



Invasive Plant Management and Revegetation Efforts in Denali National Park and Preserve

2018 Summary Report

Natural Resource Report NPS/DENA/NRR—2018/1792



**ON THIS PAGE**

A Student Conservation Association crew uses pulaskis to aerate the soil at a restoration site.

Photograph by Alyssa Schaefer

ON THE COVER

A young volunteer positions her dandelion digger over the soil at the Dandelion Demolition volunteer event.

NPS Photo / Mary Lewandowski

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Natural Resource Report NPS/DENA/NRR—2018/1792

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Abstract

The Denali National Park and Preserve Exotic Plant Management Team (DENA EPMT) is responsible for monitoring and controlling invasive plant species and restoring native habitats by collecting and planting native seeds. During the 2018 field season (May through September), two full-time EPMT staff used manual and chemical control methods to eradicate and limit the spread of seven species of invasive plants, collected 11 types of native seeds for use in revegetation projects, and gathered geospatial data of surveyed and treated sites using a Trimble GPS. With the help of 133 additional personnel including several short-term work crews and volunteers, throughout the season the EPMT was successful in removing 586 pounds of invasive vegetation and gathering 22 pounds of native seed to be used in future restoration efforts.

Acknowledgments

The authors would like to thank the following individuals and organizations for their assistance and support of our invasive plant management and restoration efforts in the 2018 season: Kathleen Kelly and the Denali volunteer department for their coordination and oversight of the Dandelion Demolition and Need for Seed events; Chris Overbaugh and Peter Frank for the outstanding orientation they provided in the beginning of the season and for their willingness to help throughout; the two Student Conservation Association Alaska Corps crews who dedicated three weeks of their time to dandelion demolition and seed collection; the nine volunteers from the New Community Project, for being friendly, helpful seed collectors; Monica, Bill, Nancy, Ginny, and Karen, who supported our seed collection efforts based out of Wonder Lake campground in August and were great company; the Youth Conservation Corps crew that spent the day removing dandelions with us; and all of the other volunteers who traveled far and wide to help us protect the diverse ecosystems of this park from invasive plants.

List of Terms and Acronyms

AKEPIC – Alaska Exotic Plants Information Clearinghouse

DENA – Denali National Park and Preserve

DVC – Denali Visitor Center

EPMT – Exotic Plant Management Team

GIS – Geographic Information System

GPS – Global Positioning System

MSLC – Murie Science and Learning Center

NPS – National Park Service

SCA – Student Conservation Association

YCC – Youth Conservation Corps

WWTP – Waste Water Treatment Plant

Introduction

Denali National Park and Preserve (DENA) is the third largest national park in the United States and consists of 6 million acres of dynamic, subarctic wilderness in interior Alaska. When the park was originally established in 1917, it encompassed only 1.6 million acres under a different name: Mount McKinley National Park. At that time, modes of transport for people to enter the park were limited to foot, horseback, and dog team in the winter season as no road, airport, or railroad existed (Bryant 2011). In 1980, with the passage of the Alaska National Interest Lands Conservation Act, the park was expanded to its current size and its name was changed to pay homage to the Alaskan Athabascan people's name for the 20,310-foot mountain that towers over the landscape: Denali. While some aspects of the park have changed over time, it remains one of only a handful of places in the world that is largely untouched by human influence.

Ecologically, DENA is heavily influenced by the presence of the Alaska Range, which runs southwest to northeast and divides the park into two major climatic zones. The park is home to several distinct ecosystems, including taiga forests, subalpine woodlands, alpine low-shrub tundra slopes, and steep peaks. Combined, these ecosystems are home to more than 1,500 species of vascular plants, mosses, and lichens, 39 species of mammals, and 169 species of birds.

Despite DENA's harsh climate and the relatively low levels of development within and surrounding the park, the natural ecosystems that exist within its boundaries are not precluded from the threat of invasive species—specifically, invasive plants. The establishment of invasive plant populations in DENA (and elsewhere) is concerning as ecologists and land managers now recognize invasive species as the second greatest threat to global biodiversity, superseded only by habitat destruction (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 (Flagstad, et al. 2017). Invasive plants often reproduce quickly and prolifically, outcompeting native plants for moisture and/or nutrients, ultimately bringing biodiversity rates down. Invasive plants have become established in DENA largely due to increased visitor traffic and construction. In the past two decades park visitation rates have nearly doubled from about 364,000 visitors in 2000 to just over 642,000 visitors in 2017 (NPS 2018).

