Invasive Plant Management in Kenai Fjords National Park
Seward, Alaska
Summer 2006 Field Season Report

The most visible non-native plant in Kenai Fjords National Park, common dandelion (*Taraxacum officinale* ssp. *officinale*), grows along the Exit Glacier Road

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Introduction

History at KEFJ

2006 marks the third consecutive year of systematic inventory, monitoring and control of exotic plants in Kenai Fjords National Park (KEFJ). Data collected during the 2006 summer field season documented the continued spread of exotic plants and control efforts by park staff and volunteers. Since 2003, resource managers at KEFJ have manually controlled non-native plant populations in the Exit Glacier area. The most current proposed Exotic Vegetation Management Plan for KEFJ (Martin 2003) focuses only on the Exit Glacier area. Infestations have since been documented and controlled in coastal areas of the park as well. In 2004, the NPS Alaska Exotic Plant Management team (AKEPMT) partnered with KEFJ to document weed infestations and incorporate the data into a regional database, joining KEFJ to a larger network of exotic plant managers. Monitoring and collection is now conducted according to a regional data collection protocol (Appendix 1). One Biological Science Technician at KEFJ, partially funded by the AKEPMT, spent the 2006 summer field season monitoring documented infestation sites, mapping infestations, and coordinating manual control efforts in high-priority areas.

Significance of exotics in KEFJ

Non-native plants threaten natural ecosystems by competing with native flora for resources such as light, water, and soil. They also interfere with nutrient cycles and hydrologic regimes, and can alter natural plant succession (Martin 2003). Interference with natural plant succession is a major concern in the Exit Glacier area. Invasive plants establish easily in disturbed areas such as roadsides, mines, burned areas, and mechanically disturbed soil. The Exit Glacier continues to recede and leave naturally-disturbed soil in its place as an outwash plain. The outwash plain could provide an ideal environment for invasive plants to establish, creating competition for early-successional plant populations, such as the native fireweed (*Epilobium angustifolium*) and alder (*Alnus rubra*). They could also significantly alter the natural viewscape of the park. As recently as 2003 it was thought that the exotic plants were limited to the human travel corridors along the Exit Glacier Road, parking lot, and paved nature trail. However, several isolated dandelion infestations were found north of the road corridor and south of Exit Creek in naturally disturbed areas (see Figure 1). The vector for weed travel into these isolated areas is still undetermined. The infestation south of Exit Creek had not been visited since its discovery in 2003 and had grown substantially in plant numbers and extent.

We also made new discoveries of exotic plants in the coastal areas of the park this year. Dinglestadt and Yalik Glaciers host populations of dandelions (*Taraxacum officinale* ssp. *officinale*) around their terminal moraines. Oxeye daisy (*Leucanthemum vulgare*) and common Timothy (*Phleum pratense*) were discovered growing in Beauty Bay in 2005 and were found again in 2006.

Results from the 2006 summer field season reflect the status of species composition and distribution of exotic plants of Kenai Fjords National Park. These new findings and results of monitoring highlight the need to seek new methods of prevention and control.

Status of exotic species in the Park

In 2006 the EPMT identified fourteen exotic plant species growing within the park (see Table 1): pineapple weed (*Matricaria discoidea*), common dandelion (*Taraxacum offinale* ssp. *officinale*), white clover (*Trifolium repens*), yellow toadflax (*Linaria vulgaris*), common plantain (*Plantago major*), alsike clover (*Trifolium hybridum*), common sheep sorrel (*Rumex acetosella*), oxeye daisy (*Leucanthemum vulgare*), timothy grass (*Phleum pratense*), tall buttercup (*Ranunculus acris*), curly dock (*Rumex crispus*), fox-tail barley (*Hordeum jubatum*), and narrowleaf hawskbeard (*Crepis tectorum*). The Alaska region EPMT maintains the official reference list of exotic plants documented in KEFJ (see Table 1).

Four species of concern grow just outside the park boundary along the Exit Glacier Road. Black medic (*Medicago lupulina*) was planted by the Department of Transportation along the road corridor. Narrowleaf hawksbeard (*Crepis tectorum*), yellow sweetclover (*Melilotus officinalis*), and red clover (*Trifolium pratense*) grow around the Resurrection River trailhead, which borders KEFJ's road entrance to Exit Glacier.

Table 1. Exotic plant species observed in or around Kenai Fjords National Park (EPMT 2006)

Common Name	Taxon	Observed inside park?	Area	Observe in 2006?
field mustard	*Brassica rapa*	Y	Unknown	N
narrowleaf hawksbeard	*Crepis tectorum*	Y	EG Road	Y
quackgrass	*Elymus repens*	N	USFS- EG Road	N
foxtail barley	*Hordeum jubatum*	Y	Unknown	N
oxeye daisy	*Leucanthemum vulgare*	Y	EG Road	Y
yellow toadflax	*Linaria vulgaris*	Y	EG Road	Y
bigleaf lupine	*Lupinus polyphyllus*	N	Unknown	N
pineapple weed	*Matricaria discoidea*	Y	Exit Glacier	Y
black medic	*Medicago lupulina*	N	USFS- EG Road	N
yellow sweetclover	*Melilotus officinalis*	N	USFS- EG Road	N
timothy	*Phleum pratense*	Y	Exit Glacier	Y
plantain	*Plantago major*	Y	Exit Glacier	Y
tall buttercup	*Ranunculus acris*	Y	Nature Trail	Y
common sheep sorrel	*Rumex acetosella*	Y	Parking lot	Y
curled dock	*Rumex crispus*	Y	Cabins	Y
common dandelion	*Taraxacum officinale* ssp. *officinale*	Y	Parkwide	Y
alsike clover	*Trifolium hybridum*	Y	Exit Glacier	Y
red clover	*Trifolium pratense*	N	USFS- EG Road	N
white clover	*Trifolium repens*	Y	EG Road	Y

Methods and Materials

Monitoring and control in Kenai Fjords National Park is conducted according to the Alaska Exotic Plant Management Team Data Collection Protocol (Appendix 1). The 2006 field season lasted from May through August and was organized by a Biological Science Technician working

out of Seward, Alaska. A Youth Conservation Corps (YCC) member assisted in field work and volunteers were recruited to help with several control events.

Logistically, KEFJ is separated into two parts: the Exit Glacier area and coastal fjords area. Our control and monitoring efforts focused mainly on the Exit Glacier area, which contains the most extensive infestations.

The road-side, trail-side, and parking lot areas of Exit Glacier are the most easily-accessible areas in the park and serve as the main human use corridors. We were able to do monitoring and control work in those areas weekly. The "Nike Stripe", south side of Exit Creek, and the outer coast all required more extensive planning and equipment to access, so were visited once each.

We began by identifying documented infestations from previous years of data collection. Starting at these locations, we collected data using a Trimble GeoXT datalogger with TerraSync software. A data dictionary created by the regional AKEPMT provided the format and information fields for data collection (see Appendix 1). After collecting data for an infestation, we manually removed individual plants using digging tools when time allowed. The team recorded species, percent cover, and the number of individual plants pulled in isolated infestations such as the Nike Stripe area, the south side of Exit Creek and for less-common infestations such as yellow toadflax. Counting plant numbers at these sites is useful for documenting the effectiveness of our manual control efforts and for recording small changes in species extent and abundance.

Figure 1. Manual control of dandelions (*Taraxacum officinale* ssp. *officinale*) at the Nike Stripe.

Field data was differentially corrected using the most relevant base station (usually CORS, Kenai), then edited with GPS Pathfinder Office 3.1. Corrected files were transferred to the regional office to be added to the AKEPMT geodatabase of exotic plants in Alaska's National Parks. Regional AKEPMT staff created shape files for our use in map-making and data presentation.

We also patrolled sites that have potential for new or undiscovered infestations. We systematically walked through areas of the park that receive or received human use. We surveyed ten general areas in the park: Exit Glacier Road, Exit Glacier Parking Lot, Exit Glacier Campground, Employee cabins, the Nature trail, Harding Icefield Trail, Nike Strip, South side of Exit Creek, Maintenance yard, and road-accessible neighboring lands.

Coastal areas in the park were monitored occasionally as transportation and time allowed. We observed five high-use beaches in the Aialik Bay area over a two-day period in August; the Holgate and Aialik public use cabins, Bear Cove, Aialik Bay Ranger Station, and Abra Cove. Other resource management specialists and park rangers looked for exotic plants during their own coastal projects.

Results

Exit Glacier road

The Exit Glacier road corridor, parking lot, and trail system were the focus of surveys and control efforts because of their accessibility and potential for spreading exotic weed infestations. The first exotic plant to appear in the summer was the common dandelion (Table 2). Dandelion infestation along the Exit Glacier Road was too extensive to control or eradicate with manual control methods, given available personnel. It is likely that even with more personnel or volunteer groups, manual control alone will not be sufficient to remove dandelions from this section of the park. Most of the plants along the roadside went to seed before they could be removed. A team of Americorps volunteers made a generous effort for a week in May, but the plants were still sparse then due to a late snow pack. It appears that the efforts did not help reduce heavy growth of the plants later in the summer.

Figure 2. Americorps crew helping control dandelions along Exit Glacier Road in May.

The largest invasive plant infestation in KEFJ is the dandelion population along the Exit Glacier Road. Road corridor monitoring also revealed one oxeye daisy, which had been controlled the

previous year and was controlled again before flowering. Pineapple weed (*Matricaria discoidea*), white clover (*Trifolium repens*), and common plantain (*Plantago major*) were found extensively along the road corridor, but were not controlled for lack of time and staff.

Table 2. Phenology report of exotic plants in Kenai Fjords National Park, based on opportunistic field observations May-August (2006). This data was not collected in past years, but is now included in the AKEPMT Data Collection Protocol.

Taxon	Common Name	Date of First Flower	Date of Seed Set
Taraxacum officinale ssp. *officinale*	Common dandelion	May 26	June 20
Linaria vulgaris		July 5	August 8
	Narrowleaf hawksbeard	July 5	August 8
Leucanthemum vulgare	Oxeye daisy	July 3	August 1
Matricaria discoidea	Pineapple weed	June 13	June 30
Trifolium repens	White clover	May 30	July 20

Exit Glacier parking lot

Control efforts were focused on Exit Glacier parking lot populations to prevent their spread further west toward the Exit Glacier outwash plain. We mapped and removed common dandelion (*Taraxacum officinale* ssp. *officinale*), pineapple weed (*Matricaria discoidea*), common plantain (*Plantago major*), and common sheep sorrel (*Rumex acetosella*) from the parking lot area. There were a total of 368 individual sheep sorrel (*Rumex acetosella*) plants this year, but they were removed before going to seed.

Campground

Exit Glacier campsites remain free of invasive plants. Scattered individuals of common plantain (*Plantago major*) and common dandelion (*Tarxacum officinale*) were documented and completely controlled in the campground parking lot area.

Employee Cabin Area

Each of the three staff housing cabins in the Exit Glacier area have exotic plants growing around them. Willow cabin had a curly dock (*Rumex crispus*) plant growing along the front deck, which was documented and controlled in 2005 and again this year. Cottonwood cabin has a dandelion (*Taraxacum officinale* ssp. *officinale*) patch outside the back door and around the campfire area. Alder cabin had a dandelion infestation in June, followed by pineapple weed (*Matricaria discoidea*) in July around the front porch. All infestations were mapped and completely removed.

Nature Trail

Two new and unusual plants appeared along the paved nature trail in July, 2006. Interpretive rangers noticed two yellow columbine plants (*Aquilegia sp.*) growing along the south side of the nature trail in the alder understory. We sent photos and descriptions to the regional office for

identification. It was determined to be a non-native horticultural plant and was removed in September. The location will be monitored for future re-growth.

An Icelandic poppy (*Papaver nudicaule*) cultivar was found growing near the yellow columbine plant. It was also collected and sent to the regional office for positive identification. The discovery of yellow columbine and Icelandic poppies growing in proximity to each other prompted an informal investigation into possible seed sources. A suspected source of these seeds is a postcard-packet of "wildflower" seeds sold by the ANHA (Alaska Natural History Association) at the Exit Glacier Nature Center and by local vendors at gift stores in town. Seed packet sales at the Nature Center have been discontinued since the discovery.

A concentrated population of dandelions continues to re-grow on top of the 1917 Moraine along the un-paved nature trail section. 436 individuals were collected this year.

Seasonal BioTechs discovered a new infestation site along the unpaved nature trail section. Common dandelion and common plantain grow in a dry creekbed underneath a wooden footbridge. We manually treated the area in June and again in July.

Harding Icefield Trail

We controlled a large patch of common dandelion (*Taraxacum officinale* ssp. *officinale*) within the first half-mile of the Harding Icefield Trail. This patch was documented and manually controlled the last two years, but continues to grow back. We removed 276 individual plants in one concentrated area.

Nike Stripe

Two park service employees and one Youth Conservation Corps member spent four days in June controlling a dandelion infestation in the "Nike Stripe" area north of Exit Glacier Road. The site is approximately ½ mile from the paved road and was named because of its resemblance to the Nike® swoosh when displayed on an aerial map. 3,589 plants were removed, compared to 2,924 individuals in 2005.

South side Exit Creek

On July 19 we waded across the headwaters of Exit Creek, just below Exit Glacier, to monitor patches of dandelions that were discovered by a NPS Inventory and Monitoring crew in 2003 (see Figure 3). The infestation is now recorded in the EPMT geodatabase and was partially controlled. The plants had already gone to seed and a new population was sprouting. Earlier control (June) would be more effective, but the creek water is often too high to cross on foot.

We also monitored around USGS survey markers along the outwash plain and found no infestations.

Maintenance Yard

In May, an Americorps volunteer group spent four hours controlling common dandelion (*Taraxacum officinale* ssp. *officinale*) and common plantain (*Plantago major*) at the KEFJ maintenance yard. Phenologically, this control event was early in the season. Many plants sprouted later, but were not controlled because of time constraints. Park vehicles travel out of

the yard daily before driving to other parts of the park. This is a potential entrance point for new weeds to spread into the park. Yellow sweetclover (*Melilotus officinalis*) grows along the road to the maintenance yard and could be spread into the park by government vehicles.

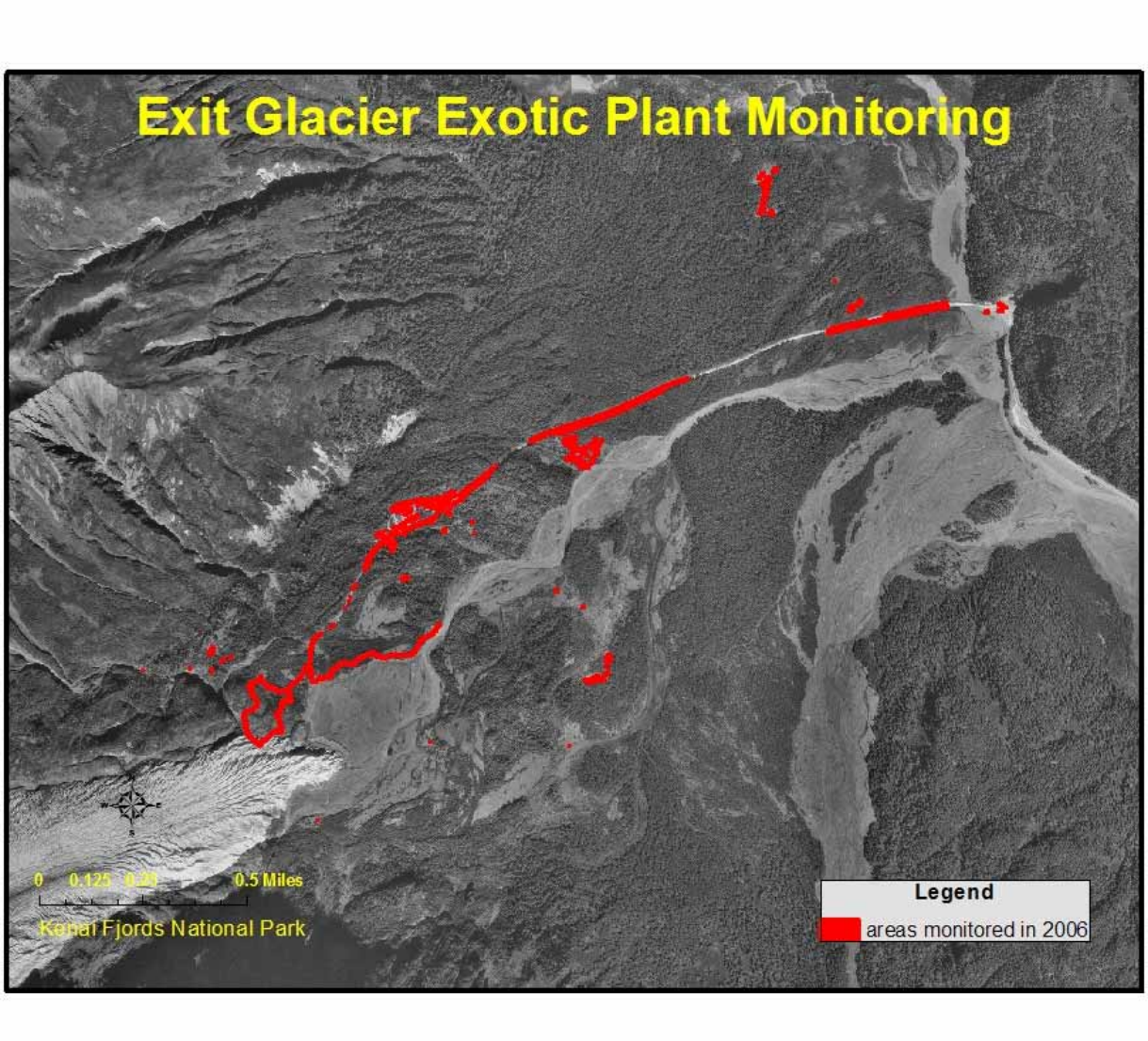

Figure 3. Exit Glacier areas mapped for exotic plant infestations in 2006.

Bordering lands

Oxeye daisy (*Leucanthemum vulgare*), narrowleaf hawksbeard (*Crepis tectorum*), yellow sweetclover (*Melilotus officinalis*) and black medic (*Medicago lupulina*) grow on neighboring US Forest Service property along the Exit Glacier Road, only a few miles away from the Exit Glacier area. The Resurrection River Trailhead parking lot borders the KEFJ park boundary and hosts the above species. We mapped and partially controlled the exotic plants there to help prevent their spread on to park land.

The Chugach National Forest's Seward Ranger District and Kenai Fjords National Park jointly-hosted a weed pull event on June 28 as part of Alaska's Statewide Weed Pull Day. Seven employees from Kenai Fjords National Park participated in the weed pull. A total of 18 people spent four hours controlling oxeye daisy (*Leucanthemum vulgare*), narrowleaf hawksbeard (*Crepis tectorum*), common dandelion (*Taraxacum officinale* ssp. *officinale*), and black medick (*Medicago lupulina*). The group pulled a total of 668 pounds of exotic plant material along Exit Glacier Road. We focused on the Resurrection River trailhead and Exit Glacier lookout point to help prevent the species from spreading into bordering park lands.

Figure 4. Volunteers at the 2006 Statewide Weed Pull Event, Chugach National Forest, Seward, AK.

