area with its radius recorded as a buffer distance and should never be larger than three meters. A line to buffer maps a linear area with the buffer distance equal to half the total width. A polygon 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. Backup data was downloaded onto the AKRWANShare, and DENA Teams Drives. Data was then synced onto ArcGIS Online. Any GPS points or attributes were edited in the field with the Tab Active 3 or using ArcGIS Online.

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 volunteer, Ed Barns. 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 17 from 9 a.m. to 2 p.m. Manual removal of *Taraxacum officinale* occurred on the Denali Visitor Center campus, MSLC, along the adjacent park road, and the Riley Creek Day Use Area. Location coordinating, volunteer forms and vouchers, and snacks; as well as wildlife safety information was provided by Kelly. Lee & Mousseau 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, 34 volunteers participated from the surrounding community and 168 pounds of dandelions were dug up by hand.



Volunteers at the Dandelion Demolition event digging *Taraxacum officinale* at the MSLC. (NPS/ED BARNES)

Denali Discovery Camp

With the help of the Denali Education Team, the DENA IPMT led an invasive plant education program for the Denali summer camp. Around 30 students, ages 7-10 learned how to identify the invasive and native dandelions that inhabit Denali National Park. The students then removed *Taraxacum officinale* in RV Parking Lot 4. The event concluded with information about how to properly dispose of invasive plant matter and great admiration for the many dandelion flower crowns created.

Need for Seed

On August 5, a public seed collection event took place in Park Headquarters, the Rock Creek Bridge, Seasonal Housing, and the Riley Creek Day Use Area. Location coordinating, volunteer forms vouchers, and snacks; as well as wildlife safety information was provided by Kelly. Lee & Mousseau provided tools, training on general ecology, and native seed identification and collection techniques. In total, 39 volunteers participated from the surrounding community and collected 4.5 pounds of uncleaned seeds.



Volunteers at the Need for Seed event collecting native seeds at the Riley Creek Day Use Area. (NPS/KATHRYN LEE)

Results

In the 2023 field season, the DENA IPMT conducted manual and chemical removal within and around Denali National Park, revegetation at the Denali entrance, and seed collection around the entrance area, Mountain Vista Rest Stop (mile 12 Park Rd), Teklanika River (mile 30 Park Rd), and Sable Pass (mile 39 Park Rd). Volunteers worked on all our projects this season: invasive removal, revegetation projects, and seed collection. 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 During 2023 IPMT Season

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	1,080.75	170	1,712	2792.75	140.48 (0.002)	3.28 (0.001)	3.19 (0.001)
2022	3	1,583	79	316	1899	59.90 (1.68)	59.90 (1.68)	59.74 (1.68)
2023	3	1,575	107	915	2,490	456.9	41.724	40.584

^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.

^C This acreage includes the actual road surface of the Denali Park Road.

Invasive Plant Management

Chemical control was applied to populations of four invasive species found in DENA. *Vicia cracca*, *Melilotus albus*, and *Lupinus polyphyllus* were targeted for herbicide application, while *Crepis tectorum* was targeted for manual removal. *Taraxacum officinale*, the most numerous invasive species in the park, was targeted for both chemical and manual treatment. Dense populations of *Taraxacum officinale* were found along the Denali Park Road, particularly around the entrance; 29 gallons of chemical herbicide mix were applied, and 304 pounds of *Taraxacum* were manually removed. *Vicia cracca*, *Melilotus albus*, and *Crepis tectorum* were mainly found along the George Parks Highway. About 40 pounds of *Crepis tectorum* were manually removed; however, because of the time and labor-intensive removal process, our team was not able to pick all the *Crepis* along the George Parks Highway. Removal of *Crepis tectorum* will need to be prioritized in the future, especially in the new wayside construction area (Mile 230-232 George Parks Highway).



Revegetation Technician Wendy Mahovlic and Invasive Plant Intern Elizabeth Mousseau getting taken down by a large infestation of *Vicia cracca*. (NPS/KATHRYN LEE)

A breakdown of manual and chemical treatment in the DENA IPMT 2023 field season can be found in tables 3 and 4.