In DENA, invasive plants primarily colonize along the sides of the park road, near campgrounds, trailheads, and in recently disturbed sites and areas of high visitor use. Thanks to its geographic isolation, invasive plant species are not nearly as prolific or dense in DENA as compared with other parks in the National Park system. Therefore, the DENA Exotic Plant Management Team (EPMT) is in a unique position with the capacity to rapidly detect new outbreaks of invasive plants and eliminate the invaders.

In addition to monitoring and controlling invasive plants with manual and chemical means, since 2004 the EPMT has been responsible for planting native seeds in previously disturbed areas, collecting native seeds for future plantings, and conducting public outreach on the importance of

invasive plant management. The purpose of this report is to summarize and discuss the methods, findings, and accomplishments of the DENA EPMT in the 2018 field season.

Methods

The DENA EPMT conducted field work from June 4 to September 6, 2018. The EPMT's full-time personnel consisted of Wendy Mahovlic, Revegetation Specialist, and Alyssa Schaefer, Student Conservation Association (SCA) intern. The team was also aided by Chris Overbaugh, Alaska EPMT Program Manager, and Peter Frank, EPMT Data Manager, both of whom provided training from May 21 to 25 in Anchorage and guidance throughout the season. Overbaugh also assisted with herbicide application from June 25 to 28. Additionally, the EPMT was assisted by several short-term work crews and volunteer groups, which are described in more detail below.

Field work was conducted in accordance with the 2018 Alaska Exotic Plant Management Team: 2018 Field Protocol (Overbaugh and Frank 2018a). The EPMT's field work involved the following general areas:

- Surveying the park and surrounding buffer areas for invasive plants;
- Controlling invasive plants using manual and chemical means;
- Collecting geospatial data using a GeoExplorer 2008 Series Trimble GPS;
- Collecting, cleaning, and planting native seeds as part of revegetation efforts.

The field season can be generally divided into two major project areas: monitoring and controlling invasive plants (May-July) and native seed collection and planting (July-September).

Invasive Plant Management

Work Prioritization

To prioritize field work, the EPMT used the guidelines established in the 2018 Field Protocol, combined with institutional knowledge gained from previous seasons.

Target Species and Phenology

Target species are prioritized based on the Alaska Exotic Plants Information Clearinghouse (AKEPIC), a database that tracks all non-native plants known to occur in Alaska and provides a plant ranking system in order to evaluate a plant's potential invasiveness and impacts of non-native plants to natural areas in Alaska (AKEPIC 2018).

In addition to considering a plant's invasiveness ranking according to AKEPIC, the EPMT also determines the timing of invasive plant control based on plant phenology. The EPMT started the season in June by targeting *Taraxacum officinale* (common dandelion) and *Descurainia sophia* (flixweed) due to their early development and flowering. Once these plants flower and go to seed, treatment is much less effective. In mid-July, the EPMT redirected its efforts to focus on other invasive plants including *Crepis tectorum* (narrowleaf hawksbeard), *Melilotus albus* (tall white sweetclover), and *Vicia cracca* (bird vetch). By early to mid-August, most plants had already gone to seed and the EPMT redirected its efforts towards native seed collection, cleaning, and propagation.

Site Location

Work site location was determined with highest priority given to recently disturbed areas (including recent construction sites or along the Park Road if there was a road widening project), newly restored sites (since invasive plants can more easily colonize in areas with minimal vegetation), and locations that could serve as vectors for spreading invasive plants to new locations in the park or elsewhere (such as parking lots, along roadsides, trails, campgrounds, maintenance areas, and gravel pits).

The George Parks Highway, which runs north to south along the eastern border of DENA, was also prioritized due to the fact that invasive plants growing along the highway can easily be dispersed into the park by vehicles, animals, people, and/or wind. Another major factor of site determination was proximity to Park Headquarters, where the EPMT office is located.

Size of Infestation and Personnel Availability

The size of invasive plant infestations is another factor that impacted work site determination this season, and went hand in hand with volunteer availability. Larger infestations were saved for volunteer groups or SCA crews since they would be unmanageable with only the two EPMT personnel. Without volunteer support, the DENA EPMT focused on keeping larger infestations contained and on treating smaller, more controllable infestations.

Control Methods

Manual Control

The DENA EPMT primarily used manual control methods to remove invasive plants in the 2018 field season. Manual control in DENA involves either hand pulling or using a dandelion digger, a stout, handheld tool with a forked end. Despite its name, the dandelion digger can effectively remove a variety of plants with larger root systems or taproots—not solely dandelions.

Hand pulling was reserved for plants with small root systems that stay close to the top of the soil, such as *Crepis tectorum*. Once plants are removed from the ground, they are placed in garbage bags and saved to be burned at the end of the season by the DENA Fire Crew.

