



Invasive Species Management for Katmai National Park & Preserve, Alagnak Wild River, and Aniakchak National Monument & Preserve

2013 Summary Report

Natural Resource Data Series NPS/KATM/NRDS—2014/672



ON THE COVER

Common dandelion (*Taraxacum officinale* ssp. *officinale*) superimposed over the Valley of Ten Thousand Smokes, symbolic of the risk to resources invasive plants create.

Photography by: Aleksandra Voznitza

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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Abstract

This year marks the fourth season that Katmai National Park & Preserve surveyed and controlled invasive plants following the Alaska Exotic Plant Management Team protocol throughout the growing season. The majority of work was focused on manual and chemical treatment of previously surveyed sites at Brooks Camp, on the Valley of Ten Thousand Smokes Road, Lake Camp, administrative areas in King Salmon, and Fure's and Nonvianuk Cabins. Common dandelion (*Taraxacum officinale* ssp. *officinale*) at Lake Camp, Fure's Cabin, and Nonvianuk Cabin; fall dandelion (*Leontodon autumnalis*) at Lake Camp; bird vetch (*Vicia cracca*) on the Valley of Ten Thousand Smokes Road; and sheep sorrel (*Rumex acetosella*) at Lake Camp were treated with Milestone VM herbicide, as these infestations are either too large to effectively control manually, in areas difficult to access, or liable to spread into uninfested areas. Overall, manual treatments have proven successful for moderately-sized infestations, like the cultural site, in controlling the extent and density of invasive plants in these areas. Katmai's remote location and the EPMT's persistent monitoring continue to provide effective barriers to the introduction of new invasive plant species. The infestations present within Katmai National Park are a stark contrast to the more omnipresent infestations found within the contiguous United States or even more urban areas of Alaska. As new construction projects arise and those that are already in progress continue, the presence of the EPMT ensures that newly-exposed areas are managed and revegetated as needed.

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Abbreviations

AKNHP Alaska Natural Heritage Program
ANIA Aniakchak National Monument & Preserve
BCDA Brooks Camp Developed Area
EDRR Early Detection/Rapid Response
EPMT Exotic Plant Management Team
FAA Federal Aviation Administration
GPS Global Positioning System
KATM Katmai National Park & Preserve
NPS National Park Service
SAGA Southeast Alaska Guidance Association
SAVEC Southwest Alaska Vocational & Education Center
SCA Student Conservation Association
USFS U.S. Forest Service
USFWS U.S. Fish and Wildlife Service
VRAA Valley Road Administrative Area
VTTS Valley of Ten Thousand Smokes

Introduction

Background

Katmai National Park and Preserve (KATM) is one of Alaska's pristine national parks, covering 4.1 million acres of tundra, glacial lakes and vast mountains. Including Alagnak Wild River (ALAG) and Aniakchak National Monument and Preserve (ANIA), these units are amongst the most remote and difficult to access in the country. Those who do come to the park usually visit Brooks Camp, where the famed Brooks Falls are located and where one might access the Valley of Ten Thousand Smokes (VTTTS). The wildlife and scenery attract thousands of visitors annually from all over the world making tourism one of the biggest threats to Katmai's ecosystem as it provides numerous opportunities for exotic plant species to be introduced and spread. Exotic, or non-native, plants are defined as any plant that occurs in a location as a result of a human action. Brooks Camp and Lake Camp receive the highest number of visitors each season, and are therefore the epicenter of the most



Figure 1. A map of Katmai National Park & Preserve.

extensive infestations within the park.

KATM has two unique advantages against the spread of exotic plants. One is being too remote for most who wish to venture into the park, which limits the anthropogenic-related advancement of many exotic plant species and the transportation of plant material. The park's boreal forest floor has proven to be another barrier that retards non-native plant establishment thus limiting the expansion of invasive plants. However, invasive plants will still threaten the park's fragile ecosystem for numerous reasons.

The webcams on the website explore.org and the recent production of movies, such as *The Ends of the Earth* in collaboration with National Geographic, has and will give viewers an inside look of the park's beauty and especially to its main-attractant, the wildlife. Although this is great publicity for what the park has to share, it creates the possibility for surge in visitor numbers, and an increase in the potential arrival of invasive plant species

Invasive plant species threaten the native ecosystem because they have evolved in a separate environment where limiting conditions or factors are present to inhibit their dispersal throughout the landscape. When established elsewhere, these limiting factors are reduced thus creating an opportunity for what would now be considered an invasive plant species to outcompete their native counterparts for resources and for space. Over time this introduced species reduces the habitat's biodiversity, contributing to habitat degradation and altering the ecosystem's essential functions. Decreased biodiversity may then lead to compromised genetic integrity of the native flora through hybridization (Vitousek *et al.* 1997, D'Antonio *et al.* 2001). Invasive plant species have the potential to affect various habitats in a variety of modes prompting proactive measures as the EPMT continue to learn more about their ecology and of new control methods.

Invasive Plant Survey & Management History

Global Positioning System (GPS) data showing the extent of invasive plant infestations in Katmai were first collected by the US Geological Survey (USGS) in 2000 and then by the EPMT in 2005 for synthesis into three databases: the Alaska EPMT geodatabase; Alien Plant Control and Monitoring (APCAM), a nationwide NPS database for invasive plant data; and the Alaska Exotic Plants Information Clearinghouse (AKEPIC), a multi-agency web-based database and mapping application providing geospatial information for non-native plants in Alaska and the Yukon run by the Alaska Natural Heritage Program (Rapp 2009). Surveys in 2005 were conducted at Lake Camp, Brooks Camp, the VTTS Road, and along the outer coast at Hallo, Swikshak and Kaguyak Bays. Small infestations and high priority species were manually treated (Bauder and Heys 2005). Control work by a single volunteer occurred in 2006 and 2007 at Brooks Camp, joined in 2007 by a Tribal Civilian Corps (TCC) crew, focusing on common dandelion at Brooks Camp (Rapp 2009). Southeast Alaska Guidance Association (SAGA) crews performed control work from 2008 through the present at Brooks Camp and Lake Camp (KATM, Mike Fitz, pers. comm., September 2, 2011).

2010 was the first season that KATM fielded two Student Conservation Association (SCA) interns throughout the summer focused on invasive plant work at Brooks Camp, the VTTS Road, Lake Camp and King Salmon. Infestations at Fure's Cabin and Nonvianuk ranger cabin were also controlled, and Jojo Lake was surveyed with nothing found. In 2011, new locations were surveyed in

Katmai National Preserve at Funnel and Moraine Creeks and Crosswind Lake; on the Outer Coast at Geographic Harbor, Takli and Little Takli Islands; and areas on and around Naknek Lake, including the Bay of Islands, and at Idavain and Margot Creeks. Three new invasive species were found in the park, including common mouse-ear chickweed (*Cerastium fontanum*), common chickweed (*Stellaria media*) and European forget-me-not (*Myosotis scorpioides*). In 2012, treatment continued in Brooks Camp, the VTTS Road, Lake Camp, Fure's Cabin and in King Salmon, in addition to landing strips throughout KATM and Aniakchak National Monument & Preserve (ANIA).

In 2013, the EPMT continued work in some of the more commonly disturbed areas of the park, which include, Brooks Camp, the VTTS Road, Lake Camp, Fure's Cabin, and in King Salmon, and were able to survey and treat along the Alagnak Wild River and the Nonvianuk Cabin and River. This year's efforts were focused on control-work and even eradication in certain areas of the park. Herbicide treatments were applied at Fure's Cabin, the VTTS Road, and for the first time, at Lake Camp and Nonvianuk Cabin.

Prevention is the most effective way to prevent the spread of invasive plant species and has therefore been a priority for the Exotic Plant Management Team (EPMT) thus far. In 2011, the EPMT installed informational signs, boot brushes and conducted vehicle inspections. This crew also began a revegetation manual to be used in future project planning to minimize species introductions associated with construction or maintenance, and to effectively restore disturbed areas before they are colonized by invasive species. The 2012 EPMT crew continued this manual's development and inspected vehicles and heavy machinery as construction events occurred.

The 2013 EPMT updated the existing signs hanging over the boot brushes for their eventual replacement by future teams. The team also participated in the events associated with Fishtival, passing out informational booklets for children and adults. The 2013 EPMT also had the opportunity to speak on behalf of previous EPMT crews about the goals that have already been achieved and the progress that has been made on lowering the number of invasive plant infestations present within KATM. The EPMT also hosted a program for children in the community at the King Salmon Visitor Center, teaching them about basic plant structure as well as the native flora they might find in their own backyards. Another program the EPMT participated in was the high school science camp that the U.S. Fish and Wildlife coordinates each year. The students take part in the camp for approximately 2 weeks and receive college credits in return, during which they learn about a variety of subjects relevant to the environmental- and biological-sciences fields. The EPMT contributed information about invasive plant ecology, management and identification, taking the students on a small tour around the Fish & Wildlife building to show them just how prevalent these species are. All of the educational and outreach programs were a big success this field season.

Methods

Fieldwork in KATM was conducted May to September 2013 in accordance with the 2013 Alaska Field Protocol (Million *et al.* 2013). Most of the fieldwork was conducted by SCA interns Nicole Landry and Aleksandra Voznitza and KATM EPMT coordinator Whitney Rapp. In early August, a six-person SAGA AmeriCorps adult crew contributed their efforts for eleven days at Brooks Camp and along the VTTS Road.