Table 3. Invasive Species Manually Treated

Invasive Species	Pounds Removed
<i>Taraxacum officinale</i>	304
<i>Crepis tectorum</i>	40
Total	344

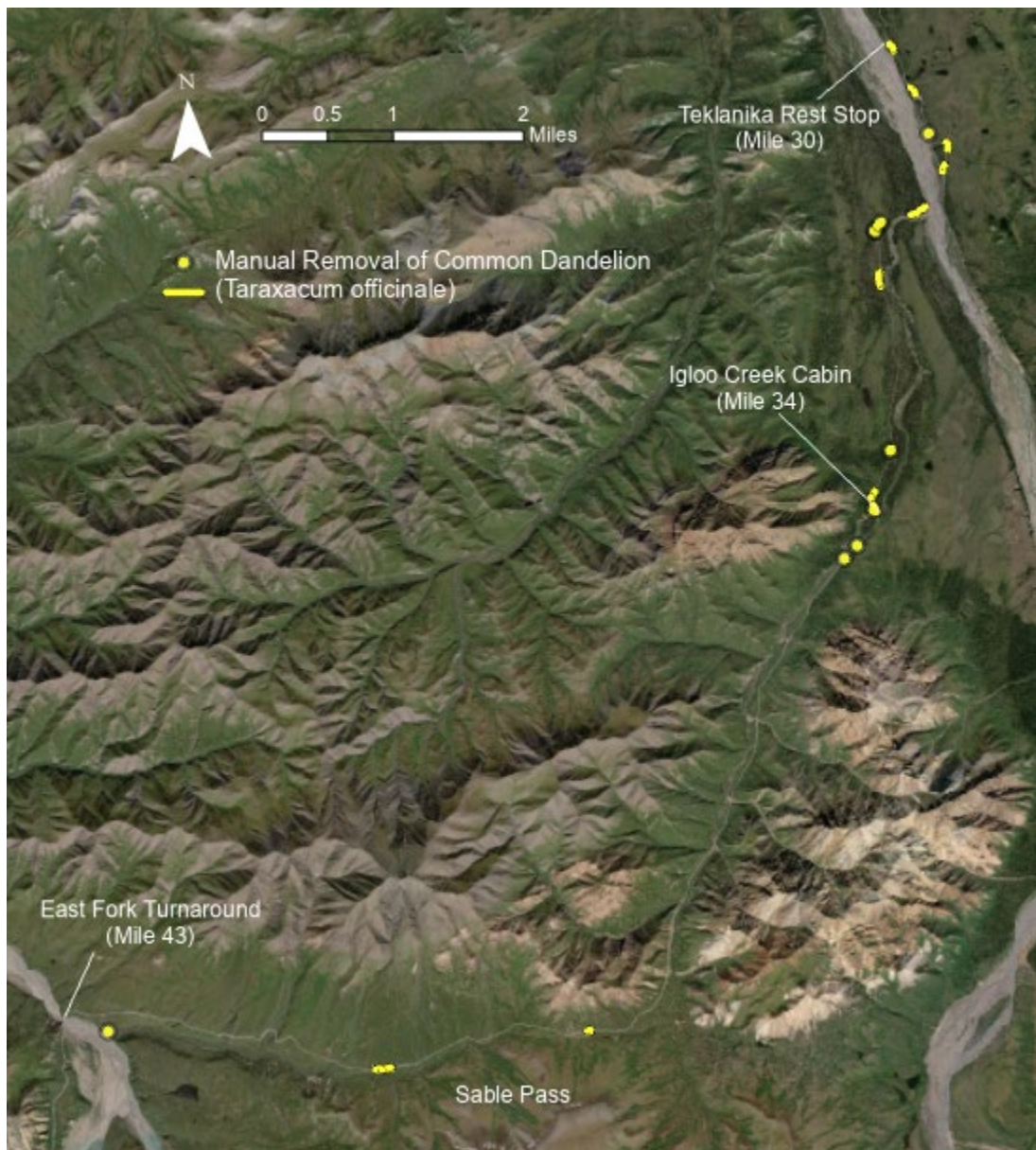


Figure 5. Manually removed infestations of *Taraxacum officinale* from Mile 30-43 on the Park Road.