Chemical Control

Chemical control is reserved for denser invasive plant infestations and plants with very weak stems, rhizomatous root systems, or other structures that make hand pulling or digging impractical, such as *Vicia cracca*. In 2018, the EPMT used two types of herbicide (Milestone and AquaMaster) and followed the protocols for herbicide application established in the 2018 Alaska Exotic Plant Management Team: 2018 Field Protocol (Overbaugh and Frank 2018a).



Revegetation Specialist Wendy Mahovlic sprays herbicide on invasive plants at the junction of the DENA Park Road and the George Parks Highway. Photograph by Alyssa Schaefer.

Major Project Areas

The EPMT focused on four major project areas in the 2018 field season: the Park Entrance (mile 0-3 of the Park Road), the East End (mile 4-53), the West End (mile 53-92), and the George Parks Highway north and south of DENA (mile 230-239 Parks Hwy). For a full list of areas where the team surveyed, monitored, and/or controlled invasive plants during the 2018 field season, see Table 1.

Three volunteer groups assisted the EPMT with invasive plant removal during the 2018 field season:

- June 4-14: SCA Crew (6 people)
- June 19, DENA Park Road Mile 17-19: YCC Crew (7 people)
- June 23, DVC campus and surrounding areas: Dandelion Demolition public event (43 people)

Table 1. Work sites and species targeted in the 2018 field season by the DENA EPMT.

Location	Work Sites	Invasive Plant Species
Entrance Area (mile 0-3)	Park Entrance and Parks Highway Intersection (DOT Bridge Project)	<i>Vicia cracca</i> , <i>Melilotus albus</i> , <i>Descurainia sophia</i> , <i>Crepis tectorum</i> , <i>Taraxacum officinale</i> , <i>Chenopodium album</i>
	Denali Visitor Center	<i>Taraxacum officinale</i>
	Aramark Dining Hall	<i>Crepis tectorum</i>
	Park Headquarters Historic District	<i>Taraxacum officinale</i> , <i>Descurainia sophia</i> , <i>Vicia cracca</i>
	Permanent Housing	<i>Taraxacum officinale</i> , <i>Vicia cracca</i>
	C-Camp	<i>Crepis tectorum</i> , <i>Taraxacum officinale</i> , <i>Hordeum jubatum</i>
	Bus Parking Lot	<i>Crepis tectorum</i> , <i>Hordeum jubatum</i>
	Bus Driver Parking Lot	<i>Taraxacum officinale</i>
	Maintenance Area (C-Camp)	<i>Crepis tectorum</i> , <i>Taraxacum officinale</i> , <i>Hordeum jubatum</i>
	Riley Creek Campground	<i>Taraxacum officinale</i>
	Riley Creek Day Use Area	<i>Taraxacum officinale</i>
	Rock Creek Bridge	<i>Taraxacum officinale</i> , <i>Descurainia sophia</i>
	Horseshoe Lake Trail	<i>Taraxacum officinale</i>
East End (mile 4-53)	Savage River Campground	<i>Taraxacum officinale</i>
	Savage Cabin Bus Parking Lot	<i>Taraxacum officinale</i>
	Toklat Artist's Cabin (mile 53)	<i>Taraxacum officinale</i>
	Mile 5	<i>Crepis tectorum</i>
	Mile 4	<i>Taraxacum officinale</i> , <i>Hordeum jubatum</i>
West End (mile 53-92)	Park Road Mile 70-92	<i>Taraxacum officinale</i>
George Parks Highway	WWTP Outflow Area	<i>Crepis tectorum</i>
	Mile 230-237	<i>Melilotus albus</i> , <i>Crepis tectorum</i>
	Mile 238 (Glitter Gulch)	<i>Melilotus albus</i>
	State Pull Out	<i>Melilotus albus</i>

Park Entrance Area (Mile 0-3)

The park entrance area, which is roughly defined as the first three miles of the Park Road, sees the most vehicle and foot traffic and includes many high-use areas such as the Denali Visitor Center, Denali Bus Depot, railroad station, several trailheads, Riley Creek campground and Mercantile, employee housing (C-Camp and the permanent housing area), Aramark employee dining hall, bus parking lot, Park Headquarters, and the Sled Dog Kennels. Due to its high visitation rate, this area was frequently monitored and surveyed for invasive plants throughout the 2018 field season.

