National Park Service
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Invasive Species Summary for the Southwest Alaska Inventory and Monitoring Network

Natural Resource Report NPS/SWAN/NRR—2009/152

ON THE COVER
Heather Wetherbee and Pyper Dixon modeling invasive plant early detection and rapid response at Kenai Fjords (KEFJ) with accurate GPS data collection.
Photograph by: Whitney Rapp, National Park Service, Glacier Bay National Park

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September 2009

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

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Please cite this publication as:

Rapp, W. 2009. Invasive species summary for the Southwest Alaska Inventory and Monitoring Network. Natural Resource Report NPS/SWAN/NRR—2009/152. National Park Service, Fort Collins, Colorado.

NPS 953/100369, September 2009

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Abstract

Invasive species pose a significant resource management concern since they can upset the native ecosystem balance. Within the Southwest Alaska Inventory and Monitoring (I&M) Network (SWAN) of the National Park Service (NPS), effort and resources have been invested in inventorying and controlling invasive plant species since 2003 by park staff and the Alaska Region Exotic Plant Management Team (AK-EPMT). Of the five park units, Alagnak Wild River (ALAG) and Aniakchak National Monument and Preserve (ANIA) have no documented invasive species within their boundaries. Within or near Katmai National Park and Preserve (KATM), Kenai Fjords National Park and Preserve (KEFJ), and Lake Clark National Park and Preserve (LACL) are 50 invasive species with a mapped infestation area exceeding 90 acres. KEFJ, which has the highest visitation, is on the road system, and has the greatest number of invasive species, has had the most control effort to date. Analyses of the effectiveness of manual and mechanical removal of invasive species in the Exit Glacier area of KEFJ shows that the number of plants and infestation area has decreased for several species and areas. None of these larger populations has been eradicated; however, several smaller populations have been successfully eliminated. In addition to invasive plants, a discussion evaluates other potential terrestrial, aquatic, and marine invasive species in the SWAN units is made that may warrant future attention.

Acknowledgments

Funding for this report was provided by the Southwest Alaska Inventory and Monitoring (SWAN I&M) Program. In particular, Michael Shephard and Dorothy Mortenson provided the framework for the report. I would also like to thank Jeff Heys, Exotic Plant Management Team (EPMT) Liaison, for creating the foundation of much of the work that has been done with terrestrial invasive plants. This project serves as a model collaborative project between the I&M and EPMT programs in the Alaska Region of the NPS.

Invasive Plants in SWAN Parks

Since 2001, baseline surveys for non-native plant species have been carried out on National Park Service (NPS) lands in Alaska. These surveys serve as the first source of data to be used in formulating long-term monitoring and control plans for exotic plant species in Alaska's NPS units. Exotic plant species are a concern to resource managers because they threaten the genetic integrity of native flora through hybridization (D'Antonio et. al 2001), can outcompete resident plant species for limited resources, and can change the structure and function of ecosystems through alterations of geochemical and geophysical processes (Ruesnik et. al 1995, Gordon 1998). Already, 1.1 million ha (2.6 million acres) or over 3% of the 34 million ha (83 million acres) managed by the NPS nationwide are infested with nonnative plant and animal species (Drees 2004). Conservative estimates of the economic costs of biotic invasions total $120 billion in the United States annually (Pimentel et al. 2005).

In Alaska, NPS lands have thus far avoided invasion by many pernicious exotic species found in the lower 48 states (Westbrooks 1998). Several factors have contributed to this legacy. The first is climate. Circumboreal flora are adapted to a wide range of climatic conditions that exotic plants typically cannot tolerate. In addition, many parklands in Alaska have remained relatively free of anthropogenic disturbances such as livestock grazing, wildfire suppression, and altered hydrological regimes that encourage the introduction of exotic species. Consequently, the remote wilderness parks in Alaska retain all of their major floral and faunal ecosystem components (Densmore et. al 2001). Despite these protective factors, the threat of exotic plant invasion is increasing due to factors including global warming, increases in construction-related disturbance, and tourism. Throughout Alaska, over 280 non-native plant species have been documented, accounting for approximately 13.5% of the flora (Carlson and Shephard 2007). Fortunately, the NPS in Alaska has the opportunity to stay ahead of exotic plant introductions before they become a serious problem, but research and active management must begin now (Spencer 2001).

The Alaska Exotic Plant Management Team (AK-EPMT) has conducted invasive plant surveys in three NPS units in the Southwest Alaska Network (SWAN): Katmai National Park and Preserve (KATM), Kenai Fjords National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). Of the three units, KEFJ is the only park accessible by the road system and has the highest visitation. The other two units are accessible by plane or boat only. Since accessibility and human activity (Table 1) are often correlated with invasive plant introductions and dispersal, the greatest invasive plant management efforts have been invested at KEFJ and the Exit Glacier area in particular, where annual work has occurred since 2004. KATM and LACL were surveyed in 2005, and KATM has had control work performed subsequently in 2007. The remaining SWAN units, Alagnak Wild River (ALAG) and Aniakchak National Monument and Preserve (ANIA), have not been specifically surveyed for invasive plants and have no documented invasive plants within their boundaries.

Table 1 – Statistics for KATM, KEFJ, and LACL regarding size, visitation, and acres of invasive plant surveys, infestations, and treatments.

Park	KATM	KEFJ	LACL
Acres of NPS Unit	4,093,239	669,983	4,030,025
Park Visitation (2003-2007 average)	62,783	256,496	5,138
Acres Inventoried (to 2007)	198.674	52.180	71.551
Acres Infested of Inventoried Area	12.059	13.185	22.274
Acres Uninfested of Inventoried Area	186.615	38.995	49.277
Acres Treated of Infested Area	2.366	8.157	0.254
% of Inventoried Land Infested	6.1%	25.3%	31.1%
% of Infested Land Treated	19.6%	61.9%	1.1%
Number of Invasive Plant Species Identified within the Park	15	20	20
Number of Invasive Plant Species Identified within and near the Park	15	36	30

Visitor data from http://www.nature.nps.gov/stats

Park total acreage from http://www.nature.nps.gov/stats/acreagemenu.cfm

All other data from AK-EPMT permanent dataset

The three NPS units share many of the same species as the most prevalent species observed during inventory efforts, including pineapple weed, common dandelion, and common plantain (Table 2). These species thrive in disturbed habitats throughout Alaska.

Table 2 – Species with the greatest mapped distribution in and around KATM, KEFJ, and LACL.

KATM	KEFJ	LACL
pineapple weed (*Matricaria discoidea*) - 11.977 acres	common dandelion (*Taraxacum officinale* ssp. *officinale*) - 11.753 acres	pineapple weed (*Matricaria discoidea*) - 17.474 acres
common dandelion (*Taraxacum officinale* ssp. *officinale*) - 6.1 acres	common plantain (*Plantago major*) - 0.886 acres	common lambsquarters (*Chenopodium album*) * - 11.158 acres
shepherd's purse (*Capsella bursa-pastoris*) - 3.711 acres	oxeye daisy (*Leucanthemum vulgare*) - 0.785 acres	common dandelion (*Taraxacum officinale* ssp. *officinale*) - 10.447 acres
common plantain (*Plantago major*) - 1.717 acres	yellow alfalfa (*Medicago sativa* ssp. *falcata*) * - 0.480 acres	common plantain (*Plantago major*) - 7.144 acres
common sheep sorrel (*Rumex acetosella*) - 1.432 acres	white clover (*Trifolium repens*) - 0.303 acres	common chickweed (*Stellaria media*) - 5.540 acres

* = only documented outside of park boundary

The three park areas also share several species that pose the greatest risk to native habitats according the Alaska Natural Heritage Program's (AKNHP) Weed Ranking Project (http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm). Several of these species, such as oxeye daisy and yellow toadflax, are frequently introduced intentionally for their attractive flowers. Other species, such as smooth brome and white clover, are often part of seed mixes used for revegetation either intentionally or as a contaminant.

Table 3 – Species of the greatest threat to KATM, KEFJ, and LACL based on AKNHP rank (0 to 100 with 100 being the greatest risk).

KATM	KEFJ	LACL
smooth brome grass (*Bromus inermis* ssp. *inermis*) - 62	white sweetclover (*Melilotus alba*) * - 80	reed canarygrass (Phalaris arundinacea) - 83
oxeye daisy (*Leucanthemum vulgare*) - 61	orange hawkweed (*Hieracium auranticum*) * - 79	orange hawkweed (*Hieracium auranticum*) - 79
white clover (*Trifolium repens*) - 59	bird vetch (*Vicia cracca*) * - 73	smooth brome grass (*Bromus inermis* ssp. *inermis*) * - 62
common dandelion (*Taraxacum officinale* ssp. *officinale*) - 58	yellow toadflax (*Linaria vulgaris*) - 69	oxeye daisy (*Leucanthemum vulgare*) - 61
narrowleaf hawksbeard (*Crepis tectorum*) - 54	yellow sweetclover (*Melilotus officinalis*) * - 65	white clover (*Trifolium repens*) - 59
Kentucky bluegrass (*Poa pratensis*) - 52	yellow alfalfa (*Medicago sativa* ssp. *falcata*) * - 64	common dandelion (*Taraxacum officinale* ssp. *officinale*) - 58
common sheep sorrel (*Rumex acetosella*) - 51	foxtail barley (*Hordeum jubatum*) - 63	common tansy (*Tanacetum vulgare*) - 57
annual bluegrass (*Poa annua*) - 46	oxeye daisy (*Leucanthemum vulgare*) - 61	alsike clover (*Trifolium hybridum*) * - 57

* = only documented outside park boundary
Ranking from http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm on 10/22/2007

The invasive plant issues of each of the three park units with known infestations will be discussed further in the following sections. In KATM and LACL, the majority of the work has been performed by the AK-EPMT. In KEFJ, the work has been performed by park staff with assistance from and using protocols developed by the AK-EPMT. Survey work has used high accuracy Trimble GPS units. These units can achieve sub-meter accuracy and have been equipped with custom data dictionaries, enabling both precise mapping and standardized data collection. They were used to map both infested areas and areas without invasive plants with detail sufficient for annual monitoring of spread. Survey methodology has generally been opportunistic sampling focused on areas of human development and frequent human use. All invasive plant data is maintained by the AK-EPMT in an ESRI geodatabase.

Invasive Plants in KATM

Three factors contribute to KATM's vulnerability to exotic plant invasion. First, KATM encloses a large land area (Table 1) with fifteen active volcanoes. The terrestrial landscape is, therefore, undergoing transformations through the ongoing colonization of areas covered by deposits of volcanic ash and sand from past eruptions. Second, Brooks Camp, located in the western interior of the park, is home to the park's only established campground and maintained

hiking trails and is a popular destination for both national and international travelers. Access into Brooks Camp is typically by floatplane via King Salmon, Homer, Kodiak, or Anchorage. Third, guided wildlife viewing and fishing trips are common along the Katmai coast and concentrated at lodges elsewhere in the park and hunting trips occur in the Preserve. So far, there are relatively few species present in King Salmon and KATM, but the threat of invasive plant introduction and spread grows every year with increasing numbers of summer visitors, the escape of planted ornamentals from towns and private residences, and ongoing construction and maintenance activities that disturb the soil, facilitating invasive plant establishment.

Figure 2 – A small patch of oxeye daisy along the Lake Camp road is the only occurrence of this species in the park.

Figure 3 – Trampling by bears at Brooks Camp can also provide invasible habitat, and they certainly complicate control efforts.

On the other hand, there are very limited avenues for the introduction of invasive plants into KATM: primarily the Lake Camp road, Brooks Camp, the Valley of Ten Thousand Smokes, and coastal use areas. The road to Lake Camp is the only section of the park accessible by private vehicles since the use of vehicles in Brooks Camp and the Valley of Ten Thousand Smokes is limited to park employees and lodge staff. Possibly as a result, KATM has fared well in its isolation and has a real opportunity to avoid the problems other parks are experiencing, but park managers must remain vigilant. The purpose of surveys in KATM during the 2005 field season were to document the distribution, abundance, and species composition of invasive plants in the four areas mentioned above and control infestations where feasible (Bauder and Heys 2005a). Subsequent control work occurred in 2006 and 2007 through the dedication of a single volunteer and also in 2007 by a Tribal Civilian Community Corps (TCCC) under the direction of KATM staff.

Table 4 – Summary of invasive plants found in different regions in KATM. Sources Bauder and Heys 2005a, AKEPIC database, and AK-EPMT geodatabase.

	AKNHP Species Ranking	Lake Camp	Brooks Camp	Valley of Ten Thousand Smokes Road	Other Backcountry Locations	Outer Coast
smooth brome grass (*Bromus inermis* ssp. *inermis*)	62		x			
shepherd's purse (*Capsella bursa-pastoris*)	40	x	x	x		
mouse-ear chickweed (*Cerastium fontanum*)	36			x		
narrowleaf hawksbeard (*Crepis tectorum*)	54			x		
wormseed mustard (*Erysimum cheiranthoides*)			x			
oxeye daisy (*Leucanthemum vulgare*)	61	x				
pineapple weed (*Matricaria discoidea*)	32	x	x	x	x	x
curlytop knotweed (*Persicaria lapathifolia*)			x			
common plantain (*Plantago major*)	44	x	x		x	
annual bluegrass (*Poa annua*)	46		x			
Kentucky bluegrass (*Poa pratensis*)	52		x			
prostrate knotweed (*Polygonum aviculare*)	45	x	x	x		
common sheep sorrel (*Rumex acetosella*)	51	x				
common dandelion (*Taraxacum officinale* ssp. *officinale*)	58		x		x	
white clover (*Trifolium repens*)	59		x			
Total Species Present		6	11	5	3	1

Survey work in the Lake Camp area has located the common invasive plant species shepherd's purse, sheep sorrel, prostrate knotweed and pineapple weed growing near the boat ramp and around the parking lot at the access to Naknek Lake. A species of greater concern based on its ability to invade low disturbance areas and displace native species is oxeye daisy, which was seen escaping from a garden planter near the driveway of a private property about 1.5 miles from the lake (Fig.2).

Figure 4 – Penny Bauder removing narrowleaf hawksbeard from the gravel pit on the Valley of Ten Thousand Smokes Road.

Brooks Camp has the greatest number of species and most vigorous populations of invasive plants of any area surveyed in KATM (Table 4). Commonly observed species include shepherd's purse, pineappleweed, common sheep sorrel, annual bluegrass, Kentucky bluegrass, and prostrate knotweed. Common dandelion grows in scattered patches and is densest at the campground and cultural site. The 2007 efforts by the TCCC crew focused on dandelion control, particularly at the Brooks Lodge, on the Brooks Falls trail, on the trail to the cultural site, and along the road near

the Brooks River. Common plantain is growing only north of the Brooks River, including near the maintenance building, in the employee housing area, on the trail to and in the campground. White clover has a very restricted distribution near the lodge commons. Shepherd's purse and wormseed mustard were found at "the corner." The NPSpecies database (SWN I&M) documents curlytop knotweed growing near the junction of the Naknek Lake and Brooks River.

The Valley of Ten Thousand Smokes Road had occasional populations of Kentucky bluegrass and pineappleweed in pull-offs. From the NPSpecies database, mouse-ear chickweed was collected near Knife Creek and prostrate knotweed from the Three-Forks Overlook. No invasive plants have been detected on the Margot Falls and Uyak trails; around the Three Forks Cabin and parking lot; and along most of the Valley Road. Several hundred yards down the social trail that leads to the southern edge of the Valley of Ten Thousand Smokes a small patch of common plantain grows. The most concerning population, however, occurs at mile 4.3 at the gravel pit on the north side of the road. Within this area, narrowleaf hawksbeard has been observed and subsequently removed annually. In 2005, there were 145 plants (Fig. 4). As of 2007, only 4 plants were located and removed before the site was buried under equipment.

Figure 5 – Backpackers heading into the Valley of 10,000 smokes may bring invasive plant seeds in the backcountry on their gear.

From the 2000 survey by Roseann Densmore and Chris McGee (USGS-BRD) of KATM (data retrieved from the AKEPIC database), common plantain, common dandelion, and pineappleweed were found growing at Kulik Lodge between Kulik and Nonvianuk Lakes. The same survey found pineappleweed and common dandelion at the Grosvenor Lodge between Grosvenor and Coville Lakes. From Katmai Lodge, which is closer to Alagnak Wild River (ALAG), pineappleweed and common plantain were observed.

Figure 6 – The large supratidal meadows on the KATM coast are vulnerable to invasion by common dandelion and other invasive plants.

The surveyed areas of the KATM outer coast revealed pineapple weed at the former Russian Orthodox Church enroute to the current Hallo Bay Lodge. Other than this population near Kaguyak Bay, no invasive plants were observed in Hallo or Switshak

Bays. The outer coast habitats are comparable to areas of Kenai Fjords National Park and Glacier Bay National Park and Preserve, which have both experienced invasion of coastal habitats by invasive species, specifically common dandelion and perennial sowthistle.

Although KATM is not free of non-native species, the species that are present are still restricted in their distributions and are generally less deleterious to native ecosystems. Through continued control activities, it is possible to contain or eradicate population of invasive plants within the park. Preventing future species introductions will be the surest way to maintain KATM's native habitats through education of park staff, local residents, commercial use operators, and visitors and the use of best management practices for ground-disturbing projects.