Outer Coast

In 2005, Christina Kriedeman (KEFJ Biotech) surveyed most of the camping and kayak landing sites, public use cabins and the ranger station in Aialik Bay. She did not find any exotics. The same sites were surveyed again in August 2006 with the same results. Beaches in Northwestern Fjord have still not been surveyed or mapped for the geodatabase.

Elizabeth Bella, a USFS Plant Ecologist working on her PhD project, documented exotic plants in the Nuka Bay area in 2005 (see Table 3). None of these plants were controlled last year, so it was a priority to monitor and control these sites during the 2006 field season.

In August 2006, KEFJ park staff re-visited Bella's documented sites in Nuka Bay. They did not find the *Leucanthemum vulgare* at the John Kinney homesite at Palisades lagoon or along the old mine road. The team attempted to use Bella's 2005 GPS points to find the exact locations, but were using data points in an unknown datum (later discovered to be WGS84). The team did find a large population of native *Dendranthema arcticum*, which looks very similar to *Leucanthemum vulgare* and could have been easily mistaken for it last year since no specimens were collected for positive identification.

Table 3. Results from a 2005 exotic plant survey of Nuka Bay, Kenai Fjords National Park (Bella 2005).

Latitude	Longitude	Waypoint	Scientific Name	Date	Number	Size	Location
59.6275568	-150.3185239	079	None	7/26/2005	N/A	N/A	McCarty Fjord, East Arm Nuka Bay
59.6466228	-150.3083085	080	None	7/26/2005	N/A	N/A	Dinglestadt Glacier Beach
59.58184	-150.2895809	081	None	7/26/2005	N/A	N/A	Desire River area
59.5651521	-150.4018176	082	None	7/26/2005	N/A	N/A	James Lagoon
59.5434313	-150.3103595	083	None	7/26/2005	N/A	N/A	Delight Lake
59.5427202	-150.659993	084	None	7/27/2005	N/A	N/A	Beauty Bay landing site
59.5459114	-150.6615632	085	*Leucanthemum vulgare*	7/27/2005	85	20	Beauty Bay, old road to mine
59.5473536	-150.661102	086	None	7/27/2005	N/A	N/A	Beauty Bay, airstrip end
59.5474272	-150.6613536	087	*Phleum pratense*	7/27/2005	150	2	Beauty Bay, airstrip
59.5518671	-150.6717644	088	*Rorippa spp.*	7/27/2005	10	1	Beauty Bay, road to mine
59.5621742	-150.5209367	089	None	7/27/2005	N/A	N/A	North Arm Cabin
59.5275814	-150.4718255	090	*Leucanthemum vulgare*	7/28/2005	20	9	Beach landing area for John Kinney homesite
59.5361652	-150.4644753	091	None	7/29/2005	N/A	N/A	John Kinney homesite

The *Rorippa spp.* found by Bella in 2005 in Beauty Bay was found to be native and non-invasive.

Phleum pratense was found along the Beauty Bay airstrip again in 2006, as noted by Bella in 2005. Her exact location was not confirmed this year because of the datum confusion. The *Phleum pratense* was growing among the native *Phleum alpinum*, which made it difficult for park staff to identify and control. Three people spent 15 minutes pulling the plants. GPS data was not collected for this infestation.

Three new infestations were discovered in coastal areas of the park in 2006: Dinglestadt Glacier, the Alaska Hills Mine, and Yalik Glacier beach. A scouting team for a new Remote Automated Weather Station (RAWS) site discovered *Taraxacum officinale* ssp. *officinale* along the south side of Dinglestadt Glacier. Resource management staff revisited the site in August to control the plants and map the location. Three people spent 35 minutes controlling the infestation. The location is not included in the AKEPMT geodatabase, but a GPS point was taken using a Garmin GPSmap76CS (see Table 4).

Resource management staff found one non-native dandelion plant while on a hike to the Alaska Hills Mine. The GPS coordinate was lost, but its location is noted as "located just before reaching the old mine ruins at the creek's edge just below the waterfall that drains into the creek" (Kriedeman 2006).

The same staff discovered a large patch of *Taraxacum officinale* ssp. *officinale* at Yalik Glacier beach, just above high tide line (see Table 4). They did not control the plants because the site is located on state land, about ¼ mile away from the park boundary.

Table 4. New outer coast exotic infestations discovered and recorded in the 2006 field season at KEFJ (NAD83 datum).

Site	Latitude	Longitude	Species	In Park?	Controlled?
Dinglestadt Glacier	59.64641	-150.33353	*Taraxacum officinale* ssp. *officinale*	Y	Y
Dinglestadt Glacier	59.64747	-150.32436	*Taraxacum officinale* ssp. *officinale*	Y	Y
Yalik Glacier Beach	59.43315	-150.70264	*Taraxacum officinale* ssp. *officinale*	N	N

Collections

Three voucher specimens were collected following the 2006 AKEPMT data collection protocol (Appendix 3): *Phleum pratense, Phleum alpinum,* and *Papavar nudicaule* (Tables 5-7).

Table 5. Specimen collection data for *Phleum pretense*.

Collnum	HLW01
Park	KEFJ
Scientific Name	*Phleum pratense*
General Locality	Exit Glacier
Specific Locality	Along Exit Glacier Road and parkin glot
Lat (DD)	60.188613
Long (DD)	-149.630769
GPS/Map	GPS
Map Datum	NAD 83
Elev	500
Elev unit	ft
Habitat	Trail and roadside
Substrate	Gravel and glacial moraine
Exposure	N,E,S,W
Slope	Flat to gentle
Abundance	common
Assoc. spp.	Phleum alpinum
Collector(s)	Wetherbee, H.
Collection Date	7/8/2006
Determiner	Wetherbee, H.
Det Date	7/10/2006
Photo#	N/A
NPS Accession #	KEFJ-00202
NPS Catalog #	KEFJ-131 83
Notes	Similar in appearance to the non-native *Phleum pratense*

Table 6. Specimen collection data for *Phleum alpinum*

Collnum	HLW02
Park	KEFJ
Scientific Name	*Phleum alpinum*
General Locality	Exit Glacier
Specific Locality	Along nature trail, road and Harding Icefield Trail
Lat (DD)	60.188057
Long (DD)	-149.631738
GPS/Map	GPS
Map Datum	NAD 83
Elev	500
Elev unit	Ft.
Habitat	Trail and roadside
Substrate	Gravel and glacial moraine
Exposure	N,E,S,W
Slope	Flat to gentle
Abundance	Infrequent
Assoc. spp.	*Phleum pretense*
Collector(s)	Wetherbee, H.
Collection Date	7/9/2006
Determiner	Wetherbee, H.
Det Date	7/9/2006
Photo#	N/A
NPS Accession #	KEFJ-00202
NPS Catalog #	KEFJ 131 84
Notes	Similar in appearance to the native *Phleum alpinum*

Table 7. Specimen collection data for *Papaver nudicaule*

Collnum	HLW03
Park	KEFJ
Scientific Name	*Papaver nudicaule*
General Locality	Exit Glacier
Specific Locality	Left side of paved nature trail, approx. ¼ mile from parking lot
Lat (DD)	60.186608
Long (DD)	-149.634061
GPS/Map	Map
Map Datum	NAD83
Elev	500
Elev unit	Ft
Habitat	Trailside
Substrate	Hardened gravel fill import
Exposure	N
Slope	Flat
Abundance	Rare
Assoc. spp.	Unidentified yellow columbine plant
Collector(s)	Wetherbee, H.
Collection Date	7/21/06
Determiner	
Det Date	not yet determined
Photo#	N/A
NPS Accession #	KEFJ-00202
NPS Catalog #	KEFJ 131 85
Notes	Positive identification still being made by AK NHP

Education

We provided exotic plant awareness training for two trail crews working in the Exit Glacier area this summer. The SAGA crew and the SCA crew received instructions on their role in preventing the spread of exotic plants in the park. We included suggestions for minimizing new disturbances, avoiding travel through seeded areas, cleaning clothing, and the use of weed-free tools and construction material.

Discussion

Overall there were more individual plants found and controlled in 2006 than in previous years. The discovery of an extensive dandelion (*Taraxacum officinale* ssp. *officinale*) infestation south of Exit Creek and two dandelion patches in the Nuka Bay area significantly increased the number of known dandelion plants in the park. These plants were controlled early in the season at the Nike Stripe area and Exit Glacier Parking lot area, but had already gone to seed in the isolated area south of Exit Creek. It can be expected that there will be even more plants there next year to be removed.

Control effectiveness

The isolated nature of two common dandelion (*Taraxacum officinale* ssp. *officinale*) infestations provided the AKEPMT with a unique opportunity to analyze the effectiveness of manual control efforts, the only technique currently used at KEFJ. Bauder and Heys (2005) discuss the effectiveness of manual control on the eradication of dandelion infestations. They conclude that, although manual control is helping to reduce exotic plant numbers in the park, it is doubtful that this method alone will completely eradicate them. The report calls for a more integrated approach to weed management. Martin (2003) outlines other control options for exotics in the park. Updating and reviewing the 2003 Proposed Exotic Vegetation Management Plan for Exit Glacier as regional national plans are changed will keep KEFJ up-to-date on the latest control measures and will help direct future control efforts.

Volunteer groups, such as the Americorps crew, would serve the park better by coming later in the summer. Their arrival date of May 16 was too early to provide effective control of exotics. The ground was still frozen and covered with snow in many areas, making it difficult to remove the few dandelions that had started coming up. If removed too late in the season (after going to seed), dandelions are difficult to control and may be inadvertently dispersed by volunteers. Dandelion populations should be controlled by mid-June or before going to seed.

Coastal areas of Kenai Fjords National Park are relatively free of exotic plants. The small infestations at Dinglestadt Glacier and Yalik Glacier should be monitored and controlled next year to prevent their spread to other beaches in the area. The Nuka Bay exotic plant locations should be added to the geodatabase in the 2007 field season. Visitors access the park's coasts by boat and the majority of land-based use is limited to beaches in Aialik and Northwestern fjords. Park rangers that visit these areas regularly can watch for exotic plants and notify resource managers of any unusual species. A patrol by the exotic plant biologist is useful for documenting the absence of exotics for the regional geodatabase.

Recommended Plans for 2007

Suggested schedule

May- plan for the season and early control of common dandelion along Exit Glacier Rd. Contact volunteer groups. Coordinate with USFS for Statewide Weed Pull Day.

June- monitor and control dandelions at Nike Stripe, along Exit Glacier Road, Harding Icefield Trail, South side of Exit Creek and Exit Glacier parking lot

July- control pineapple weed, plantain, sheep sorrel and dandelions in Exit Glacier parking lot and along nature trail. Check on yellow toadflax along roadside. Control clover along roadside and curly dock and pineapple weed around employee cabins.

August- control Timothy grass in Exit Glacier parking lot, clover along Exit Glacier road, and exotics along the outer coast

September- data management, report writing, continue monitoring for late-growing exotics

Volunteers

Volunteer groups are useful in the control of exotics in the Exit Glacier area when put in the right location and given some basic instruction. Manual control of dandelions can be time-consuming and tedious for one person. May is a good month to contact groups interested in being involved in a weed control project. June and July, when plants are most visible and abundant, are the most appropriate times to have groups involved.

During the statewide weed control event, we were approached by an individual interested in involving her group in a weed control event in the future. Elizabeth Parker, a participant in the Alaska Great Lakes Project 2006, left us with contact information in order to organize a volunteer weed pull project, possibly next year.

Contact:
Dale Rasene, Project Director
Marshall Public Schools
100 East Green Street
Marshall, MI 49068
(269)781-4844
Ishtar@aglp.com

Outward Bound Wilderness conducts 7 to 50-day backcountry trips with adults and teens and often uses the Exit Glacier campground and Harding Icefield Trail. They have a long history of service projects with the park and often are looking for a half to full day of work for their groups. One group was scheduled to spent four hours helping with a weed control project in August, but cancelled last minute.

Contact:
Cathy Fornaris, Assistant Program Director
Outward Bound Wilderness
(907)224-7073
cfornaris@outwardboundwest.org

KEFJ's own volunteer coordinator, CJ Rea, connected us with several local individuals interested in volunteering for the park. She can also organize groups and provide contacts for large-scale volunteer efforts such as Statewide weed-pull day and National Public Lands Day. These two established service days are a great opportunity to gather volunteers for weed pulling and to provide outreach to the community.

Contact:
CJ Rea
Education Specialist and Volunteer Coordinator
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Data Files

Two network drives host KEFJ's exotic plant data: H:(resource management files) and W:(AKRWanShare). To access previous years' data, resources, and reports, navigate to: H:\Projects_Completed\Flora\KEFJ_2006_Exotic_Plants.
Region-wide park data is located at: W:\ARO\NaturalResources\EPMT\Park_Specific

Useful Resources and Contacts

Alaska Natural Heritage Program. USDA Forest Service. 2006. Weed Ranking Project. Available online at http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm

Freedman, D. Weeds can be alluring invaders. Anchorage Daily News. June 29, 2006. available online at http://www.anchorageparkfoundation.org/pdf/projects/ADN6.29.06Weeds.pdf

University of Alaska Fairbanks. College of Rural Alaska Cooperative Extension Service. Alaska Committee for Noxious and Invasive Plants Management. Available online at **http://www.cnipm.org/plants.html**.

University of Alaska Fairbanks. College of Rural Alaska Cooperative Extension Service. Wanted in Alaska: Invasive Weeds Awareness Week Identification Booklet.

USDA Forest Service. 2002. A Chance to Catch the Problem Early. Available online at **http://www.fs.fed.us/r10/spf/success/Noxious_Weed_Story_2002.pdf**

References

Bauder, P. and J. Heys. 2005 Invasive Plant Manual Control Analysis. Kenai Fjords National Park. National Park Service, Alaska Regional Office.

Bryden, W. 2002. Final Report: Exotics Inventory for Exit Glacier Study Area, Kenai Fjords National Park, Summer 2002.

Densmore, R.V., P.C. McKee, C.Roland. Exotic Plants in Alaskan National Park Units.

Kriedeman, C. 2005. Final Report: Exotic Plant Management Team 2005. Kenai Fjords National Park.

Kriedeman, C. 2004. Final Report: Exotic Plant Management Team 2004. Kenai Fjords National Park.

Martin, E.L. 2003. Exotic Vegetation Management Plan for Exit Glacier. Kenai Fjords National Park.

Rapp, W. Alaska Exotic Plant Management Team Data Collection Protocol for 2006.

Appendix 1.

Welcome to the Alaska Exotic Plant Management Team Data Collection Protocol for 2006!

Last Modified
Whitney Rapp 5/22/06

This document will guide you through the process of exotic plant management data collection using Trimble GPS units and a customized Data Dictionary. It is also intended to maintain high standards of quality in the data that we collect and consistency among observers. If you have any questions about what is written here, please do not hesitate to contact Jeff Heys (907-644-3451 or Jeff_Heys@nps.gov) or Whitney Rapp (907-697-2603 or Whitney_Rapp@nps.gov).

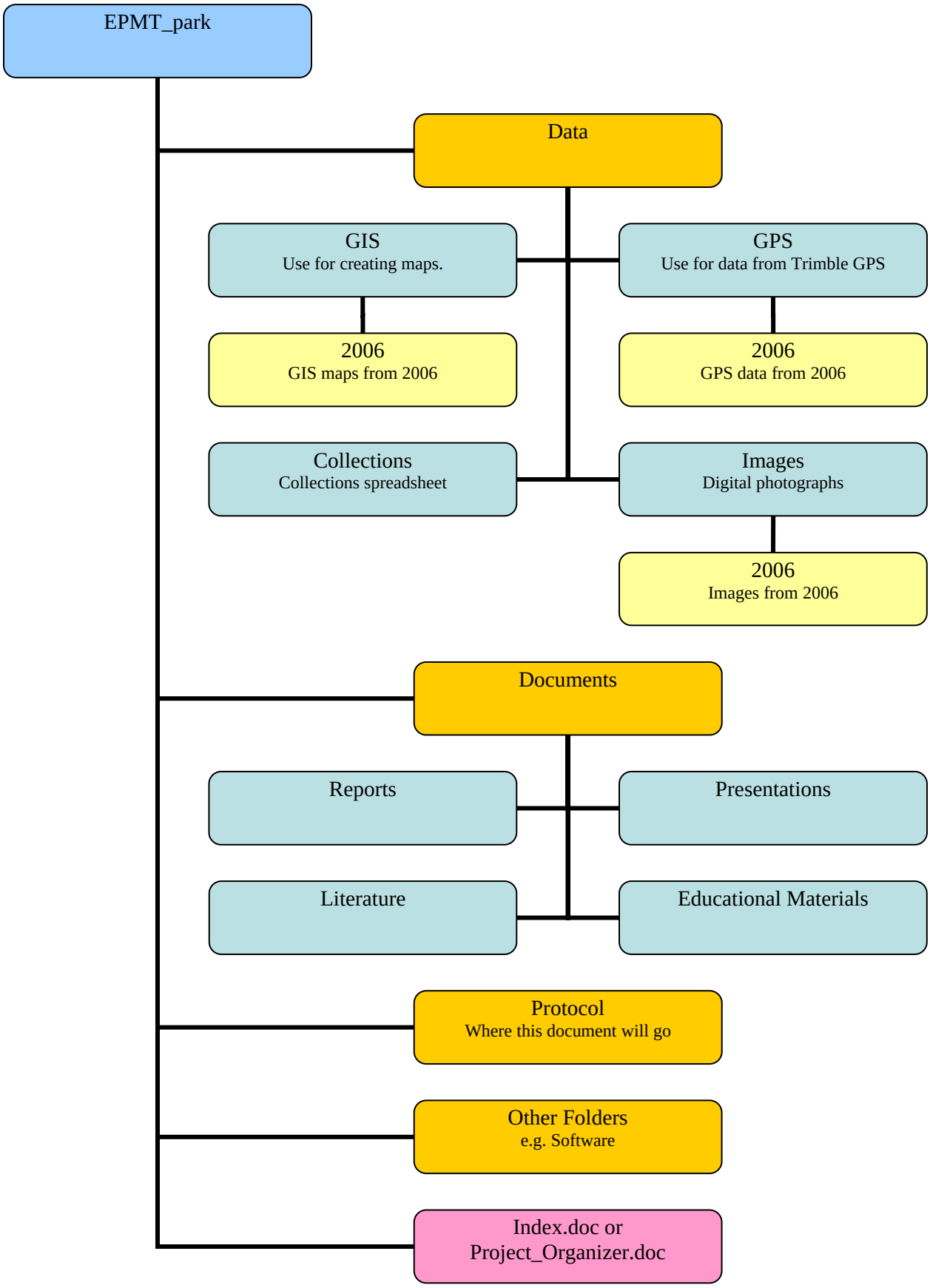
The protocol itself is a GPS-based method to map exotic plant infestations and uninfested areas and collect relevant information about them. The data will become part of a database that spans multiple years of data collection from across the Alaska Region of the NPS. It will also be incorporated into a statewide database that has been developed to track exotic plant distributions across jurisdictional boundaries.

General File Management

In an effort to organize data that works well for each team and future users of the files, a suggested file structure is described.