DENA's most prolific invasive plant, *Taraxacum officinale*, is found in high densities in the park entrance area, primarily along roads, parking lots, buildings, and in new construction sites. Since it would involve a monumental amount of time and energy to fully eradicate dandelions from the entrance area, the EPMT focuses on keeping the infestations as small and contained as possible. Dandelions are ranked 58/100 on the invasiveness scale, which is lower than many of the other invasive plants found in DENA. It is also important to note that dandelions prefer alkaline soils rather than the acidic soils that permeate the forested backcountry areas of the park; therefore, surveying for this species in these areas is not a high priority.

To make the best use of limited time and resources, the DENA EPMT used the aforementioned protocols to prioritize where to remove dandelions. When volunteer groups or SCA crews were available, efforts were focused on areas with denser dandelion populations, including the Denali Visitor Center (DVC) campus, Murie Science and Learning Center (MSLC), Park Headquarters, permanent housing area, Rock Creek Bridge, and Rock Creek trail. An SCA crew also assisted with *Descurainia sophia* (flixweed) removal in the Park Headquarters area.

When volunteer help was not available, the DENA EPMT manually removed smaller populations of dandelions from the following sites in the entrance area: C-Camp parking lot (vector, vehicles could disperse seeds deeper into park), bus driver parking lot (vector), Riley Creek campground (vector), and Horseshoe Lake Trail (proximity to wilderness areas, vector).

Later in the season after most dandelions had gone to seed, the entrance area was surveyed for other invasive plant species that are ranked higher on the invasiveness scale, including *Crepis tectorum* and *Vicia cracca*. *Crepis tectorum* is a very small, thin, fast-growing plant that is difficult to see unless it is flowering. Therefore the EPMT conducted "Crepis sweeps" in which a known infested site was visited approximately every two weeks to remove newly flowering plants. Sweeps were conducted three times in the following areas: along the Park Road between the Mercantile road and Riley Creek sign, the CLA maintenance building, bus driver parking lot, and bus parking lot.

Another area targeted in the 2018 season was the intersection of the DENA Park Road and the George Parks Highway. In 2016, the highway was expanded and large swaths of land were reseeded by the Department of Transportation (DOT). The soil used in the project was transported from Fairbanks and unfortunately contained the seeds of several invasive plant species, including *Vicia cracca*, *Descurainia sophia*, *Melilotus albus*, *Taraxacum officinale*, and *Chenopodium album* (lambsquarters). The EPMT used herbicide to control the invasive plants found in this area after obtaining the required permits from the DOT.

East End (Mile 4-53)

The East End refers to approximately mile 4 to 53 of the DENA Park Road. Since private vehicles can travel the road up to mile 15, the area between mile 4 and 15 was monitored for invasive plants more frequently. Dandelions can be found along the road between mile 4 and 15 in varying densities. Along the Park Road at approximately mile 4-4.5, there is a large area on the north side of the road that was recently disturbed and restored with native seeds. However, it appears that for the most part

the native seeds did not germinate, and the area is now covered with dandelions and *Hordeum jubatum* (foxtail barley), another invasive plant.



Dandelions covering the soil along mile 4 of the DENA Park Road. Photograph by Alyssa Schaefer.

The EPMT visited mile 4 several times throughout the season. In the beginning of June, an SCA crew removed dandelions from the area and planted native seeds in the denuded soil. At the end of July, the EPMT revisited the site to find that new dandelions had sprouted up almost as thickly as they had been found in June before manual removal. Herbicide was sprayed on the dandelions to prevent the new plants from flowering and spreading more seeds. On August 2, a nine-person volunteer group removed 50 pounds of foxtail barley from the same area. Although foxtail barley's nativity status is currently being questioned, the plant was deemed a priority for removal because of its proximity to where the DENA sled dogs are walked. The seed heads can be deadly for dogs if ingested.



The SCA crew digging up dandelions along mile 4. Photograph by Alyssa Schaefer.

Aside from mile 4, invasive plants were found and manually removed at mile 5 (*Crepis tectorum*) and Savage River campground (*Taraxacum officinale*). On June 19, a Youth Conservation Corps (YCC) crew assisted us with dandelion de-vegetation between mile 17 and 19 near Primrose rest stop. On June 6, the SCA crew assisted with dandelion removal around Sanctuary Campground (mile 22 on the Park Road). Due to a snowstorm, we had to cancel plans to manually remove dandelions between mile 22 and Toklat Ranger Station (mile 53).

West End (mile 53-92)

The West End encompasses the rest of the DENA Park Road, from approximately mile 53 to 92. Invasive plants were removed from DENA's West End between June 11 and 14. The only invasive plant known to exist in this part of the park is the common dandelion. With assistance from the SCA crew, the EPMT removed dandelions along the Park Road between mile 70 and 92.