Table 4. Invasive Species Chemically Treated

Invasive Species	Total Mix Applied (gallons)
<i>Taraxacum officinale</i>	29
<i>Melilotus albus</i>	23.5
<i>Vicia cracca</i>	8.75
<i>Lupinus polyphyllus</i>	1
Total	62.25

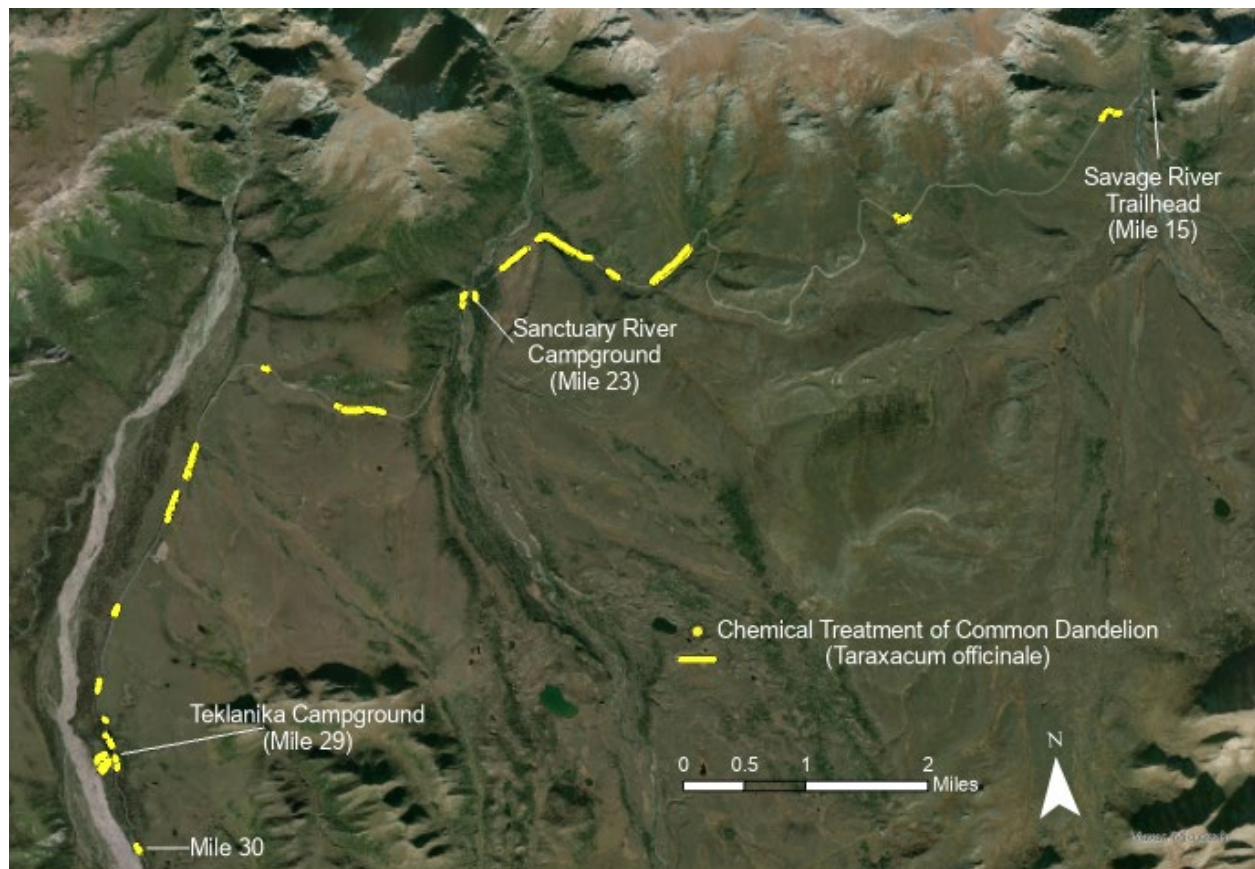


Figure 6. Areas where *Taraxacum officinale* were chemically treated from Mile 15-30 on the Park Road.



Figure 7. Chemically and manually treated invasive species from Mile 232-240 on the George Parks Highway. Areas with multiple species include *Vicia cracca*, *Melilotus albus*, and *Crepis tectorum*.