Invasive Plants in KEFJ

KEFJ has the greatest visitation of the five SWAN park units and is connected to the road system, which are two factors that make the introduction and spread of invasive species more likely. As a result, KEFJ has had seasonal staff dedicated to invasive plant management based in the Exit Glacier area since 2003. Their efforts have resulted in consistent mapping and sustained control efforts over multiple years. Regardless, there are still twenty documented non-native species from within the park and an additional sixteen species observed in the surrounding areas (Table 1). Many of these species that are significant threats to the environment (Table 5).

Figure 7 – Elizabeth Bella, Chris McKee, and Christina Kriedeman work to control invasive plants near the park boundary on the Chugach National Forest.

Table 5 – Summary of invasive plants found in different regions in KEFJ. Sources Wetherbee 2007, Wetherbee 2006, Kriedeman 2005, Kriedeman 2004, Densmore et al. 2001, Carlson et al. 2005, AKEPIC database, SWAN NPSpecies database, and AK-EPMT geodatabase.

	AKNHP Species Ranking	Exit Glacier Area	Outer Coast	Outside of Park
red top (*Agrostis gigantea*)			x	
field mustard (*Brassica rapa*)		x		x
smooth brome (*Bromus inermis*)				x
mouse-ear chickweed (*Cerastium fontanum*)	36	x	x	x
narrowleaf hawksbeard (*Crepis tectorum*)	54	x		x
orchardgrass (*Dactylis glomerata*)	54			x
quackgrass (*Elymus repens*)	59			x
splitlip hempnettle (*Galeopsis bifida*)	40			x
orange hawkweed (*Hieracium auranticum*)	79			x
foxtail barley (*Hordeum jubatum*)	63	x		
fall dandelion (*Leontodon autumnalis*)				x
oxeye daisy (*Leucanthemum vulgare*)	61	x		x
yellow toadflax (*Linaria vulgaris*)	69	x		
perennial ryegrass (*Lolium perenne*)	41			x
bigleaf lupine (*Lupinus polyphyllus*)				x
pineapple weed (*Matricaria discoidea*)	32	x		x
black medic (*Medicago lupulina*)	48			x
yellow alfalfa (*Medicago sativa* ssp. *falcata*)	64			x
white sweetclover (*Melilotus alba*)	80			
yellow sweetclover (*Melilotus officinalis*)	65			x
ball mustard (*Neslia paniculata*)				x
Icelandic poppy (*Papaver nudicale*)		x		
common timothy (*Phleum pratense*)	56	x	x	x
common plantain (*Plantago major*)	44	x		x
annual bluegrass (*Poa annua*)	46	x	x	x
Kentucky bluegrass (*Poa pratensis*)	52	x		x
tall buttercup (*Ranunculus acris*)	54	x		
common sheep sorrel (*Rumex acetosella*)	51	x		
curled dock (*Rumex crispus*)	48	x		
corn spurry (*Spergula arvensis*)	32			x
common dandelion (*Taraxacum officinale* ssp. *officinale*)	58	x	x	x
alsike clover (*Trifolium hybridum*)	57	x		x
red clover (*Trifolium pratense*)	53	x		x
white clover (*Trifolium repens*)	59	x		x
scentless false mayweed (*Tripleurospermum perforata*)	48			x
wheat (*Triticum aestivum*)				x
bird veth (*Vicia cracca*)	73			x
Total Species Present		19	5	29

Seward and the roads leading to the park (Table 6) host a number of aggressive invasive species, such as bird vetch, yellow sweetclover, yellow alfalfa, and quackgrass, which have not yet been observed within the park. Through cooperation with partners, such as the U.S. Forest Service, efforts have been made to limit the spread of invasive plants towards the park boundary (Fig. 7).

Table 6 - Summary of invasive plants detected in a 2007 USFS survey. A subsection of the study was analayzed, including the 85 locations closest to KEFJ on the Seward Highway, Nash Road, and Exit Glacier Road. Bold names indicate species not previously documented by NPS. (Arhangelsky 2008 draft)

Species	Number of Locations Observed
smooth brome (*Bromus inermis*)	1
shepherd's purse (*Capsella bursa-pastoris*)	3
mouse-ear chickweed (*Cerastium fontanum*)	23
common lambsquarters (*Chenopodium album*)	6
narrowleaf hawksbeard (*Crepis tectorum*)	2
orchardgrass (*Dactylis glomerata*)	2
quackgrass (*Elymus repens*)	3
splitlip hempnettle (*Galeopsis bifida*)	1
orange hawkweed (*Hieracium aurantiacum*)	1
foxtail barley (*Hordeum jubatum*)	2
fall dandelion (*Leontodon autumnalis*)	6
oxeye daisy (*Leucanthemum vulgare*)	29
yellow toadflax (*Linaria vulgaris)*	16
Italian ryegrass (*Lolium multiflorum*)	8
perennial ryegrass (*Lolium perenne*)	1
bigleaf lupine (*Lupinus polyphyllus*)	5
pineapple weed (*Matricaria discoidea)*	53
yellow alfalfa (*Medicago falcata*)	3
alfalfa (*Medicago sativa*)	12
white sweetclover (*Melilotus alba*)	1
yellow sweetclover (*Melilotus officinalis*)	6
Icelandic poppy (*Papaver nudicaule*)	1
common timothy (*Phleum pratense*)	50
common plantain (*Plantago major*)	73
annual bluegrass (*Poa annua*)	62
Kentucky bluegrass (*Poa pratensis*)	19
prostrate knotweed (*Polygonum aviculare*)	5
tall buttercup (*Ranunculus acris*)	6
creeping buttercup (*Ranunculus repens*)	2
common sheep sorrel *(Rumex acetosella*)	10
curled dock (*Rumex crispus*)	27
corn spurry (*Spergula arvensis*)	1
common chickweed (*Stellaria media*)	8
dandelion (*Taraxacum officinale*)	83
alsike clover (*Trifolium hybridum*)	28
red clover (*Trifolium pratense*)	3
white clover (*Trifolium repens*)	72
scentless false mayweed (*Tripleurospermum inodo*	1
wheat (*Triticum aestivum*)	1
bird vetch (*Vicia cracca*)	1

Figure 8 – Exit Glacier Road provides a path for invasive plants into KEFJ, but volunteers help curb the tide.

The Exit Glacier area has seen the majority of invasive plant work to date since it is the only area within the park boundary with significant infestations (Fig. 8). Common dandelion is the most widespread species spreading well beyond the human effected areas, including the south side of Exit Creek (Fig. 9) and the "Nike Stripe" area north of the Exit Glacier Road. Other species, thus far, have been restricted to the anthropogenically disturbed areas, including roads, trails, and near buildings. As human activity dissipates, such as farther along the Harding Icefield Trail, the number of species drops until a fully native plant community is reached. Sustained control activity over multiple years has proven effective in reducing or eradicating invasive plant populations, including yellow toadflax (Fig. 10), oxeye daisy, and

common dandelion (see Control Effectiveness section).

Over fifty of KEFJ's outer coast camping and landing beaches between Nuka Bay and Aialik Bay were surveyed in 2007 (Wetherbee 2007). Of these sites, no new invasive species populations were documented. To date, only seven invasive plant populations have been documented beyond the Exit Glacier area. Common timothy has been treated at the Beauty Bay airstrip. Control of populations of common dandelion has occurred at Dinglestadt Glacier, Pederson Lagoon, Yalik Glacier Beach, and Alaska Hills Mine (AK-EPMT geodatabase). The I&M vascular plant inventory of the park found annual bluegrass in Aialik Bay along a trail and surrounding a cabin and mouse-ear chickweed at James Lagoon in McCarty Fjord (SWAN NPSpecies database).

Due to the sustained presence of staff dedicated to invasive plant issues, the amount of education and outreach available to park staff and visitors has been greater at KEFJ than the other parks. This added awareness to the issue will likely translate to greater prevention and early detection and rapid response when invasive plants do establish.

Figure 9 – Invasive dandelions compete with dryas mats in some recently deglaciated areas near Exit Glacier.

Figure 10 – Finding yellow toadflax soon after if establishes at a new site greatly increases the chances of eradication.

Invasive Plants in LACL

Figure 11 – The town of Port Alsworth is the largest point of entry for invasive plants into Lake Clark, given the regular air traffic from Anchorage.

LACL is unique among Alaska NPS units with respect to invasive plants for several reasons. The gateway community of Port Alsworth is located within park boundaries and serves as the main access point into LACL. Port Alsworth is a bush community, accessible only by boat or plane, but it is also dependent on daily commerce with Anchorage, a city with large, well established invasive plant populations (Fig. 11). Regular travel between Port Alsworth and Anchorage greatly increases the likelihood of invasive plant introduction via hitchhiking plant materials, especially seeds. The introduction of new invasive plants will accelerate while travel between Anchorage and Port Alsworth continues, simply because of Anchorage's burgeoning weed problems.

On the other hand, besides Port Alsworth, there are limited avenues for the introduction of invasive plants into LACL, which is truly a wilderness park. There are roads only in Port Alsworth and OHV trails in only a few isolated locations. Beyond vehicular traffic, there are several potential vectors for invasive plant introduction and spread in LACL, including increasing numbers of summer visitors, especially to the outer coast; the escape of planted ornamentals from private residences and lodges; and maintenance activities that disturb the soil. So far, there are relatively few species present beyond Port Alsworth (Table 6), but given all the avenues by which they could arrive, this situation will only remain with active management (Bauder and Heys 2005b). A 2005 inventory was conducted by the AK-EPMT, but there has been no subsequent fieldwork.

Port Alsworth includes both private and NPS lands and the majority of the invasive species documented in the LACL area. Most of the species found are commonly occurring non-native species that are frequently restricted to disturbed areas, such as pineappleweed, shepherd's purse, common plantain, and prostrate knotweed. Other species, such as common dandelion, could use Port Alsworth as a springboard into wilderness areas through wind- and human-dispersed seeds. Grasses, such as smooth brome and common timothy, are silent invaders since most people will

Figure 12 – The Tanalian Falls Trail out of Port Alsworth is surprisingly free of invasive plants.

overlook grasses since they lack showy flowers. Many of the non-native species have been documented in and around private gardens, which suggests gardening is a likely source of introduction in Port Alsworth. Of the 72 acres surveyed in Port Alsworth in 2005, over 15 acres were exotic plant free, including the trail from Birch Hill compound to NPS headquarters and the entire Tanalian Falls trail (Fig. 12) (Bauder and Heys 2005b).

Table 6 – Summary of invasive plants found in different regions in LACL. Sources Bauder and Heys 2005b, Lipkin 2002, AKEPIC database, and AK-EPMT geodatabase.

	AKNHP Species Ranking	**Port Alsworth (primarily non-NPS)**	**Other Backcountry Location**	**Outer Coast**
marsh meadow-foxtail (*Alopecurus geniculatus*)		x	x	
pigweed (*Amaranthus retroflexus*)		x		
field mustard (*Brassica rapa*)		x		
smooth brome grass (*Bromus inermis* ssp. *inermis*)	62	x		
shepherd's purse (*Capsella bursa-pastoris*)	40	x		
common lambsquarters (*Chenopodium album*)	35	x		
narrowleaf hawksbeard (*Crepis tectorum*)	54	x	x	
redstem stork's bill (*Erodium cicutarium*)		x		
wormseed mustard (*Erysimum cheiranthoides*)				x
common strawberry (*Fragaria virginiana*)				x
ground ivy (*Glechoma hederacea*)	48		x	
orange hawkweed (*Hieracium auranticum*)	79		x	
oxeye daisy (*Leucanthemum vulgare*)	61	x		x
Italian ryegrass (*Lolium perenne* ssp. *multiflorum*)	41	x		
pineapple weed (*Matricaria discoidea*)	32	x		x
curlytop knotweed (*Persicaria lapathifolia*)			x	
reed canarygrass (*Phalaris arundinacea*)	83			x
common timothy (*Phleum pratense*)	56	x		
common plantain (*Plantago major*)	44	x	x	x
annual bluegrass (*Poa annua*)	46		x	x
Kentucky bluegrass (*Poa pratensis*)	52		x	
prostrate knotweed (*Polygonum aviculare*)	45	x	x	x
common sheep sorrel (*Rumex acetosella*)	51	x		
corn spurry (*Spergula arvense*)	32			x
common chickweed (*Stellaria media*)	42/54	x		x
common tansy (*Tanacetum vulgare*)	57			x
common dandelion (*Taraxacum officinale* ssp. *officinale*)	58	x	x	x
alsike clover (*Trifolium hybridum*)	57	x		
white clover (*Trifolium repens*)	59	x	x	x
thyme-leaf speedwell (*Veronica serpyllifolia*)				x
Total Species Present		19	11	14

In the Twin Lakes area, common dandelion was the only invasive plant observed. They were located in two places: Dick Proenneke's cabin (Fig. 13) and the Vandenberg cabin site. All other areas surveyed, including the Hope Creek Campground, Cogwill's Cabin, and Twin Lakes Ranger Cabin, were free from invasive plants (Fig. 14).

Figure 13 – Dick Proenneke's cabin became the site of a dandelion infestation when the sod roof was replaced with tundra mats from across the lake, where a search revealed that invasive dandelions were thoroughly integrated with the tundra plant community.

During the SWAN I&M vascular plant inventory of LACL (Lipkin 2002) and concurrent analysis of previous collections (NPSpecies), Kentucky bluegrass was collected form Little Mulchatna River approximately 3km northeast of the Fishtrap Lake and on the west shore of Portage Lake. Marsh meadow-foxtail was found at Snipe Lake, the mouth of Tanalian River, and in Port Alsworth. Narrowleaf hawksbeard was found in both Port Alsworth and growing in the sod on Dick Proenneke's cabin at Upper Twin Lake. Ground ivy, orange hawkeed, annual bluegrass, and white clover were located on the Hammond property at Miller Creek. Curlytop knotweed, prostrate knotweed, common plantain, and white clover were collected from the garden area of the Koksetna Lodge at Chulitna Bay. Alsike clover was found in Port Alsworth.

Along the LACL outer coast, the only occurrence of oxeye daisy beyond Port Alsworth was found at Silver Salmon Creek Lodge (Fig. 15), and pineappleweed, common plantain, common chickweed, common dandelion, and white clover were also found in the Silver Salmon area. Of particular concern is that invasive dandelions were found to be spreading into a supratidal meadow off an OHV trail there. Collections made from this area also indicate the presence of

Figure 14 – Since park volunteers know the most popular campsites around Twin Lakes, early detection efforts can be concentrated at these sites.

Figure 15 – Oxeye daisies are escaping cultivation at the Silver Salmon Creek Lodge in LACL.

annual bluegrass and corn spurry (NPSpecies). In the Glacier Spit area of Chinitna Bay, pineappleweed, common plantain, common dandelion, and common strawberries were observed. Collections recorded in NPSpecies document the presence of reed canarygrass, annual bluegrass, prostrate knotweed, common tansy, and thyme-leaf speedwell also present in the coastal area of LACL.

There are many non-native species occurrences that have not been mapped by the AK-EPMT, which may warrant additional field time for accurate documentation of population extents. These species include marsh meadow-foxtail, field mustard, narrowleaf hawksbeard, redstem stork's bill, wormseed mustard, common strawberry, ground ivy, orange hawkweed, Italian ryegrass, curlytop knotweed, reed canarygrass, annual bluegrass, Kentucky bluegrass, corn spurry, common tansy, alsike clover, and thyme-leaf speedwell.

Native horned dandelions (*Taraxacum officinale* ssp. *ceratophorum*) were observed in multiple locations during survey work in LACL. Since they could be mistaken for the invasive dandelions, care should be taken to properly identify dandelions in this area.

Invasive Plant Control Effectiveness

To date, the AK-EPMT has been restricted to controlling invasive plants using manual and mechanical methods only. Manual control is advantageous since 1) little training and no licensing is required, so a wide labor pool can be used; 2) minimal preparatory work is needed, including organization, supervision, and equipment, such as work gloves, hand tools, and disposal bags; 3) weather is not a limiting factor, although wet soils make plant removal easier; 4) site conditions rarely limit the ability to work; 5) there is no introduction of chemical or biological control agents to the environment; and 6) it is the most species-specific method to avoid affecting native vegetation. In contrast, manual control is disadvantageous since 1) it is highly labor intensive and physically demanding; 2) it is extremely costly for large or dense infestations due to the amount of labor needed; 3) it rarely succeeds in the short term and requires repeated treatments within a season for many years; and 4) widespread soil disturbance and trampling of vegetation result, which can promote weed seed germination and lead to soil erosion, particularly on slopes.

The effectiveness of manual control can vary widely depending on plant species, infestation size and age, timing, site characteristics, and regularity of treatment. To gauge the effectiveness of the manual treatments that have occurred thus far in SWAN parks, the efforts in the Exit Glacier area of KEFJ were examined since the most work has been performed here and consistent staffing (Christina Kriedeman in 2004-5 and Heather Wetherbee 2006-7) recorded high-quality data. The AK-EPMT GIS dataset was used for all analyses. The areas analyzed included: 1) the common dandelion infestation in the "Nike Stripe" area; 2) the common dandelion and common plantain populations on the Harding Icefield trail; 3) oxeye daisies in the Exit Glacier developed area; and 4) yellow toadflax along the Exit Glacier Road.