George Parks Highway

The EPMT conducted six surveys—on July 2, 3, 9, 11, 25, 30—for invasive plants south and north of the park entrance on the George Parks Highway between mile 238, the Nenana Canyon (the town known as “Glitter Gulch”) and mile 230, the town of McKinley Village. Chemical control was used in this area on larger infestations of *Melilotus albus* on June 27 and manual control (hand pulling) was implemented to remove isolated populations of *Melilotus albus* and *Crepis tectorum* on the aforementioned dates.

We also conducted three “*Crepis* sweeps” at the Waste Water Treatment Plant (WWTP) outflow area on both sides of the George Parks Highway just north of the DENA park entrance. A large

population of *Crepis tectorum* was found and subsequently removed from this area each time it was visited.

Data Collection and Management

The EPMT collected geospatial data (points, lines, and polygons) of invasive plant infestations that were treated and surveyed during the 2018 season. The data was collected with a handheld Trimble GeoExplorer 2008 Series GeoXT GPS unit. After the data was collected, it was corrected and edited using GPS Pathfinder Office software according to the Alaska Exotic Plant Management Team: 2018 Office Protocol (Overbaugh and Frank 2018b), then copied to a folder on a shared drive accessible by the EPMT data manager.

Native Seed Collection, Cleaning, and Propagation

Each year, the DENA EPMT collects native seeds to use in restoration projects. Park regulations require that native seeds are planted within 20 miles of where they are collected to maintain genetic diversity. Since construction projects can change or come up unexpectedly, the EPMT maintains a separate seed bank for each major section of the park and aims to add to it each year.

Seed Collection

The first step is to determine which seeds should be collected and when. The EPMT only collects the seeds of pioneer species. Over time, succession will naturally occur and these pioneer species will make way for shrubby plants such as willow and alder. Eventually, the forest will be restored to what it was before the disturbance occurred.

The EPMT carefully monitors the development of pioneer species throughout the summer so that seeds can be collected at the right time. Generally, seeds that are fully brown in color (as opposed to green) are ripe for collecting. For some species such as *Oxytropis campestris* (milkvetch), one can test the seeds for ripeness by moving the seed head back and forth. If the seeds are mature and ready to be collected, the shaking will result in a rattling sound.

When the seeds are deemed ready for collection, they are removed from the plant by hand or with scissors. For some species such as *Hedysarum alpinum* (Eskimo potato), seeds can be collected simply by “zipping” the seeds off from the stem by hand. Other seeds are harvested using scissors to cut off all of the seed pods still attached to the plant, such as *Elymus sp.* (wheatgrass). Seeds are then placed in brown paper bags and labelled with the date, location, and species name.



Brown paper bags filled with seeds collected during the Need for Seed volunteer event. (from left to right: *Oxytropis campestris*, *Poa alpina*, *Hedysarum alpinum*, and *Elymus sp.*). Photograph by Alyssa Schaefer.

Four volunteer groups assisted the DENA EPMT with seed collection and seed cleaning in the 2018 field season:

- August 2, Park Headquarters: New Community Project volunteer group (9 people)
- August 11, DENA Park Road Mile 0-3: Need for Seed East public event (60 people)
- August 13-18, DENA Park Road Mile 53-92: Need for Seed West private volunteer group (5 people)
- August 20-23, DENA Park Road Mile 0-53: SCA Crew (6 people)

Seed Cleaning



Seeds laying out to dry after Need for Seed East volunteer event. Photograph by Alyssa Schaefer.

After seeds are collected, they are laid out to dry on a mesh screen topped with muslin cloth and placed in a warm, dry place for at least one week. When dry, the seeds are either cleaned immediately or stored and cleaned at a later date. “Cleaning” refers to the removal of extraneous materials that were collected with the seeds (i.e. leaves, twigs, shells) and extracting the seed from its pod or seed head. The process varies depending on the plant species. Some seeds, such as *Hedysarum alpinum*, do not require any significant cleaning besides removing extraneous twigs and stems. Others, such as members of the grass family (*Poaceae*), require a more intensive cleaning.

For example, *Elymus* sp. seeds are collected by cutting the entire seed head off, with the spikelets still attached to the culm or stem. To clean wheatgrass seeds, we first place the seed heads into a paper bag, filling the bag until only about one-third full. Shake the bag vigorously back and forth, up and down, for about five minutes. The shaking should release the seeds from their glume. Then, we

pour the contents of the bag into a strainer with ¼-inch sized holes to allow the seeds to filter through. Some debris will likely make its way through the strainer anyway; it is then manually removed.

Once the seeds are separated from debris, they are placed in a plastic Ziploc bag, labelled with species name, date, and location, and put in a freezer until ready for use. Some seeds should be cleaned right before planting, and others can be cleaned and then stored in a freezer for several years until use.

