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, 0xeye 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 is considered to be naturally rather than anthropogenically disturbed. 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 cabin in an area that was not inventoried in 2004. It is possible that this plant was the seed source 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

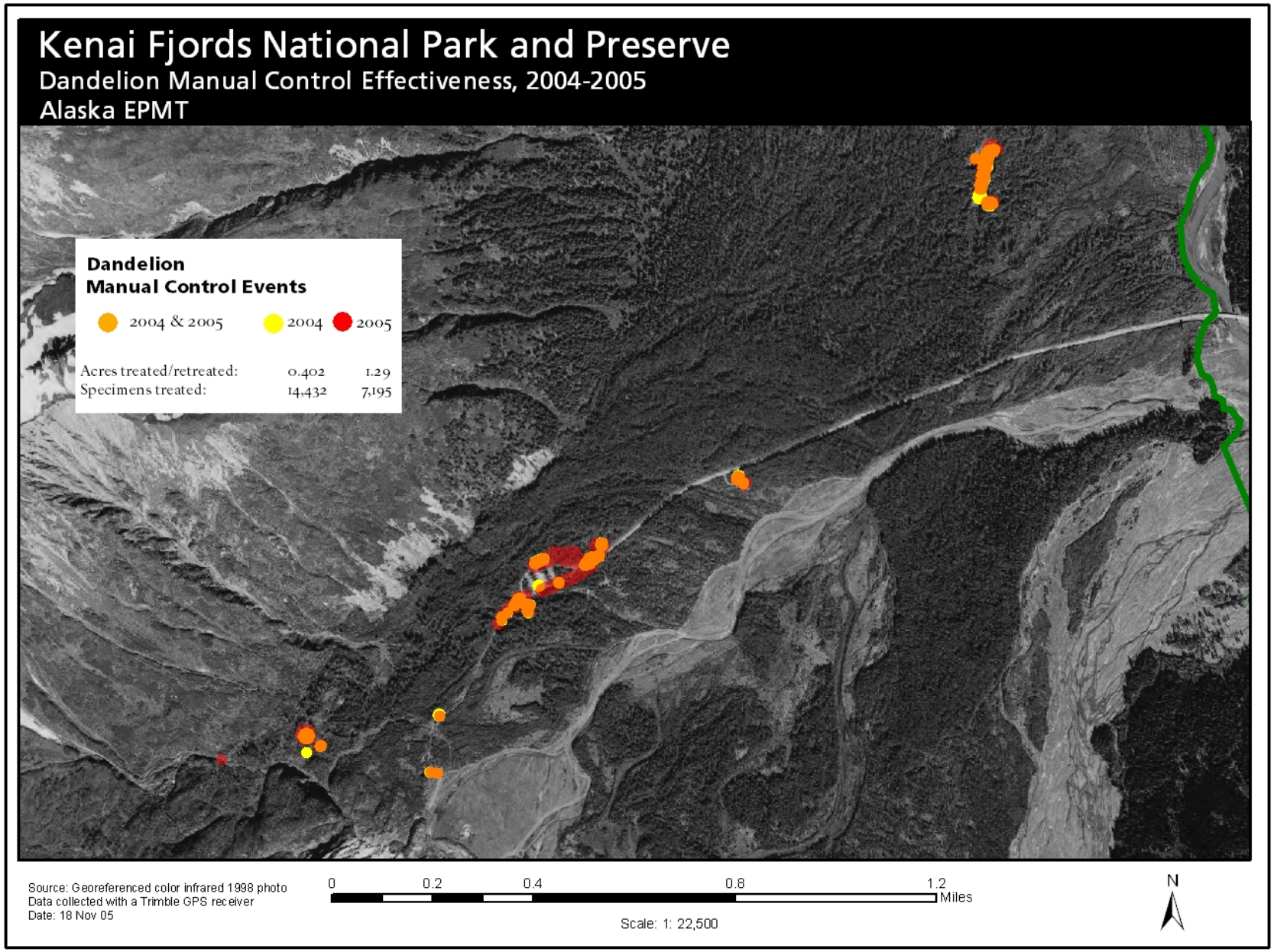


Figure 2. Dandelion Control Effectiveness in Kenai Fjords National Park, Nike Stripe