Fieldwork consisted of surveying for invasive plant species in areas within the park previously visited or unvisited by the EPMT, and focusing primarily on manual or chemical treatment in some of the most disturbed locations. All surveyed or treated areas were mapped using a Trimble GeoExplorer Series GeoXT (3000 series) or GeoXH (3000 or 6000 series) GPS unit equipped with a standardized Alaska EPMT data dictionary specific to KATM run with TerraSync. Manual treatment was conducted on all infestations throughout the Brooks Camp Developed Area (BCDA), the VTTS Road, Lake Camp and Lake Brooks. Herbicide treatments using the broad-leaf specific herbicide Milestone VM, with the active ingredient of aminopyralid, was applied by Whitney Rapp to control common dandelion (*Taraxacum officinale* ssp. *officinale*), sheep sorrel (*Rumex acetosella*), fall dandelion (*Leontodon autumnalis*), and bird vetch (*Vicia cracca*) in select locations.

Results

Overview

Table 1. Annual summary of Katmai National Park & Preserve Exotic Plant Management.

Year	# EPMT Personnel	Field Season Length	Invasive Plant GPS Data (NPS Lands/Non-NPS Lands) per Year			Total Species Documented (NPS Lands/ Regionally)
			Acres Surveyed	Species Acres Infested*	Acres Treated	
2005	2	6/20-6/29	174.325 (37.507)	6.622 (0.012)	0.076	9/10
2007	<1	intermittent	5.198	0.526	0.495	9/10
2008	<1	intermittent	6.112	0.495	0.495	12/13
2009	<1	intermittent	3.071	0.631	0.083	12/13
2010	2	5/3-9/30	105.959 (14.527)	14.417 (0.292)	7.464 (0.276)	9/18
2011	2	4/25-10/25	37.562 (1.497)	8.626 (1.497)	3.650 (0.143)	13/24
2012	2	5/20-9/28	95.867 (7.576)	11.953 (3.351)	3.262 (0.072)	13/33

* Acres infested are calculated by acres mapped times the percent cover in areas greater than 0.5 acres. If under 0.5 acres, acreage mapped is counted as 100%.

2013 Season Highlights

- A larger presence of native largeleaf avens (*Geum macrophyllum*) and a lower number of common dandelion at the cultural site signifies a successful revegetation effort made by the EPMT at this location.
- Milestone herbicide was sprayed for the first time to treat infestations of fall dandelion, sheep sorrel and common dandelion at Lake Camp and common dandelion at Nonvianuk Cabin.
- Bird vetch was not found along mile-marker 13.5 of the VTTS Road nor at the 5-mile pit this season. A new infestation was found and chemically treated on the outbound-side near the first river crossing.
- Surveyed the Nonvianuk River and the Alagnak Wild River for the first time, documenting additional infestations of common dandelion and pineappleweed (*Matricaria discoidea*), and possibly annual bluegrass (*Poa annua*), on campsites located at the confluence and on other private properties.
- Participated in one of King Salmon Visitor Center's weekly children's programs to educate the local youth about basic flower structure and the native flora that could be found in the area.
- Developed and hung informational signs throughout King Salmon headquarters and sent out an email to NPS-personnel discussing Alaska Invasive Weeds Awareness Week.

- Coordinated and conducted a restoration project located behind the VTTS maintenance building with assistance from the SAGA crew.
- Participated in the U.S. Fish and Wildlife (USFWS) Science Camp. We educated local students about the impacts of invasive plant species in Bristol Bay Borough and beyond, and taught students to identify species in the area by field examples.

Table 2. Invasive plant species observed by EPMT in Katmai National Park & Preserve and Bristol Bay Borough.

Species			Invasiveness rank*	Within KATM						Within Bristol Bay Borough				
	Scientific Name	Common Name		BCDA	VTTs Road	Lake Camp	Fure's Cabin	Outer Coast	Other location	Near NPS HQ	FAA Housing	Air Force Base	US FWS	Other location
Present on NPS lands	<i>Capsella bursa-pastoris</i>	shepherd's purse	40	X	X	X	X	-	-	X	X	-	-	X
	<i>Bromus inermis</i> ssp. <i>inermis</i>	smooth brome	62	X	-	-	-	-	-	-	X	X	-	X
	<i>Cerastium fontanum</i>	mouse ear chickweed	36	-	O	-	X	O	X	-	X	-	-	X
	<i>Crepis tectorum</i>	narrowleaf hawksbeard	56	-	X	-	-	-	-	X	X	-	X	X
	<i>Leontodon autumnalis</i>	fall dandelion	51	-	-	X	-	-	-	-	X	-	-	X
	<i>Matricaria discoidea</i>	pineapple weed	32	X	X	X	X	O	O	X	X	-	X	X
	<i>Myosotis scorpioides</i>	European forget-me-not	54	-	-	-	-	O	-	-	-	-	-	-
	<i>Plantago major</i>	common plantain	44	X	-	-	-	O	X	O	X	-	-	-
	<i>Poa annua</i>	annual bluegrass	46	X	X	-	X	O	O	-	-	-	-	-
	<i>Rumex acetosella</i>	common sheep sorrel	51	O	X	X	-	-	-	X	X	-	O	-
	<i>Stellaria media</i>	common chickweed	42	-	-	-	-	O	-	-	-	-	-	O
	<i>Taraxacum officinale</i> ssp. <i>officinale</i>	common dandelion	58	X	-	O	X	-	X	X	X	X	X	X
	<i>Trifolium repens</i>	white clover	59	O	-	-	-	-	-	X	-	X	-	-
	<i>Vicia cracca</i>	bird vetch	73	-	X	-	-	-	-	-	-	-	-	X
Detected only off NPS lands	<i>Alopecurus pratensis</i>	meadow foxtail	52	-	-	-	-	-	-	-	O	-	-	-
	<i>Caragana arborescens</i>	Siberian peashrub	74	-	-	-	-	-	-	-	-	X	-	X
	<i>Galeopsis bifida</i>	split-lip hempnettle	50	-	-	-	-	-	-	-	-	-	-	X
	<i>Hieracium umbellatum</i>	narrowleaf hawkweed	51	-	-	-	-	-	-	-	-	X	-	X
	<i>Leucanthemum vulgare</i>	oxeye daisy	61	-	-	-	-	-	-	X	X	-	-	X
	<i>Linaria vulgaris</i>	yellow toadflax	69	-	-	-	-	-	-	-	-	-	-	X
	<i>Lotus corniculatus</i>	birdsfoot trefoil	65	-	-	-	-	-	-	-	-	-	-	X
	<i>Papaver nudicaule</i>	Iceland poppy	39	-	-	-	-	-	-	-	-	-	-	X
	<i>Phleum pratense</i>	common timothy	54	-	-	-	-	-	-	-	-	-	-	X
	<i>Prunus padus</i>	European bird cherry	74	-	-	-	-	-	-	-	-	X	-	-
	<i>Ranunculus acris</i>	tall buttercup	54	-	-	-	-	-	-	-	-	-	-	X
	<i>Ranunculus repens</i>	creeping buttercup	54	-	-	-	-	-	-	-	-	-	X	-
	<i>Rumex crispus</i>	curly dock	48	-	-	-	-	-	-	-	-	-	-	X
	<i>Securigera varia</i>	crownvetch	68	-	-	-	-	-	-	-	-	-	-	X
	<i>Sorbus aucuparia</i>	European mountain ash	59	-	-	-	-	-	-	-	-	X	-	X
	<i>Tanacetum vulgare</i>	common tansy	60	-	-	-	-	-	-	-	X	-	-	O
	<i>Trifolium hybridum</i>	alsike clover	57	-	-	-	-	-	-	X	X	X	-	X
	<i>Trifolium pratense</i>	red clover	53	-	-	-	-	-	-	-	-	X	-	-
	<i>Tripleurospermum inodurum</i>	scentless false mayweed	48	-	-	-	-	-	-	X	-	-	-	X

X - Observed during current EPMT field season.

O - Observed during prior EPMT field seasons, but not this field season.

* Invasiveness rankings taken from AKNHP (<http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-biographies/>) on 9/24/12 with a value of 0 (low) to 100 (high) possible.

Brooks Camp

Brooks Camp is located at the mouth of the Brooks River on the shore of Naknek Lake. Even though it's remote, accessible only by float plane or boat, visitors come from all over the world to take part in an assortment of activities that range from exploring the VTTS to bear-viewing at the famous Brooks River platforms. However, due to the ever increasing rate at which visitors come to Brooks Camp it is also the most heavily infested area of KATM. The most common of invasive plant species include common dandelion, common plantain (*Plantago major*), shepherd's purse (*Capsella bursa-pastoris*), annual bluegrass and pineappleweed.



Figure 2. A map of Brooks Camp.

EPMT efforts this year were primarily focused on manual control, not inventory, due to the amount of data that has already been collected throughout the BCDA. Manual treatment was the primary method of removal, and common dandelion, shepherd's purse and common plantain were the focal points of our efforts. In response to previous years' recommendations, the SAGA crew arrived later in the season to assist with EPMT efforts. The crew ranged in ages from 21- to 25-years-old and worked together cooperatively, having already spent an entire season working throughout the state of Alaska. SAGA assisted with the more heavily-infested areas such as the closed trail from the old bridge terminus to the north side of the river, the maintenance yard adjacent to Tuckerville, the parking spots around the lower platform and on the Spit Road (Barge Road). The crew was also a great help with revegetating the open area behind the maintenance building on the VTTS Road.