Seed Planting

After seeds are collected, cleaned, and placed in the freezer for storage, the EPMT plants the seeds in recently disturbed areas. We used the same methods for seed planting in 2018 as established in the last year's summary report: "Exotic Plant Management and Revegetation of Disturbed Sites in Denali National Park and Preserve: Summary Report 2017" (Virnston and Mahovlic 2018).

Outreach and Education

Educating the public is a powerful tool in invasive plant management. If park visitors are made aware about the dangers that invasive species pose on natural ecosystems in DENA and are taught to identify some of the main culprits, it can be beneficial in two ways: 1) the knowledge turns the visiting public into citizen scientists with a sense of empowerment, giving the ordinary person a tangible way to make a difference, and 2) empowering individuals to notice invasive plants could help the DENA EPMT locate plants that they may have otherwise overlooked in the 6 million acre park.

In the 2018 season, the DENA EPMT held two large, public volunteer events in conjunction with the DENA volunteer office. While conducting fieldwork, the EPMT had to frequently stop working in order to answer questions from curious visitors. This allowed the EPMT the opportunity to give short talks on invasive plant identification and removal techniques.

Dandelion Demolition

The fifth annual Dandelion Demolition event took place on Saturday, June 23. The event was organized by the DENA volunteer office and led by SCA Intern Alyssa Schaefer. Forty-three community volunteers—including an entire Cub Scout troop—gathered to assist with dandelion removal in the Denali Visitor Center (DVC) campus, including the parking lot, pathways, and along the Park Road surrounding the area. Schaefer educated the group on how to identify native and non-native dandelions, how to remove the plant, and on invasive plant management in DENA in general.



SCA Intern Alyssa Schaefer demonstrates how to pull up a dandelion at the Dandelion Demolition volunteer event. NPS Photo / Mary Lewandowski



A young volunteer examines the dandelion he just removed from the ground at the Dandelion Demolition event. NPS Photo / Mary Lewandowski

In total, the group put in 150.5 hours of work and successfully removed 131 pounds of dandelions. Prizes were given out by the volunteer office for winners of longest root, biggest flower head, and most dandelions pulled. The event is a fun way to educate local people about invasive plants and inspire the younger generation to care about national parks and environmental conservation.

Need for Seed

On Saturday, August 11, sixty volunteers gathered to assist with native seed collection efforts in another public event hosted by the DENA volunteer department and led by Alyssa Schaefer. Volunteers met at the Denali Visitor Center parking lot for a discussion on the role of native seeds and restoration in the park, safety guidelines, and a demonstration of how to identify and collect seeds from several plant species. Then, the group divided into two. One group went to the Riley Creek Day Use Area, located at the very front of the park by the Riley Creek campground, and collected *Hedysarum alpinum* seeds. The other group travelled to the Park Headquarters area and collected the following seeds around the administrative buildings, the permanent housing complex, and along the sides of the Rock Creek Bridge: *Hedysarum alpinum*, *Elymus* sp., *Poa alpina*, *Oxytropis campestris*, and *Astragalus*. In total, volunteers put in 300 hours of work and collected 8.4 pounds of seed.



Volunteers collect *Poa alpina* in the Park Headquarters area. Photograph by Alyssa Schaefer.

Results

In the 2018 field season, the DENA EPMT manually removed or chemically treated seven invasive plant species. Of these seven, the most time was used to control the *Taraxacum officinale*, the most prolific invasive plant in the park. The EPMT also collected and/or cleaned the seeds of 11 native plant species for use in future revegetation projects. Additionally, the EPMT received volunteer assistance with invasive plant removal and seed collection from two major events and several other small groups in the 2018 field season. Total field hours for the EPMT and volunteer crews, acres surveyed, acres infested, and acres treated, as compared with previous years, can be found in table 2.

Table 2. Annual overview of field work conducted by the DENA EPMT from 2004 to 2018.

Year	EPMT 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 (0.08)	1.182 (0.03)	1.07 (0.007)

^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 Control

The EPMT spent the most time (353 person hours) on manual control of *Taraxacum officinale* (common dandelion), DENA's most prolific invasive plant. A total of 439 pounds of the plant was removed in the 2018 season. Since the dandelion is so widespread and has the ability to be carried deeper into the park by vehicles, feet, and buses, the EPMT spent the most time and effort manually

removing it. A full breakdown of DENA EPMT's manual removal work in the 2018 field season can be found in table 3.

Table 3. Species breakdown of estimated DENA EPMT manual removal work in the 2018 field season.