1. In collaboration with your supervisor or IT staff, identify the appropriate place to store your data at your park that is accessible by you, secure, and routinely backed up. This may be on your local machine (C:\) or on a network drive.
2. Create a folder (such as EPMT_(park code)) in this location that will contain ALL of your data, documents, etc. Within this folder, tiers of subfolders can be created.
3. The suggested file structure is diagramed below with each balloon representing a folder. This is definitely not exhaustive of the possibilities, but it is a framework to organize files, is adaptable for many years, and will be useful for others.
4. In the root folder, create an index document (index.doc or Project_Organizer.doc) in Word that directs people to the various files within the folders. Using hyperlinks will further facilitate others to find relevant information quickly.

***** All GPS data, photos, rover file status, and time record** should be edited and updated to the regional drive by the end of every pay period (every 2 weeks). This will ensure that the data is being processed correctly and timely on your part and that Jeff/Whitney can process it into the national databases and have the data available for use.


EPMT_park
Data
GIS
Use for creating maps.
GPS
Use for data from Trimble GPS
2006
GIS maps from 2006
2006
GPS data from 2006
Collections
Collections spreadsheet
Images
Digital photographs
2006
Images from 2006
Documents
Reports
Presentations
Literature
Educational Materials
Protocol
Where this document will go
Other Folders
e.g. Software
Index.doc or
Project_Organizer.doc

Trimble GPS Units

To begin with, this protocol does not provide instructions on the operation of Trimble GPS units. The Alaska EPMT teams will be using Trimble GeoXT receivers and Pathfinder Office 3.0 software. This piece of the protocol should be addressed through Trimble training provided by Joel Cusick (907-644-3549). The binder provided for the class should be thoroughly reviewed by those not participating in this year's training. In addition, many GPS solutions are posted on the regional GPS web page - http://inpakroms03web/rgr/gps/tips.htm.

GPS Data

With that, let's jump right into the data dictionary that lies at the heart of our data collection using the Trimble GPS.

***** All GPS data** should be edited and updated to the regional drive by the end of every pay period (every 2 weeks). This will ensure that the data is being processed correctly and timely on your part and that Jeff/Whitney can process it into the national databases and have the data available for use.

GPS Transfers

To have the GPS communicate with the computer, you must have Microsoft ActiveSync installed on the computer. The current version 4.1 is available online. Once ActiveSync is installed, the GPS cradle is connected to the computer, and the GPS (already on) is placed in the cradle, the GPS should connect to the computer. If you have problems, try restarting computer, reconnecting the GPS, and reconnecting the cradle. If you still have problems, try contacting one of us.

GPS Settings

Files must be initially transferred to the Trimble unit using the Data Transfer utility in Pathfinder Office. They are located in the GPS_Settings folder in 2006_OUTGOING_DATA.

Transfer the following 4 files to the GPS:

1. Configuration file (Summer_06_TerraSync.tcf) following the instructions in the associated word file. If you get an error on the GPS, you are likely not running the current version (2.53) of TerraSync. Please upgrade from http://www.trimble.com/terrasync_ts.asp?Nav=Collection-39289 using the Pocket PC 2003 option. You will need your TerraSync serial number to upgrade
2. Coordinate System Export file (AK_3-10.CSW) following the instructions in the associated word file.

3. Data Dictionary file (06_AKEPMT_master.ddf) after you have arranged the fields (see "Data Fields" section).
4. Data file (_06data_PARK.imp) of data from previous years. (Not completed 5/15/06)

Set time zone:

1. Go to the "Start" menu of the Trimble unit
2. Tap on "Settings"
3. On the "System" tab, tap on "Clock"
4. Verify that the time zone is set to "GMT-9 Alaska" and tap OK.

To standardize our Trimble units for data collection, we are using a configuration file that sets the most important GPS settings to predetermined values.

1. Open up TerraSync on the unit (tap F1)
2. Select "Setup" from the main menu.
3. Below the "Current Configuration:" box, tap on the box labeled "Change"
4. Select "Summer_06_TerraSync" from the menu and tap on "Load"
5. Tap on the "Logging Settings" box from the "Setup" screen.
6. By default, the antenna height is 4.921 ft. Click on the wrench icon and change the height to just below your own height. You should hold the GPS at this height to collect data.
7. Still in "Logging Settings," change the "Filename Prefix" (default 'R') to the first letter of your last name.
8. Still in "Logging Settings," change "Between Feature Logging" to Style "Time" and Interval "5s." This will maintain a track log for photo linking.

GPS Background Images

Having a background file display on your GPS or in PFO can be very helpful to navigate to a new location or verify that data is correctly recorded. To get a background image to display, you must create a jpg file in ArcGIS, transfer the file, and verify the coordinate systems of the GPS.

1. Make a map in ArcGIS. Some helpful information may include background photo, USGS topographic maps, NOAA charts, previous data, park boundaries, trails, etc.
2. Record what the map coordinate system is by double clicking on the "Layers" icon in the right navigation window. Look at the "Coordinate System" tab. The map should be in a projected coordinate system (like UTM). Be aware that regional data is being converted from NAD27 to NAD83 in 2006.
3. Once the data is arranged as you would like it and the screen has the map extent that you want (zoom in and out to export what is visible in the window), select "Export Map" from the "File" menu.
4. Experiment with different resolutions and qualities. Having a background image will slow down map drawing, so you need to balance between speed and image quality. The higher the resolution and quality, the slower the image will redraw. Since map drawing is affected by how large the map is, you may want to create several smaller maps for different study areas so the GPS has less to redraw at any one time.

5. Check the "Write World File" option and save the map.
6. Open PFO (testing the image in PFO will save you much anguish with the GPS)
7. Select "Coordinate System" in the "Options" window. Define the coordinate system to match the exported map. This is only changing how data is displayed, not how it is collected or saved. If the image was in NAD27, select "NADCON (Alaska)" for the datum NOT "NAD27 (Alaska)". For NAD83, select "NAD 1983 (Alaska)" for the datum. If these options aren't showing up, revisit updating PFO at the beginning of the GPS Data File Management section.
8. Make sure both units are in meters and hit "OK."
9. Load the background in PFO by selecting "Background" from the "File" menu. Click "Add" and navigate to the image.
10. Change the coordinate system to match the coordinates you just established for PFO.
11. Select "OK" and the image should load.
12. Verify the image is correctly positioned by opening a data file (.ssf or .cor) and verify that the features align with the image.
13. Connect your GPS to the computer.
14. Using PFO transfer the image to the GPS using the "Send" tab and "Add"ing a "Background."
15. On the GPS, go to "Setup" in TerraSync.
16. Change the "Coordinate System" to match those defined in PFO. If the correct datum is not appearing, revisit the "Coordinate System Export" updates in the GPS Settings section.
17. Go to "Map" and under "Layers" select "Background File." Choose the correct file.
18. Under "Layers", make sure the "Background" option is checked. Image should display and you won't get an error if all the coordinate systems were properly assigned.

Data Fields

You may use the Data Dictionary editor utility in Pathfinder Office to arrange the data collection format for your own convenience:

- Please **do not** remove or add attribute values or data fields.
- Note that any field you alter as described below must be altered in all three feature classes (Pnt2Buf, Line2Buf, and Poly).
    - An easy way to do this is by copying the data field you've altered (ctrl+c),
        - Pasting it into the other feature classes (ctrl+v),
            - And then deleting the duplicate unaltered field it replaces (Delete key).
- Arrange the order of attribute values using the up and down arrows so that the ones you use most commonly are at the top of each list.
    - Set the values that you use for most records as defaults.
        - Save the modified file with your initials (e.g., 06_AKEPMT_JAH.ddf).

Location_Name	This is the general area where the activity takes place, with several possible in each park unit. For a description of each area, please see the LocationID table below. Note that a

	single LocationID must either be inside or outside of the park boundary; please pay careful attention to this in choosing the appropriate one. You should certainly arrange these in the order of your most common usage.
Disturbance_Type	Because most of Alaska's exotic plants grow only on disturbed sites, we are tracking what disturbance types are being invaded by what species in NPS units. The options are listed in the Disturbance Type table below. The most frequently applicable type is fill importation, which includes roadsides and construction sites.
Site_Description	The location description is an opportunity for you to delineate in words the exact location, as well as any information about that location that might be important. The first provision should enable someone who looks at a table of your data to understand where within the LocationID the work took place without having to use GIS. Please take the time while editing to be complete and also try to be concise. The second provision should note if there is special significance in the location, such as remoteness, proximity to a stream or river, or potential to be easily spread into other areas.
Buffer_Distance_M	This is the buffer distance in meters that will be used to convert points and lines into polygons. If you imagine the shape you will be creating, the buffer distance should extend the point or line to the boundary of the infestation at its maximum distance from the center point or line. The buffer distance will therefore be half the width of a linear shape or the radius of a circle around a point. The GPS unit can also offset a line so that you may walk the edge of a linear infestation, offset the line to the middle of the infestation, and assign a buffer distance according to its width. The buffer for uninfested roads and trails should generally be 5 meters, measured from the centerline of a trail or the barren edge of a road.
Taxon	This is the dominant exotic plant species of a particular infestation. All species that have been reported from Alaska NPS units are on this list. If the species of concern does not appear on the list or you are uncertain of its identity, enter "Other" and note the species or uncertainty in the Remarks field. If the mapped area is free of exotic plants, enter "None".
Phenology	The phenology of the dominant exotic species is especially important for control timing and future planning. These are quite simple, with options of "rosette", "no_flower", "full_flower", "in_seed", and "stand_dead" (standing dead). Record the dominant phenology of the population at the time; however, in the remarks, you can clarify if the species has multiple phenologies. If there are no exotics present, enter "none".
%_Cover	The cover class percentage of the dominant exotic species is a critical measure of an infestation's density. Imagine yourself suspended directly above the polygon you are mapping, including the buffer applied to points and lines. The value you enter is the percentage of the entire area that is covered from this angle by the material of the exotic species, with options of 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, and 100. This is much easier to do with small areas than with large ones, so please start by practicing with small patches and be conservative with your estimates (i.e., underestimate rather than overestimate). Note that there is a correlation between this value and the buffer distance or size of a polygon: as the buffer distance increases for a particular group of plants, their percent cover of the total area decreases. Do not worry if most of the time the value entered is 1, for this is common with the small and disperse plant populations we are dealing with. It is more important to record the true extent of an infestation than to demonstrate that an infestation is relatively dense.
Stem_Count	This is a stem count of the dominant exotic species. Please only enter a value when you are certain that you can provide a relatively accurate count of individual plants. If the action is a control event, this is much easier to ensure, for each person involved can count the number of plants he or she controls. If the action is not a control event, please do not record a value over 100 unless you have carefully counted the plants. You will find during control that there are almost always more plants than you saw at first. If you don't count the plants, leave the field blank and do not enter 0. A zero should only be used if there are no plants.
Action	"Inventory" is the first documentation of a particular infestation, whereas "Monitor" is a follow-up visit to a previously inventoried site from this year or previous years. "Treatment" is the first control effort for a particular infestation and "Retreatment" applies

	to any subsequent control efforts in either the same or successive years. "Manual" involves pulling or digging. "Mechanical" involves actions like mowing, weed-whacking, chain-sawing, etc. "Chemical" involves the use of herbicides.
CntrlEffrt	For planning and evaluation, it is helpful to have a relative indicator of the control effort required for a particular infestation. This can be projected if the infestation is not controlled or actual if it is. To standardize, "low" refers to an infestation that could be manually controlled by one person in less than an hour. "Medium" infestations could be controlled by one person in less than an 8-hr. day. "High" infestations would require multiple people or multiple days to control.
Is_Exhaustive	If all the exotic plants encountered were recorded, enter "yes." If only a subset of species are recorded, enter "no." In general, you should record all species; however, if you are trying to map a particular species very accurately, you may want to use this option to ignore other species.
Comments	This is a free-for-all for you to convey anything that seems important about an infestation or uninfested area, such as: control might not work for a particular reason; species' identity is uncertain or not listed in the species list; components of the native plant community; potential for spread if left untreated; data collection is incomplete; where to look if hidden; invading undisturbed plant community; apparent source of infestation; similar native species in the same area; need for monitoring, etc. **Please use all lower case for consistency.**
Park_Unit	Associated park is the four-letter code for whatever park unit you're working in, which should be set as the default value.
Is_Inside_Park	If the area mapped is located on park land, enter "yes"; if it lies outside of the park boundary or on inholdings, enter "no".
Recorder_Name	These are the initials of the person using the Trimble unit. Set your initials as the default value.
Team_Name	If you are performing the activity in question alone or with help, enter "AKEPMT". If you are recording the accomplishment of volunteers, enter "Volunteer", or of other NPS personnel, enter "Other".
2Taxon, 3Taxon… 2Phenology, 3Phenology… 2%_Cover, 3%_Cover… 2StemCount, 3StemCount… 2Action, 3Action… 2Control_Effort, 3Control_Effort…	We have provided additional fields for 9 more exotic species other than the dominant species at a particular site. In general, we prefer that you record each species individually with its own shape rather than use these additional fields. This option is provided to save you time when there is a whole complement of species infesting the same area and you don't have time to map them individually. Remember that if the extents of each species are not the same, this option should not be used. For each additional species, you must also enter the phenology, percent cover, stem count, action, and control effort (see above) using additional fields provided.
StartDate, StartTime	Don't worry about these fields, because the unit creates them automatically for each feature recorded.

LocationID	Park	InPark	Location Description
serpentine_springs	BELA	yes	Serpentine Hot Springs and ATV trails radiating out from there
dmts_rd	CAKR	yes	road from Red Dog Mine to port
kakagrak_hills	CAKR	yes	abandoned military base and airstrip
kotzebue	CAKR	no	Kotzebue and surroundings

first_mile	DENA	yes	park road from the entrance to headquarters, including headquarters
kantishna	DENA	no	inholdings at the end of the park road
mckinley_village	DENA	no	development along Parks Highway outside the boundary
nenana_river	DENA	yes	banks of the Nenana River
park_rd	DENA	yes	park road between headquarters and Kantishna
parks_hwy	DENA	yes	Parks Highway along boundary
kuyuktuvuk	GAAR	yes	Kuyuktuvuk watershed and Oolah Pass
bartlett_cove	GLBA	yes	frontcountry Glacier Bay
beardslees	GLBA	yes	Beardslee Islands
dry_bay	GLBA	yes	Dry Bay and vicinity
east_arm	GLBA	yes	coastline of the East Arm of Glacier Bay
glacier_bay_other	GLBA	yes	areas within the park, but outside those otherwise described
gustavus	GLBA	no	Gustavus and surroundings
main_bay	GLBA	yes	the portion of Glacier Bay to the south of the two arms
west_arm	GLBA	yes	coastline of the West Arm of Glacier Bay
king_salmon	KATM	no	King Salmon and surroundings
lake_camp	KATM	yes	Lake Camp road and Pike's Ridge trail
brooks_camp	KATM	yes	Brooks Camp and surroundings
10000_smakes_rd	KATM	yes	road to the Valley of 10,000 Smokes
katm_outer_coast	KATM	yes	anywhere along the Katmai coastline
port_alsworth_town	LACL	no	the private lands of Port Alsworth
port_alsworth_nps	LACL	yes	parklands in Port Alsworth and surroundings
twin_lakes	LACL	yes	the Twin Lakes area
lacl_outer_coast	LACL	yes	anywhere along the Lake Clark coastline
exit_glacier	KEFJ	yes	Exit Glacier Road and associated development and trails
kefj_outer_coast	KEFJ	yes	anywhere along the Kenai Fjords coastline
seward	KEFJ	no	Seward and surroundings
chilkoot_trail	KLGO	yes	the Chilkoot Trail Unit
dyea	KLGO	yes	Dyea
skagway	KLGO	no	Skagway and surroundings
white_pass	KLGO	yes	the White Pass Unit
chitina	WRST	no	Chitina and surroundings
kennicott	WRST	yes	Kennicott (Town and Mine Site), Bonanza Ridge and Root Glacier Trails
may_creek	WRST	yes	NPS compound, airstrip, and surrounding roads and trails
mccarthy	WRST	no	McCarthy and surroundings
mccarthy_rd	WRST	yes	region from Copper River bridge to Kennicott River plus ATV trails
nabesna_rd	WRST	yes	Nabesna Road and ATV trails
remote_airstrip	WRST	yes	Peavine, Huberts, Tana, Jake's, C-N confluence, Chisana so far

slana	WRST	no	area outside of the park at the entrance to the Nabesna Road
viscenter	WRST	yes	headquarters and visitor center complex
coal_creek	YUCH	yes	Coal Creek watershed including road to Woodchopper Creek
sitka_nps	SITK	yes	Areas within SITK
sitka_outside_nps	SITK	no	Areas outside of SITK
other			Describe the location

Disturbance Type	Disturbance Description
ABDHOME	Abandoned Homesite
ANIMAL	Animal Related Disturbed Site
BRSHCUT	Mechanical Brush/Tree Cutting
COASTAL	Coastal/Beach
FLIMPRT	Fill Importation (e.g. Road or Railroad)
GLACIER	Glaciation
GRAZING	Grazing
HRBCIDE	Herbicide Application
LOGGING	Logging
MATEXTR	Material Extraction (e.g. Quarry)
MINING	Mining
MOWING	Mowing
ORVDST	ORV Disturbance
OTHER	Other Mechanical Substrate Alteration
PLOWING	Plowing
RIVER	River Action
SLIDE	Landslide/Avalanche
STREAM	Stream Action
THERMAL	Thermal Disturbance
TRMPLNG	Trampling
VOLCANO	Volcanic Action
WIND	Wind Disturbance/Erosion
WLDFIRE	Wildfire
WNDTHRW	Windthrow
NONE	No Disturbance

Collecting Data - Point, Line, or Polygons?

When you walk up to an infestation of exotic plants, the first question to ask yourself is: can this patch be best represented as a point, a line, or a polygon? Because all patches take up 2-dimensional space, they are all actually polygons. Using GPS units to map exact polygons takes a good deal of time, so we sometimes save time by mapping them as points or lines and using a certain “buffer distance” that the plants extend from the point or line.

In addition to mapping infestations, you should map areas where there are no exotic species to document that you looked and for future monitoring. This is critical baseline data – the absence of exotics is as valuable as the presence of exotics. Use the "none" or "0" option for the data fields to record the absence of exotic plants.

Points

- Use points on a very small patch of plants in a circular shape. Use a "buffer distance" around the radius of the circle to capture the size of the patch.

Lines

- Use a line to represent a long string of plants along a roadside, shoreline, or similar edge. Apply a "buffer distance" equal to half the width of the linear patch.

Polygons

- Actual polygons are best used to map large or irregular shapes that are not well-represented by points or lines. They can also be used to map infestations of particular concern, in order to provide sufficient precision to be able to document short-term changes in patch shape.

General Tips for Using the GPS

- While recording a feature, hold the unit head-high and away from your body, so that it can "see" more sky.
- The logging interval (how often the unit records a position within a feature) has been set in the data dictionary to one second for points and five seconds for lines. This is the desired interval; however, when satellite availability is marginal the 5 seconds may be too long to collect sufficient points. In this situation, temporarily change the logging interval to 1 second
    1. While in the Data view (because you're collecting a feature) tap "Options"
    2. Select "Logging Interval" and change the "Logging Interval" to "1s"
    3. When good satellite coverage resumes, readjust the interval to "5s"
- We recommend recording at least ten positions for points and enough positions for lines to delineate the shape (more around the corners and curves, less for straight lines).
- For the integrity of the data, it is a good idea to begin a new rover file every few hours rather than using the same one all day. Also, make sure each event is in a separate rover file.
- Remember that you can always press "Pause" to stop the recording of positions temporarily while the feature is still open.