BCDA Campground & Dumpling Mountain

The Brooks campground is heavily used and is the only improved camping area in KATM. Brooks campground is mostly used by campers; however, hikers also frequently navigate through to gain access to the Dumpling Mountain Trail. The northern half of the campground is the most heavily infested, those infestations occurring mainly in open areas, footpaths and alongside any permanent structures, like the food/gear cache and covered picnic areas. The invasive plants that are most commonly seen are the common dandelion, common plantain, pineappleweed and shepherd's purse. As advised by last season's EPMT, minimal time was spent attempting to distinguish native mustard from the invasive, shepherd's purse early in the summer as it becomes readily discernible later in the season.

June: The 2012 field crew found, and was able to positively identify common plantain, shepherd's purse, common dandelion and pineappleweed in and throughout Brooks campground during this month. This field season, due to a delayed green up and the presence of a denser canopy creating large, shady areas, only common dandelion and some common plantain had developed enough to be positively identified and manually controlled. Common dandelion rosettes and flowers were



Figure 3. Brooks Campground in June.

identified and manually controlled mostly along the trails interspersed throughout the campground; however, large patches were also found in some of the bigger, more heavily-used campsites. Shepherd's purse and pineappleweed rosettes were noted in June, those rosettes resembling these species were too young to positively identify, so no control effort was conducted. Annual bluegrass could be found lining most trails, including those leading to the campground, and dispersed along the Dumpling Mountain Trail. Whitney Rapp reported common plantain rosettes located at approximately 900-feet elevation on the Dumpling Mountain Trail, which was noted as a priority for EPMT's next visit to the BCDA.

July: Surveillance of the BCDA resulted in minimal reoccurrences of dandelions, though a few rosettes were found scattered throughout the area. The primary invasive plant present and in seed was shepherd's purse, which could

be found throughout the BCDA and especially in highly trafficked and disturbed locations. The overall presence of shepherd's purse was not as extensive as the previous month's dandelion infestation, taking roughly two days to manually control versus the five days it took on the previous visit. Pineappleweed occurred in dense infestations throughout the BCDA, especially where bear traffic is heaviest. An example of such infestations can be found at the base of both the Riffles and Brooks Falls.

Common plantain was found in the Brooks campground in flower and in the no-flower stages of phenology along the main entrance area of the campground and around the first picnic shelter. The picnic shelters closest to the entrance and the restroom have proven to be the epicenter of the densest infestations of shepherd's purse throughout the campground, whereas the campsites had very little shepherd's purse present. It should be noted that the 'back trail' to the campground, and not the boundary trail alongside the beach, is also used when visitors need to transport their gear to the campground and a bear is present on the beach, therefore surveying and control efforts should also be focused on this trail in future seasons. As of this season, no invasive species were found on or along this trail. Extra caution should be taken on this trail as it is also utilized by a large number of bears especially in July when the salmon run is at its peak.

August: The SAGA crew arrived in August this year, rather than June like previous years, to assist with the EPMT's control and restoration efforts throughout the BCDA and along the VTTS Road. Efforts within the BCDA were focused on manual control of pineappleweed, common dandelion, shepherd's purse and common plantain. All infestations were easily treated and accounted for when working with the SAGA crew. This season pineappleweed and shepherd's purse were densest around the food and gear cache building and the picnic shelters. Common dandelions were found in scarce numbers throughout the campground. Common plantain was most abundant throughout, and

especially on the western border. Similar to previous years, the southern section had very few infestations.

Employee Facilities

The employee facilities are situated in a number of locations; however, the majority of the NPS cabins are located on 'Park Avenue', which is between the ranger station and Brooks campground. Employees of Brooks Lodge live in the area commonly referred to as Tuckerville. It should be noted that new employee facilities for both the NPS and Brooks Lodge personnel are being constructed off of the VTTS Road, in close proximity to the maintenance building and fueling station. The area is and will continue to be vulnerable to invasive plant infestation because of the high potential for fill materials and construction equipment to inadvertently transport seeds and provide the ideal disturbed ground for invasive plant success.

June: Annual bluegrass and pineappleweed were found along the generator building, Park Avenue, Tuckerville, the fenced-in storage yards, the maintenance and bath house buildings and the incinerator building. Due to their undeveloped nature and their low invasive rank, efforts were primarily focused on priority species. Patches of common plantain were manually controlled alongside the generator building, specifically the north side of the building. Common dandelion was found in Tuckerville within close proximity to the main entrance; however, its extent was minimal in comparison to the trails leading north from Tuckerville to the Brooks Lodge storage and recreational building. Common dandelion was also found alongside the trail and in minor patches around other small buildings or sheds west of the Brooks Lodge storage/recreational building. Small patches of common dandelion were also found on the southern and eastern sides of the incinerator building, an area that was noticeably trampled upon more often.



Figure 4. The maintenance yard adjacent to Tuckerville. Pineappleweed could be found in vast amounts.

July: Tuckerville was resurveyed and dandelions were manually controlled in areas that were not previously noted or mapped. Shepherd's purse was also mapped and controlled in this area, as well as in the adjacent maintenance yard and the recreation, bathroom and law enforcement storage buildings and sheds. Common plantain was found again around the generators and the generator building; however, it was not found as extensively as reported in previous years. Pineappleweed was the only invasive found around the ranger station. Native mustard was noted near the fire hydrant; however, no invasive shepherd's purse was found growing nearby like the EPMT previously discovered. The white clover (*Trifolium repens*) found near the generators prior to the 2012 field



Figure 5. Chronology of photos of the common dandelion infestation at the cultural site.

season, was again not found. A specimen of smooth brome (*Bromus inermis* ssp. *inermis*) was taken for positive identification alongside the generator trail leading down to the beach. This specimen is to be mounted and sent to AKNHP for identification.

August: Inside the fenced area of Tuckerville, common dandelion was again found and treated amongst the infestation of pineappleweed and shepherd's purse. The SAGA crew assisted the EPMT with treating the now carpeted maintenance yard adjacent to Tuckerville. This was a large undertaking requiring an entire day, plus a couple of hours on the following day, to treat the pineappleweed and a few areas of shepherd's purse. As equipment and vehicles are constantly brought through this area, it is highly recommended that this area remains a priority for treatment in the years to come.

Cultural Site

The Brooks Camp cultural site exhibit can be reached via a short walk down a trail leading from the auditorium, and is the site of a prehistoric pit house, or *barabara*, which has been reconstructed to demonstrate how the native Alaskans of several thousand years ago once lived (Bodeau 1992). The grassy areas around this site immediately adjacent to the building are a concern because they are maintained with occasional brush cutting and have had significant infestations of common dandelion. However, past seasons of manual treatment and revegetation have proven successful, as the density of common dandelions has decreased and species that had been reseeded continue to grow. Those species include native yarrow (*Achillea millefolium*), largeleaf avens and a few Jacob's ladder (*Polemonium acutiflorum*). SAGA helped with manual treatment of the common dandelion infestation amongst the native grasses, but required only about 45 minutes of their time to do so. Other non-native plants that have been found at this site include shepherd's purse and pineappleweed, but were only found growing on the pathways leading to the entrance of the cultural site building. This site continues to be a high priority site to track the dandelion infestation and to also monitor the

progress of previously revegetated species.

June: Annual bluegrass was noted along the cultural trail leading from the BCDA; however, it was not inventoried nor controlled due to its low invasive rank and extensive coverage. Pineappleweed was noted along the trailhead and starting at the informational sign at the cultural site, leading up to the building entrance, but again, it was neither inventoried nor controlled. Individuals of common dandelion began appearing approximately 10 yards from the edge of the lawn adjacent to the cultural site building, expanding its coverage as one got closer, from 1-5%, to approximately 6-25% in some parts of the lawn. Common dandelion could also be found on the slope leading up to and behind the cultural site informational sign. Shepherd's purse was not yet detectable. Native largeleaf avens covers upwards of 6-25% of the lawn alongside the cultural site building, is a definite improvement from previous field seasons.

July: Approximately one hour was spent at the cultural site during this visit to Brooks Camp due to a relatively sparse dandelion infestation. Shepherd's purse was not detected. Pineappleweed continues to persist along the trail, but has not attempted to penetrate the surrounding native vegetation. The largeleaf avens began going to seed during mid-July.

August: Only a few hours were required to treat the path and grassy areas surrounding the cultural site with the SAGA crew's assistance. Common dandelion and pineappleweed were manually treated, dandelion in the grasses and pineappleweed entirely on the trail. A few individuals of shepherd's purse were also manually treated near the entrance of the cultural site building.

Brooks Lodge

Brooks Lodge consists of a number of rooms or cabins for visitors to stay in and is also the hub of visitor activity from the beginning of June, until Brooks Camp closes in mid-September. Brooks Lodge is comprised of Skytel, several cabins, the dining hall and lounge, the public bathroom facilities, the Brooks Lodge office, trading post and the interweaving trails. Common dandelion, shepherd's purse, pineappleweed and common plantain were the invasive species most commonly found around these buildings. The best time to survey and treat around the cabins is the afternoon, when visitors are out of their cabins.