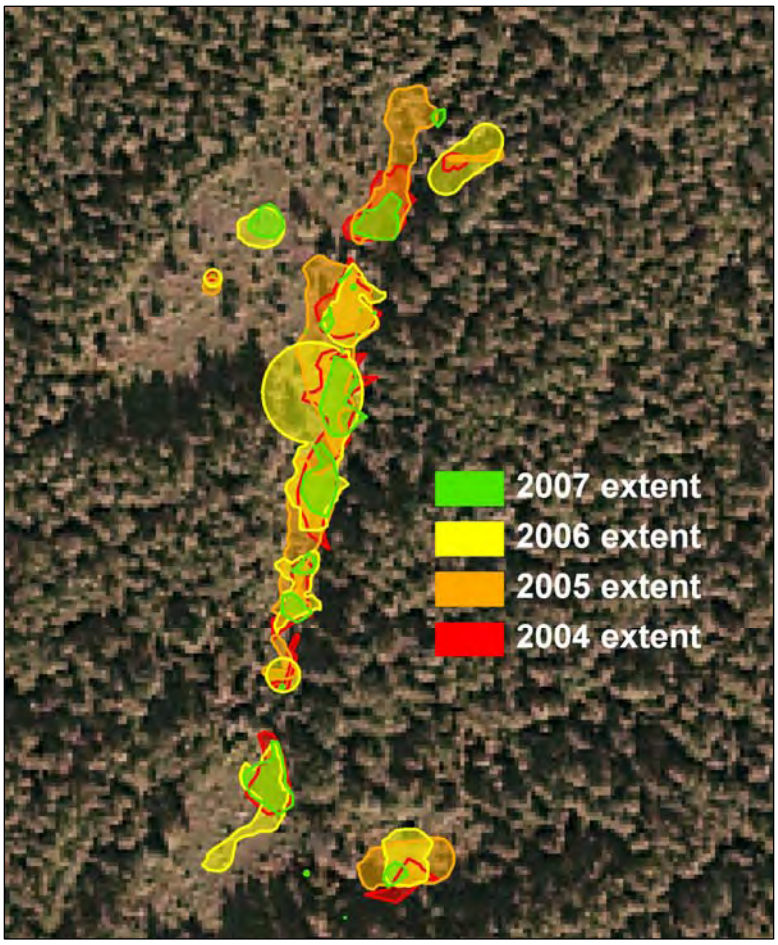

Figure 16 – The population extents of common dandelion in the "Nike Stripe" area between 2004-2007. The core population has been fragmented and other populations reduced in size from manual removal of plants.

Common Dandelion in the "Nike Stripe" Area

The "Nike Stripe" area is a naturally disturbed area approximately 700 meters north of the Exit Glacier Road. Although few people visit the area, common dandelions have successfully invaded the open site. Through persistent manual control methods, the number of plants and infestation acreage has decreased by 97% and 48% since 2004 (Fig. 17). These values indicate that the number of plants have dropped dramatically, although complete plant counts may not have occurred in 2006 and 2007 since some mapped populations did not include a stem count. The infestation area initially increased in extent, but it has now decreased. In 2007, it is clear that larger populations have now fragmented into smaller populations over the four years of treatment (Fig. 16). Manual treatment has proven effective in reducing the common dandelions in this area, but continued treatment is still required.

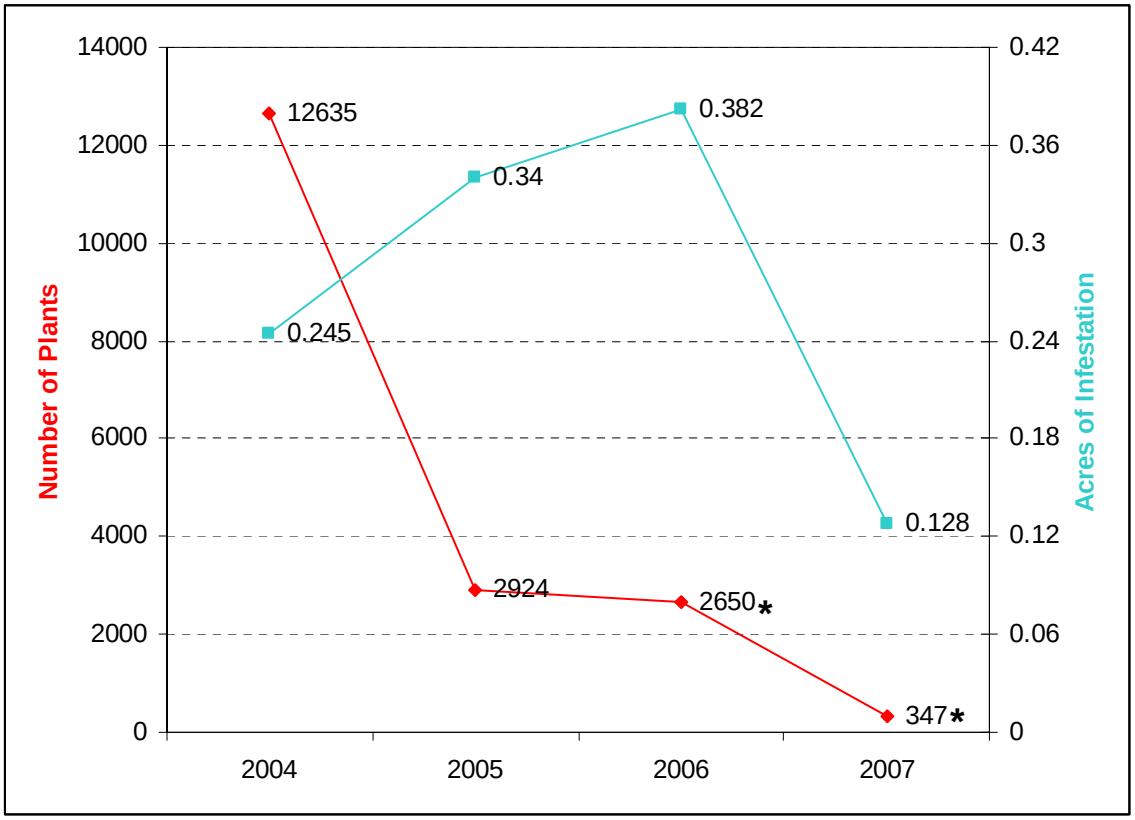

Figure 17 – Results of common dandelion manual treatment at the "Nike Stripe" area of Exit Glacier 2004-2007. * indicates the number of plants counted is incomplete.

Common Dandelion and Common Plantain on the Harding Icefield Trail

The Harding Icefield trail leads from the developed area nearly four miles to a view of the icefield. Along the trail, both common dandelion and common plantain have been found and controlled repeatedly since 2004. For the common dandelion, there has been a 59% reduction in the number of plants, but only a 12% reduction in area (Fig. 18). One reason the area has not decreased more dramatically is that new dandelion populations are being found further and further along the trail (Fig. 20).

For common plantain, the number of plants removed decreased 71% between 2004 and 2006, but during the same period, the infestation area increased (Fig. 19). Since the areas being mapped were very small, the inter-annual variations may be less conclusive due to the range of error in mapping. There was no data collected in 2007; however, there were still plants present (Kriedeman pers. com.). Since common plantain does not disperse seeds by wind like dandelion, it would seem more plausible that continued effort would result in control of this species in these locations.

From both species analyzed, it is clear that the invasive species populations are congregated near the beginning of the trail (Fig. 20 - right hand side of image) and taper off dramatically as the

trail proceeds to its destination. The continued attention to control along this trail will be able to contain the invasive plants to the more disturbed areas of the Exit Glacier area. Public education may help in preventing visitors from transporting unwanted plants further along the trail.

Figure 18 – Results of common dandelion manual treatment along the Harding Icefield Trail in KEFJ 2004-2007.

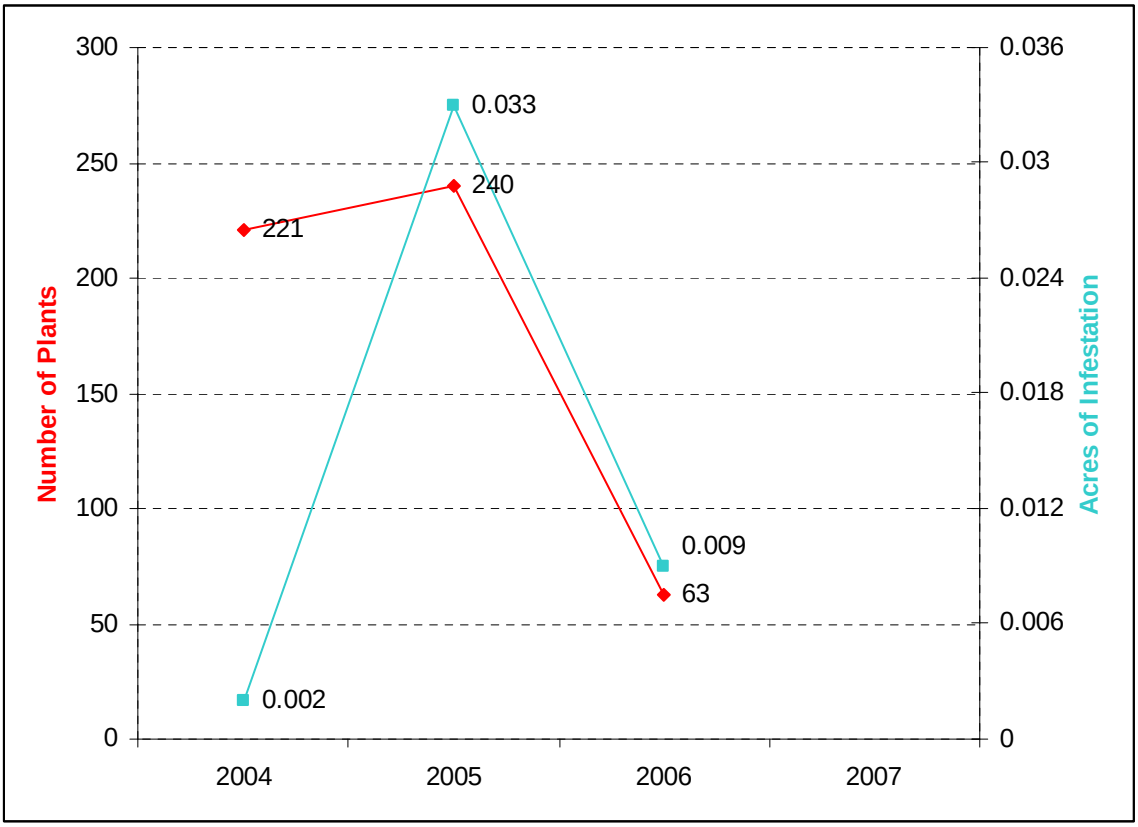

Figure 19 – Results of common plantain manual treatment along the Harding Icefield Trail in KEFJ 2004-2006. No data was collected in 2007, which may indicate that no plants were found.

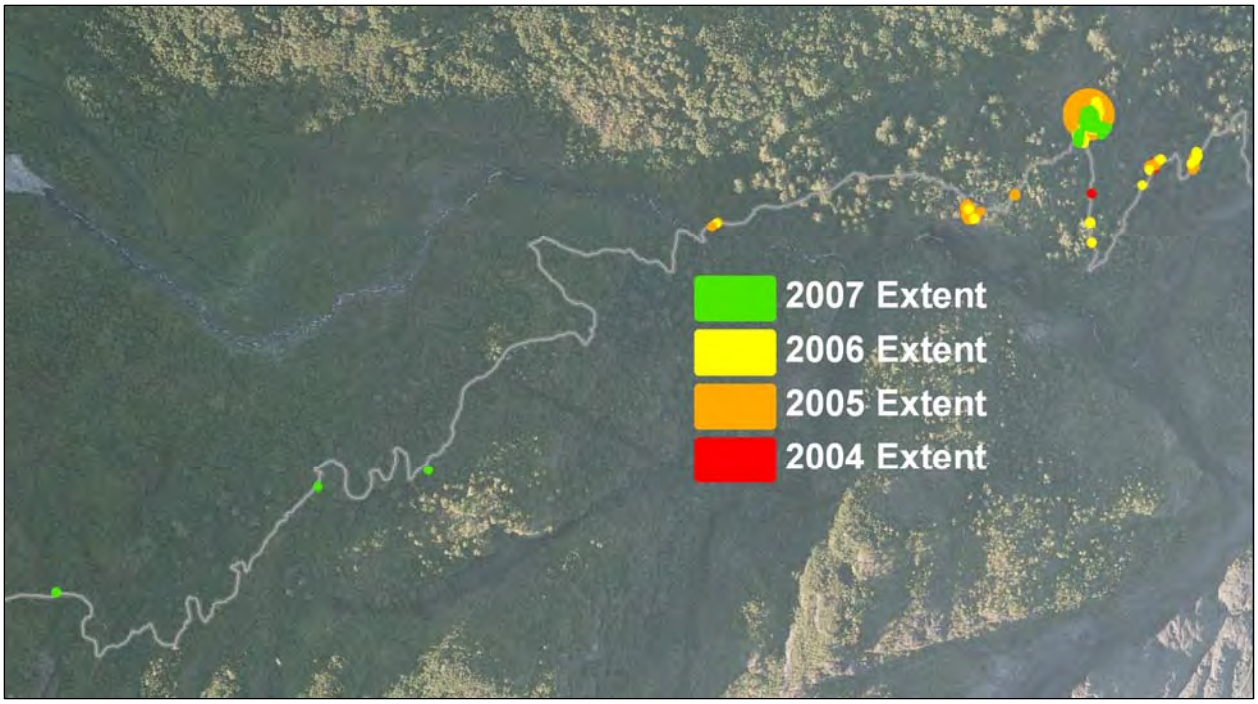

Figure 20 – The population extents of common dandelion and common plantain (combined) along the Harding Icefield Trail between 2004 and 2007. Many populations have been greatly reduced or eradicated; however, there are new population emerging farther along the trail.

Oxeye Daisy in the Developed Area

Unlike in other Alaskan National Parks, oxeye daisies have not yet created a large, self-sustaining population within KEFJ. As a result of careful observation and subsequent control, all the daisies have been removed annually from the Exit Glacier area. Consequently, in 2007, no plants were observed (Fig. 21). This is a clear demonstration that early detection and rapid response is effective in eliminating invasive species. Other species at KEFJ that have similarly been eliminated include Icelandic poppy and a cultivated columbine that were found in 2006.

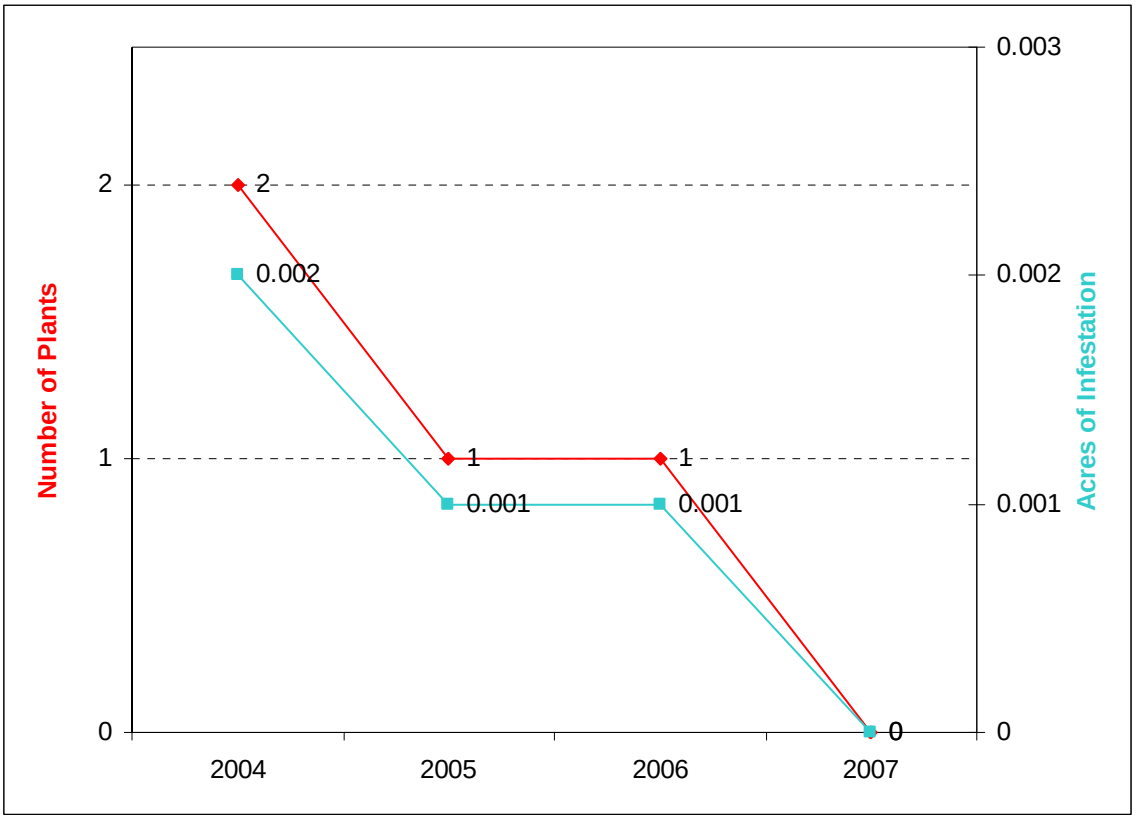

Figure 21 – Results of oxeye daisy manual treatment in the Exit Glacier area 2004-2007. These results support the effectiveness of early detection and rapid response to eradicating species before the populations expand.