- Stopping and resuming a feature. If you are mapping a large area with multiple common species (such as a long road) and suddenly stumble upon an unusual species, you should map the unusual species more accurately then lumping into the larger polygon. In this case, stop the existing feature, map the specific feature, then resume the original feature.
    1. In TerraSync, stop the current feature by clicking "OK."
    2. Map the new feature.
    3. To resume the original feature, in the menu where you usually pick the feature type, switch "Collect" to "Update Features."
    4. Select the feature you want to resume. It is probably the second closest distance, and you will be able to see the comment along the bottom of the screen.
    5. Click "Begin" followed by "Log."
    6. Select "Continue Feature (Append)" to continue adding points to the original feature.
    7. End the feature like normal.
    8. To collect a new feature, you will need to change "Update" back to "Collect."
- Turn on/off sounds when collecting positions
    1. On the Start Menu tap on "Settings"
    2. On the "Personal" tab, select "Sounds and Notifications"
    3. On the "Volume" tab, check "Programs" and "Notifications" and adjust the volume bar.
- Offset feature. In general, you should map the boundaries with buffer as exactly as possible; however, sometimes you will be unable to map an edge because of satellite coverage (e.g., under trees, next to a building) or physical barriers (e.g. river, fallen trees). In these cases, you can map a set distance from the target and set the offset and direction. The offset applies to the whole feature, so plan ahead!
    1. With the feature already open, select "Offset" from the "Options" menu.
    2. For a line or polygon, the direction is the direction the target is from you as you walk the segment. The horizontal distance is the distance that you are from the target edge.
    3. For a point, you have 5 options: Distance-Bearing, Distance-Distance, Triple Distance, Bearing-Bearing, Triple Bearing. See this QuickStart file for more information.

Monitoring

All control sites from previous years should be monitored and retreated this summer. The reason for this is that we are in the beginning stages of exotic plant management in Alaska's NPS units, and we need to know what is working and what is not. Beyond this, it is generally recommended for any exotic plant control that the site be monitored into the future, because there may still be a seedbank in the soil or plants may resprout. For control sites where there are exotic plants present upon return, control the site again and plan to return within a month or so to evaluate the effectiveness.

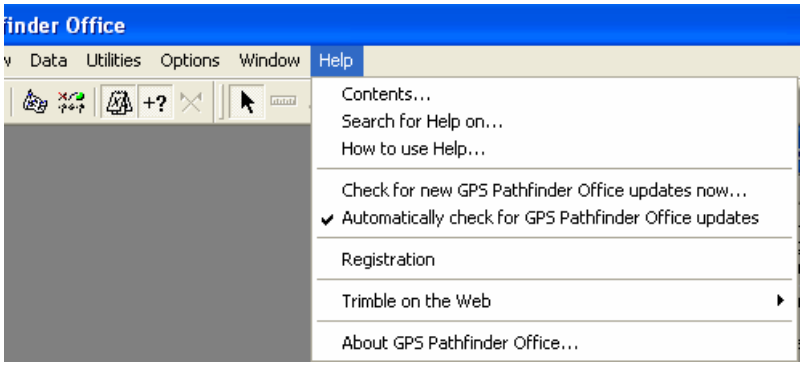
Navigating to Previously Recorded Polygons

Particularly when treating and monitoring previously documented sites, it is important to be able to relocate a site. Using the "Map" screen is generally much easier that using the "Navigation" screen.

MUST WRITE WHEN PARK DATA FILES READY

GPS Data File Management

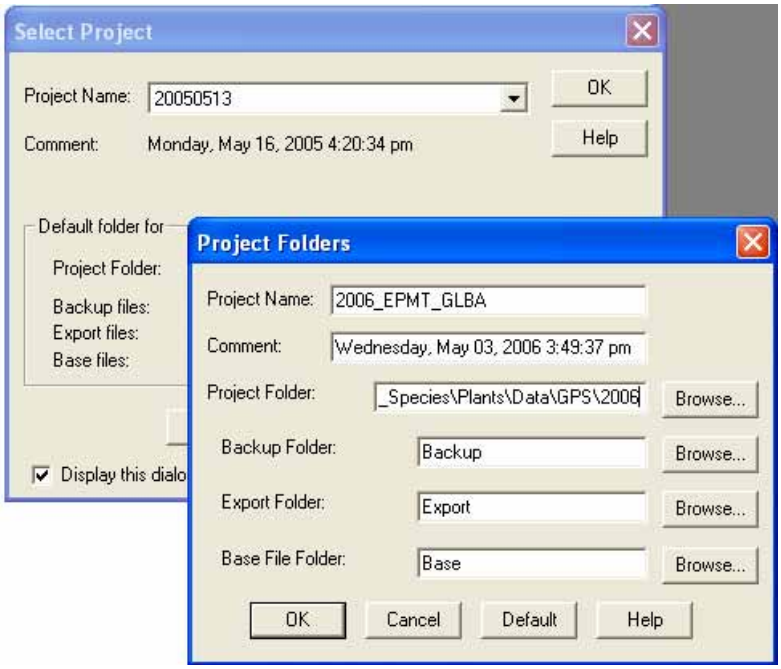
All GPS data that you collect this summer will be processed using Pathfinder Office (PFO) 3.00 software, Trimble's desktop data management software. At the beginning of the season, make sure the software is updated and that it will continually update by selecting the option in the help menu. Depending on your park's computer settings, you may not be able to automatically update software. Talk to your local IT staff for assistance.



Update PFO to have the current Alaska coordinates following the associated directions.

Selecting a Project

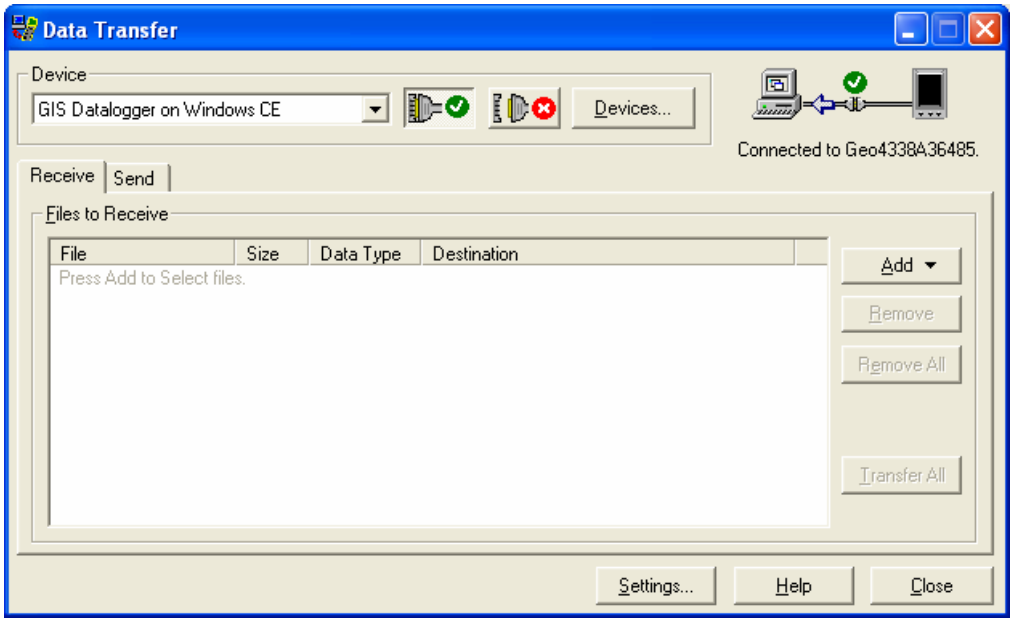
1. Open GPS Pathfinder Office 3.0.
2. The first time you download GPS files for the season, create a new project for your park by selecting "New"
3. Give the "Project Name" the title "2006_EPMT_(park code)" and browse to the …\Data\GPS\2006 folder for the "Project Folder."



4. Select “OK”
5. Click “Yes” when it asks, “Folder already exists Do you want to continue?”
6. Creating the new project creates 3 new folders within …\Data\GPS\2006 – Backup, Base, and Export.
7. Create one more folder (Final_Edits) within the project folder.
8. For the rest of the season, select the project name from the drop down menu that appears in the “Select Project” screen.

Transferring Rover Files

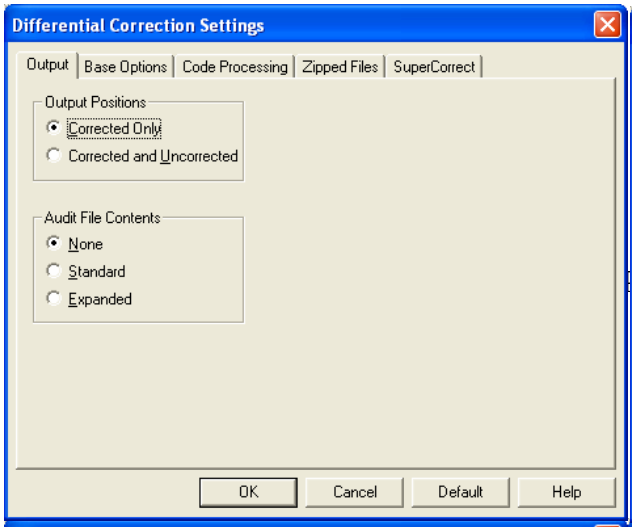
1. Transfer your rover files (.ssf) from the GPS unit to this folder as soon as possible after data collection.
2. In PFO, select “Utilities” > “Data Transfer”

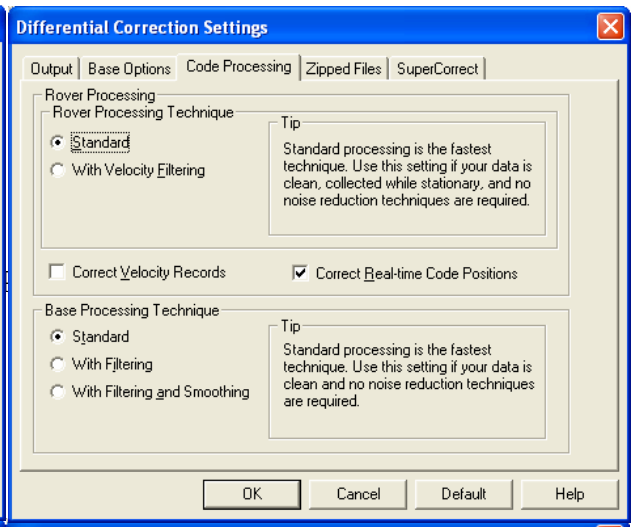


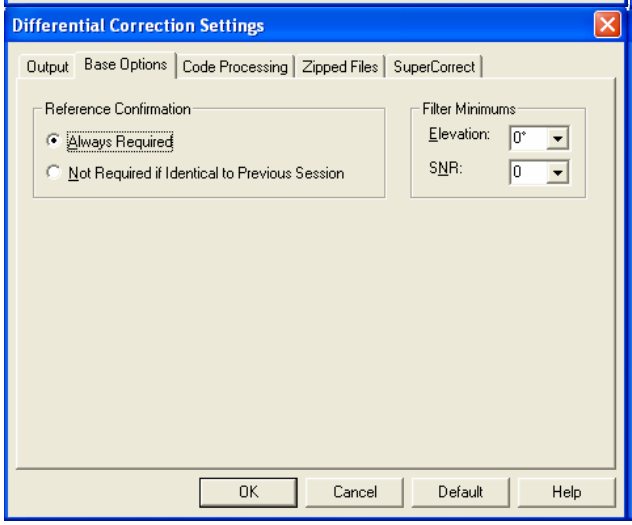
3. Make sure the device is “GIS Datalogger on Windows CE”
4. The GPS should connect (status in upper right) when you click the button with the green circle with check mark.
5. Click “Add” and “Data File”
6. Select all the files needing to be transferred.
7. Click “Transfer All.”
8. Back up your rover files immediately in the project Backup folder.

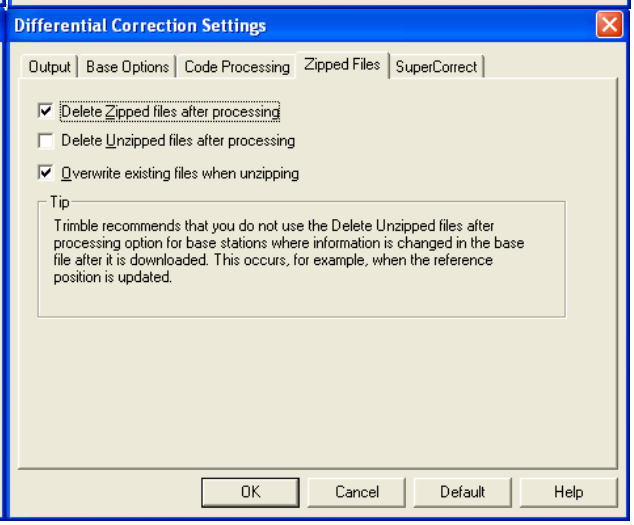
Differentially Correcting Rover Files

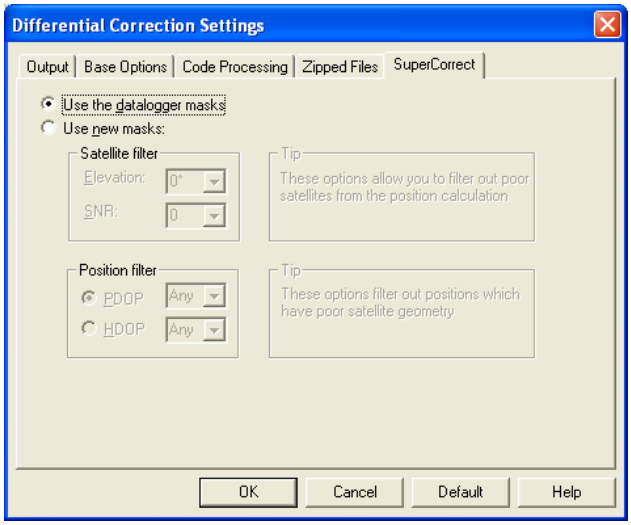
1. In PFO, select “Differential Correction” from “Utilities.”
2. Browse to the file(s) that need to be corrected. If you experience problems differentially correcting a file, process it by itself; however, you can generally do multiple files at the same time.
3. Get the most current base station information by hitting “Internet Search.”
4. Generally, you want to select the closest base station to where the data was collected. Sometimes, however, you may have to select a different base station.
5. Do not change any of the base station information or reference positions.
6. Verify that the “Settings” match the following screen captures.

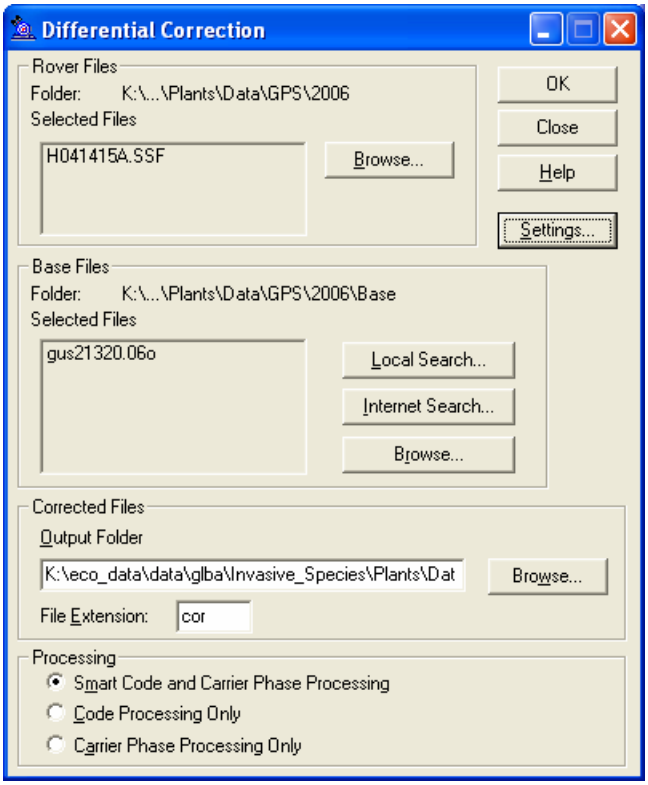

Differential Correction Settings
Output
Base Options
Code Processing
Zipped Files
SuperCorrect
Output Positions
Corrected Only
Corrected and Uncorrected
Audit File Contents
None
Standard
Expanded
OK
Cancel
Default
Help


Differential Correction Settings
Output
Base Options
Code Processing
Zipped Files
SuperCorrect
Rover Processing
Rover Processing Technique
Standard
With Velocity Filtering
Tip
Standard processing is the fastest technique. Use this setting if your data is clean, collected while stationary, and no noise reduction techniques are required.
Correct Velocity Records
Correct Real-time Code Positions
Base Processing Technique
Standard
With Filtering
With Filtering and Smoothing
Tip
Standard processing is the fastest technique. Use this setting if your data is clean and no noise reduction techniques are required.
OK
Cancel
Default
Help


Differential Correction Settings
Output
Base Options
Code Processing
Zipped Files
SuperCorrect
Reference Confirmation
Always Required
Not Required if Identical to Previous Session
Filter Minimums
Elevation:
0°
SNR:
0
OK
Cancel
Default
Help


Differential Correction Settings
Output
Base Options
Code Processing
Zipped Files
SuperCorrect
Delete Zipped files after processing
Delete Unzipped files after processing
Overwrite existing files when unzipping
Tip
Trimble recommends that you do not use the Delete Unzipped files after processing option for base stations where information is changed in the base file after it is downloaded. This occurs, for example, when the reference position is updated.
OK
Cancel
Default
Help


Differential Correction Settings
Output
Base Options
Code Processing
Zipped Files
SuperCorrect
Use the datalogger masks
Use new masks:
Satellite filter
Elevation:
0°
SNR:
0
Tip
These options allow you to filter out poor satellites from the position calculation
Position filter
PDOP
Any
HDOP
Any
Tip
These options filter out positions which have poor satellite geometry
OK
Cancel
Default
Help



9. Back up your .cor files immediately in the project Backup folder.

Editing Files

In order to ensure high data quality, please review and edit every rover file within a few days of the data collection.

1. Copy your corrected files from the project folder into the "Final_Edits" folder and add the prefix "edited_" to each file name. For example, R051015A.cor becomes edited_R051015A.cor. Copying and renaming the file before editing ensures that you do not overwrite the original corrected file when you begin editing.
2. Check the validity of positions, once differentially corrected, to make sure they match what you recorded in the field. Using a background image will help with this.
3. Click "Delete" in the Feature Properties window to see that the features positions are reasonable. The "Delete" does not delete your points but it gets rid of the feature grouping the points. Points should have all of their positions clustered together. Lines should have their positions aligned in a linear pattern. Polygons should have a linear boundary. You may need to delete whacky points (using the "Delete" in the "Position Properties" window), such as points more than a few meters from the center of a point or points that double back in a line or polygon. If a feature was recorded as the wrong type (e.g. line collected as point), follow this protocol for correcting. Document deletions in the rover log. Once the feature looks good, click "Undelete" in the "Feature Properties" window to regroup the positions.