June: Common dandelion was interspersed throughout the lawns and paths of Brooks Lodge as well as around the fish freezing building. The greatest amount of time expended for manual control of common dandelion was spent in this area. Dandelions were also found in the lawns between cabins 22, 23 and 24; near the public bathhouse; between the oxbow marsh overlook cabins; and in front of the recreational storage building for Brooks Lodge. An extensive patch of common dandelion could also be found in the lawn immediately to the east of the Brooks Lodge office entrance. A single shepherd's purse that was in seed was treated in the lawn alongside the entrance of Katmai Trading Post, and an extensive patch was manually controlled under cabin 24 of Brooks Lodge. Pineappleweed and annual bluegrass could be found on and along the trail edges throughout the BCDA.

July: Dandelions and plantain continue to persist in patches in the lawns and alongside the paths leading to and from the Brooks Lodge cabins from the visitor center. The densest infestations of dandelions were present in the lawn between the Overlook cabins and the long stretch of cabins directly behind. Shepherd's purse was again found near cabin 22; however, extra care was taken to positively identify it without disturbing the guests present within the cabin. Native mustard was again found growing alongside the invasive mustard directly in front and underneath the trading post entrance. However, time spent within this area was limited due to high bear activity. Dandelion rosettes and shepherd's purse that were in seed were found along the Brooks Lodge office, trading post, fish freezing building and the trails leading to "the corner."

August: Common dandelion, common plantain, shepherd's purse and pineappleweed continued to persist throughout this area, common dandelion and pineappleweed being the most extensive. The open grassy areas amongst the overlook cabins and beside the public bathrooms of Brooks Lodge harbor the most widespread infestations of common dandelion. Pineappleweed was present throughout the footpaths of the Brooks Lodge Cabins. Cabins 22 and 23 have shepherd's purse growing underneath the porches and cabins. An individual of clover (*Trifolium* sp.) was noted and treated by the Trading Post of Brooks Lodge. A specimen was not taken for identification; however, white clover was located near the public bathhouse in previous years making it a priority species to look for in successive seasons.

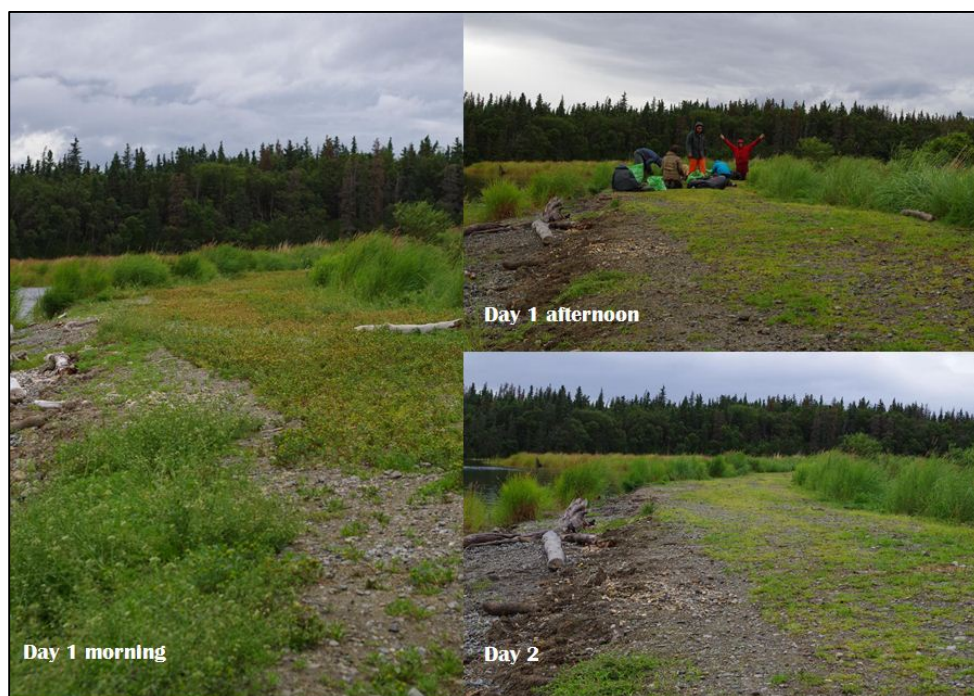


Figure 6. Photo sequence of treatment effort with SAGA on the closed trail located by the mouth of Brooks River.

Mouth of Brooks River

The mouth of the Brooks River is also a hub of activity; it is under constant use from visitors and employees alike for fishing, wildlife viewing, boating and vehicle usage. Areas of concern include the gravel trail from Brooks Trading Post to "the corner," the closed trail, the lower platform and Spit Road.

The closed trail is a gravel bar or trail that led to where the bridge previously terminated on the north side of the river. It was abandoned in 2009 and is now almost completely overrun with shepherd's

purse and pineappleweed. The Spit Road connects where the barge and other vessels beach on the south side of the river mouth to the Lower River Platform area. Although it is not used frequently, it is heavily infested with shepherd's purse and pineappleweed. The effects of regular disturbance and an extensive seed bank are further exacerbated by ample sunlight in these locations, demonstrating how rapidly colonization by invasive species occurs under suitable conditions in the absence of restoration (Frank and Woods 2011). Time and effort would be more efficiently spent if focused on control of the established infestation and seed collection in preparation for future revegetation efforts. Reclamation of these sites is not yet feasible due to future construction plans at these locations; however, plans should continue to be made in order to further prevent the spread of invasive plants and to revegetate those areas that have been disturbed, and those that may be disturbed in future construction zones.

June: Pineappleweed and annual bluegrass were found on trail margins leading down to “the corner,” along the closed trail and surrounding the lower platform on the southern side of the Brooks River bridge. Shepherd's purse may also be found in this area; however, it was too early in the season to make a positive identification.

July: The trails and structures surrounding the Brooks River mouth were not surveyed or manually controlled due to the high numbers of bears present during this time of year and it is advised to future EPMT staff that no attempt be made to manually treat this area in July.

August: A large effort was made by the EPMT and SAGA crew during this time to manually treat pineappleweed and shepherd's purse infestations present along the closed trail and surrounding the lower platform. These two plant species densely covered the closed trail and the valley bus parking areas across the river, requiring several days of attentive control efforts in order to remove the plants. Due to the high amount of sun exposure, most plants were either in seed, dying or dead and new rosettes of pineappleweed were beginning to grow. Extra care was taken to ensure that seeds were not incidentally spread while removing.

The closed trail and the areas surrounding the lower platform continue to be areas of high infestation due to the constant human and bear disturbance; however, it's priority level continues to remain low. Effort should be made to prevent the further spread of invasive plants along the trail and lower platform; however, due to future construction plans in this exact area, any efforts of a preventative or restorative nature would be futile at this time.



Figure 7. Brooks Falls in July. There were 19 bears at the falls this particular evening.

Brooks Falls Trail & Platform

The infestation of pineappleweed and shepherd's purse underneath the platform is one of the more challenging areas to treat because plant phenology is delayed due to high amounts

of shade and the large number of bears that frequent the falls. Additionally, this season's late green up challenged the EPMT work. Control efforts continue to be ineffective due to the high amount of disturbance, and therefore seed dispersal, facilitated by bear movement and grazing.

June: Due to reasons previously mentioned, pineappleweed and shepherd's purse were at too early a developmental stage to positively identify. There was one individual common dandelion rosette noted at the beginning of the Brooks Falls trail leading to the falls platform.

July: This area was not visited or attempted due to the high bear activity in the area during this time.

August: This area was not visited with the SAGA crew due to the presence of bears and the safety concerns associated with moving a large group at a quick pace when necessary. Upon visual appraisal, the site continues to be trampled by continuous bear activity, leaving most individuals of pineappleweed and shepherd's purse in poor condition. The pineappleweed remains most dense on the bank of the river where bear activity is very high and more scarce on the surrounding bear trails leading to and from the falls. Based on the low invasive ranking of pineappleweed, the EPMT monitors the infestation but does not prioritize it for treatment. The infestation is denser than what is usually observed for this species, probably because of the regular bear disturbance and nutrient source.

Lake Brooks Side

The infrastructure near Lake Brooks lies on the south side of the Brooks River headwaters, approximately 1/3 mile down the road from the VTTS Road turnoff. The area provides a popular fishing spot, access for floatplanes, and residential housing for many of the NPS employees. This area has seen an increase in the number of invasive plants present, which may be related to the increased amount of construction and therefore traffic disturbing old and new areas of establishment. Shepherd's purse, common dandelion, common plantain and pineappleweed were found interspersed throughout this area. Shepherd's purse and pineappleweed could be found within the maintenance yard starting in July. Pineappleweed has begun to densely cover the yard behind BL-3 and should be closely monitored in the future as a site that is highly disturbed by both NPS employees and anglers traveling to the small riffles downstream. Another area of concern is the septic field, where the new power line for the generator at the VTTS maintenance facility will run (KATM, Whitney Rapp, pers. comm). This site already has shepherd's purse and was treated, despite the recent construction activity. As mentioned with the closed trail and Spit Road, further mitigation would be unproductive due to future construction efforts that are planned in this location, otherwise known as the Valley Road Administrative Area (VRAA).

June: The Lake Brooks' maintenance yard, residential and visitor areas were all manually treated for common dandelion and common plantain. Rosettes of common dandelion and common plantain could be identified in some of locations with more sun exposure; however, it was difficult to positively identify shepherd's purse this early in the season. Infested locations include the grassy areas adjacent to the residential cabins and newly constructed area at the end of the Lake Brooks road.