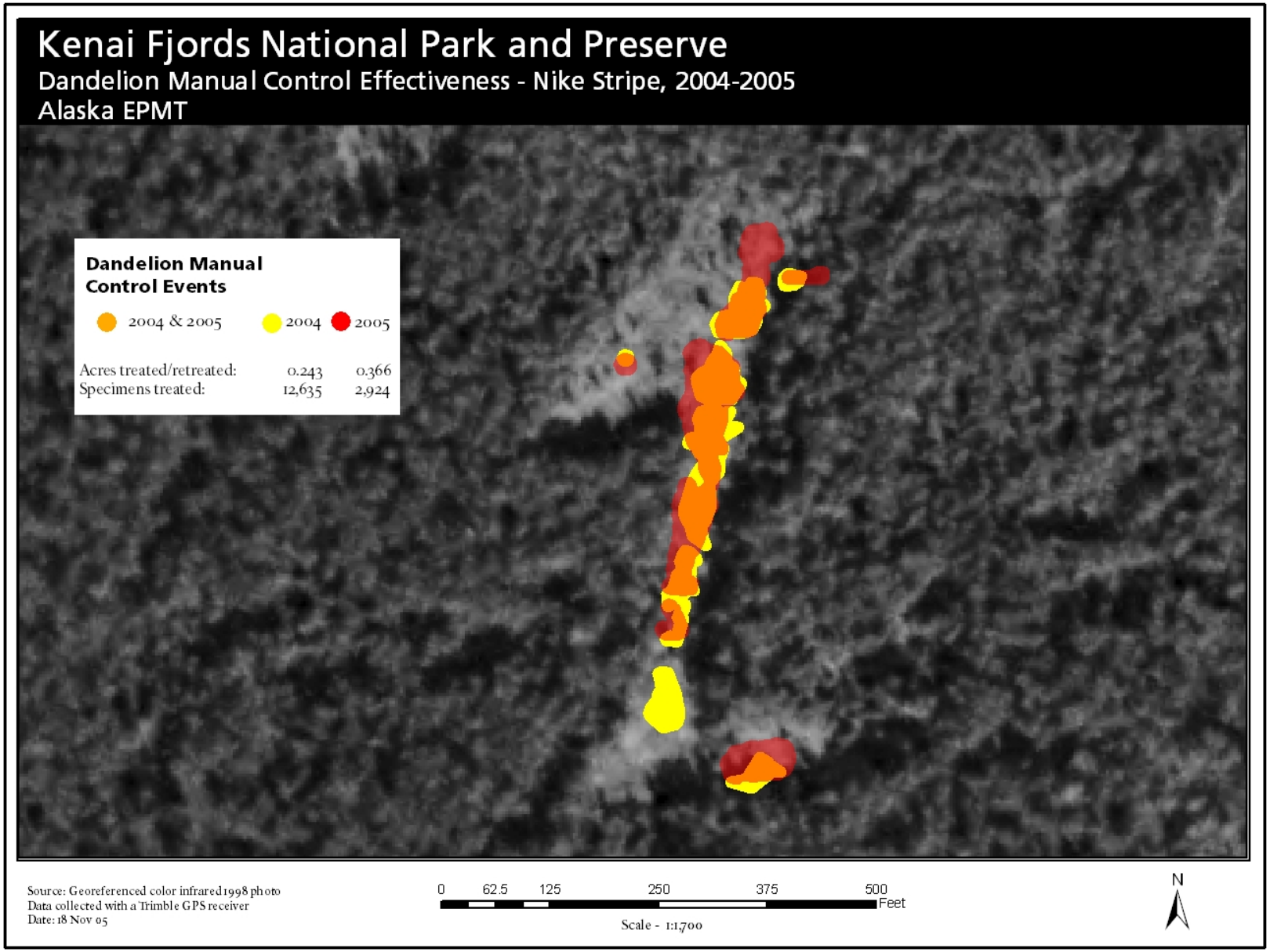


Figure 3. Dandelion Control Effectiveness in Kenai Fjords National Park, Trail System