4. Review the attributes attached to each features to check that the information is accurate and complete.
5. Elaborate on location descriptions or comments and eliminate any bad data. If you wrote in shorthand only understandable by you, now is the time to convert it to complete thoughts!
6. Please take the necessary time to make your data as finished as possible. These files will be transformed into GIS data at the end of the season for anyone to peruse.
7. In the project folder, maintain a status spreadsheet park_rover_file_status_2006.xls (save the spreadsheet locally with your park code as a prefix) to keep track of which files still need to be edited. List any issues, deletions, deviations from the protocol, or field notes you had for each rover file.
8. Copy the Final_Edits files into the project Backup folder.
9. Periodically burn a CD of the project folder and upload all rover files (.ssf, .cor, and edited.cor) and log to the \\Nps\akrdfs\WAN\ARO\NaturalResources\EPMT\2006_INCOMING_DATA folder at the end of every pay period.
10. Once you have finished editing a file, you are done with it until the end of the season.
11. Once all edited files are complete, let us know and we will transform them into GIS files to ensure consistency among park units and send them back to you for your reference in preparing the seasonal report.

Keeping Track of your Hours

All of our data must be entered into a nationwide database (APCAM – the Alien Plant Control and Monitoring database) that requires very specific information about the amount of time spent and people involved in every activity we perform, not only in the field but also in the office.

To ensure consistency between all the parks, Jeff and/or Whitney will be doing all the data entry in APCAM. Please realize that this is a major burden that you will not have to bear. In order for this to happen, however, we will require very specific information on the time you spend on individual activities on a daily basis from the moment you read this protocol until the last day you work for the EPMT in 2006. I know that this seems extreme, but there is no other way to satisfy the database requirements and minimize database angst.

1. Please copy the spreadsheet park_time_record_2006.xls to your local folder and change “park” to your park’s acronym.
2. At the end of each day, make a log of what happened.
3. All work time activities should be accounted for, including:
   - Preparation
   - Travel
   - Inventory
   - Control
   - Monitoring
   - Restoration
   - Education

- Data management
- Planning

4. If the activity is associated with a GPS rover file, record those file(s) in your time log.
5. Every time you open the file, it will update the sum of the total hours spent working in each category (tab "Sum of Hours by Category") and display a pie chart (tab "Chart of Hours by Category").
6. As with all important files, back this one up on a regular basis.

Here's an example of a hypothetical 2-day trip to Denali. The fields shaded gray are automatically calculated.

Day of Week	Date	Start Time	End Time	Category	Location	Activity description	Rover File Associated with Activity	Person 1	Person 2	Number of other people	Total People	Total People Hours
Wed	6/14/2006	7:00	8:00	Preparation	Office	Preparation for Parks Highway control event		JAH	PSB		2	2.00
Wed	6/14/2006	8:00	12:00	Travel	Travel	Travel from Anchorage to DENA		JAH	PSB		2	8.00
Wed	6/14/2006	12:30	13:30	Inventory	Parks Highway	Inventory of Several Melilotus infestations	H061412A.ssf	JAH	PSB		2	2.00
Wed	6/14/2006	13:30	14:00	Education	Parks Highway	Education and orientation for volunteer groups		JAH	PSB		2	1.00
Wed	6/14/2006	14:00	17:00	Control	Parks Highway	Melilotus control event w/ 6 volunteers from DENA	H061412A.ssf	JAH	PSB	6	8	24.00
Thur	6/15/2006	8:00	9:00	Outreach	DENA	Meeting with park staff		JAH			1	1.00
Thur	6/15/2006	8:00	10:00	Monitoring	DENA	Monitoring of 2004 control sites	H061514A.ssf	PSB			1	2.00
Thur	6/15/2006	9:00	10:00	Control	DENA	Vicia control with park staff	H061514A.ssf	JAH		3	4	4.00
Thur	6/15/2006	10:00	14:00	Travel	Travel	Travel from DENA to Anchorage		JAH	PSB		2	8.00
Thur	6/15/2006	14:00	17:00	Data Management	Office	Data management, upload/editing		JAH	PSB		2	6.00

Photo Management

***** All photo data** should be edited and updated to the regional drive by the end of every pay period (every 2 weeks). This will ensure that the data is being processed correctly and timely on your part and that Jeff/Whitney can process it into the national databases and have the data available for use.

Photos are an excellent tool for exotic plant management, not only to document infestations and sites for our own internal purposes, but also to convey to others what we're dealing with and what we have accomplished. Several excellent photo opportunities include:

- Before and after photos of infestations that are controlled

- Volunteer events – work in action
- New or uncertain species, range expansions, or particularly nasty infestations
- Close-ups of particular species to aid in identification
- Restored plant communities
- Educational events
- Yourselves and others working with exotic plants

That said, we can only use these photos later on if we keep them organized and collect relevant information about them.

Taking Photos

In 2006, we are going to maintain our existing protocol of taking a GPS "Photo_pt" feature, as well as turning on the track log to enable us to link photos with the software GPS-Photo Link.

- Set the camera's clock to be as close to the GPS clock as possible.
- Resolution should be as high as reasonable given memory constraints, with the optimal filesize (for a .jpg) being greater than 500 KB per photo.
- Before you take your first picture of the day, take a picture of your GPS screen showing the time with seconds. This is critical for the GPS-Photo link software.
- Start>Settings>System>Clock has this screen. Because the GPS screen is reflective, make sure this photo is legible.

- For photos of anything on the ground, please collect a "Photo_pt" feature using your Trimble unit at the spot where you are standing when taking the photo.
- Include with the feature enough information to enable anyone to determine what the photo should display.
- Keep track of the photo number or name and include this information in the Trimble unit under the "Photo_pt" feature.

Managing Photos

We recommend that you manage your photos – meaning upload, organize, and delete useless photos – at the same time that you're editing your spatial data in Pathfinder Office.

- Maintain subfolders by event, such as 20060613_Weed_Pull, that will help you and us locate a photo.
- Step through the "Photo_pt" features with an image browser window open at the same time and ensure that they are linked, i.e. the rover file of "Photo_pt" features have the image name in the comment field.
- Delete any photos that are unusable – blurry, too dark/light, etc.
- In each images "Properties," fill in the "Author" with the photographers initials, the "Subject" with description of the photo, and the "Comments" with a lat/lon and/or descriptive location.
- Always keep the original images. If you want to edit an image, resave it with another name, such as [original filename]_edited.
- At least initially, we will process the photos with GPS-Photo Link.
- At the end of every pay period, transfer all photos you have that are connected to "Photo_pts" or otherwise.

Voucher Specimens

What to Collect

In order to back up our observations of plants in the field, voucher specimens should be collected under certain circumstances:

- Any species previously unrecorded in a park unit must be collected.
- Any species that you cannot positively identify must be collected.
- Any species with a significant range expansion or found in remote areas should be collected, with priority given to species of greater concern.

In 2006, please make an effort to fully collect all specimens previously reported but not collected. Please refer to the table AK_EPMT_Master_Exotics.xls for a list of all the species reported for each park with a column for when the plant was collected. Data for collection years before 2005 were taken from the I&M database NPSpecies and may need verification with your park herbarium. Please let Whitney Rapp know of any changes needed to this spreadsheet.

How to Collect

A photo should be taken of the whole plant prior to collection, and a "Photo_pt" should be collected to document its location. All parts of the plant should be represented, including roots

and flowers or fruits, and should be preserved using a plant press or heavy books with newspaper. Each species should be dried within newspaper and labeled with the information below or a unique collection number (initials followed by a number – WSR01, WSR02) that relates back to the master table.

Please review the University of Alaska Museum's collection recommendations (http://www.uaf.edu/museum/herb/howtocoll.html).

Information about the specimen collected should be recorded in the spreadsheet (park ID)_Collections_2006.xls. It may not be feasible to record all fields, but an effort should be made to populate as many fields as possible. Fields in bold in the table below are required.

Collnum	Initials followed by number. e.g. WSR01
Park	Four letter park acronym. e.g. GLBA, DENA
Scientific Name	Best identification possible. AKNHP will verify all identifications and modify as necessary.
General Locality	General location of specimen. e.g. Parks Highway or Bartlett Cove.
Specific Locality	Specific location of specimen. e.g. 1.5 miles from park boundary on east side of road.
Lat (DD)	Latitude in decimal degrees. e.g. 59.68595
Long (DD)	Longitude in decimal degrees. e.g. -135.56987
GPS/Map	Source of lat/long - from GPS or calculated from map.
Map Datum	Map datum used for lat/ long (NAD27, 83 etc).
Elev	Elevation of collection.
Elev unit	ft or m
Habitat	Describe habitat. e.g. roadside, coastal meadow, riparian, spruce forest
Substrate	Substrate texture (gravel, sand, loam, etc) and/or moisture (wet, moist, dry, etc)
Exposure	Which way the site faces (N, S, E, W, etc)
Slope	Angle of site (flat, gentle, steep)
Abundance	Relative abundance of species at location (abundant, common, infrequent, rare)
Assoc. spp.	Other native or non-native species growing in the area.
Collector(s)	Enter as: Heys, J. Enter multiple collectors separated by commas with "&" before the last collector: Heys, J. & Rapp, W.
Collection Date	full date (6/25/2006)
Determiner	Person who identified specimen.
Det Date	Date specimen was identified (9/27/2006).
Photo#	Name of digital image or full path to image.
NPS Accession #	Generally, the entire set of specimens will receive the same accession number from the park's curator.
NPS Catalog #	Each specimen will get a unique number from the park's curator. If 3 common dandelions are collected, please make 3 separate rows each with their own catalog #.
Notes	Any other taxonomic or collection notes/comments, such as flower color (some blossoms fade with drying, some colors intensify), odor, conspicuous use by animals, specimen looks like a hybrid or doesn't match descriptions, etc.

We have set up an agreement with the University of Alaska Natural Heritage Program in Anchorage to not only assist us with the identification of species but also to prepare herbarium specimens (mounted on paper and with proper labeling) of any plants we collect in the field.

At the end of the season:

1. Obtain the accession number and catalog numbers from your park's collections curator.
2. Verify that each specimen is identified by at least its Collection Number.
3. Send all specimens to Jeff Heys at the regional office with a print out of (park ID)_ Collections_2006.xls
4. Ensure the table (park ID)_Collections_2006.xls is transferred to your park's folder within the regional folder \\Nps\akrdfs\WAN\ARO\NaturalResources\EPMT\2006_INCOMING_DATA

Phenology Log

Throughout the season, please record when exotic species first flower and first set seed using the park_Phenology_2006.xls spreadsheet (save the spreadsheet locally with your park code as a prefix). It may be easiest to print out the sheet and routinely write down the dates throughout the season. Then, enter the information into the spreadsheet. If you visit several park areas periodically that you suspect have different phenologies, record dates on separate sheets for these different locations.

Seasonal Report

The seasonal report for your park is your chance to summarize what you've learned and accomplished with regard to exotic plant management. These are immensely valuable for record-keeping and future planning, and it will also demonstrate to your supervisor the quality of your work. There is no page limit for this, because it's more important that you get across what you did and found this summer, no matter the length. Please be as thorough as possible with this. Templates from past seasonal reports are available and will be sent out at the end of the season.

Items to be covered in the report:

- Accomplishments (Prevention, Detection, Inventory, Control, Monitoring, Restoration, Education, Contacts, etc.) – use your time log to remind yourself of all the activities you have been involved in
- Summarize 2006 exotic plant distribution (diversity and relative species abundance in frontcountry and backcountry) in comparison to what you know of results from previous years. Highlight any new species or situations of particular concern.
- Recommendations for next year are your chance to improve what we do.
- Please include a table that includes all the invasive species documented in and around your park at any time. This should be the list from AK_EPMT_Master_Exotics_2006.xls and any additional species documented in 2006. If there are species on our master list that you do not believe should be there, please let us know. Include in this table if you observed it in 2006 and what parts of the park it was seen (e.g. Park Headquarters, Park Road, Backcountry, Outside Park).

- Anything else you think is important
- Please use ITIS accepted scientific and common names

As far as timing goes, the data process must be complete by Sept. 1 at the latest and preferably earlier so that we can troubleshoot any problems or inconsistencies that arise. We would prefer to have the reports by Sept. 15th, but if that presents a problem, let us know. In any event, if you have any questions or issues, give us a call. We will be traveling around the state for much of the summer, but we will be checking messages periodically and you guys are our top priority.

Thank you for your participation this summer!! Please give Jeff or Whitney any suggestions to how we can improve this protocol and the program. We hope that you are interested in continuing to work with the Alaska Exotic Plant Management Team in the future.

Appendix 2.

Exotic Vegetation Management Plan for Exit Glacier
Eveline Leon Martin
August 12, 2003

Revised September 8, 2004

BACKGROUND

Exotic plants are widely recognized as a major threat to natural areas and ecosystems. An exotic plant is defined as a plant that occurs in a given place as a result of direct or indirect, deliberate, or accidental actions by humans (NPS 2000). Exotic species have not evolved with other species native to the place in question, and therefore are not a natural component of the ecological system characteristic of that place. The term "exotic" is often used synonymously with the terms alien, non-native, weed, and introduced. Invasive exotic plants are ecologically harmful and can lead to loss of habitat for native plant and wildlife species, reductions in biodiversity, and changes to natural ecological processes such as plant community succession, nutrient cycling, and hydrologic regime.
Invasive exotic plants usually establish themselves in soil disturbed by construction, travel, recreation, etc. Subsequently, machinery, native wildlife species such as moose, rodents and birds, vehicles, people, wind and water can transport seeds to new areas.

This plan currently focuses only on the Exit Glacier area of Kenai Fjords National Park, as exotic plants have not yet been documented on the coastal areas of the park. Nine species of exotic plants were identified in the park along Exit Glacier Road, campground, parking area and trails (Table 1). Densmore et al. (2001) noted that pineapple weed *(Matricaria discoidea*), common dandelion *(Taraxacum officinale* ssp. *officinale*) and white clover (*Trifolium repens)* were found around the ranger station and parking lot and that common dandelion was scattered along the trails but not found on glacial moraines or the outwash plain. Common dandelion was the only abundant exotic plant found along Exit Glacier road inside the park. Densmore et al. (2001) also noted yellow toadflax *(Linaria vulgaris*) growing along Exit Glacier Road inside the park. Seeds for these plants were probably introduced in fill used for road or structure construction. It is also possible that seeds could have been carried into the park on motor vehicles or deposited from feces of domestic animals.

Densmore et al. (2001) found seven additional species of exotic plants growing along Exit Glacier road outside the park boundary (Table 1). These included alfalfa (*Medicago sativa),* yellow sweetclover (*Melilotus officinalis*), red clover (*Trifolium pratense),* oxeye daisy (*Leucanthemum vulgare*), and narrowleaf hawksbeard (*Crepis tectorum*). These plants were apparently introduced in a reseeding mix after that section of road was paved in 1999. If left uncontrolled, it is likely that all of these species would eventually spread into the park.

Two other exotic plants growing in the Seward area are tufted vetch (*Vicia cracca*) and scentless false mayweed (*Tripleurospermum perforata*) which are established around the Alaska Sealife

Center. These species were apparently introduced with topsoil from Anchorage for landscaping. These species have spread rapidly around Anchorage and have the potential to do the same in Seward and the Exit Glacier area.

During the summer of 2002, common dandelion, which was previously thought to occur only in disturbed areas such as along the road and trail corridors of Exit Glacier, was documented to have spread into natural areas (Bryden 2002). Common dandelion was found in areas of sparse vegetation both north and south of Exit Glacier road several kilometers from the road corridor.

Table 1. Exotic species found in and around Kenai Fjords National Park (from Densmore et al. 2001).

Exotic plants found within Kenai Fjords National Park.		Exotic plants on Exit Glacier Road or in the Seward Area.	
Species Name	**Common Name**	**Species Name**	**Common Name**
Festuca rubra	Red fescue	*Crepis tectorum*	Narrowleaf hawksbeard
Linaria vulgaris	Yellow toadflax	*Elymus repens*	Quackgrass
Lupinus polyphyllus	Large-leaved lupine	*Leontodon autumnalis*	Fall dandelion
Matricaria discoidea	Pineapple weed	*Leucanthemum vulgare*	Oxeye daisy
Plantago major	Common plantain	*Medicago sativa*	Alfalfa
Rumex acetosella	Common sheep sorrel	*Melilotus officinalis*	Yellow sweet clover
Taraxacum officinale	Common dandelion	*Trifolium pratense*	Red clover
Trifolium hybridum	Alsike clover	*Tripleurospermum perforata*	Scentless false mayweed
Trifolium repens	White clover	*Vicia cracca*	Tufted vetch

PROGRAM OBJECTIVES

This Exotic Vegetation Management Plan is developed following National Park Service guidelines (NPS 2000) for natural resource management and integrated pest management procedures. According to the guidelines, management of populations of exotic plant (and animal) species will be undertaken wherever control is prudent and feasible. Managers will take action whenever such species interfere with natural processes and the perpetuation of natural features or native species, disrupt genetic integrity of native species, significantly hamper the management of the park or adjacent lands, pose public health hazards, or create a hazard to public safety.

Integrated Pest Management (IPM) is a decision making and action process that uses pest and environmental information along with available pest control methods to prevent unacceptable levels of pest damage in the most economical way and with the least possible hazard to people, property, and the environment (NPS 2000). An integrated pest management approach can be effective in reducing the number of invasive exotic plants and their spread to other areas. IPM procedures preserve the biological diversity of native plants by containing, eradicating, and/or controlling undesirable invasive exotic plants. IPM procedures will be used to determine when to control exotic plants and whether to use mechanical, physical, chemical, cultural, or biological

means, or a combination of these. An IPM approach targets an individual plant species and then prescribes the control method or combination of methods that will best achieve the desired result.

The goals of an exotic vegetation management program are 1) preventing new infestations of target species within the park and 2) maintaining populations below a level where they have negative effects on native species populations, successional dynamics, and ecosystem properties. These goals will be accomplished with the objectives described below.

- Objective 1: Prevent spread of known exotic species populations and survey to detect new infestations.
- Objective 2: Increase public awareness.
- Objective 3: Manage existing exotic plant populations.
- Objective 4: Monitor to determine population levels and effectiveness of control treatments.

1. Prevent spread of known exotic species populations and survey to detect new infestations

The most important part of a invasive exotic plant management program is prevention. Prevention is proactive rather than reactive, and it is the most cost effective of the management actions considered in this plan. Exotic plant invasion can also be prevented by maintaining healthy plant communities and by reducing human impacts and use patterns. Vectors of spread, such as road shoulders, campgrounds, viewpoints, trailheads and heavily used trails, will be surveyed each year to find new infestations. New infestations will be removed before they become well established. Exotic plants found along the park boundary on adjacent property will be noted. Visual surveys of potential habitats will be conducted for each target species at least once every three years. The best time to search for each species will depend on bloom period or other easily identifiable phenological characteristics.