July: All previous infestations were present in addition to shepherd's purse as it was more easily identified later in the season. This species could be located throughout the maintenance yard and underneath the residential cabins as well as the newly constructed area found at the very end of the road past the residential cabins.

August: SAGA and the EPMT retreated the maintenance yard for shepherd's purse and a few individuals of common plantain found across the road near a storage shed. Priority was aimed at the treatment of the now dense patch of shepherd's purse located underneath the first residential cabin, and the common plantain and common dandelion also found in the grassy areas surrounding both cabins.

The Valley of Ten Thousand Smokes

The Valley of Ten Thousand Smokes is a former river valley now covered in volcanic ash following the 1912 eruption of Novarupta, and even today one would observe that much of the floor is still devoid of vegetation (Frank and Woods 2011). The VTTS Road, extending 23 miles from the BCDA through boreal forest and alpine tundra, is the access to the valley and represents a likely vector for invasive plants to spread into the backcountry (Mortensen *et al.* 2009). The EPMT started to survey this road in 2005. Visually scanning the road from a slow moving vehicle, they found infestations of pineappleweed, shepherd's purse and annual blue grass in most pull off locations up to the first river crossing. Bird vetch was found along mile marker 13.5 and manually treated without success. As a result, following the completion of the Alaska Region Invasive Plant Management Plan environmental assessment that authorizes the use of herbicides where physical control methods are ineffective, Milestone herbicide was applied beginning in June 2011 (NPS 2010). A small reoccurrence of this species was manually treated later on during the 2011 season and then again in the 2012 season with success. The 2013 survey found no bird vetch at this location; however, a new patch of bird vetch was found on the Valley-side of the first river crossing along the outbound side of the road. Due to the previous poor results from manual treatment efforts, all flowers were manually removed and the plants were immediately sprayed with herbicide in August. This exemplifies the principle of early detection/rapid response (EDRR) of high priority species.



Figure 8. The new bird vetch infestation found in August at the first river crossing.

Valley Road Administrative Area (VRAA)

The construction near the Brooks Camp end of the road (VRAA) will be the site of future employee housing and is connected to the VTTS Road maintenance area.

The road, utility corridors and two cabins are completed pending further construction efforts along the entirety of the VRAA. No invasive species were present when construction began. As of this field season, pineappleweed and shepherd's purse (two plants on the pathway between the two cabins) were discovered. This area will be crucial for continued monitoring due to the abundance of activity that will continue to disturb this area.



Figure 9. A clear day at the Valley of Ten Thousand Smokes.

The VTTS Road maintenance building was built in 2010, it consists of a fueling station and a fenced yard that surrounds the large building. The yard is filled with trailers, heavy construction vehicles and other materials that are frequently moved to different sections of the yard or to areas within Brooks Camp. The recent construction for the VRAA has removed the vegetation adjacent to the maintenance yard, and a large swath of forest leading to it.

July: The EPMT spent approximately three hours manually controlling shepherd's purse along the southern- and western-sides of the maintenance building, and along the southern-edges of the fence. The densest infestation was found along the fence, adjacent to the gate, located in the southwest-corner. One could find shepherd's purse underneath trailers, equipment and especially where the fence meets the gravel, in fact, the latter was quite challenging for manual control efforts. Shepherd's purse could also be found interspersed outside the western edge of the fence, along drainages running into the natural vegetation, which is a concerning matter.

August: The last few days of the SAGA crew's time was spent at this location, first retreating the shepherd's purse infestation, then assisting us with the revegetation effort conducted in the clearing outside the maintenance yard. Native grasses and forbs were transplanted from down the VTTS Road to this area and seeds recently collected were planted in rows. See Prevention and Restoration section of report for more details. This location was revisited numerous times and will continue to be an area of particular importance to the EPMT.

Squirrel Camp

Squirrel Camp is located on the one-mile marker on the VTTS Road and has been used as temporary contractor housing since the early 1990's (KATM, Richard Sherman, pers. comm.). This site continues to be an important site to monitor due to the anticipated increase in intensity of construction projects that are to be conducted within the BCDA and the VRAA. Construction workers and equipment will frequently travel between construction sites and this location, thus creating ample opportunity for invasive plant colonization. The previous years' surveys recorded annual blue grass, pineappleweed and shepherd's purse at this location.

July: Squirrel Camp had no detectable invasive plant species present within camp besides pineappleweed.

August: Squirrel Camp was revisited with the SAGA crew briefly and both pineappleweed and shepherd's purse were found. Shepherd's purse was mapped and manually treated in the few locations where found.

September: Construction anticipated in fall of 2013 was delayed until at least 2014.

5-Mile Gravel Pit

The gravel pit, located on the VTTS Road, is the source for fill material throughout Brooks Camp and the VTTS Rd., and will continue to be used for the VRAA construction project. The materials at the pit are frequently moved throughout this area; therefore, areas that were once previously infested during one season may no longer be accessible the following year. It is recommended to future EPMT members that they not only visit sites that were once infested, but do a thorough sweep of the entire gravel pit each visit.

July: Shepherd's purse and a few individuals of narrowleaf hawksbeard (*Crepis tectorum*) were the main invasive plants of concern and those that could be positively identified were manually treated. Pineappleweed is also present; however, due to its low invasive rank it was left untreated. The seed bank for narrowleaf hawksbeard may be close to being exhausted as very few plants were found this year.

August: All previous infestations were present, apart from narrowleaf hawksbeard, upon revisiting. The SAGA crew and the EPMT treated and mapped the few individuals of shepherd's purse and pineappleweed that were present within the pit. The largest infestation of shepherd's purse is located in the northwestern section of the gravel pit directly adjacent to the large mound of gravel on the hill facing the small fenced-in maintenance yard.

Mile 13.5

Mile marker 13.5 on the VTTS Road is the site of a previous infestation of bird vetch that was not detected in 2013.

July: The EPMT used background files on the Trimble GPS unit to locate the site of the previous years' bird vetch infestation on mile-marker 13.5; however, no infestation was found and was therefore inventoried as such. Upon further surveillance of the Three Forks Visitor Center and other pull-off locations there were no further invasive plant infestations located.

August: For a partnership development day, the EPMT took the SAGA crew for a half-day trip out to the Valley of the Ten Thousand Smokes. Upon returning, the EPMT discovered a fairly large patch of bird vetch on the roadside approximately fifty yards from the first river crossing. Plans were made to apply herbicide to the infestation due to previous years' success with this method on a subsequent trip that month. The seed pods and inflorescence were carefully removed prior to spraying, as seeds were ripe and soon to be expelled.

Other VTTS sites (Margot Falls, Ukak Falls, & Windy Creek Trails)

July: The various small turnaround locations along the valley road were invasive free upon surveying, as was the main trail leading down to Ukak Falls from the Three Forks Visitor Center. The Margot Falls and Windy Creek trails were visited and inventoried as having no infestations.

August: These sites were not revisited during this time period.

September: The Ukak Falls trail down to the valley was surveyed briefly with no high ranking invasive plant species found. There were patches of annual bluegrass found along the edges of the first section of the trail. The Ukak falls trail was surveyed again with the same results. These infestations were identified based upon previous summary reports' identification and survey efforts.



Figure 10. One of the signs posted to make visitors aware of the recent herbicide application.

Naknek Lake

Fure's Cabin

Fure's Cabin is a restored public use cabin situated in Naknek Lake's Bay of Islands, and is surrounded by a south facing grass field. As the access point to the Portage Trail leading to Grovesnor Lake and the Savonoski Loop, and a popular camping spot, it steadily receives small groups of hikers and boaters. Previous teams have found that the grass field surrounding the cabin is infested with common dandelion and the trail leading up to the cabin is lined with annual bluegrass. Pineappleweed and shepherd's purse were

found around the fire pit. Few invasive plants have extended along the Portage Trail to date.

June: The size of the dandelion infestation continues to decrease and the time dedicated to control efforts has greatly decreased as well (KATM, Whitney Rapp, per. comm.). The relative percent coverage of the invasive common dandelion warrants the continued use of Milestone herbicide, which has proven successful since 2011 to reduce the percent coverage of dandelions. One work day was spent removing common dandelion flowerheads in preparation for herbicide spraying. Another half day was spent assisting Whitney Rapp in locating and chemically treating plants.

Other invasive plants found in the area were annual bluegrass, which lined the pathways around Fure's Cabin, pineappleweed and shepherd's purse, which were at too young a developmental stage to make a positive identification but are known to be present due to previous season's reports. Pineappleweed and shepherd's purse could be found in the grass surrounding the fire pit. Native species of chickweed and dandelion were also made note of along the



Figure 11. Whitney Rapp and Nicole Landry surveying the Portage Trail connecting Fure's Cabin to Grosvesnor Lake.

Portage Trail leading to Grosvenor Lake. Common mouse-ear chickweed, the invasive species, was not found on the Portage Trail during this survey effort.

July: Little less than an hour was spent at Fure's Cabin during the month of July. The goal of the trip was to remove all signs posted in June regarding herbicide application and assess how effective the herbicide treatment was. Among native grasses there were many large rosettes of dandelions that were identified as either new growth or plants that were missed. Compared to previous years, the blue dye was not as visible on the property, which may be a result of the unusually high amount of sunlight KATM has received over the summer, causing the dye to dull or fade quicker in comparison to what has been observed in previous seasons. A few off target species appeared to have slight herbicide damage, including fireweed (*Epilobium angustifolium*) and yarrow (*Achillea millefolium*). The point specific treatment method is utilized to minimize damage to the surrounding native flora; however, it can be expected that some native flora will be affected in denser vegetation. The small population of shepherd's purse was found to be in seed around the fire pit outside the cabin and took very little time for the EPMT to remove.