Native Seed Collection

DENA IPMT collected the seeds of nine native plant species in the 2023 field season. Notable collection sites included Parks Highway Mile 240, the Denali Entrance Area, Savage River, Teklanika River bar, and Sable Pass. In total 32.77 pounds of native seeds were collected, and 39.86 pounds of seeds were cleaned. An additional 7.09 pounds of seeds were cleaned from previous years. A breakdown of native species collected and cleaned can be found in table 5.

Table 5. Native Seeds Collected and Cleaned

Native Species	Pounds Collected ^A	Pounds Cleaned ^B
<i>Oxytropis campestris</i>	6.64	7.94
<i>Elymus sp.</i>	5.34	9.86
<i>Hedysarum alpinum</i>	13.4	13.4
<i>Lupinus arcticus</i>	0.21	0.21
<i>Poa alpina</i>	0.33	0.93
<i>Solidago multiradiata</i>	0.02	0
<i>Arnica sp.</i>	0.01	0
<i>Senecio vulgaris</i>	0.03	0
<i>Hedysarum mackenzii</i>	6.52	6.52
<i>Festuca altaica</i>	0	1
Total	32.77	39.86

^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.

Revegetation Project

DENA IPMT conducted one revegetation project in the 2023 field season. Our team spent 28 person hours revegetating approximately 0.13 acre. More information on the revegetation project can be found in table 6.

Table 6. DENA IPMT revegetation work in the 2023 field season.

Site	Date Planted	Seed Species	Pounds of Seeds Planted	Acres Revegetated	Person Hours
Mile 0	August 18	<i>Hedysarum alpinum</i> , <i>Hedysarum mackenzii</i> , <i>Oxytropis campestris</i> , <i>Elymus sp.</i> , <i>Poa alpina</i> , <i>Lupinus arcticus</i> , <i>Delphinium aconitum</i> , <i>Arnica sp.</i> , annual rye, fertilizer	2.62	0.13	28
Total					



SCA Crew mixing soil and planted seeds at the Denali Park Entrance revegetation site. (NPS/KATHRYN LEE)



Figure 8. Revegetation area at the Denali Park Entrance (Mile 237 George Parks Highway).

Conclusions

The 2023 Invasive Plant Management Team (IPMT) had a successful season of invasive plant management, native seed collection and revegetation. Throughout June and July 2023, Revegetation Technician, Wendy Mahovlic, with the help of SCA interns, crews, and volunteers manually removed 344 pounds of *Crepis tectorum* and *Taraxacum officinale*. The team chemically treated 40.6 acres and sprayed 62.25 gallons of herbicide within and around Denali National Park. Prolific concentrations of invasive species were seen along roadsides (increased encroachment into tundra areas), trails and transport areas. With the help of the volunteer and education departments, we educated 64 students and volunteers on invasive species identification and proper removal through the Dandelion Demolition Event and the Denali Discovery Camp activity.

Regarding untreated infestations, the IPMT took an inventory of the George Parks Highway construction site (Mile 230-232), and Wendy Mahovlic estimated the 34.5-acre area would cost \$26,900 for each summer of manual and chemical management. Mahovlic was also able to fly to Kantishna to monitor the untreated infestations of *Taraxacum officinale* from Mile 52-92.5 on the Park Road. Due to three years of inactivity, infestations of *Taraxacum officinale* and *Vicia cracca* had spread considerably. In future seasons, NPS personnel should continue monitoring established infestations, high visitation areas, and disturbed sites to create prevention strategies based on population dispersal trends.

Throughout August, the IPMT collected native seeds to replenish the DENA Native Seed Bank. With work starting on the Pretty Rocks Landslide bridge project, the team focused on collecting seeds within 20 miles of that construction zone. In total, 32.77 pounds of native seeds were collected, and 39.86 pounds were cleaned. At the Need for Seed event, 39 volunteers collected 4.5 pounds of uncleaned seeds and learned the importance of native plants for ecosystem health. The phenology of wildflowers this season was later than usual due to an abnormally cool spring and summer. April 2023 was the fourth coldest April on record (Central Alaska Network, 2023). Though wildflowers were very productive this year, the seeds were late to mature. Our team had difficulty finding ripe seeds when we started collecting in late July and early August. The IPMT used 2.64 pounds of native seeds to revegetate 0.13 acres at the Denali Park Entrance.