Invasive exotic plants are abundant on disturbed areas such as roadsides, developed areas, and trails because:

- In some cases exotic plants have been purposely introduced to revegetate disturbed areas following construction. Using exotic plants in seed mixes to revegetate disturbed areas occurred in 1999 on the adjacent USFS stretch of Exit Glacier Road during paving.
- Gravel used on roads, trails, and for fill is a source of invasive exotic plants.
- Continued maintenance activities in these areas facilitates dispersal of exotic plants from colonized to uncolonized areas.
- Visitors inadvertently bring in seeds of problem plants on vehicles, clothing, boots and camping equipment.

Several actions can be taken to prevent introduction of exotic plants. Topsoil disturbed by construction activities should be properly stored, and replaced after work is completed. If topsoil, gravel, or fill are brought into the park, they should be weed seed free. Revegetation around park facilities will use only native plants with locally collected seed and plants. Shrubs and trees should be a component of the same habitat as the planting site.

Cooperative activities with adjacent landowners will be conducted to decrease source populations. The USFS is the directly adjacent to the Exit Glacier area of the park. They recently initiated a management plan to control exotic vegetation along Exit Glacier Road. We can combine resources to work together to manage exotic plants in the Resurrection River Valley.

2. Increase Public Awareness

Educating the public about exotic plants and cooperating with park neighbors are essential for successful prevention and control of exotic plants in the park. Information about exotic plant problems will be shared with the general public, park employees, visitors and neighbors through interpretive programs, the park's environmental education program, site bulletins, and press releases. Park neighbors will be contacted to discuss coordination of management efforts, specifically the USFS with their newly implemented exotics management program for Exit Glacier Road.

3. Manage existing exotic plant populations

Occurrences of exotic plants will be identified before control actions are implemented by mapping the target population using GPS and entering the information into GIS. Densmore et al.'s (2001) preliminary data on exotic plants at Exit Glacier, including population size, habitat description, and GPS locations, can be used as a baseline. Densmore et al. (2001) also ranked each species found according to the exotic species ranking system developed by Hiebert and Stubbendieck (1993). The criteria in this ranking system provide a relative measure of the significance of impact and feasibility of control or management. Any new species found will be ranked using this system.

Prior to any exotic plant control, treatment options will be evaluated so that the control actions selected will be both biologically and logistically sound. Methods of exotic plant management are commonly categorized as physical, cultural, biological, chemical controls, and prescribed burning. Physical methods include both manual and mechanical methods. Cultural methods include the encouragement of competitive displacement by native plants and prescribed grazing. Biological control is usually interpreted as the introduction of insects or pathogens which are highly selective for a particular weed species. Chemical control includes both broadcast and spot application. Prescribed burning includes both broadcast burning and spot treatment. General descriptions of each type of control are presented below, although some would not be applicable for the Exit Glacier area.

Once locations of target species populations are identified, mapped, and monitored (see monitoring objective below), sites should be prioritized for control as not all locations are likely to receive treatment at the start of the program. Control should be implemented at locations most interior working to those most exterior of the Exit Glacier area. Remote sites should be treated first, such as along the Harding Icefield Trail and in the gravelly area (the Nike Stripe) some distance north of the road. Then areas in the parking lot and along the road should be managed, working systematically toward the boundary of the park. Once control is started at a site, it should be continued each year until all target plants are removed or contained.

Manual Control

Manual control methods employ hand labor to remove undesirable vegetation. These methods are highly selective and permit removal of exotic plants while minimizing damage to surrounding native vegetation. Hand pulling may be used to destroy the seedlings of any exotic species. Seedlings are best pulled after a rain when the soil is loose. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds. Pulling the rosettes before flowering will prevent the deposition of more seeds into the soil, although there may still be a large dormant seed reserve underground. Hand hoeing can destroy plants readily while they are still small, either by cutting off their tops or by stirring the surface soil so as to expose the seedlings to the drying action of the sun. The object of hoeing is to cut off exotic plants without going too deeply into the ground and causing damage to the roots of desirable vegetation. Hand digging is the removal of rootstocks and is a slow but effective way of destroying plants. Such a technique is only suitable for small infestations and around trees and shrubs where other methods are not practical. Manually operated tools such as brush cutters, power saws, axes, machetes, loppers and clippers can be used on woody exotics. This can be an important step before many other methods are tried as it removes the above ground portion of the plant. Often, cutting the above ground portion and leaving the root intact is only partially successful because the remaining roots may resprout.

Mechanical Control

Mechanical methods of control use mechanized equipment to remove above-ground vegetation. These methods are often non-selective in that all vegetation on a treated site is affected. Two common mechanical methods are scarification and mowing. Scarification involves the use of plows or discs to uproot plants. This technique results in various degrees of soil disturbance and may create erosion problems. Soil disturbance is likely to provide bare areas highly suited for exotic plant establishment. This technique is not recommended except in regularly plowed fields. Chopping, cutting or mowing is accomplished by tractor-mounted mowers on even ground or by scythes on rough or stony ground. Repeated mowing is often necessary to prevent root sprouts from getting large and setting seed.

Cultural Methods

Biological competition involves sowing native plant species which have the potential to outcompete invasive exotics for important resources. In some cases later successional plants may be encouraged to take root among the unwanted vegetation. These seeds and seedlings may establish sufficiently to eventually shade out exotic species. Sheep, goats, and livestock can be used for prescribed grazing.

Biological Control

The term biological control is used to refer to the use of insects or pathogens to control exotics. The introduction of exotic natural enemies to control plants is a complex process and must be thoroughly researched before implementation to assure success. Examples of biological control agents are insects such as root mining weevils, leaf eating beetles, and flower eating beetles that can attack

flowers and severely reduce seed production. If bio-control insects become established, they may provide continuous control of the plant without further human actions.

Chemical Control

Herbicides may be applied non-selectively (i.e., broadcast treatments) or selectively (i.e., spot treatments). Broadcast application usually uses non-selective herbicides and will kill most, if not all, of the vegetation sprayed. Those species which survive the treatment may, after repeated sprayings, form an herbicide-resistant vegetation cover, thus creating a more difficult problem to deal with. Such broadcast spraying may also kill off native plants which have the ability to outcompete exotic plants. Broadcast herbicide application may be most effective where the infestation is very dense. It may also be useful following the removal of mature plants so as to reduce the soil seed bank. Spot chemical methods consist of various techniques for manually applying herbicides to individual plants. These methods are highly selective as only specific target plants are treated. Spot applications are most efficient when the density of stems to be treated is low.

Prescribed Burning

A flame thrower or weed burner device can be used as a spot treatment to heat-girdle stems. These techniques have the advantage of being less costly than basal and stem herbicide treatments and are suitable for use during wet weather and snow cover; it cannot be used during periods of wildfire hazard. Large areas of exotic plant infestation may be broadcast burned in order to remove the standing mature plants. This may be accomplished with a pre-spray of herbicide to kill and desiccate plants. Burning is best followed by either repeated burning to exhaust the soil seed bank or by revegetation with fast growing, aggressive native species. Top kill, however, can increase above ground density of unwanted species which resprout.

4. Monitor to determine population levels and effectiveness of control treatments

A monitoring program will be implemented to determine the baseline population of each targeted exotic species at each control site prior to initiating any control treatments. Subsequently, the effects of treatments on invasive exotic plant populations and on associated native species will be monitored. Treatment refers to the actual method of control (pulling, mowing, herbicide application, etc.). If results show satisfactory progress toward the management goals, treatments will continue. If they are unsatisfactory, the treatments will be modified or abandoned altogether in favor of more effective methods. Treatments will be stopped if they do not substantially affect the invasive exotic plant, if their effects on native species, visitors, soils or water reach unacceptable levels, or if the invasive exotic plant is ranked into a lower category.

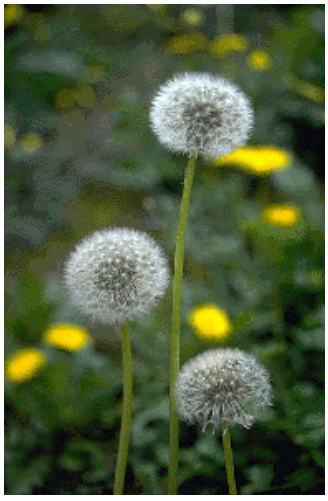
As most locations at Exit Glacier where exotic plants occur are linear corridors (such as roads and trails), one transect will be established in the center of the corridor (i.e., on the road shoulder between the pavement and denser vegetation where exotics clearly do not occur). These variable length transects will be permanently established with start and end stakes for replication prior to each year of treatment and will traverse from one end of the invaded area to the other exceeding it on either end by 10 m. At locations that are not linear, parallel transects will be

established every 25 m with a random start point. At locations that are small or plants are sparse, all plants can be counted. This monitoring system will allow us to ask what the changes in the targeted exotic species populations are over time at a particular site. Percent cover of the target exotic species and all other plants will be recorded along the variable length transects using the point intercept method. Every 10m a $1m^2$ quadrat will be placed along each transect to obtain density counts of targeted species. Cover and density data will be collected each year prior to implementation of control treatments. Paired t-tests will be used to analyze population changes from year to year and to compare effectiveness of control treatments.

MANAGEMENT TECHNIQUES FOR TARGET SPECIES

Two species are targeted for the full exotic plant management program. Common Dandelion (*Taraxacum officinale* ssp. *officinale*) and Yellow Toadflax (*Linaria vulgaris*) were identified by Densmore et al. (2001) as occurring in the Exit Glacier area and rated as having at least moderate urgency for control. All the other species listed as occurring in the Exit Glacier area rated as low urgency and are therefore not targeted at this time. Other species that were found outside of the park boundary will be targeted only for monitoring and prevention at this time: Narrowleaf Hawksbeard (*Crepis tectorum*),
Oxeye Daisy (*Leucanthemum vulgare*), Yellow Sweetclover (*Melilotus officinalis*),
Tufted Vetch (*Vicia cracca*). If these species are found inside the park, they will be added to the list of species targeted for full management.

Common Dandelion (*Taraxacum officinale* ssp. *officinale*)



Description and Identification

Common dandelion (*Taraxacum officinale* ssp. *officinale*) is a perennial herb in the aster family (Asteraceae). Plants have a basal rosette of toothed leaves, leafless hollow flower stalks, yellow flower heads up to 5 cm broad, and a taproot at least 15 cm in length. The whole plant has milky white sap. Flowers mature into fluffy white seed heads.

A native dandelion, *T. officinale* ssp. *ceratophorum*, can be distinguished from the exotic dandelion by the involucral bracts. The bracts on the native dandelion have "horns" while the exotic dandelion lacks "horns".

Biology

Common dandelion was introduced from Europe and Asia in the mid 1600's by European settlers and is now an established weed of lawns, pastures, roadsides, and disturbed areas throughout North America. Densmore et al. (2001) observed common dandelion growing only in disturbed areas (both vegetation and organic soil layer disturbance) and found that it does not persist after it is shaded out.

Reproduction occurs from seed dispersed to disturbed sites or from resprouting from the root or root segments. Plants can produce hundreds of seeds each year which are wind-dispersed for long distances. Common dandelion does not need to be pollinated to set seed, instead, flowers develop seeds through a process called apomixis, producing offspring that are genetically identical to the parent (ANPC 2002).

The ranking conducted by Densmore et al. (2001) (according to the Hiebert and Stubbendieck (1993) exotic species ranking system discussed above) found that common dandelion falls under a moderate urgency for control at Exit Glacier. The current level of impacts scored 12 out of 50 points, its ability to become a pest scored 24 out of 50 points, and the feasibility of control scored 44 out of 100 points.

Management Options

Control options for common dandelion include chemical, manual, and cultural methods:

Systemic herbicides, such as Glyphosate, can be applied as a spot weeder (DGS 2003). The active ingredient of systemic herbicides is taken up by the foliage and transported down to the rest of the plant. They take about 10 to 14 days to work so may not prevent the weeds producing seeds before they die. The best time for herbicide application is at the seedling stage. For perennials, such as common dandelion, an application of a systemic herbicide in the autumn when they are passing sugars to the underground parts for winter storage, can be very effective for weeds that are difficult to control. It is best to apply during periods of good growth when the plant is moving sap around so the chemical will be taken with it.

Although herbicides can be very effective, at this point chemical control would not be the first choice in control treatment of common dandelion as manual control can be effective as well. Manual control efforts were implemented along Exit Glacier Road and in the parking lot in 2000 and 2001 with many volunteers hand pulling plants. Pulling tools (i.e., two pronged forks) were used to remove as much of the root as possible. In 2001, over 7000 plants were removed. Similar hand pulling treatments have been in place at Denali National Park and have are determined to be successful (Densmore et al. 2001).

Flowering phenology of common dandelion at Exit Glacier varies from the end of May through June. Control treatments must be implemented in that time frame prior to seed set to be most effective. Removing plants that have seed heads can help in spreading the seed further than if left alone. Plants that cannot be removed prior to seed set can be pulled once all the seed has fallen as it would prevent plants from coming up again the next spring, although this is not as effective as removing plants prior to seed set.

The cultural method of seeding a mixture of native plants on disturbed areas can greatly reduce the number of common dandelion seeds that establish and reduce growth of those that do (Densmore et al. 2001). Seed can be broadcast in late summer or early fall for germination the following spring.

Hand pulling and native plant competition treatments are the recommended methods for control of common dandelion at Exit Glacier. Prior to any control treatment, monitoring of the existing populations of dandelion should be implemented and sites should be prioritized for control as discussed in the Program Objectives section above. Plants should be pulled with as much of the taproot severed beneath the root crown, from as early in spring as possible until flowering ends and seed set begins. Plants should be counted as they are pulled to keep a tally of how many are removed. Pulled plants should be placed in garbage bags and allowed to sit in the sun for several weeks before disposal at the transfer station. Bagging “cooks” the plants so that any seed that may be viable are killed.

Yellow Toadflax (*Linaria vulgaris*)

Description and Identification

Yellow toadflax (*Linaria vulgaris*) is a perennial herb in the figwort family (Scrophulariaceae), grows 0.2 to 0.8 m tall. Leaves are pale green, linear, and sessile. A toadflax plant contains from 1-25 vertical, floral stems. Flowers are 1 inch long, yellow and orange, with a spur. The tap root may penetrate one meter into the soil. Horizontal roots may grow to be several meters long, and can develop adventitious buds that may form independent plants. Yellow toadflax seeds are flattened, winged and 1-2 mm long. A mature plant can produce up to 30,000 seeds annually.

Biology

Yellow toadflax is a native of southeastern Europe and southwestern Asia which was introduced to the United States as an ornamental plant by early colonial gardeners. Yellow toadflax reproduces by seed and vegetative propagation. Once established, high seed production and the ability for vegetative reproduction allow for rapid spread and high persistence. Yellow toadflax is an aggressive invader capable of forming colonies through adventitious buds from creeping root systems. It rapidly colonizes open sites such as roadsides, fences, clear cuts, and pastures and is capable of adapting growth to a wide range of environmental conditions (TNC 2003a). Disturbed or cultivated ground is a prime candidate for colonization. These colonies can push out native grasses and other perennials, thereby altering the species composition of natural communities.

The seedlings of toadflax are considered ineffective competitors for soil moisture with established perennials and winter annuals. However, once established yellow toadflax suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials (TNC 2003a).

Yellow toadflax has a relatively short lifespan. Individual plants live up to five years with an average lifespan of 3.8 years (TNC 2003a). The life span of yellow toadflax stands is dependent on environmental conditions and the reproductive success of individual plants. The relatively short lifespan of toadflax plants bodes well for controlling this species.

Yellow toadflax is listed under the State of Alaska regulations for Plant Health and Quarantine as a restricted noxious weed with a maximum allowable tolerance of 1 seed per pound contaminating commercial seed (Densmore et al. 2001). It is also listed as a noxious weed in seven other states.

The ranking conducted by Densmore et al. (2001) (according to the Hiebert and Stubbendieck (1993) exotic species ranking system discussed above) found that yellow toadflax falls under high urgency for control at Exit Glacier. The current level of impacts scored 7 out of 50 points, its ability to become a pest scored 31 out of 50 points, and the feasibility of control scored 50 out of 100 points.

Management Options

Monitoring should be conducted in early spring (May and June) when yellow toadflax plants have formed buds and are beginning to flower. Any management program should also be conducted during this time. This is when root carbohydrate reserves are at their lowest, which makes it more difficult for the root system to recover (TNC 2003a). Follow-up work in late June or early July is recommended to locate and remove any late-flowering plants.

This species' extensive root system makes it difficult to control. Successful control can be obtained by pulling, or killing the plants with herbicide, before seed production begins. Since the plant also spreads through vegetative propagation, and the seeds can remain dormant for up to ten years, this process must be repeated every year for at least ten years to completely remove a stand (TNC 2003a). Competitive perennial grasses and forbs should be planted to utilize water and nutrients that would otherwise be readily available to toadflax.

The key to managing yellow toadflax is to eliminate or greatly reduce seed production from established individuals (by cutting or pulling seed stalks prior to seed set) and destroy toadflax seedlings that arise from the soil seed bank before these plants become established (as above, plus herbicide). Permanent, long-term control cannot be achieved with herbicide treatment alone. Herbicides should be applied during flowering before seed dispersal, if it is to be effective. The herbicides glyphosate, dicamba and picloram are considered effective for controlling toadflax. Cutting or removal of the above ground portion of yellow toadflax plants reduces the current year growth, but it will not kill them. Cutting yellow toadflax stands in spring or early summer is an effective way to eliminate plant reproduction through seed production and dispersal. However, the long dormancy of toadflax seeds requires that the process be repeated annually for up to ten years. Hand pulling toadflax before seed set each year can be an effective control method. The hand pulling experiment on the Magnusson Butte Preserve in Washington (TNC 2003a) showed that toadflax can be significantly reduced by pulling once a year as long as new seed is eliminated. Once again, this method must be repeated annually for up to ten years to completely remove a stand.

Narrowleaf Hawksbeard (*Crepis tectorum*)

Description and Identification

Narrowleaf hawksbeard (*Crepis tectorum*) is an annual herb of the aster family (Asteraceae). It grows 20-50 cm tall from a taproot and has a rosette of basal leaves and alternate leaves on the flowering stem. The leaves have backward pointing teeth and margins rolled under. The flowering stem branches with a single flower on each branch. The flowers are bright yellow and similar to dandelions in appearance and size. The seed heads look like small dandelion seed heads.

Biology

Narrowleaf hawksbeard was introduced from Europe and Asia and was first reported in Canada. It is now a weed of disturbed areas throughout the northern US and Canada. It is generally not regarded as an invader of natural areas.

This species reproduces from seed dispersed to a disturbed site. The plant can grow as an annual, germinating in the spring and dying at the end of the growing season, or as a winter annual, germinating later in the growing season, overwintering as a rosette of leaves, producing seeds the following growing season and then dying.

The ranking conducted by Densmore et al. (2001) (according to the Hiebert and Stubbendieck (1993) exotic species ranking system discussed above) found that narrowleaf hawksbeard falls under high urgency for control at Exit Glacier. The current level of impacts scored 7 out of 50 points, its ability to become a pest scored 21 out of 50 points, and the feasibility of control scored 80 out of 100 points.

Management Options

Control treatments will not be outlined at present as this species does not yet occur in the park. However, if prevention and early detection efforts find any narrowleaf hawksbeard plants in the park, those plants will be pulled and locations documented with GPS.