August: While traveling the Portage Trail, the infestation of common mouse-ear chickweed was once again observed, but not treated due to time constraints portaging gear to Grosvenor Lake.

The Bay of Islands

The 2011 EPMT traveled to the Bay of Islands and revealed no invasive plant species present despite clear signs of human trampling caused by fishing and camping activities. The 2012 and 2013 teams did not visit the area due to challenges in logistics and time constraints. It was noted in previous reports that this area remains an area to be surveyed in future seasons either as part of a law enforcement patrol effort or simply as an EPMT trip. These islands remain an area of concern due to their frequent use and their proximity to areas of known infestation at Fure's Cabin, Brooks Camp and Lake Camp, all of which are infested departure points. It is recommended that this area be surveyed or revisited as part of an extended trip, which could be in conjunction with a Fure's Cabin trip.

Margot & Idavain Creeks

The 2011 EPMT first surveyed Idavain Creek (west of the Bay of Islands) and Margot Creek (terminating in Iliuk Arm) due to their high popularity as fishing destinations on Naknek Lake. Anglers arrive via boat or floatplane, land on the beaches and walk the bear trails running along the creek banks. Therefore areas that were surveyed at Margot Creek included these trails, the length of the beach, the large campsite and fire pit at the mouth and the trail along the left-side of the creek. No invasive plant species were observed. The beach at Idavain Creek was surveyed revealing three individuals of pineappleweed, which were promptly removed and logged. Upon revisit by the 2012 EPMT, no invasive plant species were found at either locations but both teams were limited as to the amount of area they could survey or treat due to the high density of bears that frequent these locations. No effort was made during the 2013 field season to survey or treat this area due to the lack of invasive plant species present during the previous years' visits. Additionally this year's efforts were heavily focused on the eradication of infestations that were more heavily disturbed.

American Creek

American Creek is a premier location for rainbow trout fishing or white water rafting down its turbulent waters. Of course, another main attractant for these visitors is the variety of wildlife that can often be found fishing and traveling along the creek's shores. Trapping cabins, such as Fure Line Cabin and the Hartzell-Fure Cabin Complexes, were built and utilized by Roy Fure and John Hartzell. These two trappers were forced to relocate when Katmai National Monument made its second boundary expansion, as trapping and hunting are illegal within a National Monument, and later park. Both Roy Fure and John Hartzell were also known to establish gardens for sustenance while inhabiting these cabins, and so it is possible that non-native plant species were introduced and may have persisted (Clemens and Norris 1999).

This area is therefore a priority as a place for the EPMT to visit due to the many contemporary campsites and also its historical usage. The 2013 EPMT were unable to survey American Creek due to logistics and weather challenges. Guides to the area have reported seeing dandelions, but it is unclear whether they are native or non-native ones (Rapp pers. comm. 2012).

Grosvenor Lake and Savonoski Loop

This season, the first effort to survey Grosvenor Lake, Grosvenor Lodge, and the Savonoski Loop occurred between 8/9-8/15. August is late in the season for survey work, particularly for confirming which species of dandelion is present and in areas where *Calamagrostis* grass dominates to see other herbaceous species. The survey work occurred primarily via kayak paralleling the shoreline, so detection was also limited. No invasive plants were detected along the southwestern shore of Grosvenor Lake.

In an effort to encourage visitation of the Katmai area, airline executive Raymond I. Petersen laid out a plan to set up a series of five tent camps in the lake country west of the Aleutian Range. As a part of this effort, Coville Camp was constructed to appeal to fisherman and explorers alike. The Camp was later called Grovesnor after Dr. Gilbert Hovey Grovesnor, longtime editor of the *National Geographic Magazine* and a major proponent during the original effort to establish Katmai as a national monument (1918). The original camp consisted of one cookhouse, five guest tents, a pump house and a root cellar (Clemens and Norris 1999).

Modern Grosvenor Lodge still has a rustic character. Amongst the buildings, common dandelion, annual bluegrass, shepherd's purse, and pineappleweed were found. Lodge manager, Ray Irvin, and staff have made efforts over the years to manually control the dandelions and other invasive plants and supported collaborative efforts with



Figure 12. Dandelions growing along the shoreline to the west of Grosvenor Lodge.

future EPMT. The invasive plants are currently constrained to the mowed areas as the surrounding vegetation is dense grass. It is possible that an early season survey would detect additional infestations in surrounding areas.

Dandelions appearing to be the non-native species were also found in several areas along the shoreline between Coville and Grosvenor Lakes. Accessing these sites for treatment will require a boat. No survey work was performed along the shores of Coville Lake.

Several other areas of dandelions were found on the northwestern shore of Grosvenor. Since plants were not in flower in all areas, the sub-species determination is not confirmed; however, the leaves were more likely the non-native species. In particular there is an isthmus of land separating a beaver pond from Grosvenor that had dense infestations particularly at its southern end. As the survey progressed clockwise around the lake, areas of native horned dandelions were encountered, which affirms the need to survey the area when plants are at peak bloom.

The Savonoski Loop is a paddling route from the Portage Trail (from Fure's Cabin in the Bay of Islands of Naknek Lake) along Grosvenor Lake to the Savonoski River into the Iliuk Arm of Naknek Lake. No other surveyed sites, including likely camping areas, had invasive plants detected, except for the campsite, known as Bluff Camp, on river right at the start of the Grosvenor River. At Bluff Camp, there was common mouse-ear chickweed well-integrated into the native vegetations, which would make control difficult. There were also dandelions growing without any flowers and leaves that looked both native and non-native.

No other invasive species were observed along the Grosvenor or Savonoski Rivers, including the former Old Savonoski site, which was surveyed by foot. Additionally, no invasive plants were observed on Spruce Island, a well-established campsite.

The Savonoski settlement, located near the mouth of the Savonoski River, functioned as a base for subsistence based foraging and hunting, including being a supplier of the fur trade when it was the primary economic activity with the Alaska Commercial Company (ACC) (Clemens and Norris 1999). Invasive plant species may have been deposited either by the previous inhabitants or by visitors or park service personnel that have explored the area, which warrants further investigation.

Lake Camp

As the only location in the park accessible by road to Bristol Bay Borough, Lake Camp is the major access point into the park for anglers, boaters, local residents, and NPS staff. As a result, Lake Camp



Figure 13. A dense infestation of common dandelions in the northwestern corner of Grosvenor Lake.

is particularly vulnerable to the introduction of invasive plants found in King Salmon and Naknek (Mortensen *et al.* 2009). A significant management concern is the transportation of construction vehicles and equipment to Brooks Camp through Lake Camp, as they are ideal vectors for transporting invasive plants.

During the 2010 and 2011 seasons extensive efforts were made on manually treating the infestations of sheep sorrel, shepherd's purse and fall dandelion that were present throughout Lake Camp. During the 2010 season fall dandelion was first discovered and has been manually treated in all subsequent years. With the assistance of a SAGA crew, EPMT manually treated the widespread infestation of sheep sorrel; however, as of the 2012 and 2013 field seasons, this effort was found to be largely unsuccessful.

Consequently, Milestone herbicide was applied for the first time at Lake Camp targeting fall dandelion, sheep sorrel, and the very small infestation of common dandelions in July and August. The effort was deemed successful as 75-96% of those sprayed were later found either dying or dead.



Figure 14. Whitney Rapp treating fall dandelion at Lake Camp.

June: Extensive inventorying and manual control effort was conducted on the infestation of sheep sorrel and fall dandelion present at Lake Camp. Sheep sorrel was found encompassing the road side that leads from the lower parking area up to the larger, upper parking area, the berm of the road revealing the most coverage. This plant could also be found lining the entire upper parking area, the lavatory trail and the trail adjoining the picnic area. Pineappleweed and fall dandelion were found interspersed throughout this area and on the roads interconnecting the parking lots. Annual bluegrass could be found lining both the parking lot and roads at Lake Camp; however, little effort was spent on identification as it was previously identified and because of its low invasive rank. Manual control effort was conducted on fall dandelion and sheep sorrel within the picnic area and along the upper parking lot; however, due to the invasive plants' extensive coverage of the area, and the relentless whitesocks and mosquitoes, the EPMT made short, frequent visits.

July: In preparation for herbicide spraying, the EPMT went to Lake Camp to map and to remove the flowering heads of fall dandelion and some sheep sorrel. In addition, areas that were not previously mapped for fall dandelion were logged. The EPMT revisited Lake Camp later in the month and plants that were beheaded appeared to produce even more heads, with those located near the Lake Camp sign most vigorous.

Later in the month, EPMT traveled again to Lake Camp to apply herbicide to fall dandelion and sheep sorrel. Shepherd's purse was also present but due to the ineffectiveness of the herbicide on mustards, shepherd's purse was manually treated. The sheep sorrel previously along the road margins were no longer present following road grading that destroyed most of the vegetation directly adjacent to the roads leading to and from the lower boat ramp area. The EPMT also discovered a small

number of common dandelions, which had not been redetected since 2011. The roadsides and recurring infestation will require close monitoring in coming seasons.