Yellow Toadflax along the Exit Glacier Road

Yellow toadflax is perceived as a difficult to control species, particularly because of its creeping rhizome and vegetative reproduction. In the Exit Glacier area, the south side of the Exit Glacier road has several populations of yellow toadflax that have been treated since 2004. Over this four

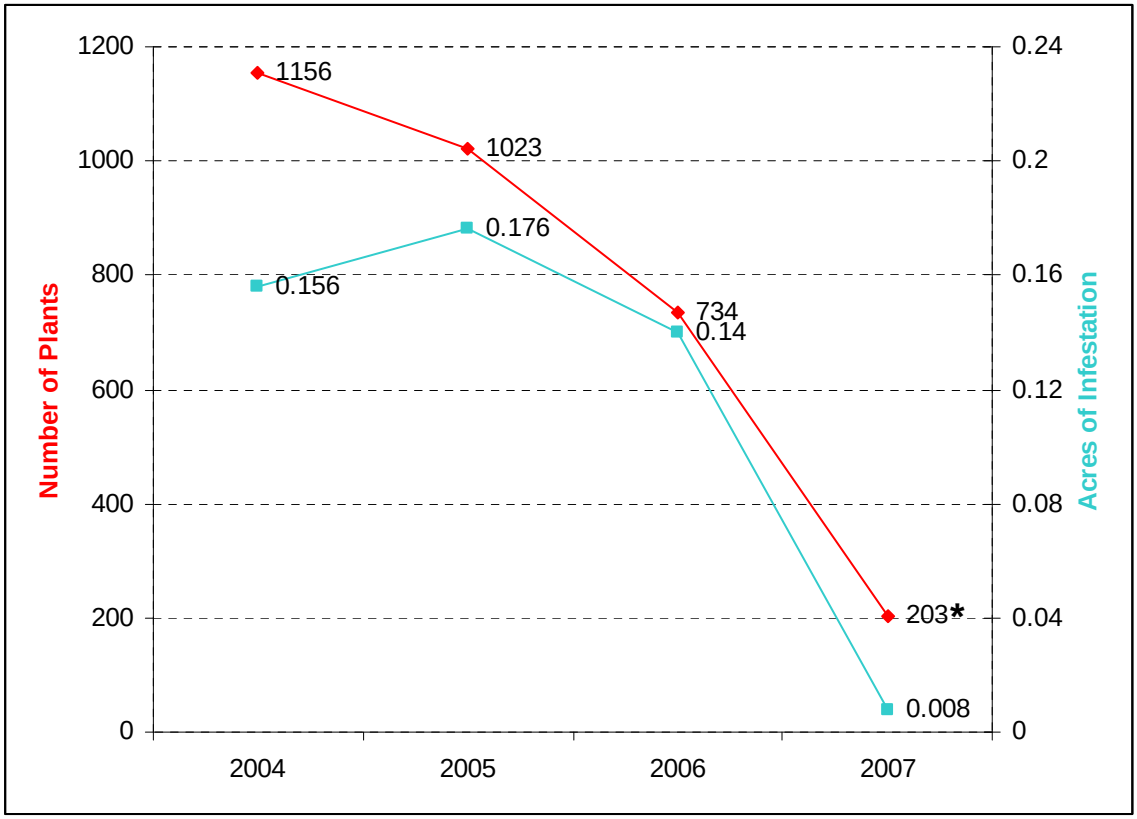

Figure 22 – Results of yellow toadflax manual treatment along the Exit Glacier Road 2004-2007. * indicates the number of plants counted is incomplete.

Figure 23 – The population extents of yellow toadflax along the Exit Glacier Road between 2004 and 2007. Many populations have been greatly reduced or eradicated; however, there are new population emerging.

year period, an 82% decrease in the number of plants and a 95% decrease in the infestation area has been observed (Fig. 22). The population extents have been reduced dramatically to small residual populations (Fig. 23). It is likely that continued effort will be required to maintain the

progress already achieved, but at this point the populations are controllable and are no longer producing seeds.

Other Areas and Manual Treatment

The analyses of manual control effectiveness in KEFJ show that manual control has been effective at reducing population sizes and extents. That being said, aside from possibly oxeye daisies, each of these populations analyzed still requires sustained labor each summer to maintain the progress achieved to date. All of these populations were also less than half an acre, and in most cases considerably less that that. Larger infestations would likely overwhelm the available staff and volunteers on an annual basis. For instance, in 2007, the south side of Exit Glacier Creek was inventoried and 2.318 acres of common dandelion were found. Not only is it difficult to cross Exit Glacier Creek safely, but the population is also six times larger than the "Nike Stripe" area that has already been labor intensive. Manual control of this population is likely to exceed the effort available at the park. Alternatively, effort invested in controlling this population would diminish the time available to inventory and control other areas of the park.

Other Invasive Species Concerns

Beyond terrestrial plant surveys, little or no work has been performed in or around SWAN parks to document the presence or absence of other invasive species. Other invasive taxa, including mammals, birds, pathogens, and invertebrates, could threaten the integrity of the SWAN parks. Marine and freshwater systems are also vulnerable to invasion and consequent ecosystem modifications. The following sections detail some of the potential risks that warrant monitoring.

Terrestrial Systems

Terrestrial animals and pathogens could jeopardize the integrity of SWAN parks. Although no non-plant invasive species have yet been documented in terrestrial systems, there are many species that could invade. Birds, such as common pigeon (*Columba livia*), European starling (*Sturnus vulgaris*), and Eurasian collared doves (*Streptopelia decaocto*), could compete with native species. Rats and mice have proven disastrous to nesting bird colonies, especially on Aleutian Islands. A multitude of terrestrial invertebrates, such as insects, earthworms, and slugs, can wreak havoc on a landscape scale. For instance, the ambermarked birch leafminer, an introduced insect in Alaska, can cause extensive defoliation of birch trees. Finally, pathogens, including viruses, bacteria, and fungus, can be introduced to systems and affect a wide range of species.

Aquatic Systems

Aquatic invasive plants pose a concern to water quality, fish habitat, plant community structure and complexity, and human life and property. Humans are the primary vector for dispersal either intentionally or accidentally. Intentional introductions might include deliberate planting of fragrant waterlily (*Nymphoides peltata*) for aesthetics or non-native pondweed (*Potamogeton* sp.) for waterfowl attraction. Accidental introductions could occur by float planes, boats, trailers, people, and gear from infested to uninfested waterbodies (Pfauth and Sytsma 2005).

Few records of invasive aquatic plants exist in Alaska to date. A 2005 field study detected no invasive plants in several National Wildlife Refuge lakes as well as Lake Hood, the primary float plane base in Anchorage (Pfauth and Sytsma 2005). Invasive aquatic plants that have been observed in Alaska include Canadian waterweed (*Elodea canadensis*), purple loosestrife (*Lythrum salicaria*), fragrant waterlily, and watercress (*Rorippa nasturtium-aquaticum*) (Carlson and Shephard 2007). Many aggressive invasive plants have yet to be observed, including hydrilla (*Hydrilla verticillatea)*, watermilfoils (*Myriophyllum* spp.), and Brazilian elodea (*Egeria densa*). An aquatic diatom, *Didymosphenia geminate* commonly known as didymo or rock snot, is a growing concern in North America since it can smother surfaces affecting fish, invertebrates, and plants. The species has been documented in Alaska and is native at least to Brooks River in Katmai (D. Rinella pers. comm.. 2007 to J. Heys); however, worldwide, the species is expanding its range and is taking advantage of new habitats. Historically, the species appears to have been restricted to circumboreal, cold, oligotrophic waters. Today, the species is blooming to nuisance levels in warmer, more-nutrient rich waters at lower latitudes (Spaulding and Elwell 2007). To date, no inventory effort has been made to document the presence of invasive aquatic plants in SWAN parks.

Beyond plants, other aquatic invasive animals can pose similar threats to aquatic habitats by out-competing native species for available habitat and food or altering the systems they inhabit. There is significant concern in Alaska about the presence of Atlantic salmon (*Salmo salar*) that escape from fish farms from Canada and further south, particularly as they may affect the five native salmon species. Other non-native fishes known to be in Alaskan waters include American shad (*Alosa sapidssima*), brook trout (*Salvelinus alpinius*), and yellow perch (*Perca flacescens*), which were intentionally introduced for sport fishing (ADFG 2008). Anglers, in contrast, are concerned with the introduction of New Zealand mudsnail (*Potamopyrgus antipodarum*) and whirling disease (*Myxobolus cerebralis*). New Zealand mudsnails can reach densities exceeding half a million per square meter in introduced systems in the western United States. Whirling disease, a parasitic infection, causes fish to swim erratically and sometimes die. Finally, zebra mussel (*Dreissena polymorpha*) and the closely related quagga mussel (*Dreissena bugensis*) have received significant attention in other states where it is estimated that the cost to control these species is around $1 billion annually. These species out-compete native bivalves, clog water intake lines, sequester nutrients essential for primary production, and are not preferred food sources for indigenous fish (Piorkowski 2002).

Marine Systems

The coastal marine systems of the SWAN parks are also at risk for invasive species. At the terrestrial margin, vascular plants, such as saltmarsh cordgrass (*Spartina alterniflora*) and dwarf eelgrass (*Zostera japonica*), can modify estuarine habitats and processes. A drift card study to see the potential dispersal of smooth cordgrass seeds from established populations in California, Oregon, Washington, and British Columbia resulted in cards being found within the Gulf of Alaska, including Kodiak Island and near Ketchikan, suggesting that SWAN coastal habitats are vulnerable to invasion (Howard 2008). Marine alga can also invade new habitats and affect marine processes.

Crustaceans, including the European green crab (*Carcinus maenus*), can compete with native crabs, such as Dungeness crabs, which would not only affect the marine ecosystem, but it would also affect valuable commercial fisheries. Other marine invertebrates, such as tunicates (clubbed tunicate (*Styela clava*), colonial sea squirt *(Didemnum lahillei*), and others), act as "fouling" organisms covering natural and man-made surfaces. There have been no studies to determine the presences of invasive marine invertebrates in SWAN parks, although protocols exist and monitoring is underway for green crabs and tunicates in Southeast Alaska, Prince William Sound, and Kachemak Bay. Fish, including the anadromous Atlantic salmon and American shad, can also affect marine systems.

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Appendices

Appendix A – List of Known Invasive Plants within or near SWAN Parks

Taxon	AKNHP Species Ranking	Acres Mapped (2003-2007) ALAG	ANIA	KATM	KEFJ	LACL	Total Acres Mappe
red top (*Agrostis gigantea*)					present		
marsh meadow-foxtail (*Alopecurus geniculatus*)						present	
pigweed (*Amaranthus retroflexus*)						0.078	0.078
field mustard (*Brassica rapa*)					0.001	present	0.001
smooth brome grass (*Bromus inermis* ssp. *inermis*)	62			present	present	0.081	0.081
shepherd's purse (*Capsella bursa-pastoris*)	40			3.711		0.078	3.789
mouse-ear chickweed (*Cerastium fontanum*)	36			present	present		
common lambsquarters (*Chenopodium album*)	35					11.158	11.158
narrowleaf hawksbeard (*Crepis tectorum*)	54			0.003	0.029	present	0.032
orchardgrass (*Dactylis glomerata*)	54				present		
quackgrass (*Elymus repens*)	59				present		
redstem stork's bill (*Erodium cicutarium*)						present	
wormseed mustard (*Erysimum cheiranthoides*)				present		present	
common strawberry (*Fragaria virginiana*)						present	
splitlip hempnettle (*Galeopsis bifida*)					present		
ground ivy (*Glechoma hederacea*)	48					present	
orange hawkweed (*Hieracium auranticum*)	79				present	present	
foxtail barley (*Hordeum jubatum*)	63				0.001		0.001
fall dandelion (*Leontodon autumnalis*)					present		
oxeye daisy (*Leucanthemum vulgare*)	61			0.020	0.785	0.175	0.980
yellow toadflax (*Linaria vulgaris*)	69				0.107		0.107
Italian ryegrass (*Lolium perenne* ssp. *multiflorum*)	41				present	present	
bigleaf lupine (*Lupinus polyphyllus*)					present		
pineapple weed (*Matricaria discoidea*)	32	present		11.977	0.126	17.474	29.577
black medic (*Medicago lupulina*)	48				present		
yellow alfalfa (*Medicago sativa* ssp. *falcata*)	64				0.480		0.480
yellow sweetclover (*Melilotus officinalis*)	65				present		
ball mustard (*Neslia paniculata*					present		
Icelandic poppy (*Papaver nudicale*)					present		
curlytop knotweed (*Persicaria lapathifolia*)				present		present	
reed canarygrass (*Phlaris arundinacea*)	83					present	
common timothy (*Phleum pratense*)	56				0.125	0.078	0.203
common plantain (*Plantago major*)	44	present		1.717	0.886	7.144	9.747
annual bluegrass (*Poa annua*)	46			present	present	present	
Kentucky bluegrass (*Poa pratensis*)	52			present	present	present	
prostrate knotweed (*Polygonum aviculare*)	45			0.040		0.078	0.118
tall buttercup (*Ranunculus acris*)	54				0.001		0.001
common sheep sorrel (*Rumex acetosella*)	51			1.432	0.018	0.081	1.531
curled dock (*Rumex crispus*)	48				0.001		0.001
corn spurry (*Spergula arvensis*)	32				present	present	

Taxon	AKNHP Species Ranking	Acres Mapped (2003-2007) ALAG	ANIA	KATM	KEFJ	LACL	Total Acres Mappe
common chickweed (*Stellaria media*)	42/54					5.540	5.540
common tansy (*Tanacetum vulgare*)	57					present	
common dandelion (*Taraxacum officinale* ssp. *officinale*)	58			6.100	11.753	10.447	28.300
alsike clover (*Trifolium hybridum*)	57				0.162	present	0.162
red clover (*Trifolium pratense*)	53				0.001		0.001
white clover (*Trifolium repens*)	59			0.001	0.303	1.392	1.696
scentless false mayweed (*Tripleurospermum perforata*)	48				present		
wheat (*Triticum aestivum*)					present		
thyme-leaf speedwell (*Veronica serpyllifolia*)	*		present			present	
bird vetch (*Vicia cracca*)	73				present		
Total Species Present		2	1	15	36	30	93.584