The species native to Alaska's interior are hardy and strong; they must be in order to survive in the subarctic climate. However, as more visitors want to explore DENA's beauty and wildness, investments going into infrastructure around the park have increased. These new routes for transportation, trails and now the Pretty Rocks Landslide project have created freshly disturbed areas where invasive species thrive. As long as there are construction projects in DENA, the IPMT will have an important role in protecting the integrity of DENA's native plant populations. Whether it be through chemical and manual invasive species management, or native seed collection and revegetation, the IPMT acts as the first line of defense against invasive species in DENA.

Concerns and Recommendations

Surveying and Geospatial Data Recommendations

In 2023, the Alaska IPMTs changed GPS systems from the handheld Trimble Geo 7X GPS Units to using the ESRI Field Maps app on a Samsung Tab Active 3 Tablet. Overall, our team preferred the new GPS system because of the ability to visualize data in the field and on ArcGIS Online. DENA IPMT chose to backup and sync the data at the end of each field workday because we minimized download time and easily stayed on top of data edits. By referencing the map on ArcGIS Online, our team was able to track progress and prioritize work accordingly. The DENA IPMT found the new system to be an improvement on the previous system.

Downloading Base Maps in Field Maps App

ESRI Field Maps has an option to download offline maps for data collection, which allows the user to see a base map even without cell service. Initially, the DENA IPMT downloaded one large, low-quality, offline Denali base map as a backup option for data collection. The map included the entire park boundary and highway areas where we worked throughout the summer. The team then downloaded several smaller and higher quality maps of specific sections around the park. However, our team found these higher quality maps to be unnecessary. Denali National Park has few man-made features other than the park road, and the low-quality map still allowed the user to spot all the important locations. To simplify data collection, downloading, and syncing, we recommend using one or two large, low-quality maps instead of downloading several high-quality maps.

Using the Leica GG04

Based on recommendations in training, the DENA IPMT acquired a Leica GG04 to help with GPS accuracy in the field. After running a few tests, our team decided the accuracy of the Tab Active 3 did not need to be improved upon. In our tests, the Leica improved accuracy by 3-6 feet. The Leica requires extra labor to set up and carry around in the field, which is not worth the minimal increase in accuracy.

Species Prioritization Using Standard Polygons

Standard polygons are locations with persistent infestations of invasive plants. We recommend that the DENA IPMT update the standard polygons to become locations with specifically *Vicia cracca*. This invasive plant can endure several years of treatment due to its reproduction through rhizomatous roots. Throughout the season, we found several of the standard polygons were superfluous because invasives had not returned after previous treatment. The standard polygons should be reviewed and updated yearly.

Community Workshop on Invasive Plants

From Mile 238-240 on the George Parks Highway, the hotels outside of the Denali Park Entrance have many infestations of invasives species on their properties. This land is important to manage because of its proximity to the park, and these locations could serve as hotspots for seed dispersal from tourist traffic. The DENA IPMT recommends holding a community workshop for the local hotel landscaping teams on invasive management. With community support, the IPMT could prevent future infestations stemming from these uncontrolled areas.

Recommended Study on Native Seed Success after Herbicide Use

Herbicide inevitably leads to some native plant death, usually to the species immediately surrounding the sprayed area. There is not much scientific literature on revegetation efforts after an area has been chemically treated in Alaska. How long does the herbicide affect the environment after treatment? Would replanting native species after treatment be an effective measure against further invasive infestations? Our team is curious to see data on native seed success after herbicide use specific to Alaskan environments.

Concerns over Future DOT Construction

The recent construction project on the George Parks Highway (mile 230-232) has had an extensive outbreak of *Crepis tectorum*. An infestation of this quantity is likely because the invasive seeds were contaminating either the gravel spread throughout the site or the revegetation seed mix. If the most effective management effort for invasive plants is preventing introduction, the DENA IPMT needs to work with the DOT to ensure that these infestations are limited as much as possible. Without more effort from the DOT, these construction site infestations could easily spread into the Denali Backcountry.

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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 April, 2023

National Park Service
U.S. Department of the Interior



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