Oxeye Daisy (*Leucanthemum vulgare*)

Description and Identification

Oxeye daisy (*Leucanthemum vulgare*) is a perennial herb in the aster family (Asteraceae) Tall stems (20-80 cm) arise from a woody rhizome. Plants have a daisy type flower with white ray petals and a yellow center; heads are solitary at ends of branches. Both basal and stem leaves have wavy to lobed margins and stem leaves alternate. Flowers smell strongly of sage.

Biology

Oxeye daisy was introduced from Europe as a garden plant. It is now a weed of disturbed areas throughout North America and is listed as a noxious weed in six states. This species is popular as a garden ornamental and has been sown along roadsides as a wildflower. This plant is persistent and spreading in Alaska.

This species reproduces from seed dispersed to disturbed sites and also from creeping rhizomes. Each plant can produce many seeds each year.

The ranking conducted by Densmore et al. (2001) (according to the Hiebert and Stubbendieck (1993) exotic species ranking system discussed above) found that oxeye daisy falls under high urgency for control at Exit Glacier. The current level of impacts scored 8 out of 50 points, its ability to become a pest scored 33 out of 50 points, and the feasibility of control scored 65 out of 100 points.

Management Options

Control treatments will not be outlined at present as this species does not yet occur in the park. However, if prevention and early detection efforts find any oxeye daisy plants in the park, those plants will be pulled and locations documented with GPS.

Yellow Sweetclover (*Melilotus officinalis*)

Description and Identification

Yellow sweetclover is an annual or biennial herb of the legume family (Fabaceae), sweet-scented, with alternate, pinnately three-foliate leaves. The flowers are yellow in small, slender spike-like racemes with a deciduous corolla, free from the filaments. The legume is ovoid, leathery and wrinkled, longer than the calyx, and scarcely dehiscent, with one or two seeds. Plants have an erect, branched, glabrous or glabrate stem, 1-3 m high, with leaflets that are closely serrate, obovate-oblong and obtuse.

Biology

Melilotus spp. are native to the Mediterranean area through central Europe to Tibet. They were reported in North America as early as 1664 and have been extensively used by agriculturalists as forage crops, soil builders, and as a nectar source for honey bees (TNC 2003b). The sweetclovers have spread from cultivation and thrive in waste places and roadsides throughout the U.S. and Canada.

Yellow sweetclover is adapted to a wide range of climatic conditions. The long taproot makes it drought tolerant and winter hardy, but it cannot withstand prolonged flooding. Yellow sweetclover easily invades open areas and may compete for resources with native species.

In the first season of growth plants produce a vegetative shoot which typically grows to 10-30 cm by fall. Most root development occurs in late summer, after crown growth has slowed. The shoot dies back in autumn, and the taproot and crown bud overwinter. The following spring and early summer, one or more flowering shoots emerge from the buds and rapidly elongate, often attaining a height of 100 cm by late summer.

Yellow sweetclover flower in June and July and is an obligate biennial (flowers and dies in the second year of growth (TNC 2003b). Rainwater runoff and stream flow are probably the most important means of seed dispersal, although wind can blow seeds up to several meters. Newly mature seeds will be soft, but as they dehydrate they become temporarily "hard" or impermeable, and can remain viable in this state for many years. Temperatures of less than 15 ^{o}C are optimal for germination, and germination inhibition occurs above 15 ^{o}C, so seeds germinate in spring and

fall and are less likely to germinate during the summer. A high percentage of seeds remain hard and contribute to the development of a large seed bank. These seeds will remain dormant until conditions are optimal for scarification, so abundance can fluctuate greatly from year to year (TNC 2003b).

The ranking conducted by Densmore et al. (2001) (according to the Hiebert and Stubbendieck (1993) exotic species ranking system discussed above) found that yellow sweetclover falls under high urgency for control at Exit Glacier. The current level of impact (for those populations outside the park but likely to invade the park) scored 15 out of 50 points, its ability to become a pest scored 36 out of 50 points, and the feasibility of control scored 35 out of 100 points.

Management Options

Control treatments will not be outlined at present as this species does not yet occur in the park. However, if prevention and early detection efforts find any yellow sweetclover plants in the park, those plants will be pulled and locations documented with GPS.

Tufted Vetch (*Vicia cracca*)

Description and Identification

Tufted vetch (*Vicia cracca*) is a perennial herb in the pea family (Leguminosae). It is a climbing plant with weak stems. Each leaf has 8-10 pairs of leaflets and tendrils at the end of the leaf. The bluish-violet pea-like flowers are borne in one-sided 20-50 flowered racemes. The fruit are hairless pod to 3 cm long.

Biology

Tufted vetch was introduced from Europe and has naturalized to become a weed of roadsides and disturbed areas. This species is listed as a noxious weed in Alaska. Tufted vetch usually establishes in disturbed area including those with well developed vegetation. The plants overgrow herbaceous vegetation and climb up and over shrubs. It has been observed as an invader of natural areas as well.

This species reproduces from seed dispersed to a disturbed site and from buried seed. Seeds are large and not easily dispersed, but can spread more easily when tendrils and vine branches with seed pods cling to vectors, are broken off the plant, and carried to a new location. Some of the seeds produced each year are physically dormant – the seeds do not germinate until the seed coat is sufficiently broken down to admit water.

Densmore et al. (2001) did not rank this plant as they did not locate it in any of their surveys. However, they do state that monitoring for and immediately eradicating this species is a very high priority.

Management Options

Control treatments will not be outlined at present as this species does not yet occur in the park. However, if prevention and early detection efforts find any tufted vetch plants in the park, those plants will be pulled and locations documented with GPS.

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Appendix 3.

Invasive Plant Manual Control Analysis
Kenai Fjords National Park

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Introduction

Summer 2005 marked the fifth year that baseline surveys for non- native plant species were carried out on National Park Service (NPS) lands in Alaska, and the second year for Kenai Fjords National Park (KEFJ). These surveys serve as the first source of data for preparing long- term management plans for these species in Alaska's NPS units. Invasive plant species are a concern to resource managers because they can threaten the genetic integrity of native flora through hybridization (D'Antonio et. al 2001), out-compete native plant species for limited resources, degrade fish and wildlife habitat, and change the structure and function of ecosystems through alterations of geochemical and geophysical processes (Ruesnik et. al 1995, Gordon 1998). Other NPS regions are experiencing these impacts and more: as of 1996, invasive plant species infested an estimated 7 million acres of NPS lands, with 4,600 acres of new infestations occurring daily (NPS 1996).

The first line of defense against invasive plant establishment on parklands is a regular survey for new arrivals in areas of human use and soil disturbance, like roads and trails, the naturally disturbed areas that intersect them, like riverbanks and burned areas, and any previously documented infestations. With the appearance of a new invader, control measures should be started immediately before the population spreads. Early detection and rapid response minimize the costs and efforts necessary to control large or well-established infestations. Only manual invasive plant control has been used to date in KEFJ, meaning that plants are removed by hand or using simple tools. The effectiveness of manual control can vary substantially by plant species, infestation size and age, timing, site characteristics, and regularity of retreatments.

Manual control of invasive plants has multiple logistical and environmental advantages. Little training and no licensing are required to pull weeds, and so volunteers and park staff alike can participate. It demands only minimal preparatory work, including organization and supervision, and equipment, including work gloves, simple tools, and bags for disposal. Weather is seldom a problem, although wet soils release roots more easily than dry soil. Site- specific conditions rarely inhibit the work. Manual

control introduces no chemical or biological control agents that may adversely impact an ecosystem. Finally, manual control is the most targeted approach, tending to have the least impact on native plant species of any control method.

Manual control also has significant disadvantages relative to alternative invasive plant control methods. It is highly labor intensive and physically demanding, making it slow and extremely costly for large areas or dense infestations. Under the latter conditions, manual control rarely results in short- term eradication, instead requiring repeated efforts, usually on the order of several visits per season for many years. Finally, manual control methods may also lead to widespread soil disturbance, which can promote weed seed germination and lead to soil erosion on slopes.

Weighing these advantages and disadvantages requires careful recording of efforts and evaluation of manual control effectiveness, species by species and site by site. This report addresses these needs for three species found near Exit Glacier in KEFJ: dandelion (*Taraxacum officinale* ssp. *officinale*), oxeye daisy (*Leucanthemum vulgare*), and yellow toadflax (*Linaria vulgaris*). This area was chosen for analysis because of its small, well- defined human footprint, limited invasive plant infestations, and successive summers of high- quality data collection by the same employee, Christina Kriedeman.

Methods

The 2005 summer field season marked the second year that extensive surveys for invasive plants were conducted in Alaskan parks using highly accurate Trimble GeoXT GPS units. These units achieve sub- meter accuracy and were equipped with data dictionaries, enabling both precise mapping and standardized data collection. In KEFJ, Trimble units were used to map areas infested with invasive plants in both 2004 and 2005 with detail sufficient for annual monitoring of spread and analysis of control effectiveness. Attributes were designed to describe the size, diversity, and severity of invasive plant infestations in a given area (Table 1) and whether the infestation was inventoried, monitored, treated, or retreated.

The method used to survey lands for invasive plants was opportunistic sampling, focused on areas of human development and frequent use as reported by park staff. All areas considered in this analysis were exhaustively surveyed by foot in both 2004 and 2005. ArcGIS (ESRI 2002) software was used to generate shapefiles for both years that included all GPS records, from which maps of manual control analysis were generated (Figures 1- 5). For future use, the GIS data referenced here are included within the Alaska Exotic Plant Management Team Geodatabase. Manual control of invasive plants was accomplished in 2004 and 2005, led by the same NPS staff member, and was achieved by using a 'dandelion digger' to remove as much as the root as possible. Areas that were manually treated in 2004 were revisited in 2005, resurveyed to analyze treatment effectiveness, and retreated. Every invasive plant infestation treated over both years was recorded and mapped.

Results

Dandelion

Dandelion was manually treated in three different areas in both 2004 and 2005 (Figure 1): along the westernmost stretch of Exit Glacier Road, including the parking lot and campground; along the Harding Icefield and Exit Glacier trail system; and the Nike Stripe, a naturally disturbed area located approximately 700 meters north of the Exit Glacier Road (Figure 2). Overall, in 2004, 0.402 acres of dandelions were treated, with a total of 14,432 individuals inventoried and removed. In 2005, a total of 1.29 acres were retreated and/or treated, with 7,195 individuals removed.

The most heavily dandelion- infested area in KEFJ was the Nike Stripe. In 2004, 12, 635 specimens were inventoried and removed from a total of 0.243 acres. In 2005, the number of dandelions, 2,924 individuals, inventoried and controlled was drastically lower than in 2004. However, the area treated in 2005, totaling 0.366 acres, was greater than in 2004.

The Harding Icefield and Exit Glacier trail system was infested with dandelions only at certain points, especially at overlooks, where visitors likely pause to enjoy the

scenery (Figure 3). In 2004, a total of 846 dandelion specimens encompassing 0.067 acres were encountered and treated on the Harding Icefield and Exit Glacier Trails. In 2005, the number of dandelions reported and treated increased to 1,388 specimens. Likewise, the number of acres infested increased to 0.267.

Oxeye daisy

In 2004, oxeye daisy was recorded growing in two areas, along Exit Glacier Road and beside the car parking lot located at the end of Exit Glacier Road (Figure 4). In both cases, only single specimens were recorded and treated. In 2005, oxeye daisy was not recorded growing where it was previously treated in 2004, but one single plant was discovered and treated growing at the Willow Cabin. In both years, the total infested areas amounted to less than 0.002 acres.

Yellow toadflax

Yellow Toadflax was recorded growing along the Exit Glacier Road in both 2004 and 2005 (Figure 5). In 2004, 1,156 specimens were inventoried growing on 0.058 acres. All specimens were treated. In 2005, both the number of specimens recorded and the total acres infested decreased to 1,023 specimens growing on 0.036 acres. All specimens recorded in 2005 were part of a single infestation, except one single individual that was recorded growing adjacent to the car parking lot at the end of the road, approximately two miles from the main infestation.

Discussion and Management Recommendations

The effectiveness of invasive plant manual control methods in KEFJ varied depending on both site and species (Table 2). At the Nike Stripe, manual control of dandelion proved moderately effective. Although the area infested increased approximately 51% from 2004 to 2005, the number of specimens recorded and treated experienced a 77% decrease. In analyzing the effectiveness of manual control at this site, it is important to consider additional factors, in particular the history of the site and

current visitations rates. This area was subject to high winds that resulted in downfall, disturbing the soil and opening the canopy, which are conditions conducive to dandelion invasion. Seeds were most likely brought in on the boot heels of researchers studying the site. Due to this area's lack of established trails, only a small number of people visit every year, thereby reducing the spread of seeds within the area. It may be that isolation from human activity, and definitive site boundaries with a limited amount of disturbed area, contribute to the effectiveness of manual dandelion control methods at the Nike Stripe. It is important to note that without treatment, dandelion will continue to spread throughout this area. During a 2002 survey, 340 dandelions were recorded here, but not treated (Bryden, 2002). Two years later this incipient population experienced a 3700% increase.

Manual dandelion control methods were not as effective on the Harding Icefield and Exit Glacier Trails. The total infested area experienced a 299% increase from 2004 to 2005. Likewise, the number of specimens recorded and treated increased 64%. There are two major differences between the Harding Icefield and Exit Glacier trail system and the Nike Stripe. Disturbance on the trails is human- caused and perpetuated by continued trail maintenance and visitor use, while disturbance at the Nike site is natural and non- recurring. In 2001, 100,000 visitors traveled to Exit Glacier (Kenai Area Plan, 2001), and it can be reasonably assumed that many of these people hiked on the Harding Icefield and Exit Glacier trail system, likely carrying dandelion seed further along the trails.

The infestation of yellow toadflax along the Exit Glacier Road presents a different situation because it has not yet spread to area trails and is limited to the road corridor. Manual control of yellow toadflax appears to be only moderately effective. The total infested area decreased 38%, from 2004 to 2005, and similarly, the number of specimens recorded and treated decreased 12%. In terms of reducing a source infestation, these numbers are encouraging, although it is unlikely that manual control will be effective in completely eliminating this species from the park. It is also important to note that in 2005, one single plant was recorded in the car parking lot, almost two

miles away from the main infestation. This suggests that seeds from the main infestation can and will spread along the Exit Glacier Road, most likely by traveling on the undercarriage of passing vehicles.

Oxeye daisy, also recorded along the Exit Glacier Road, presents a unique opportunity in invasive plant management. Typically, infestations are discovered after they have already grown too large to control easily and economically by means of manual control methods. In the case of oxeye daisy in KEFJ, there exists the ideal condition for eradication of an invasive plant from an area by means of manual control: a conspicuous species, present in extremely low numbers and easily uprooted by hand. In 2004, two specimens were treated, which did not re- grow in 2005, although one specimen was recorded in another location, growing in front of a historic cabin (this area was not inventoried in 2004). It is possible that the infestation found in 2005 (possibly intentionally planted for ornamental purposes) was the source infestation for the two separate plants recorded growing along Exit Glacier Road in 2004.

It is recommended to continue manual removal of dandelion at the Nike Stripe. Manual control of this species proved moderately successful. Dandelion control must be timed in the spring because they flower earlier than most other species in Alaska. Sites may have to be retreated multiple times during a single summer season due to dandelion's aggressive behavior and ability to recover and flower again even after treatment.

Although manual control of dandelion proved only moderately effective on the Exit Glacier Road and the Harding Icefield and Exit Glacier Trails, in absence of other control methods, manual control of dandelion is strongly recommended to prevent further spread. These infestations, at best, are simply being maintained at current or slightly below past levels, but without any form of control, dandelion populations would explode. The untreated 2002 dandelion population explosion at the Nike Stripe serves as evidence of a potential dandelion takeover, in which one resulting scenario entails dandelion spreading onto glacial outwash plains. To protect KEFJ from the ecological, aesthetic, and economic impacts of dandelion spread, it is strongly recommended that a

more integrated weed management approach be adopted to significantly decrease the dandelion population and prevent its spread to other more remote areas of the park.

Likewise, it is recommended to continue manual control of yellow toadflax. Manual methods proved moderately effective, but because this infestation is fairly large and this species is notoriously difficult to remove once established, alternate measures may prove more effective in eliminating the population of yellow toadflax quickly before it has a chance to spread to other areas of the park. Cutting, mowing, and tilling are effective ways to eliminate plant reproduction by seed and hand- pulling can control small infestations if monitored and retreated over many years.

Because only a few specimens of oxeye daisy were recorded in 2004 and 2005, it is extremely important to continue to monitor these sites to ensure that buried seed does not sprout and create new individuals. If new individuals are observed, they should be treated manually and monitored. It is recommended to continue manual treatment of this species until it is apparent that a population is growing, in which case alternative control methods may be needed. It is also extremely important to engage the local community in discussion about the perils of using oxeye daisy, often sold under the name “Shasta daisy,” and other invasive species as garden plants.

Table 1. Selected fields used in GPS data dictionary and GIS shapefile for invasive plant surveys, summer 2005.

LocationID	Location ID (exit_glacier, kenai_outer_coast)
Dstrbncs	Disturbance Type (coastal, stream, river, glacier, fill importation, trampling, wind throw, slide, animal, material extraction, ORV disturbance, mowing, wildfire, logging, mining, grazing, plowing, brush cutting, herbicide, wind, thermal, volcano, abandoned homesite, or other)
LctnDscrpt	Location Description
BufferM	Buffer distance (in meters) to convert points and lines to polygons
Taxon	Dominant exotic species
Phenology	Phenology of dominant exotic species (rosette, no_flower, full_flower, in_seed, stand_dead, or none)
CvrClssPer	Cover class percentage of dominant exotic species (0, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100)
Action	Inventory, Monitor, Treatment, or Retreatment
Treatment	Treatment type (none, Pull/Dig-Manual, Cut, Basal Bark, Basal- thinline, other)
CntrlEffrt	Projected/actual control effort (low <1 hour, medium 1-8 hours, high >8 hours)
Undetermined	Stem count of dominant exotic species
Remarks	Remarks
StartDate	Date of site visit
StartTime	Time of site visit
AssocPark	Associated park (KEFJ)
Recorder	Recorder (CLK – Christina Kriedeman)
Taxon2, Taxon3…	Additional 4 fields for 4 other exotic taxa for each unique site including fields for Phenology, Cover Class Percentage, and Stem Count
Spatial Accuracy Fields	Range of attributes to describe spatial information and precision
Acres	GIS-calculated acreage of each infested or uninfested area

Table 2. Comparison of manual control by species.