August: Lake Camp was revisited in late August to assess whether the herbicide treatment was successful, and was proved so. Most of the fall dandelion plants were either dead or dying and only a few individuals were found interspersed in areas of infestation. Sheep sorrel continues to persist throughout the Lake Camp parking areas and picnic area, therefore Whitney Rapp returned to treat the remaining sheep sorrel with Milestone herbicide.

Katmai National Preserve & Alagnak Wild River

Little Ku/Nanuktuk Creek

Little Ku is a small lake surrounded by alpine tundra vegetation that comes directly to the waterline. This site is often utilized as a float plane access point for anglers destined for Nanuktuk Creek. This area was surveyed in 2011 with no invasive plants found. In 2012, the Little Ku tundra strip was surveyed with no invasive plants found. The 2013 EPMT did not survey this area due to its low priority as a site that requires attention.

Moraine Creek, Funnel Creek and Crosswinds Lake

The mouth of Moraine Creek at the north eastern edge of Kukaklek Lake is the terminus of many fishing and rafting trips and is a frequently utilized landing site for both float and wheeled planes picking up their clients. The EPMT inventoried along Moraine and Funnel Creeks over several days in August 2011. The crew found only three small areas of annual bluegrass. The first area was a severely trampled mud bank at the end of the portage trail from the pot hole where rafters and anglers stage their floats down the river. The second location was a tent impression nearest the fire pit at the campsite near the Crosswinds Lake/Moraine Creek confluence. The final location was a well worn float plane loading area approximately 0.5 miles up from the mouth of Moraine Creek. Each infestation was less than three square meters and limited to locations of high disturbance, largely devoid of other vegetation (Frank and Woods 2011). The 2012 EPMT surveyed the Moraine Creek sand blow airstrip and found it free of invasive plants. If feasible, future EPMTs should revisit these sites to monitor and control the annual bluegrass infestations; however, the EPMT was not able to visit during the 2013 field season.

Nonvianuk Lake to Alagnak Wild River

The Alagnak Wild River is a separate NPS unit co-managed by Katmai. The river flows from Kukaklek Lake and is also fed by the Nonvianuk River draining Nonvianuk Lake. The NPS does not maintain any public facilities along the Nonvianuk or Alagnak Rivers; therefore, those looking to find accommodations in this area must camp or stay at one of the many private lodges on private parcels. When surveying this area it is important to consider that there are private inholdings along the river and that it is unlawful to trespass upon this land without acquiring approval from the landowners. This has made surveying and treatment efforts complicated, and it is therefore highly recommended that future EPMTs obtain permission from the various lodge owners prior to visiting.



Figure 15. Nicole Landry surveying the Nonvianuk River bank.

In 2011, the KATM EPMT briefly revisited the Nonvianuk ranger cabin and trails leading from the river. Previously documented infestations of common dandelion were relocated, but both horned dandelions and what appear to be hybrids were also observed. Hybrid species can outcompete native species by creating more fertile populations, and should therefore be closely monitored in coming seasons (Brock 2004). Additionally, along the banks of the Nonvianuk River upstream from the ranger cabin where camping often occurs, the common plantain infestation was relocated along with new discoveries of annual bluegrass and mouse-ear chickweed.

During the 2013 field season, herbicide was applied to the dandelions; however, common plantain and mouse-ear chickweed were not detected. Upon continued and more extensive surveying of the Nonvianuk and Alagnak Rivers, only one infested area was found with common dandelion and pineappleweed on private land at the confluence of Nonvianuk and Alagnak Rivers. Another camp site was spotted farther down the Alagnak River and should

be revisited in the future. The EPMT did not seek permission to survey any private land on these rivers; therefore, inventory was conducted while in the boat or wading off shore. It should be a priority to obtain permission to survey and control invasive plants on campsites and other private lands, to prevent further spreading of these plants on to other riverside campsites or commonly used fishing spots.

Pfaff Mine

Pfaff mine was a prospecting site that Ernest Pfaff established a lode claim to and that the Bureau of Land Management later declared as null and void in 1984. The Mine itself is located adjacent to the boundary line between what is Park and Preserve. Remnants of an airstrip and a large wanigan, or shelter, are some of the remains from the prospecting activity. Other more hazardous items, like 55 gallon drums, that were left onsite from the mining period 1964 -1984 (ADEC 2013) have since been removed. In conjunction with servicing the weather station here, the landing strip and areas near the residence were surveyed for the first time this year. No invasive plants were detected in this tundra-dominated vegetation. The former mining roads on the hillside were not visited and look from a distance to be regrowing in brush.

Outer Coast

The Katmai coast has a long history of anthropogenic uses including villages, canneries, farms and mining operations. Identifying and surveying areas of former use and disturbance is of primary importance as they may contain older and more severe infestations, which have previously gone undocumented. Current anthropogenic uses of the coastal regions include bear viewing at Geographic Harbor and Hallo Bay, NPS ranger cabins at Amalik and Swikshak Bays and private lodges at

Kaguyak and Kukak Bays. In a previous KATM invasive plant report from 2005, pineappleweed was documented growing in Kaguyak Bay on a trail from the beach to Hallo Bay Lodge, while no invasive species were documented at Hallo or Swikshak Bays (Bauder and Heys 2005). The 2010 KATM EPMT was also able to briefly visit Katmai Bay and Amalik Bay where they encountered no invasive species (Shepherd and Bartley 2010).

The outer coast is one of the most logistically challenging places to reach in the park and original efforts to survey at Hallo and Swikshak Bays were thwarted by inclement weather during the 2011 and 2012 field season. During the 2011 field season, trips to Geographic Harbor, Amalik Bay, Kukak Bay and Kaguyak Bay were successfully completed. The 2013 EPMT made two attempts to fly to Swikshak Bay, and one attempt to fly to Dakavak and Hallo Bays, but were unsuccessful due to inclement weather each time.

Katmai and Dakavak Bays

Surveys in 2011 and 2012 detected no invasive plants in the surveyed areas.

Geographic Harbor/Amalik Bay

Geographic Harbor is a popular bear viewing destination and was the site of previous industrial activity. During the summers of 1950 and 1951, Geographic Harbor became a pumicite mining extraction site headed by John Grove of the Stock and Grove Company of Anchorage. The NPS issued a cease and desist order and shut Grove's operations down the following winter. As of recent, there are only remnants of a derelict building (Clemens and Norris 1999). In 2011, Geographic Harbor was surveyed with no invasive plant species found. It was not resurveyed in 2012 or 2013, but the area is an option for future seasons.

Takli and Little Takli Islands, which sit in Amalik Bay, were home to a fox farm and trapping cabin from the early 1930's to 1940's, while Amalik Bay itself was the center of many prospecting and mining operations dating back to the early 1900's (Clemens and Norris, 1999). Prior to that, the area was occupied by native Alaskans. This history of human use draws frequent visits by NPS archeologists and personnel. The islands are both fairly dry with vegetation composed primarily of grasses, making them ideal sites for the establishment of invasive plants. As of a recent 2011 survey, no invasive plant species were encountered. Future surveys should attempt to locate the historic use sites to ensure that no invasive species are present. Site visits to the Amalik Bay cabin in 2010 and 2011 revealed no invasive species present. The 2012 and 2013 EPMTs were not able to resurvey these areas, but it remains an option for future seasons (Connealy and Parker 2013).

Kafli Bay

Pre-1912, Kafli Bay was the site of a rising saltery and store, and where Katmai and Douglas villagers came to beach seine for salmon. These operations attracted many people from surrounding locations within Katmai, its resident population was steadily increasing, until Novarupta erupted and hindered any further development (Clemens and Norris 1999). This site continues to be of cultural significance and is visited by cultural and other NPS staff; therefore, it would be a good place to survey as no EPMT staff have ever visited this area.

Kukak Bay

At Katmai Wilderness Lodge, annual bluegrass, common plantain, common chickweed and common mouse-ear chickweed were found around the lodge and European forget-me-not and other ornamentals in planters. 2011 was the first time those species had been found on the outer coast (Frank and Woods, 2011).

Kukak Bay is of important archeological significance as it was the site of the Kukak Cannery, which operated during the 1920's and early 1930's by first the Hemrich Packing Company and then later by the Pioneer Packing Company in 1932. The site was abandoned in 1936 and by 1941 the site was destroyed by a fire that swept through the area. The cannery was partially rehabilitated in 1948 and operations resumed there until 1951 by Mainland Fisheries but have since been abandoned (Clemens and Norris 1999). Along with the establishment of homesteads by the cannery, gardens may have been planted, which warrants further investigation by the EPMT.

The 2013 EPMT received assistance from archeologist, Linda Chisholm, as well as fish technician, Bob Peterson, who visited this site and took photos of any suspicious plants that they happened to come across; however, no invasive plants were noted. It was highly advised by these individuals that any future trips to this site should be done with extreme care as rusted metal and rotten wood beams are present, along with a large number of bears that frequent this area. It was also explained to EPMT that the best time to land any water vessel is during lowtide so that one may avoid any artifacts located under water just offshore or adjacent to the dock.

Hallo Bay

A survey of the north meadow of Hallo Bay revealed no invasive plants in 2005. All other attempts to visit this area were thwarted by weather.

Kaguyak Bay

Kaguyak Bay operated as a clam digging location in conjunction with Mainland Fisheries' Kukak Bay operations. The last structure that remained standing was a Russian Orthodox Church which dated pre-1912; however, by 1965 the building was burned down by clam diggers who had taken residence in it.