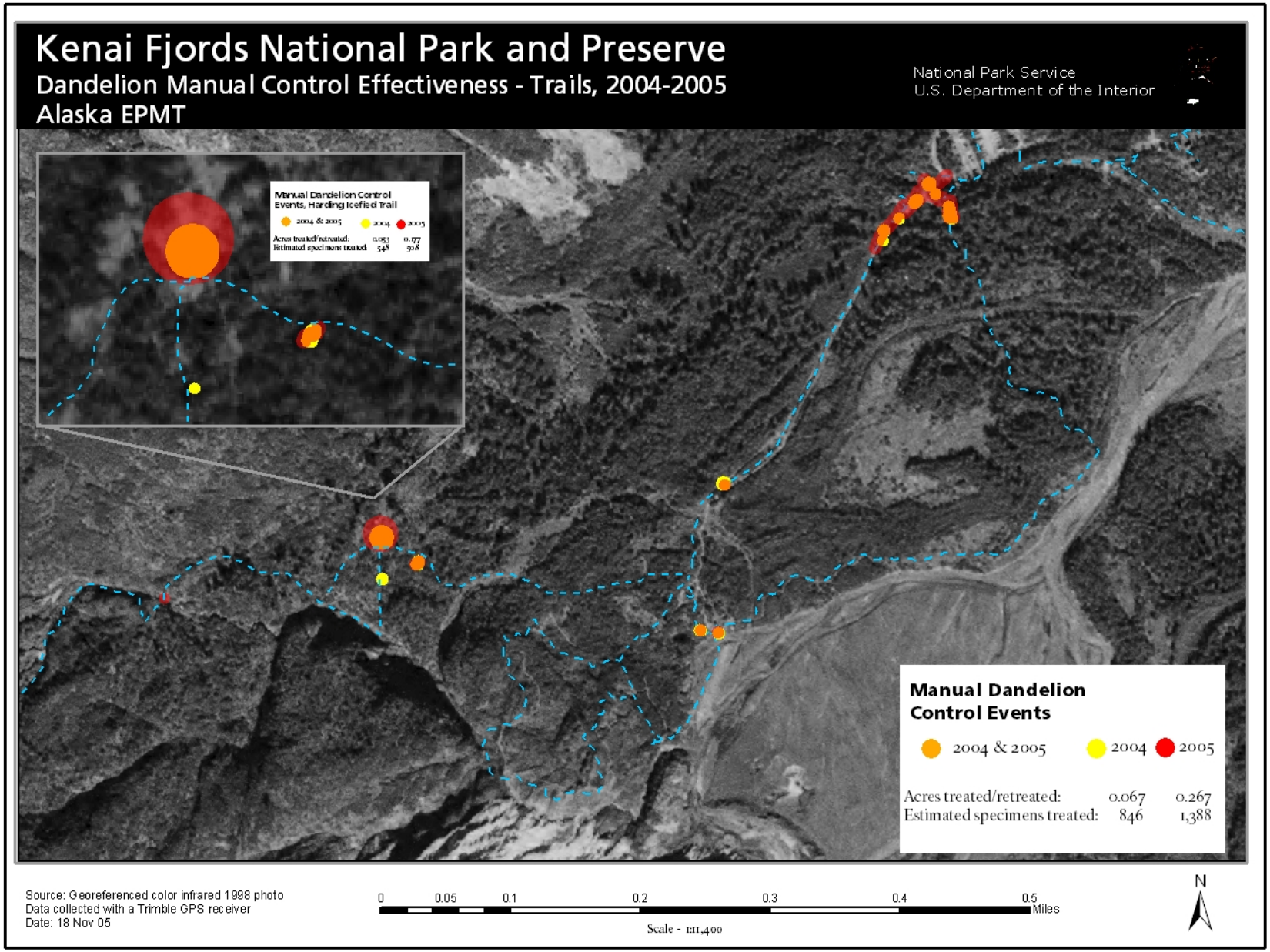


Figure 4. Oxeye Daisy Control Effectiveness in Kenai Fjords National Park