	2004	2005		2004	2005	
Species	**Acres treated**	**Acres treated**	**% change**	**Specimens treated**	**Specimens treated**	**% change**
Dandelion						
Overall	0.402	1.29	+220.9	14,432	7,195	-50.1
Nike Stripe	0.243	0.366	+50.6	12,635	2,924	-76.9
Trails	0.067	0.267	+298.5	846	1,388	+64.1
Yellow toadflax	0.058	0.036	-37.9	1,156	1,023	-11.5
Oxeye daisy	0.002	0.001	-50.0	2	1	-50.0

Figure 1. Dandelion Control Effectiveness in Kenai Fjords National Park and Preserve

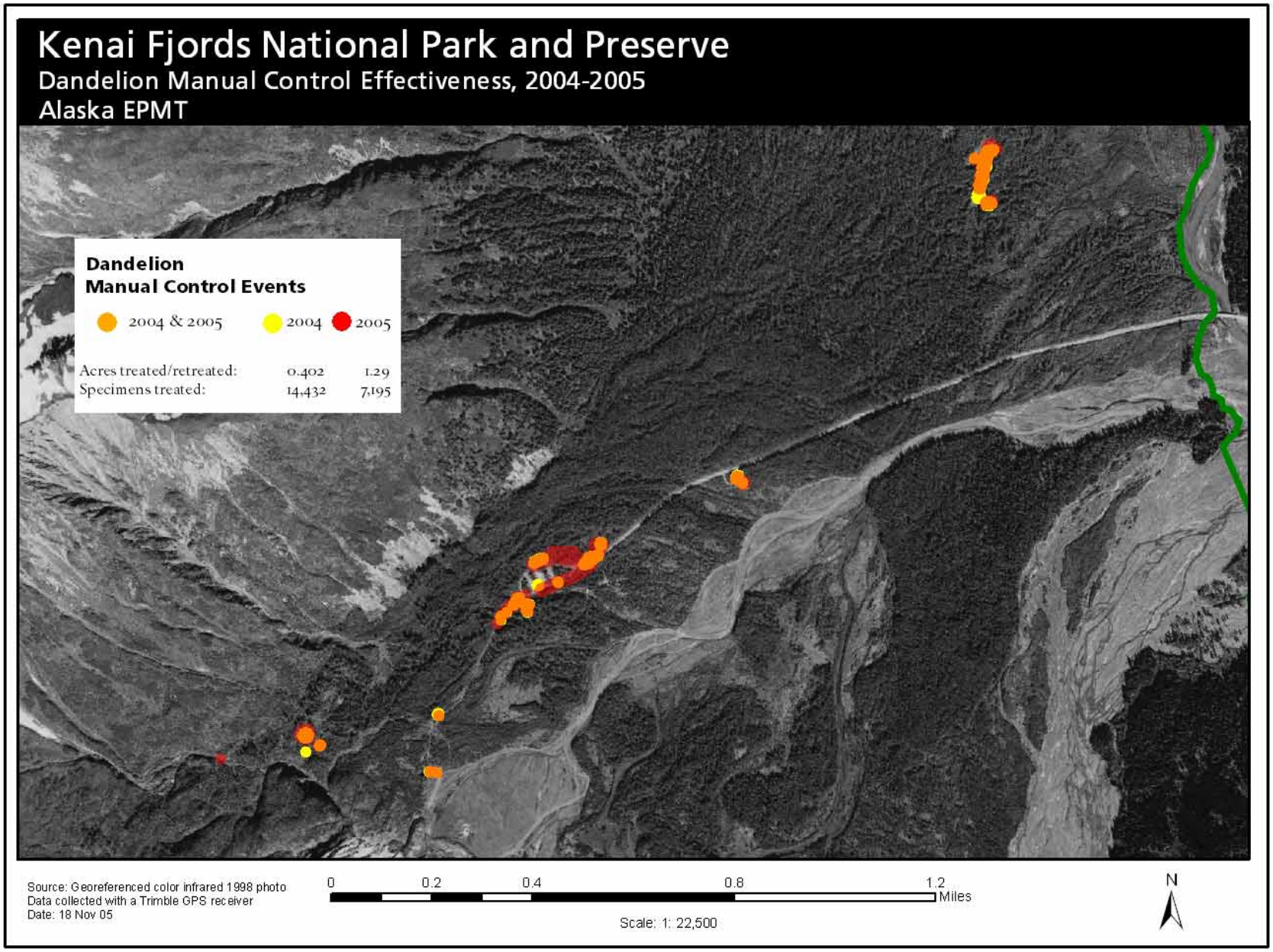


Figure 2. Dandelion Control Effectiveness in Kenai Fjords National Park and Preserve, Nike Stripe

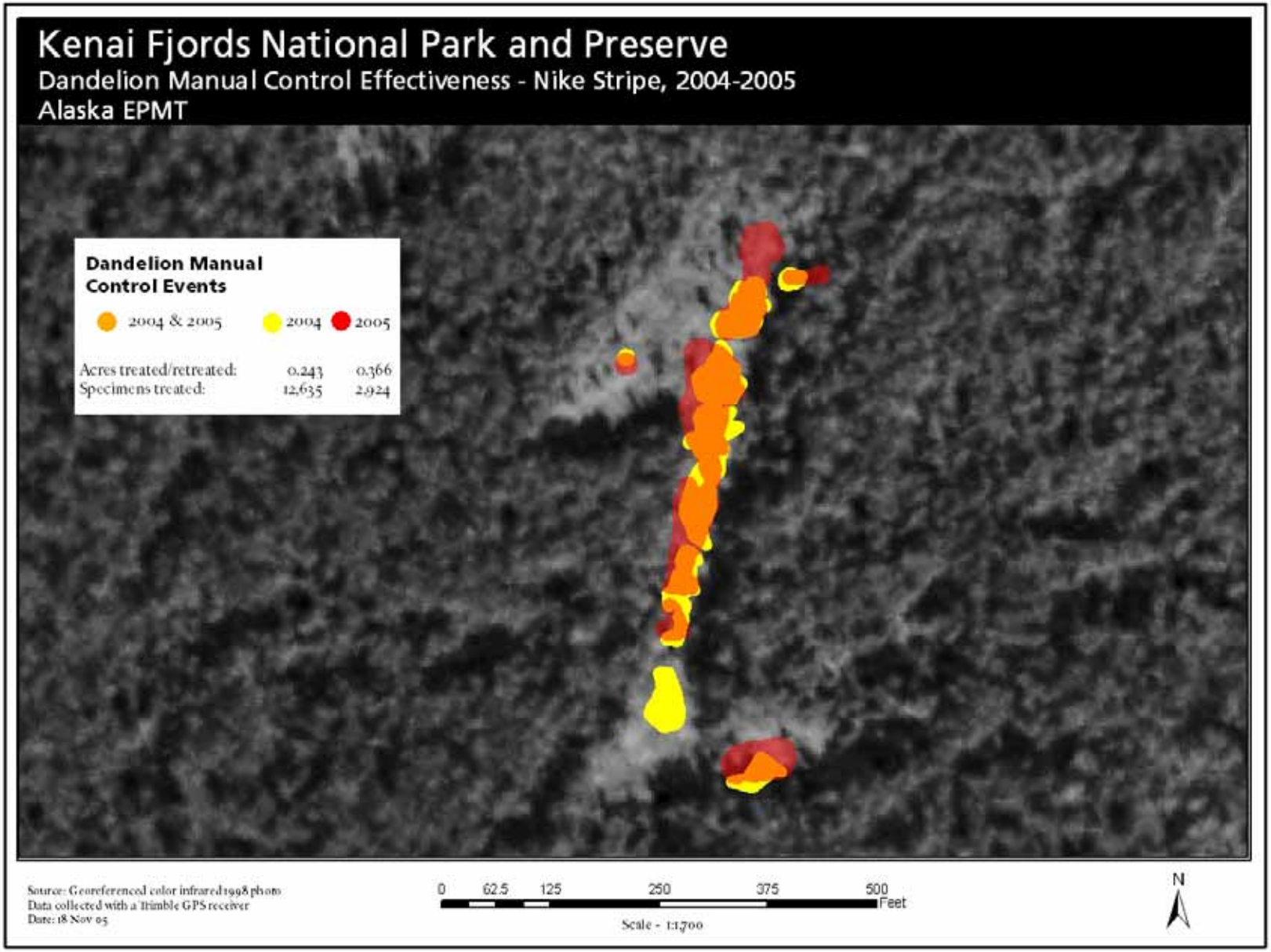


Figure 3. Dandelion Control Effectiveness in Kenai Fjords National Park and Preserve, Trails

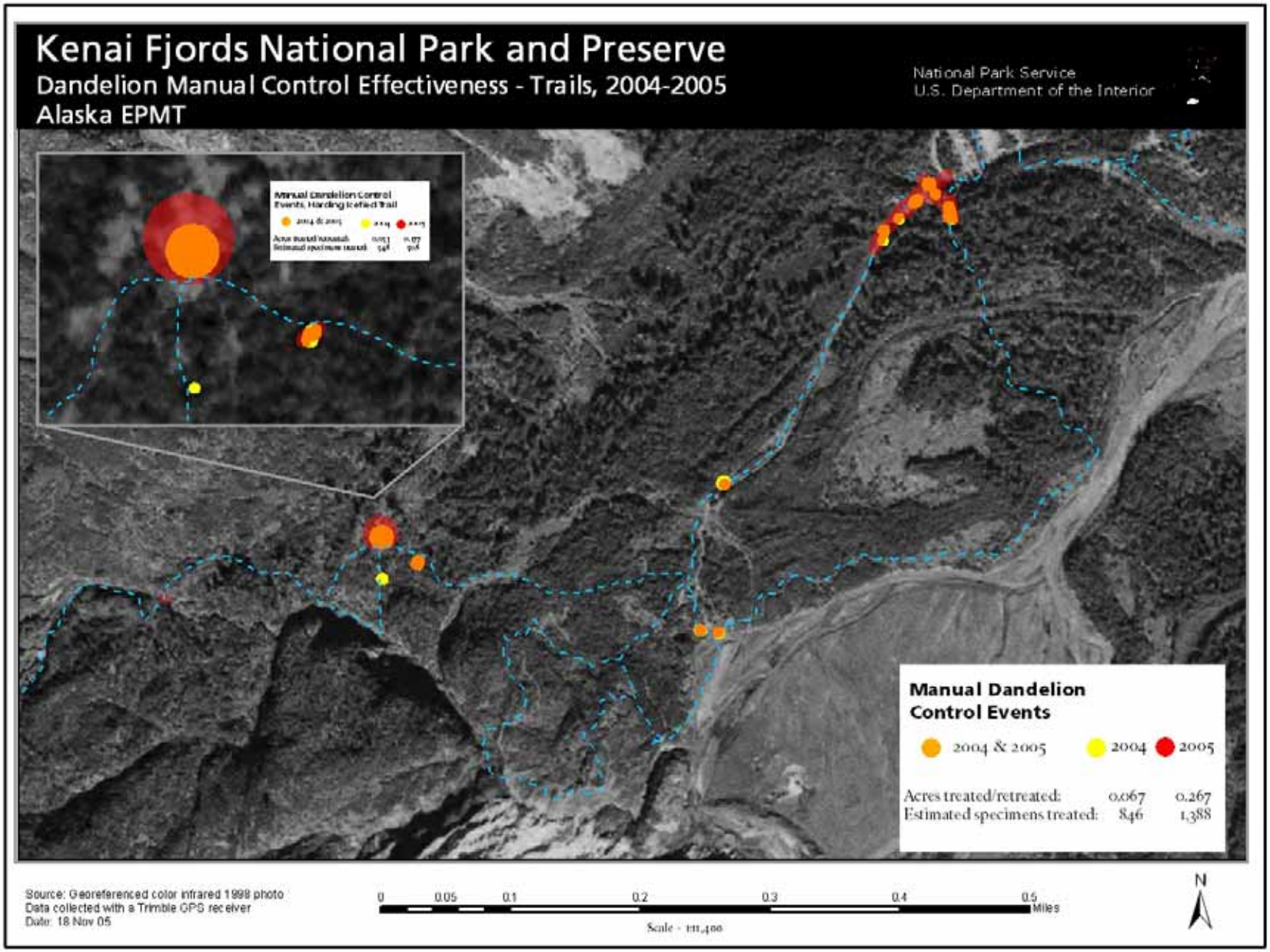


Figure 4. Oxeye Daisy Control Effectiveness in Kenai Fjords National Park and Preserve

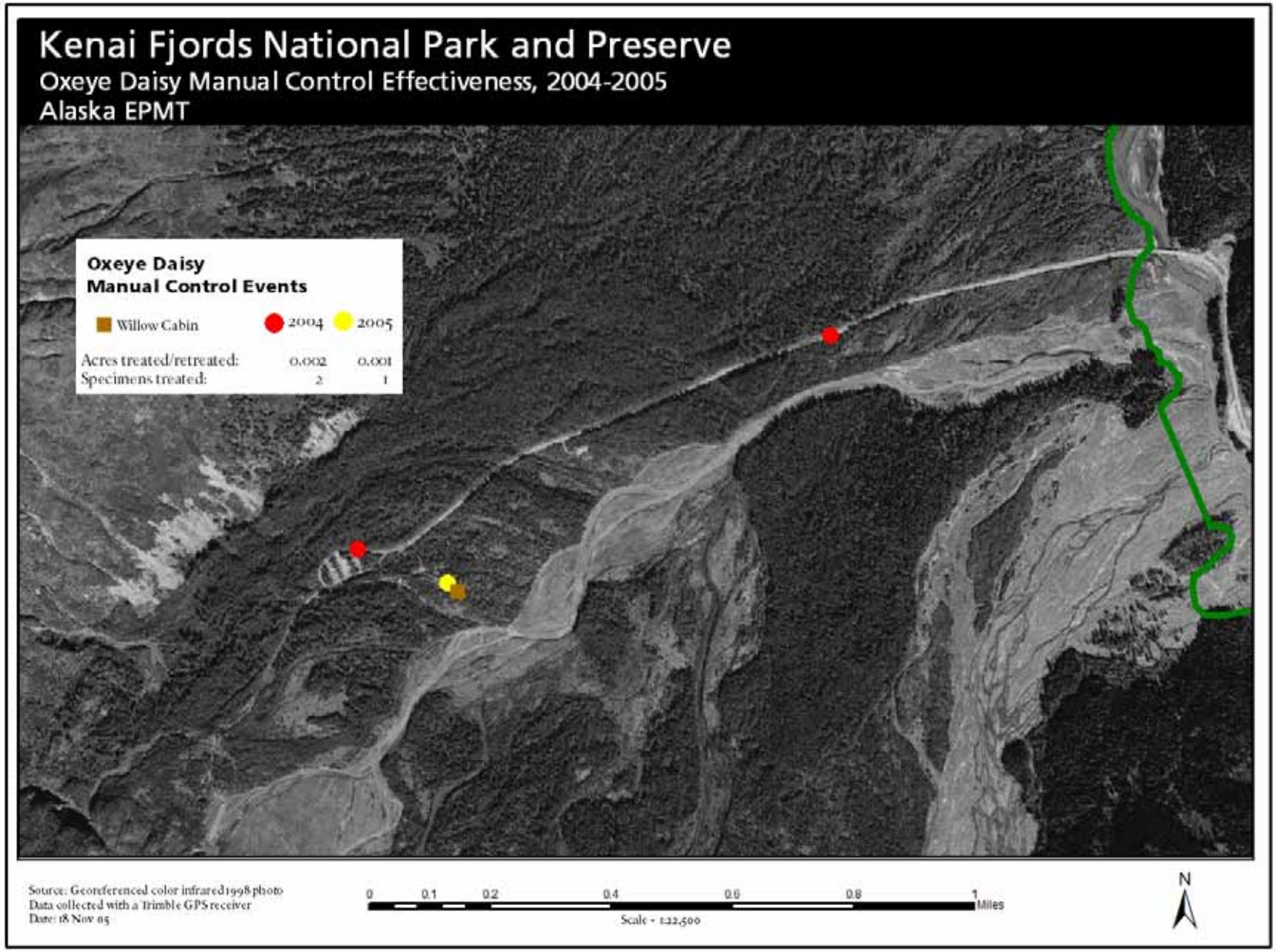
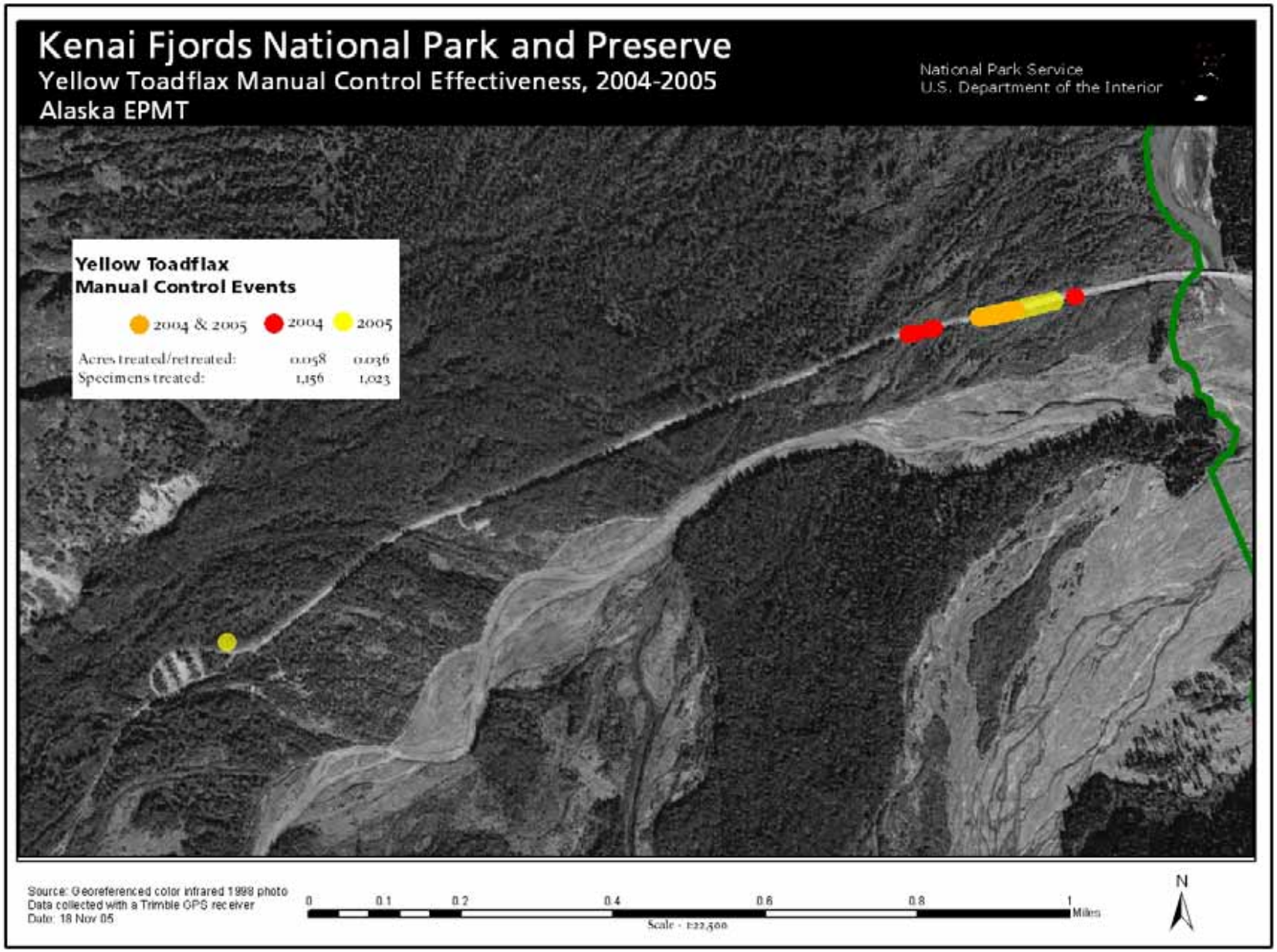


Figure 5. Yellow Toadflax Control Effectiveness in Kenai Fjords National Park and Preserve



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