* Nativity questionable

Observed within NPS boundaries

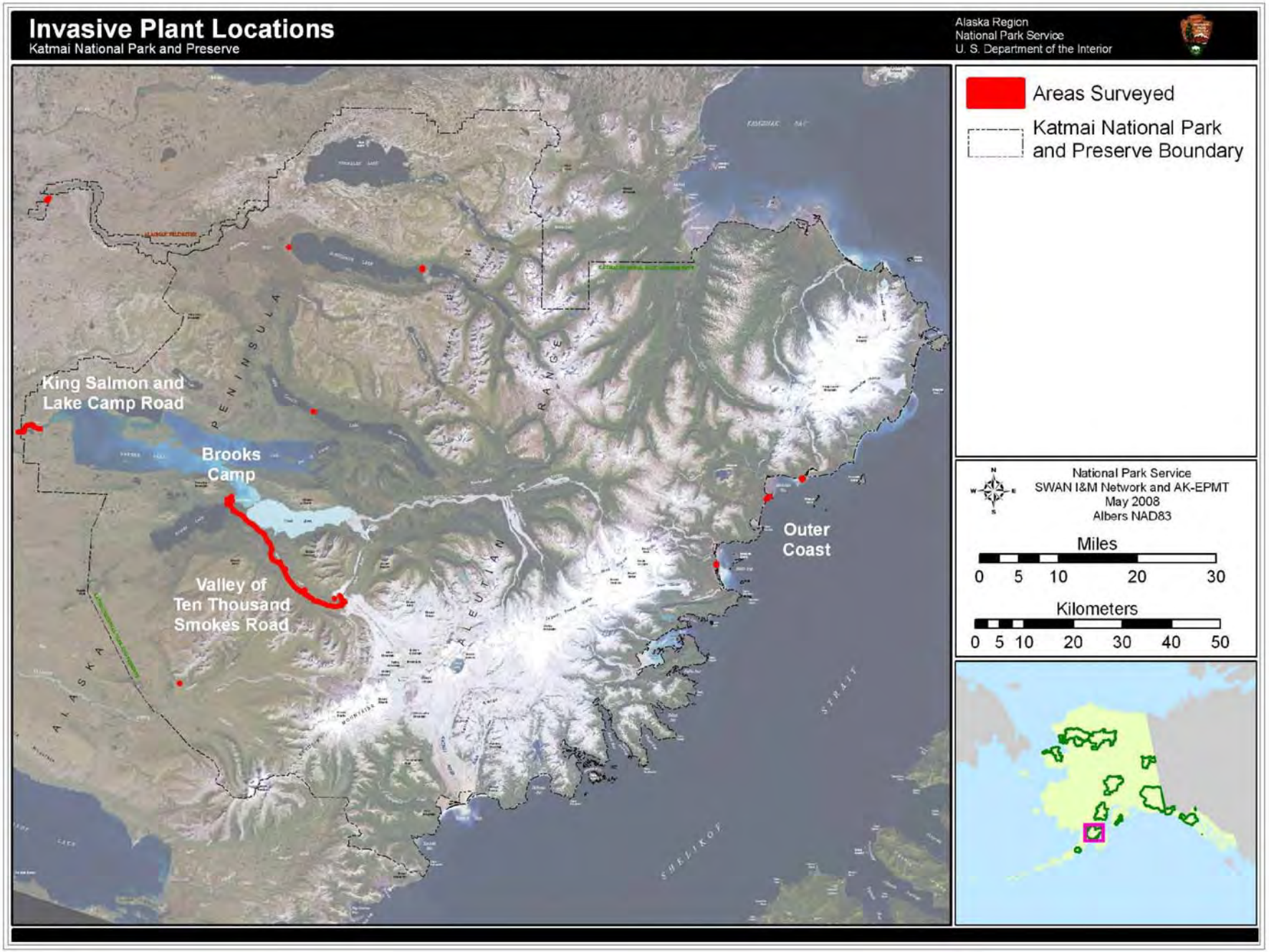
Observed only outside NPS boundaries

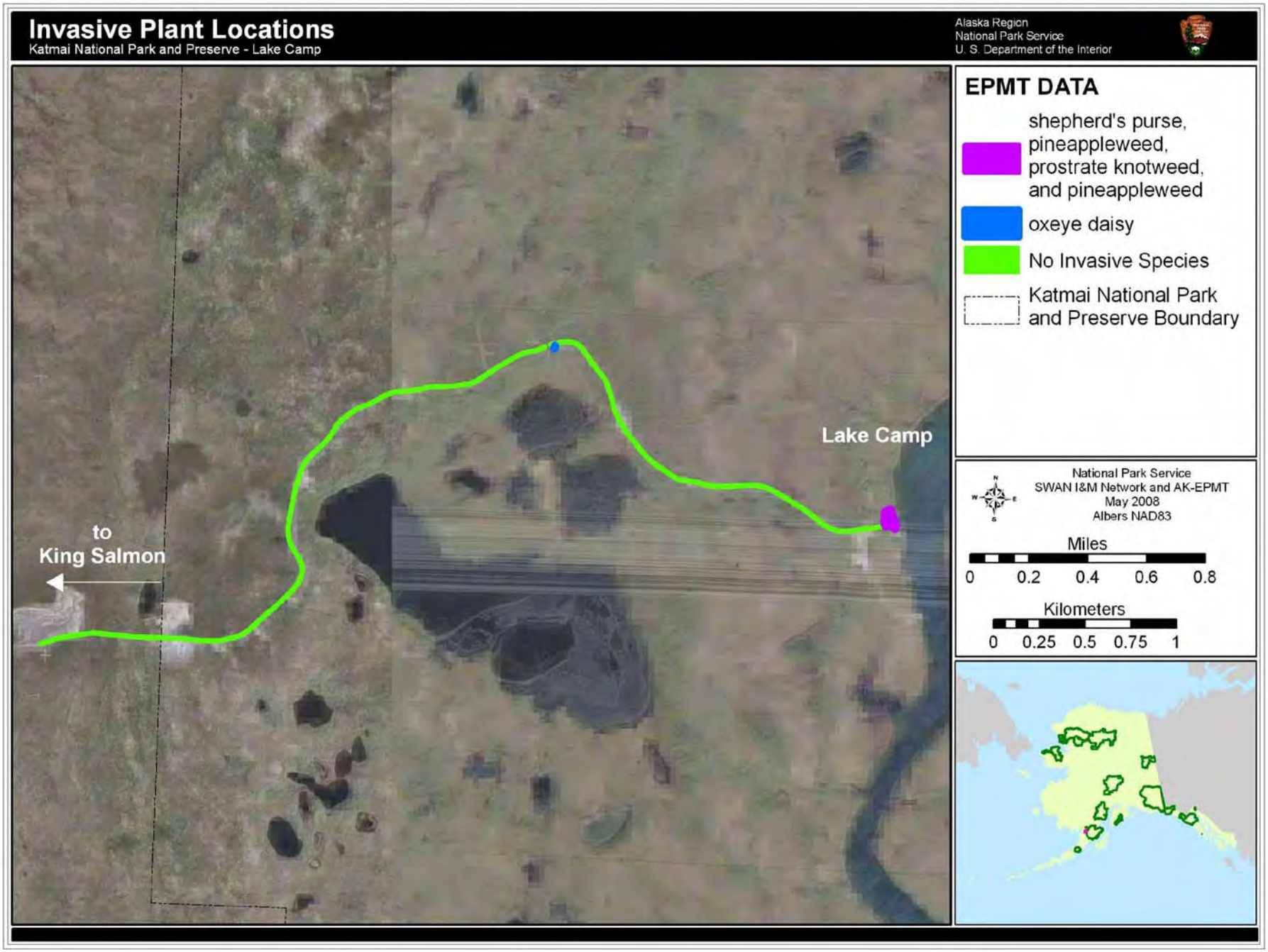
Species reported, but location not confirmed

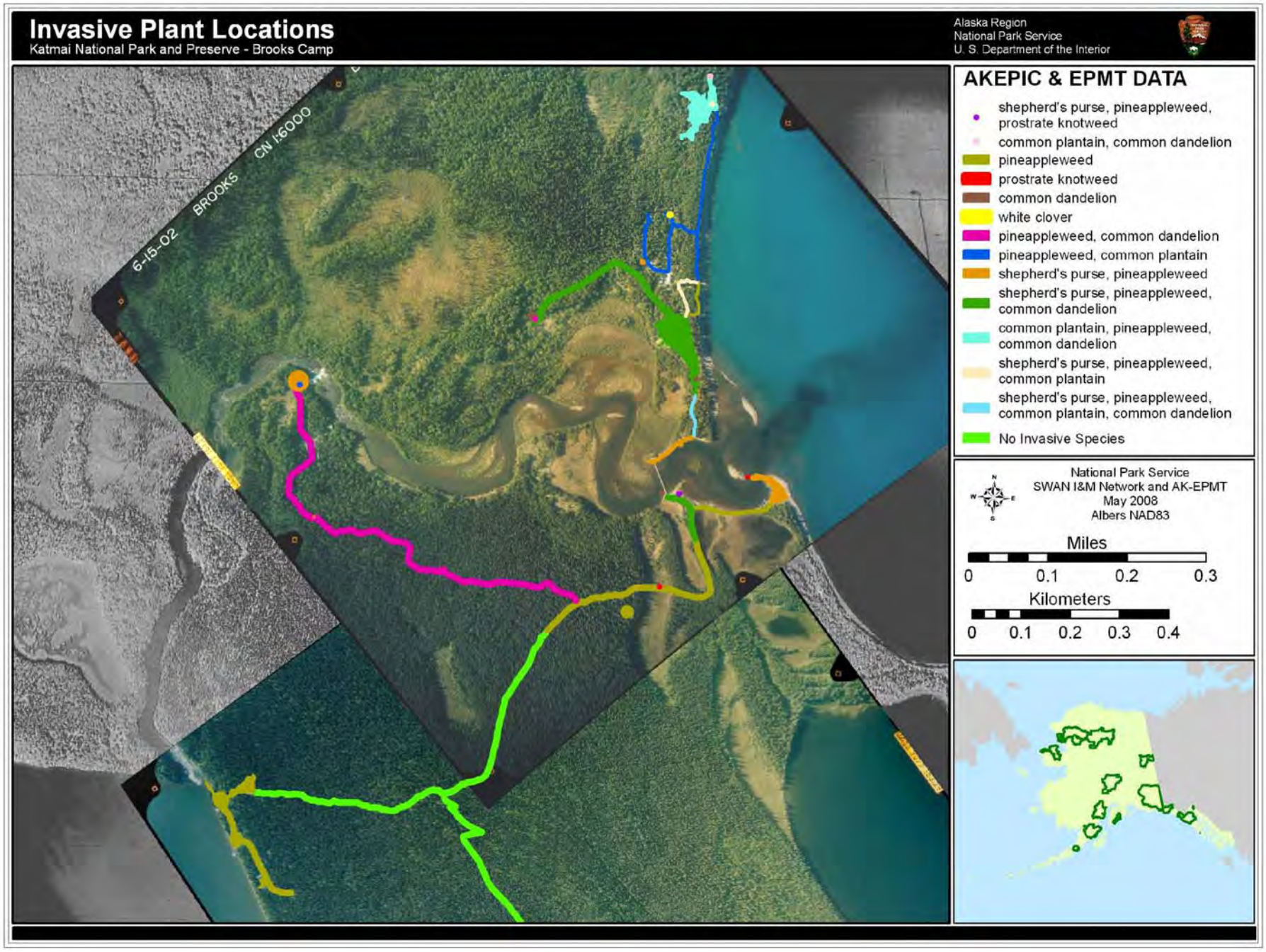
Appendix B – Location Maps of Invasive Plants in SWAN Parks

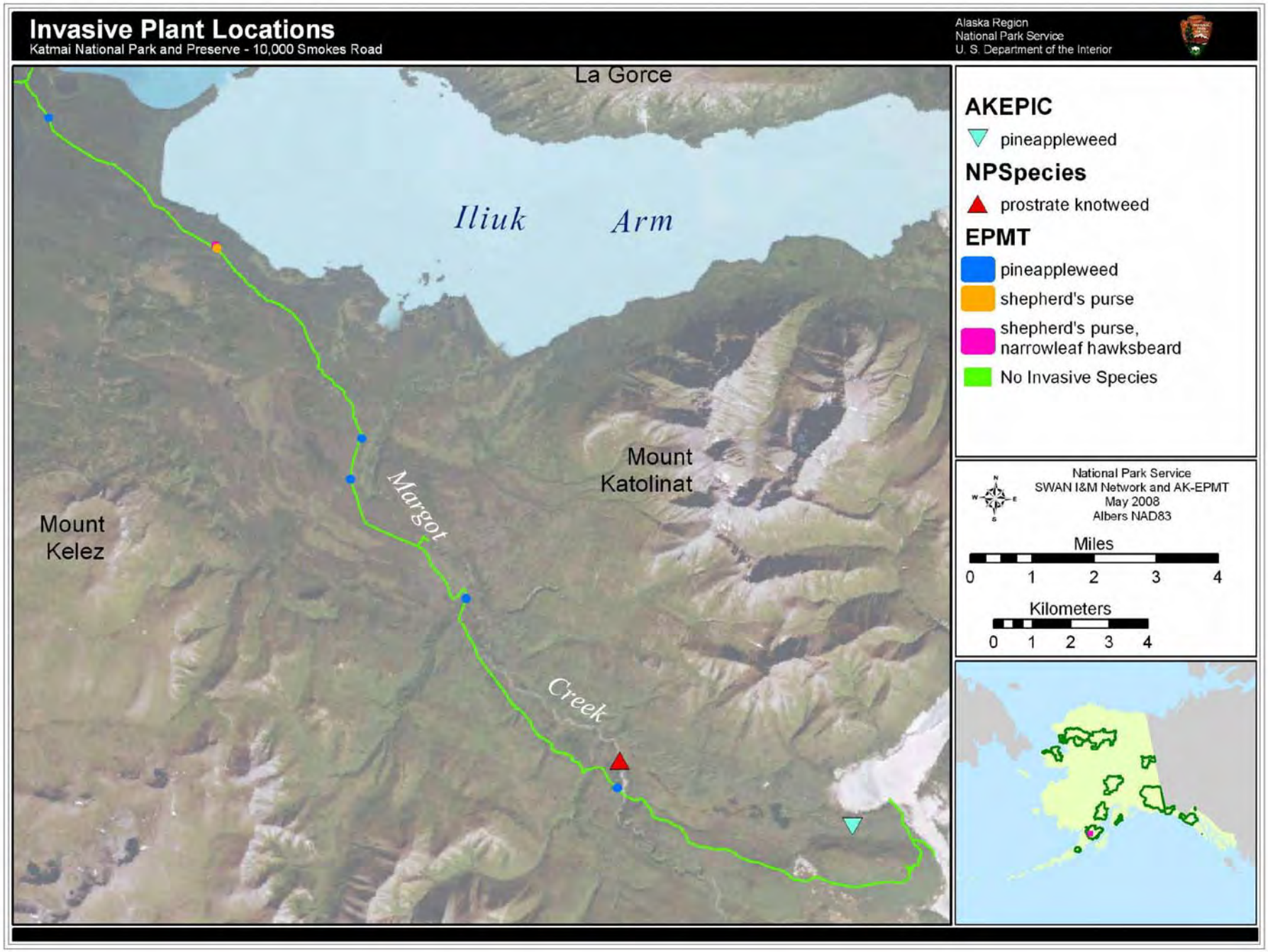
Katmai National Park and Preserve – Areas Surveyed
Katmai National Park and Preserve – Lake Camp
Katmai National Park and Preserve – Brooks Camp
Katmai National Park and Preserve – 10,000 Smokes Road
Katmai National Park and Preserve – Northern Region
Katmai National Park and Preserve – Outer Coast
Kenai Fjords National Park – Areas Surveyed
Kenai Fjords National Park – Exit Glacier Beyond Park Boundary
Kenai Fjords National Park – Exit Glacier Road
Kenai Fjords National Park – Exit Glacier Area
Kenai Fjords National Park – Exit Glacier and Harding Icefield Trails
Kenai Fjords National Park – Outer Coast
Lake Clark National Park and Preserve – Areas Surveyed
Lake Clark National Park and Preserve – Port Alsworth
Lake Clark National Park and Preserve – Port Alsworth Region
Lake Clark National Park and Preserve – Twin Lakes
Lake Clark National Park and Preserve – Outer Coast

The primary data source for these maps was the AK-EPMT geodatabase. When applicable, additional invasive plant locations were included from the NPSpecies database (SWAN I&M), AKEPIC (Alaska Exotic Plant Information Clearinghouse – statewide interagency database accessed 5/1/08), or draft USFS 2007 Survey of the Kenai Peninsula (data will be assimilated into AKEPIC).


Invasive Plant Locations
Katmai National Park and Preserve
Alaska Region
National Park Service
U. S. Department of the Interior
Areas Surveyed
Katmai National Park and Preserve Boundary
King Salmon and Lake Camp Road
Brooks Camp
Valley of Ten Thousand Smokes Road
Outer Coast
PENINSULA
ALEUTIAN RANGE
ALASKA
SHELIKOF
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 5 10 20 30
Kilometers
0 5 10 20 30 40 50


Invasive Plant Locations
Katmai National Park and Preserve - Lake Camp
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT DATA
shepherd's purse, pineappleweed, prostrate knotweed, and pineappleweed
oxeye daisy
No Invasive Species
Katmai National Park and Preserve Boundary
Lake Camp
to King Salmon
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 0.2 0.4 0.6 0.8
Kilometers
0 0.25 0.5 0.75 1


Invasive Plant Locations
Katmai National Park and Preserve - Brooks Camp
Alaska Region
National Park Service
U. S. Department of the Interior
6-15-02
BROOKS
CN 16000
AKEPIC & EPMT DATA
shepherd's purse, pineappleweed, prostrate knotweed
common plantain, common dandelion
pineappleweed
prostrate knotweed
common dandelion
white clover
pineappleweed, common dandelion
pineappleweed, common plantain
shepherd's purse, pineappleweed
shepherd's purse, pineappleweed, common dandelion
common plantain, pineappleweed, common dandelion
shepherd's purse, pineappleweed, common plantain
shepherd's purse, pineappleweed, common plantain, common dandelion
No Invasive Species
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 0.1 0.2 0.3
Kilometers
0 0.1 0.2 0.3 0.4


Invasive Plant Locations
Katmai National Park and Preserve - 10,000 Smokes Road
Alaska Region
National Park Service
U. S. Department of the Interior
La Gorce
Iliuk Arm
Mount Katolinat
Mount Kelez
Margot Creek
AKEPIC
pineappleweed
NPSpecies
prostrate knotweed
EPMT
pineappleweed
shepherd's purse
shepherd's purse, narrowleaf hawksbeard
No Invasive Species
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 1 2 3 4
Kilometers
0 1 2 3 4