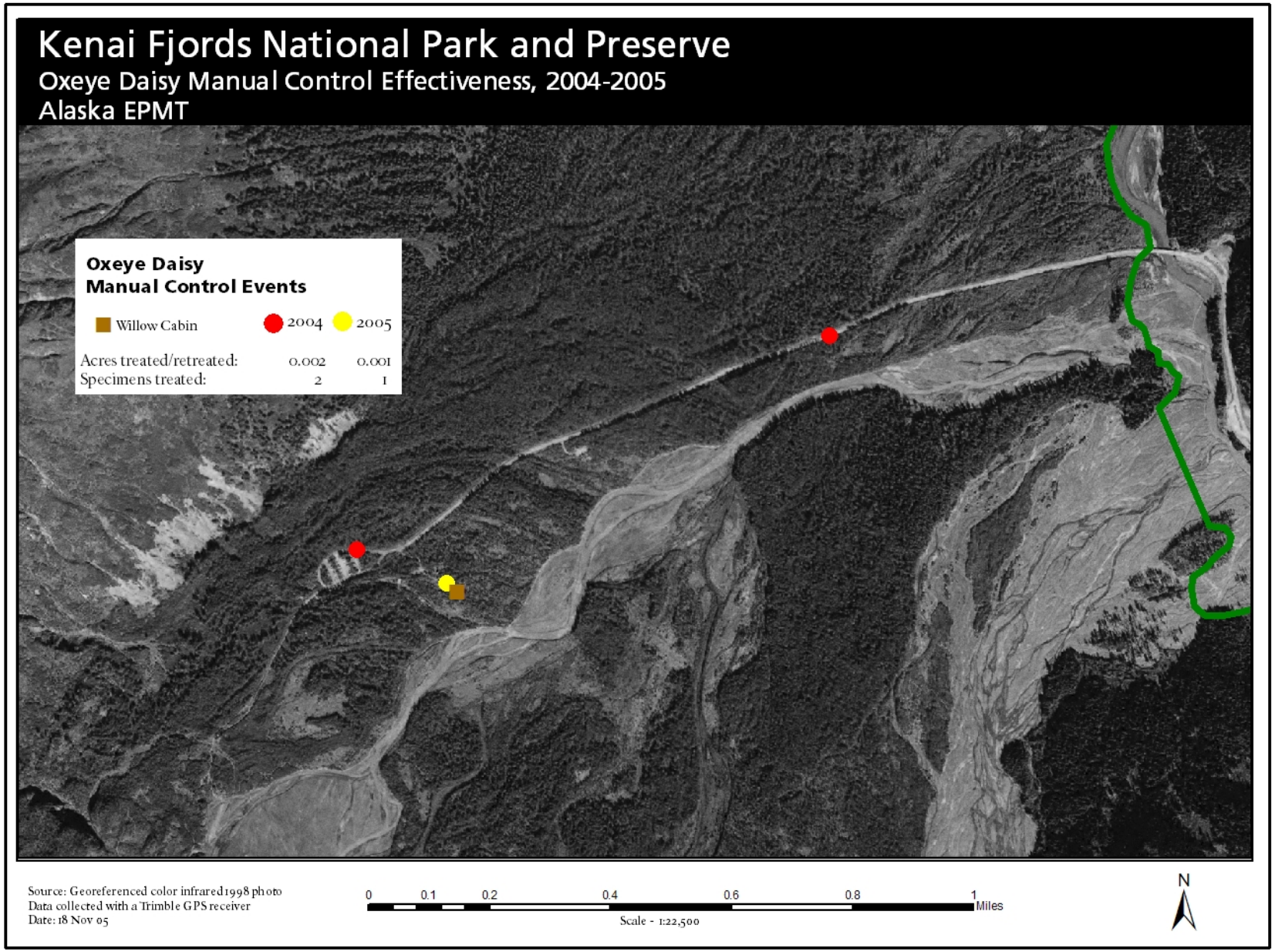
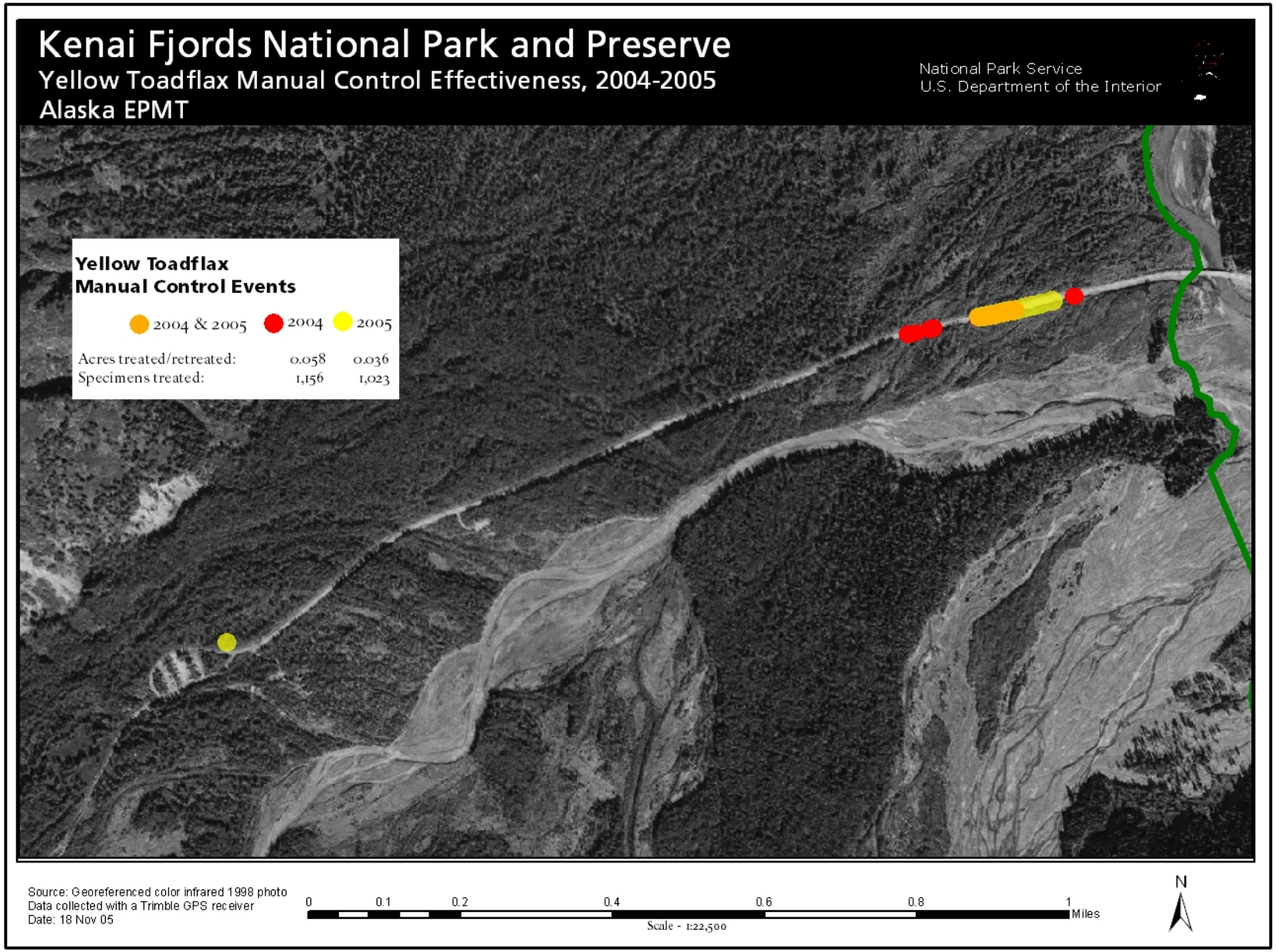


Figure 5. Yellow Toadflax Control Effectiveness in Kenai Fjords National Park



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