Invasive Species	Pounds Removed	Person Hours
<i>Taraxacum officinale</i>	439	353
<i>Hordeum jubatum</i>	50	9
<i>Melilotus albus</i>	44	16
<i>Crepis tectorum</i>	38	35
<i>Descurainia sophia</i>	15	11.5
Total	586	424.5

The EPMT used 28.65 gallons of herbicide solution (mix) to chemically treat invasive plants in the 2018 field season. The majority (21.19 gallons) was used to treat populations of *Taraxacum officinale* and *Vicia cracca*. The EPMT chose to spray populations of *T. officinale* that were very dense and would have taken an exceptional amount of time to manually remove. Since *Vicia cracca* cannot be fully eradicated by manual control, the EPMT only uses chemical means to control it. A breakdown of the total amount of mix applied by plant species can be found below in table 4.

Table 4. Species breakdown of DENA EPMT chemical treatments in the 2018 field season.

Invasive Species	Total Mix Applied (gallons)
<i>Taraxacum officinale</i>	10.81
<i>Vicia cracca</i>	10.38
<i>Descurainia sophia</i>	6.1
<i>Hordeum jubatum</i>	0.75
<i>Chenopodium album</i>	0.33
<i>Melilotus albus</i>	0.28
Total	28.65

Native Seed Collection

Of the 11 native plant seed species collected in the 2018 season, *Hedysarum alpinum* was the most collected seed with 6.93 lbs. collected. The plant is widespread in DENA, particularly alongside the Park Road within the first 15 miles. In total, the EPMT collected 22 lbs. of seed and cleaned 17 lbs. of seed. See table 5 for a full breakdown of all the plant species collected and cleaned in the 2018 season.

Table 5. Species breakdown of estimated DENA EPMT seed collection work in the 2018 field season.

Native Species	Pounds Collected ^A	Pounds Cleaned ^B
<i>Astragalus alpinus</i>	1.11	0.42
<i>Arnica alpina</i>	0.19	0.19
<i>Arnica lessingii</i>	0.06	0.06
<i>Carex sp.</i>	0.57	0.08
<i>Calamagrostis purpurescens</i>	0	0.07
<i>Elymus sp.</i>	6.23	5.72
<i>Hedysarum alpinum</i>	6.93	6.57
<i>Leymus innovatus</i>	1.97	1.97
<i>Oxytropis campestris</i>	2.52	0.78
<i>Pedicularis labradorica</i>	0.23	0
<i>Poa alpina</i>	2.13	1.06
<i>Sanguisorba menziesii</i>	0.1	0.08
Total	22.05	17

^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.

Restoration Projects

The EPMT worked on three smaller-scale restoration projects in the 2018 field season. Since there are several larger-scale projects on the horizon (C-Camp Leach Field, Ghiglione Bridge project, Mile 231 Wayside, Eielson Roof, and Toklat Utilities) that will require large quantities of native seeds, the EPMT spent more time collecting and cleaning seeds as opposed to planting.

Murie Science and Learning Center (MSLC) Septic Tank

On June 5, the EPMT and SCA crew of six people planted a native seed mix containing *Hedysarum alpinum*, *Oxytropis campestris*, *Poa alpina*, *Elymus sp.*, *Betula glandulosa*, and Annual rye in the septic area outside the MSLC at approximately mile 1 of the DENA Park Road. The soil was first tilled and aerated using a Pulaski, and then the seeds were mixed with sand and fertilizer and distributed evenly over the soil.

Mile 4 Previous Revegetation Site

On June 7, after the SCA crew removed a dense population of dandelions from along the DENA Park Road at mile 4, they planted a native seed mix with the same contents as the MSLC Septic Tank project. Since the area was just denuded of vegetation, the soil did not require any further aeration via Pulaski.

Willow Cuttings at Eldorado Creek

On June 13, the EPMT and SCA crew of six assisted Shannon Coykendall, Physical Science Technician, with restoration efforts (willow cuttings) at Eldorado Creek in Kantishna. The purpose of the project, which began in 2014 is to restore the creek to its original path, which was altered by miners in the 1970s.

First, suitable mature willow trees were selected from along the river bank and surrounding area. Using pruners, ten- to twelve-inch cuttings were made and placed in a bucket with a couple inches of water. Then, using a piece of rebar, the EPMT dug four- to five-inch holes into the sides of the dry river bed where the willows were to be planted. Two fertilizer tablets were placed near the bottom of the hole and the cuttings were placed in the hole, not touching the fertilizer. Finally, the newly planted willow cuttings were watered with fertilizer and water.