Invasive Plant Locations

Katmai National Park and Preserve and Alagnak Wild River - Northern Region

Alaska Region
National Park Service
U. S. Department of the Interior

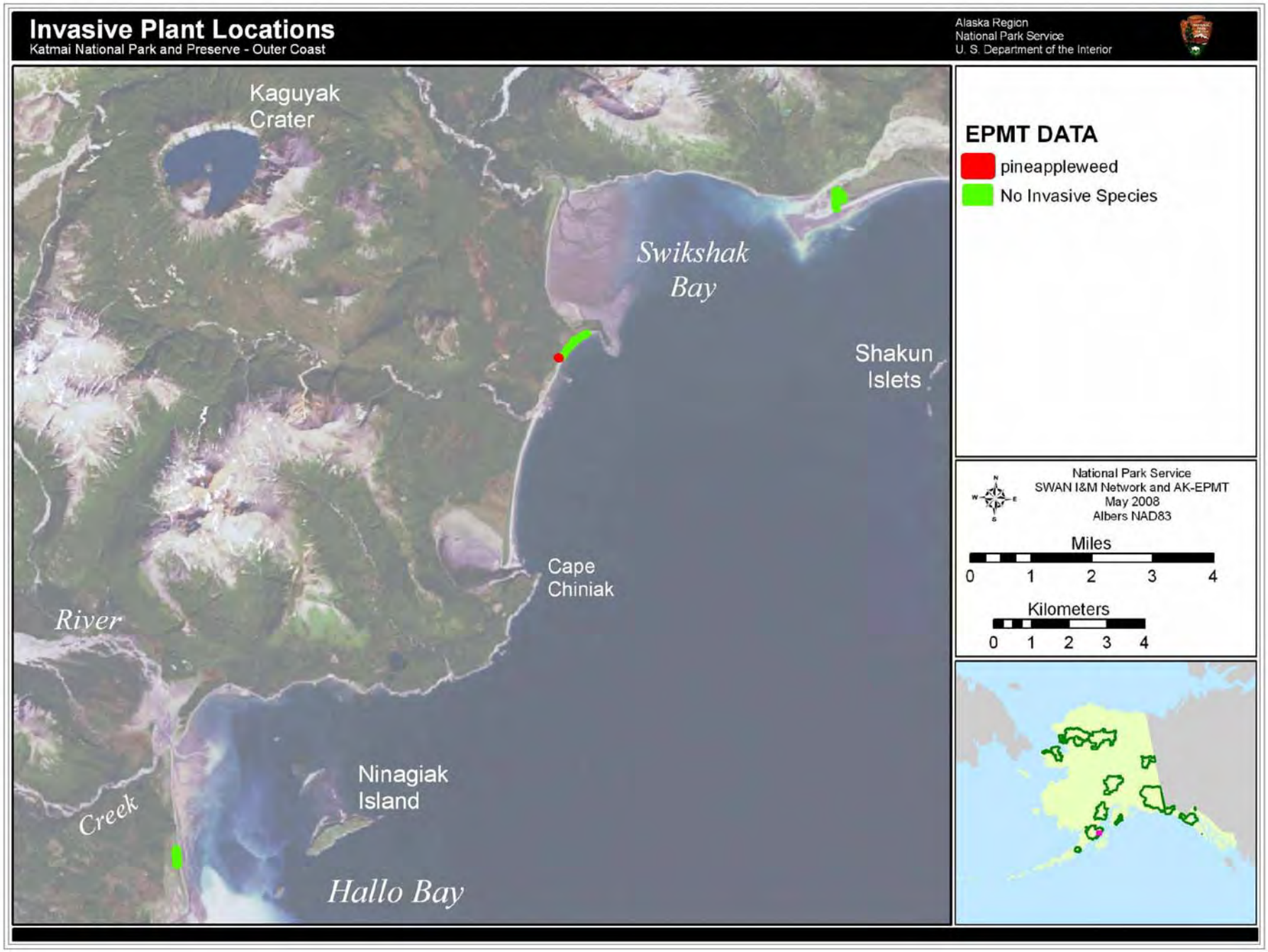
AKEPIC DATA

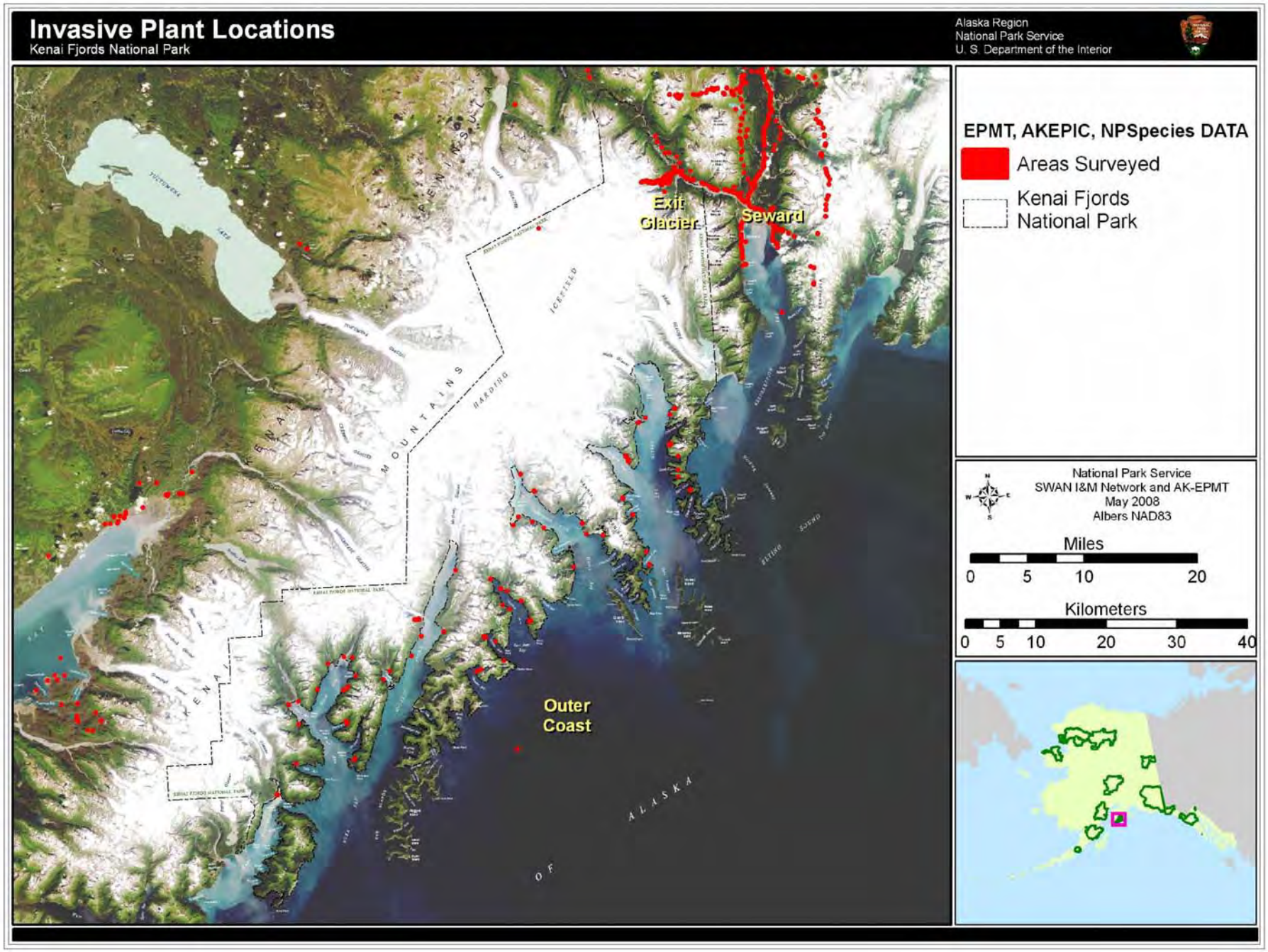
- pineappleweed
- common plantain
- common dandelion
- Park Boundaries

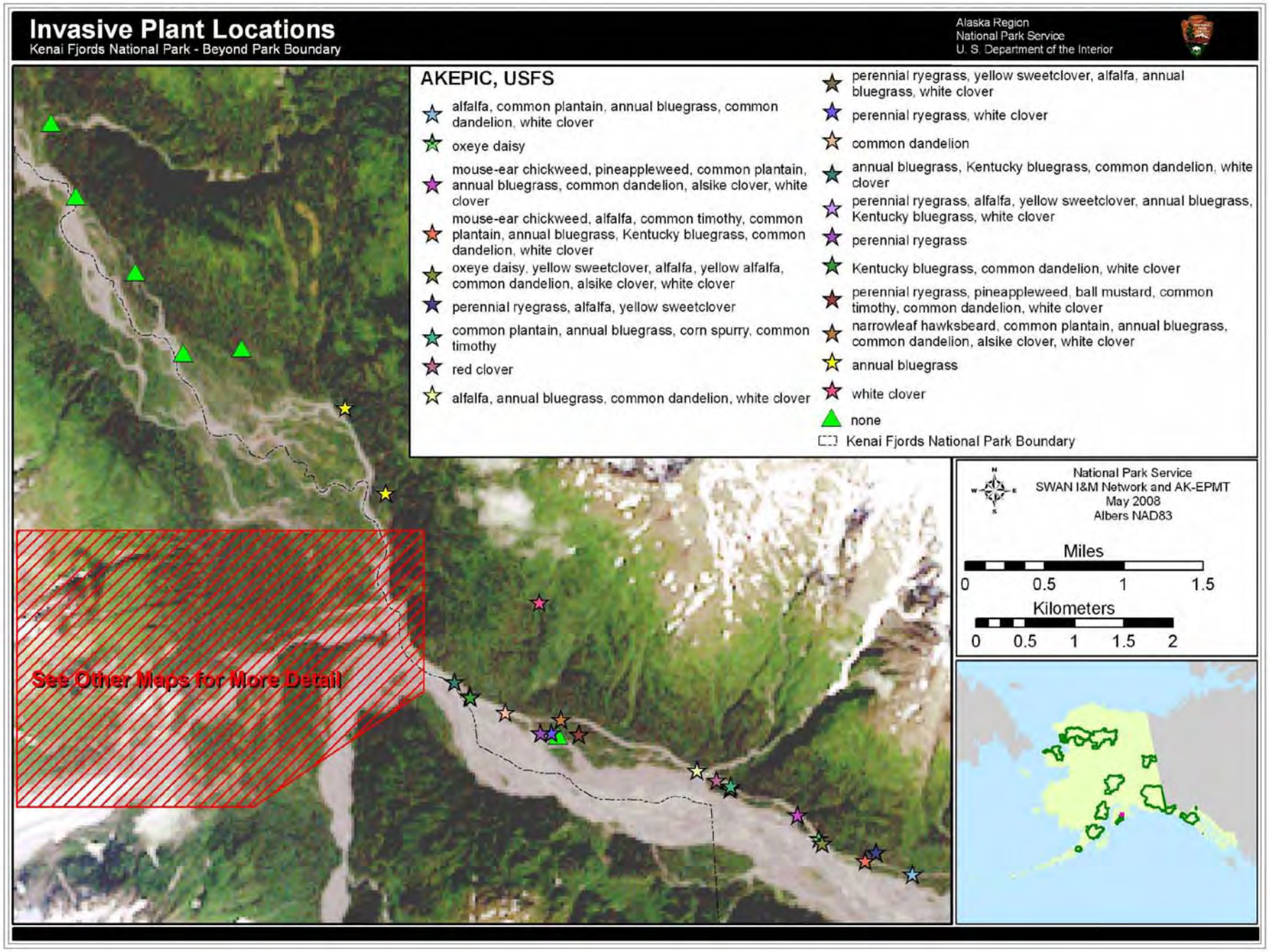
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83

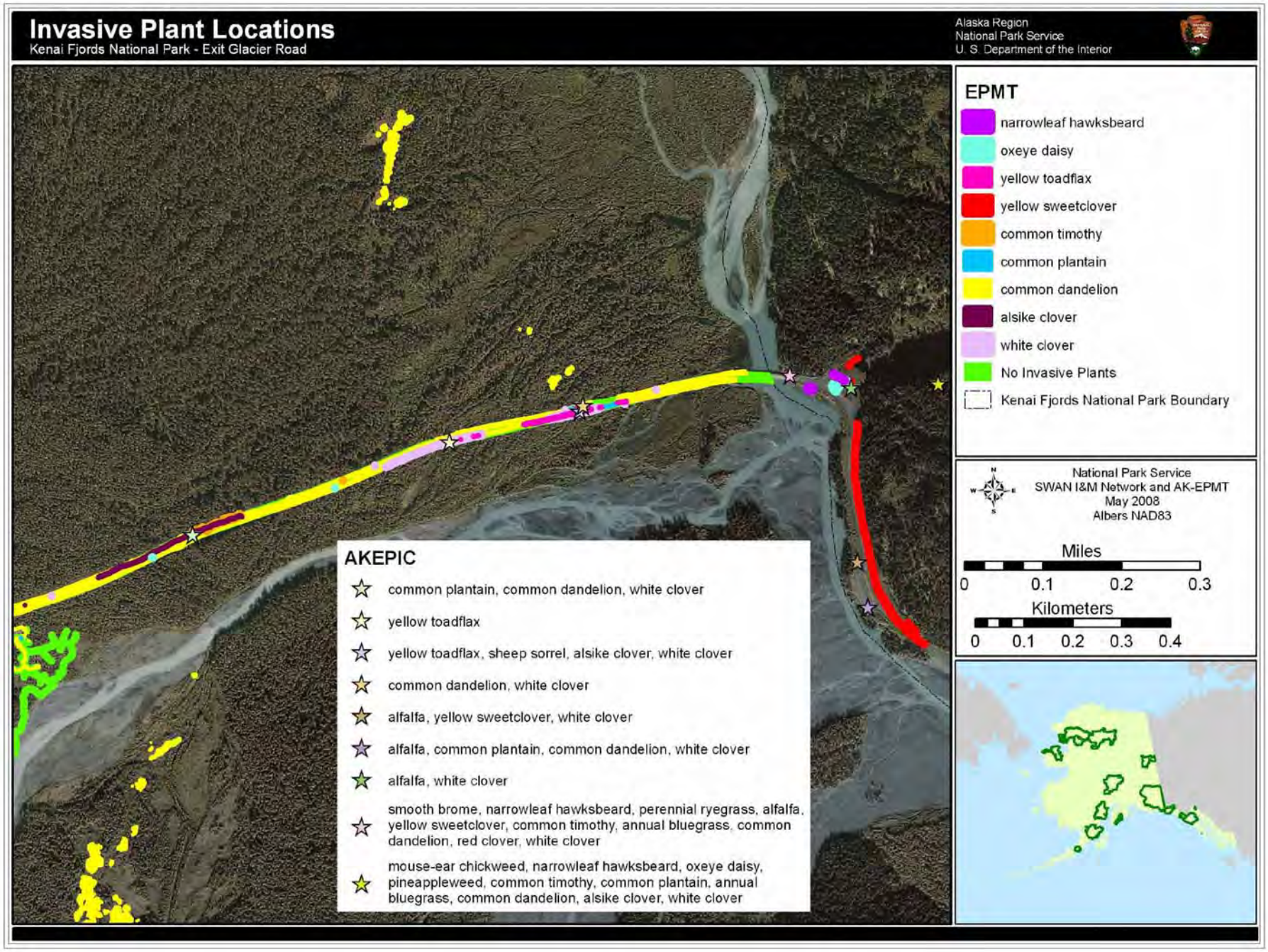
Miles
0 3 6 9 12

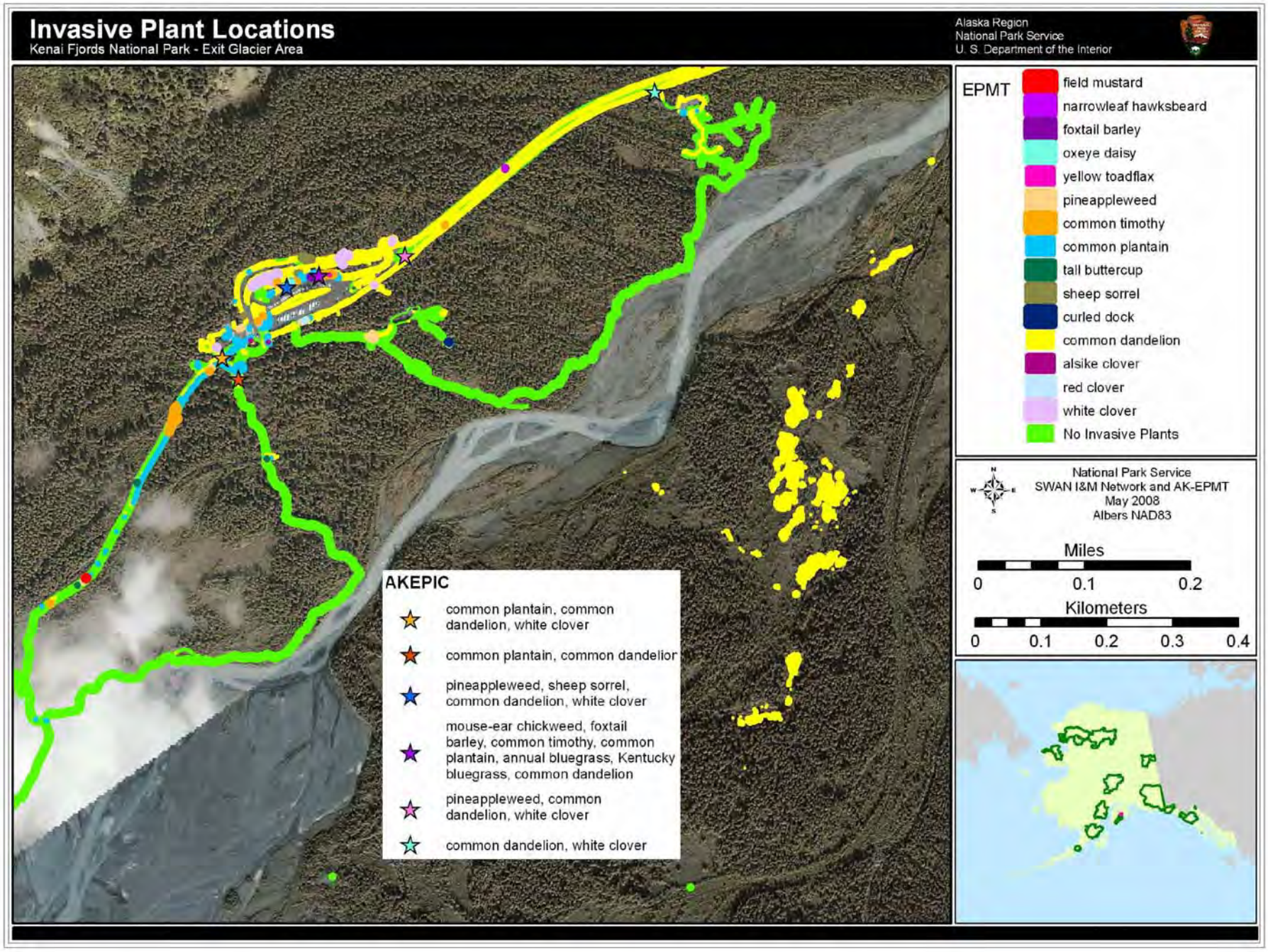
Kilometers
0 5 10 15 20

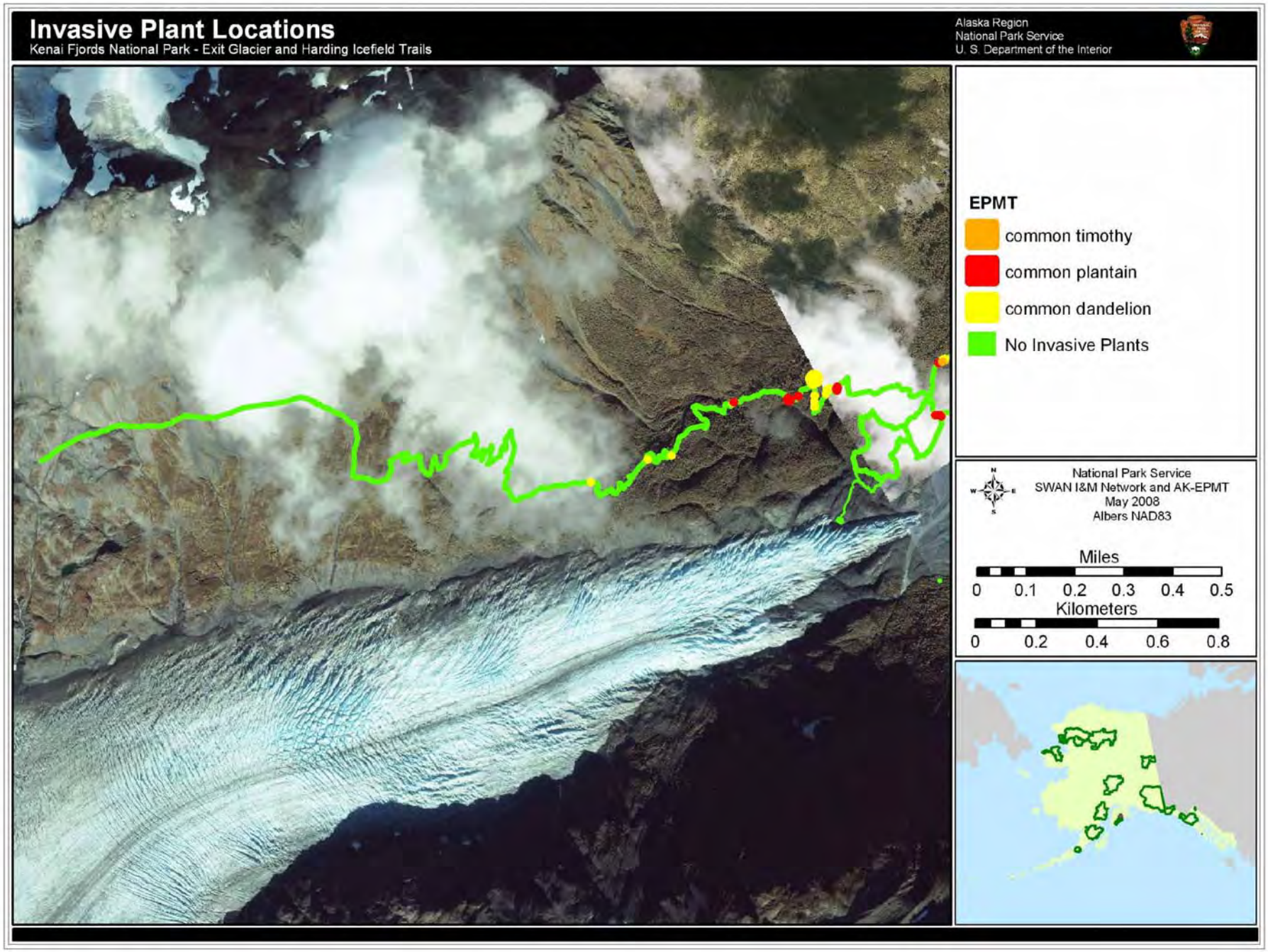

Invasive Plant Locations
Katmai National Park and Preserve - Outer Coast
Alaska Region
National Park Service
U. S. Department of the Interior
Kaguyak Crater
Swikshak Bay
Shakun Islets
Cape Chiniak
River
Ninagiak Island
Creek
Hallo Bay
EPMT DATA
pineappleweed
No Invasive Species
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 1 2 3 4
Kilometers
0 1 2 3 4

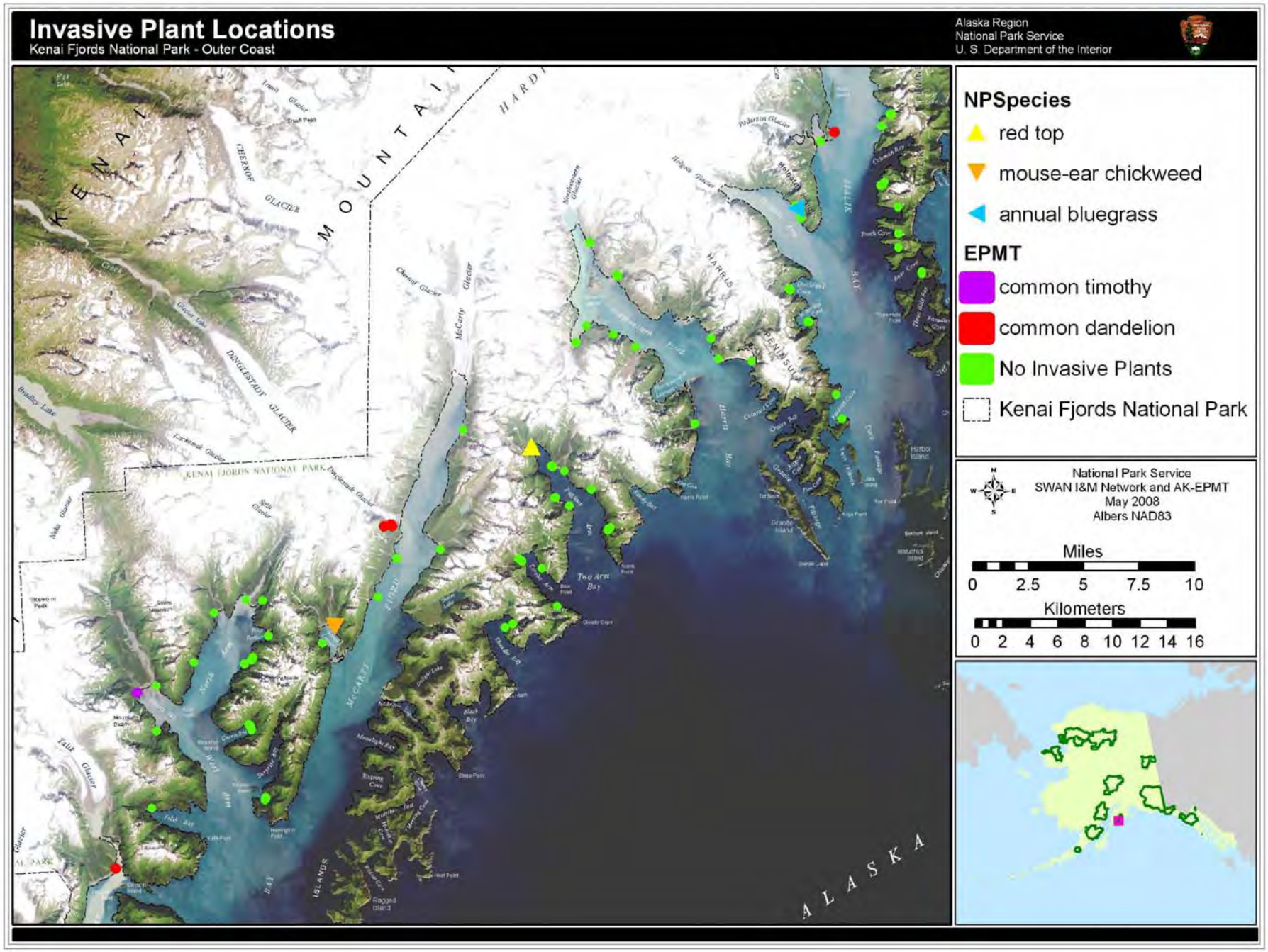

Invasive Plant Locations
Kenai Fjords National Park
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT, AKEPIC, NPSpecies DATA
Areas Surveyed
Kenai Fjords National Park
Exit Glacier
Seward
Outer Coast
KENAI MOUNTAINS
HARDING ICEFIELD
GULF OF ALASKA
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 5 10 20
Kilometers
0 5 10 20 30 40

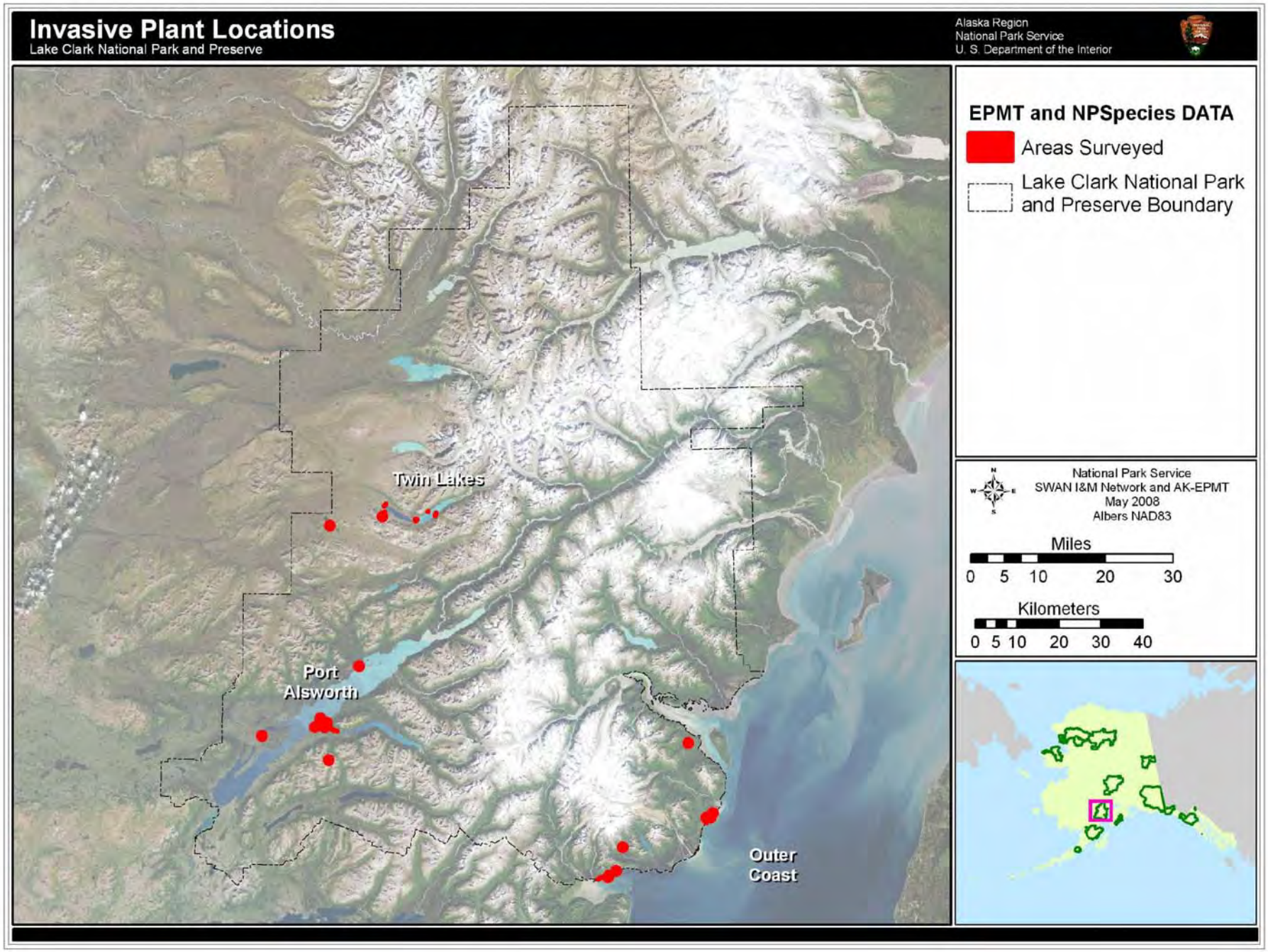

Invasive Plant Locations
Kenai Fjords National Park - Beyond Park Boundary
Alaska Region
National Park Service
U. S. Department of the Interior
AKEPIC, USFS
alfalfa, common plantain, annual bluegrass, common dandelion, white clover
oxeye daisy
mouse-ear chickweed, pineappleweed, common plantain, annual bluegrass, common dandelion, alsike clover, white clover
mouse-ear chickweed, alfalfa, common timothy, common plantain, annual bluegrass, Kentucky bluegrass, common dandelion, white clover
oxeye daisy, yellow sweetclover, alfalfa, yellow alfalfa, common dandelion, alsike clover, white clover
perennial ryegrass, alfalfa, yellow sweetclover
common plantain, annual bluegrass, corn spurry, common timothy
red clover
alfalfa, annual bluegrass, common dandelion, white clover
perennial ryegrass, yellow sweetclover, alfalfa, annual bluegrass, white clover
perennial ryegrass, white clover
common dandelion
annual bluegrass, Kentucky bluegrass, common dandelion, white clover
perennial ryegrass, alfalfa, yellow sweetclover, annual bluegrass, Kentucky bluegrass, white clover
perennial ryegrass
Kentucky bluegrass, common dandelion, white clover
perennial ryegrass, pineappleweed, ball mustard, common timothy, common dandelion, white clover
narrowleaf hawksbeard, common plantain, annual bluegrass, common dandelion, alsike clover, white clover
annual bluegrass
white clover
none
Kenai Fjords National Park Boundary
See Other Maps for More Detail
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 0.5 1 1.5
Kilometers
0 0.5 1 1.5 2

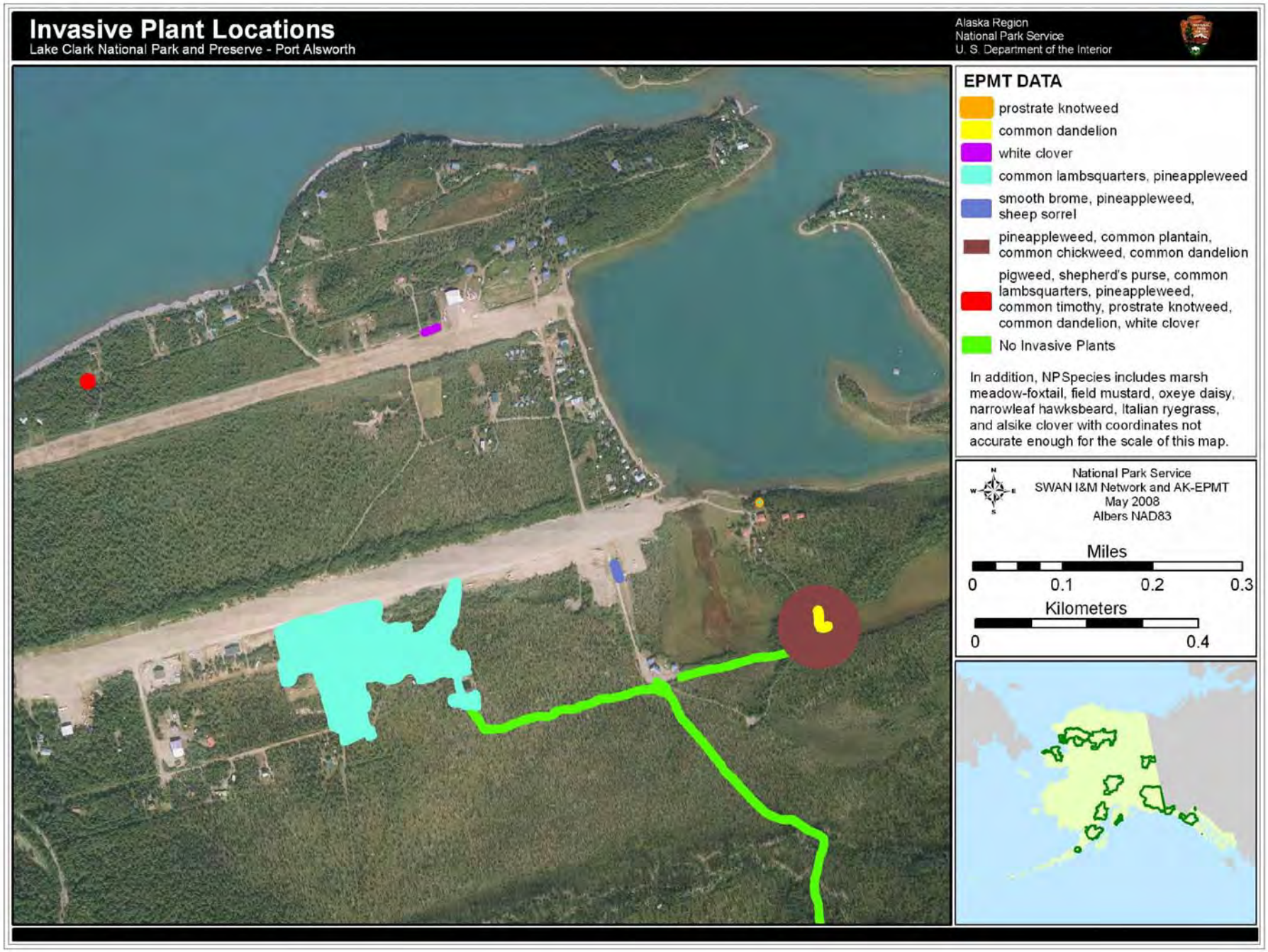

Invasive Plant Locations
Kenai Fjords National Park - Exit Glacier Road
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT
narrowleaf hawksbeard
oxeye daisy
yellow toadflax
yellow sweetclover
common timothy
common plantain
common dandelion
alsike clover
white clover
No Invasive Plants
Kenai Fjords National Park Boundary
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 0.1 0.2 0.3
Kilometers
0 0.1 0.2 0.3 0.4
AKEPIC
common plantain, common dandelion, white clover
yellow toadflax
yellow toadflax, sheep sorrel, alsike clover, white clover
common dandelion, white clover
alfalfa, yellow sweetclover, white clover
alfalfa, common plantain, common dandelion, white clover
alfalfa, white clover
smooth brome, narrowleaf hawksbeard, perennial ryegrass, alfalfa, yellow sweetclover, common timothy, annual bluegrass, common dandelion, red clover, white clover
mouse-ear chickweed, narrowleaf hawksbeard, oxeye daisy, pineappleweed, common timothy, common plantain, annual bluegrass, common dandelion, alsike clover, white clover