Situations of Concern and Recommendations

In the 2018 field season, the DENA EPMT had great success with removing and chemically treating invasive plants and collecting and cleaning native seeds. To improve the efficacy of the EPMT's field season next year and in the years to come, several suggestions for improvement are highlighted below, along with notes about particular situations of concern.

Bird Vetch (*Vicia cracca*)

Vicia cracca increased its presence in the park this year. This plant has a high ranking on the invasiveness scale (73/100) due to its rhizomatous roots (which means that it will not be vanquished by hand pulling) and its ability to spread quickly and suffocate native vegetation. Several populations of *Vicia cracca* were found in the permanent housing area (behind Park Headquarters) for the first time this season. The area was restored as part of the Utilidoor revegetation project in 2017 and the soil was transported from Fairbanks, where *Vicia cracca* is widespread. All plants found were treated with Milestone herbicide.

Three new populations of *Vicia* were also found along the Denali Park Road at approximately mile 19 (one population) and mile 1 (two populations). All infestations were treated with Milestone herbicide. In the future, the EPMT should continue to be vigilant in surveying for *Vicia* in the aforementioned areas and in general, particularly in the entrance area and East End of the park.

Riley Creek Bridge Project

The Riley Creek bridge project area refers to the land at the DENA park entrance at the intersection of the George Parks Highway and the Denali Park Road, which was reseeded in 2016 by the DOT when the road was widened. This year, the EPMT discovered that five invasive plants had become established in the area: *Vicia cracca*, *Descurainia sophia*, *Melilotus albus*, *Taraxacum officinale*, and *Chenopodium album*. All plants found were treated with herbicide in June. Later, in early August, the area was revisited by the EPMT and new *Vicia cracca* plants were found in the area, at a higher density than what was there in June.

The area should be monitored and treated more frequently than once per season to better control invasive plants that grow at different times.

Mile 4 Previous Revegetation Site

In the 2018 field season, we devoted a significant portion of time and volunteer energy to controlling a thick infestation of dandelions along the Park Road at approximately mile 4. Unfortunately, about one month after an SCA crew manually removed dandelions from a section of the heavily infested area, new dandelions began to grow, filling the section with the plants again by mid-July. Upon noticing the new plants, the EPMT applied herbicide on the dandelions which had not yet gone to seed. In future seasons, the EPMT should keep this lesson in mind and know it may be more effective to treat thick infestations of dandelions with herbicide first rather than expending time with manual digging. The area should be revisited next year to determine the efficacy of the herbicide treatment.

***Melilotus albus* along the George Parks Highway**

Several dense populations of *Melilotus albus* were found along the George Parks Highway during the 2018 field season. The populations were mapped with GPS and annotated with the note: “spray with herbicide next year.” Treating these plants should be a priority since the plant is highly invasive and puts out large quantities of seed (up to 350,000 seeds per plant).

Outreach to Backpackers

Look further into installing a boot brush station at the Denali Bus Depot with an interpretive sign, so that backcountry visitors are informed about the park’s plight with invasive plants and how they can personally get involved to help stop the spread of invasive seeds. This will help to decrease the chance of invasive seeds making it further along the park road and into the backcountry, and educate visitors on the importance of the EPMT’s work at the same time.

Dandelion Control

In future years, the EPMT should consider getting started with manual or chemical control of dense populations of dandelions earlier in the season, such as those outlined in Appendix A. Due to their intimidating size, inconvenient location, or time constraints, these areas were not included in the EPMT’s manual control schedule in 2018.

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Appendix A: List of Dandelion Infestations

Although this list is not exhaustive, it indicates some of the larger dandelion populations that exist in DENA. Hopefully future DENA EPMTs can use this information to determine schedules for manual and chemical control.

- South end of Triple Lakes Trail
- C-Camp edge by Shaffer Building parking lot
- Behind the Shaffer Building
- Mile .5 to mile .75 Park road: Post office road to Denali Bus Depot (south side especially)
- Mercantile parking lot
- Panabode across from IT
- Duplexes in permanent housing
- Front of apartment building in permanent housing
- Across from EDR/next to MSLC – next to reveg spot, around sewage holes
- Mile 4 previous revegetation site
- Rock Creek Trail under power lines
- Next to railroad crossing (across from Horseshoe Lake trailhead)
- Park road between HQ and mile 11 (between mile 6-7 (approx.) is not too bad)
- Mile 13 (approx.) – large pull-off with a sign that talks about “Mountain Building” – many dandelions here and then a little further east there is a wide, dry stream bed with lots of dandelions on the north side
- Savage Cabin parking lot
- Entrance to the museum (Resources building)
- Horseshoe Lake Trail past little bridge over beaver pond
- Mt. Healy Overlook Trail

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