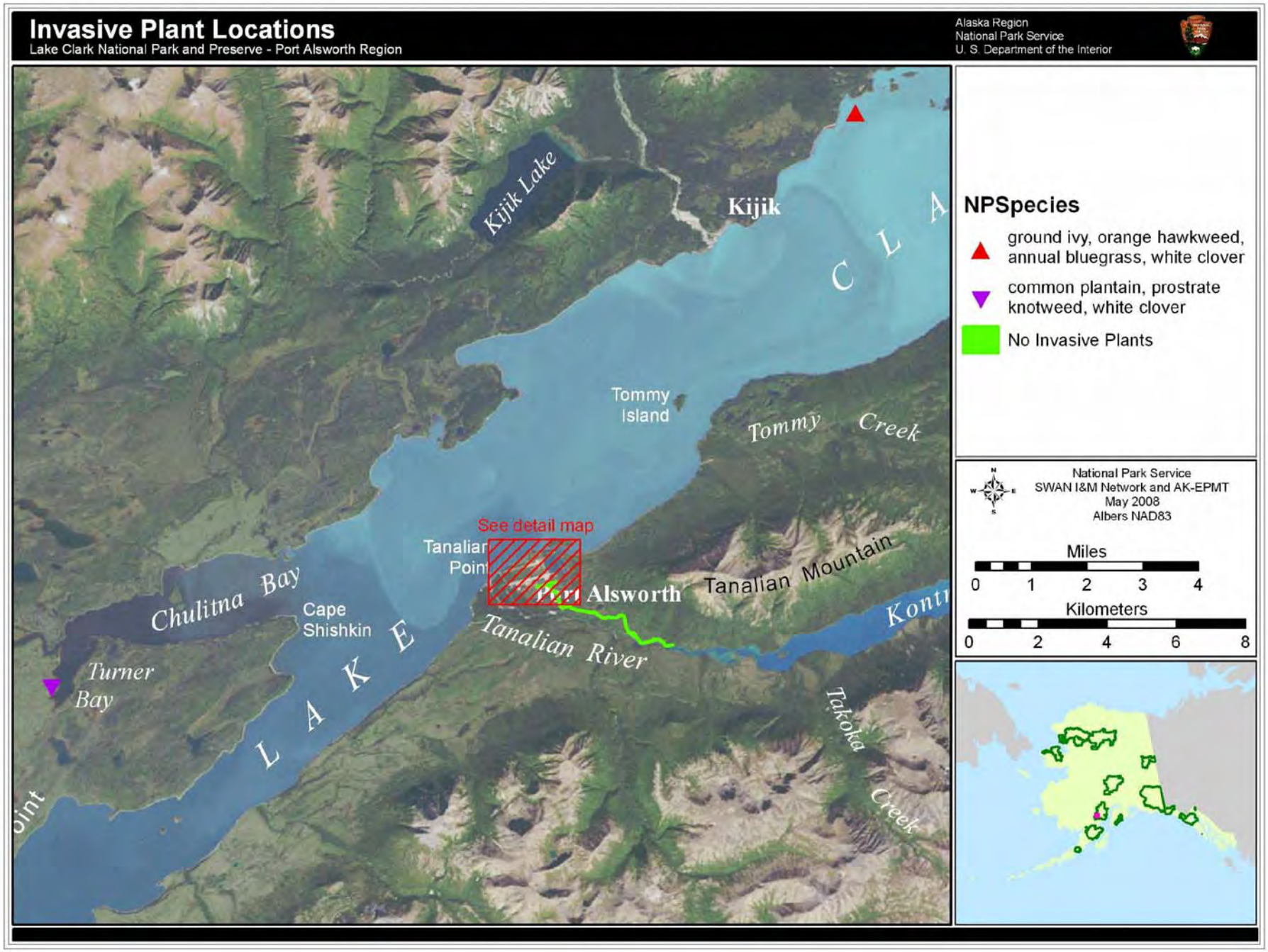

Invasive Plant Locations
Kenai Fjords National Park - Exit Glacier Area
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT
field mustard
narrowleaf hawksbeard
foxtail barley
oxeye daisy
yellow toadflax
pineappleweed
common timothy
common plantain
tall buttercup
sheep sorrel
curled dock
common dandelion
alsike clover
red clover
white clover
No Invasive Plants
AKEPIC
common plantain, common dandelion, white clover
common plantain, common dandelior
pineappleweed, sheep sorrel, common dandelion, white clover
mouse-ear chickweed, foxtail barley, common timothy, common plantain, annual bluegrass, Kentucky bluegrass, common dandelion
pineappleweed, common dandelion, white clover
common dandelion, white clover
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0
0.1
0.2
Kilometers
0
0.1
0.2
0.3
0.4

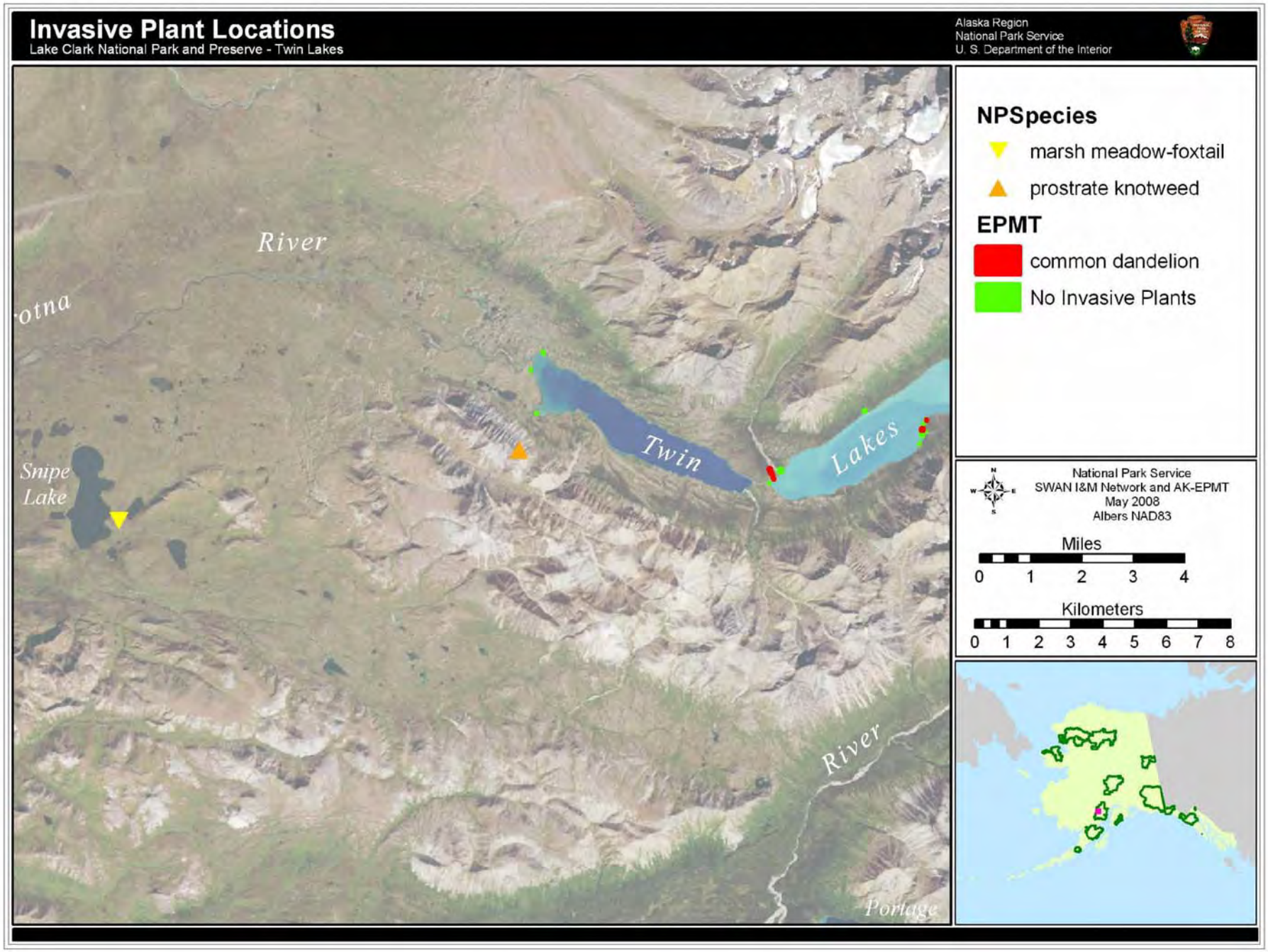

Invasive Plant Locations
Kenai Fjords National Park - Exit Glacier and Harding Icefield Trails
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT
common timothy
common plantain
common dandelion
No Invasive Plants
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 0.1 0.2 0.3 0.4 0.5
Kilometers
0 0.2 0.4 0.6 0.8

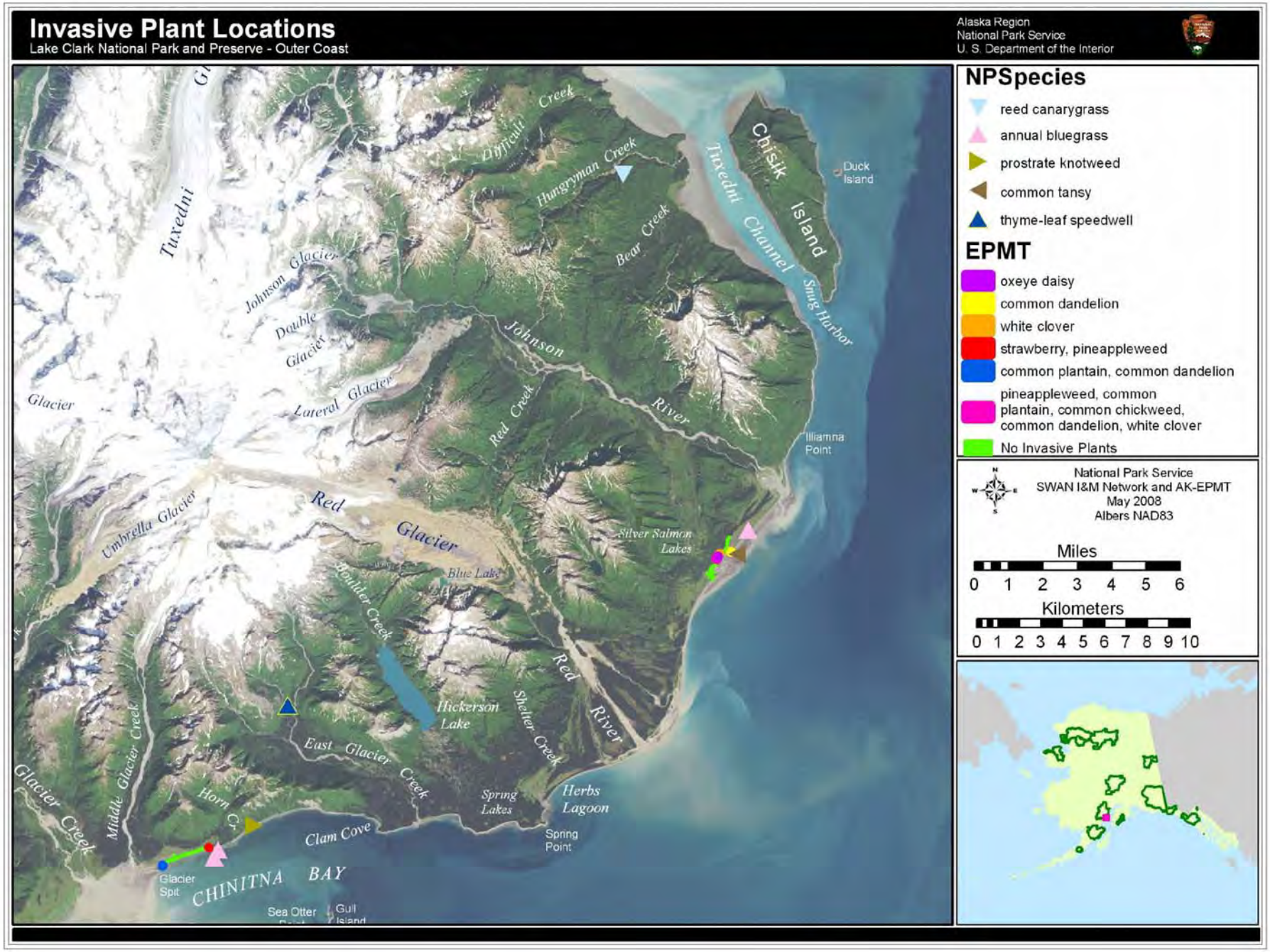

Invasive Plant Locations
Kenai Fjords National Park - Outer Coast
Alaska Region
National Park Service
U. S. Department of the Interior
NPSpecies
red top
mouse-ear chickweed
annual bluegrass
EPMT
common timothy
common dandelion
No Invasive Plants
Kenai Fjords National Park
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 2.5 5 7.5 10
Kilometers
0 2 4 6 8 10 12 14 16
KENAI MOUNTAINS
HARDING ICEFIELD
McCARTY
HARRIS PENINSULA
KENAI FJORDS NATIONAL PARK
ALASKA


Invasive Plant Locations
Lake Clark National Park and Preserve
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT and NPSpecies DATA
Areas Surveyed
Lake Clark National Park and Preserve Boundary
Twin Lakes
Port Alsworth
Outer Coast
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 5 10 20 30
Kilometers
0 5 10 20 30 40


Invasive Plant Locations
Lake Clark National Park and Preserve - Port Alsworth
Alaska Region
National Park Service
U. S. Department of the Interior
EPMT DATA
prostrate knotweed
common dandelion
white clover
common lambsquarters, pineappleweed
smooth brome, pineappleweed, sheep sorrel
pineappleweed, common plantain, common chickweed, common dandelion
pigweed, shepherd's purse, common lambsquarters, pineappleweed, common timothy, prostrate knotweed, common dandelion, white clover
No Invasive Plants
In addition, NPSpecies includes marsh meadow-foxtail, field mustard, oxeye daisy, narrowleaf hawksbeard, Italian ryegrass, and alsike clover with coordinates not accurate enough for the scale of this map.
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0
0.1
0.2
0.3
Kilometers
0
0.4


Invasive Plant Locations
Lake Clark National Park and Preserve - Port Alsworth Region
Alaska Region
National Park Service
U. S. Department of the Interior
Kijik Lake
Kijik
Tommy Island
Tommy Creek
See detail map
Tanalian Point
Port Alsworth
Tanalian Mountain
Chulitna Bay
Cape Shishkin
Tanalian River
Turner Bay
Takoka Creek
NPSpecies
ground ivy, orange hawkweed, annual bluegrass, white clover
common plantain, prostrate knotweed, white clover
No Invasive Plants
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 1 2 3 4
Kilometers
0 2 4 6 8


Invasive Plant Locations
Lake Clark National Park and Preserve - Twin Lakes
Alaska Region
National Park Service
U. S. Department of the Interior
River
otna
Snipe
Lake
Twin
Lakes
River
Portage
NPSpecies
marsh meadow-foxtail
prostrate knotweed
EPMT
common dandelion
No Invasive Plants
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 1 2 3 4
Kilometers
0 1 2 3 4 5 6 7 8


Invasive Plant Locations
Lake Clark National Park and Preserve - Outer Coast
Alaska Region
National Park Service
U. S. Department of the Interior
NPSpecies
reed canarygrass
annual bluegrass
prostrate knotweed
common tansy
thyme-leaf speedwell
EPMT
oxeye daisy
common dandelion
white clover
strawberry, pineappleweed
common plantain, common dandelion
pineappleweed, common plantain, common chickweed, common dandelion, white clover
No Invasive Plants
National Park Service
SWAN I&M Network and AK-EPMT
May 2008
Albers NAD83
Miles
0 1 2 3 4 5 6
Kilometers
0 1 2 3 4 5 6 7 8 9 10
Tuxedni
Difficult Creek
Hungryman Creek
Bear Creek
Chisik Island
Duck Island
Tuxedni Channel
Snug Harbor
Johnson Glacier
Double Glacier
Johnson River
Lateral Glacier
Red Creek
Illiamna Point
Umbrella Glacier
Red Glacier
Silver Salmon Lakes
Blue Lake
Boulder Creek
Hickerson Lake
Shelter Creek
Red River
Middle Glacier Creek
East Glacier Creek
Glacier Creek
Horn Cr.
Spring Lakes
Herbs Lagoon
Clam Cove
Spring Point
Glacier Spit
CHINITNA BAY
Sea Otter
Gull Island

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 953/100369, September 2009

National Park Service
U.S. Department of the Interior

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Fort Collins, CO 80525

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