The 2011 EPMT conducted survey work near Hallo Bay Wilderness Camp from the coastal margin to the property boundary with no access to private lands. Annual bluegrass, pineappleweed and common plantain were discovered on the trails leading from the beach to the lodge. This year, Roy Wood, Chief of Interpretation, visited the area and documented dandelions as well, which the lodge



Figure 16. Google Earth image of Kukak Bay and cannery location.

staff has been aggressively removing. Follow-up conversations with the lodge should be made to provide recommendations on treatment and disposal options.

Swikshak Bay & Lagoon

Swikshak Bay allows for the same opportunity for invasive plant establishment as Kukak cannery due to its archeological and cultural significance as both a satellite location for clamming operations run by Kukak Cannery and as a site where a fully functioning cannery once occurred. The remnants of the latter were destroyed in 1972 by KATM personnel who deemed the dilapidated buildings as hazardous and unsightly (Clemens and Norris 1999). Abandoned vehicles and structures were observed by NPS personnel while making trips related to bear management at Swikshak Lagoon. These remnants can be found on the small peninsula-like land formation that Swikshak River creates (Fig. 17). Swikshak Bay was visited by a field crew in 2005 where no exotic species were documented; however, the lagoon has since never been surveyed for non-native plant species (Bauder and Heys 2005). Incidental trips by EPMT staff to the area have thus far not documented any invasive plants.

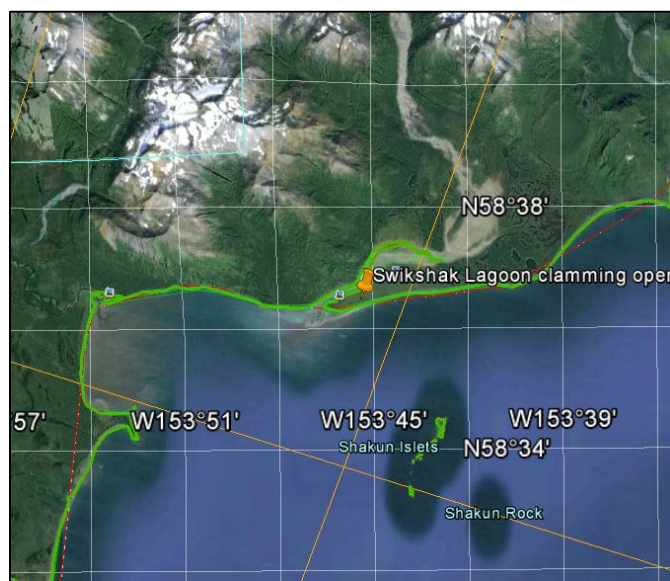


Figure 17. A Google Earth image of Swikshak Bay and Lagoon.

Other Locations

There are a number of other lodges on both federal and private lands within KATM's administrative boundary, as well as weather stations and other manmade structures that are visited for maintenance and tourism. Twelve years ago, several lodges were surveyed and three invasive species, common plantain, common dandelion and pineappleweed, were present in disturbed areas around Grosvenor, Katmai, and Kulik Lodges (Densmore *et al.* 2001). Common plantain was found at Katmai and Kulik Lodges, pineappleweed was found at Grosvesnor and Katmai Lodges, and common dandelion was found at all three lodges. Since these lodges are not often frequented by NPS staff, opportunities to survey these areas are limited.

In 2012, ground surveys of the airstrips were conducted in Katmai with no invasive species documented. Airstrips surveyed included Kulik Lodge, including some of the area between the airstrip and the lodge; Moraine Creek Sand Blow, Little Ku Tundra, and Contact Creek. EPMT staff should resurvey lodges, airstrips, and bases of commercial activity in the future.

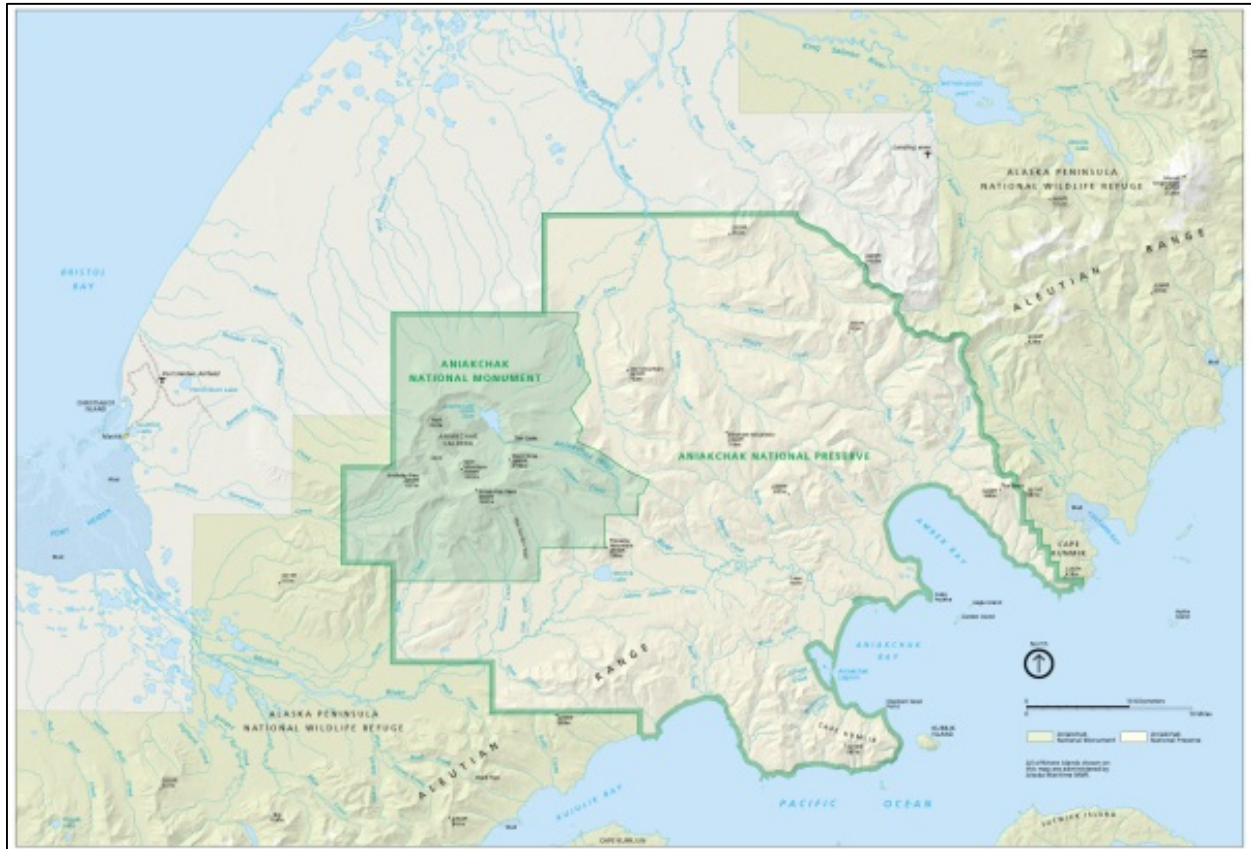


Figure 18. A map of Aniakchak National Monument.

Aniakchak National Monument & Preserve

Aniakchak National Monument & Preserve (ANIA) is a remote, undeveloped and infrequently visited NPS unit, situated on the Alaska Peninsula approximately 130 miles south of KATM. Though it is a separate park unit, KATM assumes administrative duties for ANIA. Floristic inventories performed by the AKNHP in 2004 and field work conducted in the preserve in 2009 detected no exotic species. During surveys performed in 2010 by the AKNHP, common dandelion was discovered growing along the Aniakchak River (Shepherd and Bartley 2010). Scattered plants were growing along the river in undisturbed areas, which is an uncommon habit for dandelions in this region.

A 2012 visit by the EPMT to ANIA surveyed landing strips at Lava Creek Cabin, Klutsch's Cinder Strip, and Cinder River. All landing strips were free of infestations. The trip also included landing on the beach near Packer's Cabin located in Aniakchak Bay. No invasive species were found; however, native dandelions were present in full flower. Specimens were taken in order to confirm that they were, in fact, native and not a hybrid species between native and common dandelion. At Packer's cabin a patch of nonnative chives were growing and suspected to have been a remnant of past cultivation; however, the species is not considered invasive.

Bristol Bay Borough

NPS Administered Property

The NPS administrative area includes housing, administrative and maintenance facilities. These buildings and the grounds that surround them are heavily trampled and utilized for various park service activities and tasks. King Salmon not only acts as a location for headquarters, but also a main access point to all locations within KATM and points beyond. It is therefore one of the most likely source areas for accidental spread of invasive plants into park lands by NPS staff.



Figure 19. NPS Administered Property boardwalk with an unusually late May 17, 2013 dusting of snow.

June: The quadplex, floatplane dock, maintenance yard and dorm housing area, as well as the interconnecting walkways, act as the main corridors for NPS employees and were surveyed early this year. This area continues to be an area of significant infestation and therefore our efforts were primarily focused on manual treatment, rather than inventory. The invasive plant species that were present this month were common dandelion, pineappleweed, sheep sorrel and narrowleaf hawksbeard rosettes. Common dandelion and pineappleweed could be found scattered throughout the NPS administered properties; however, narrowleaf hawksbeard and sheep sorrel could only be found in the maintenance yard. Specific locations for denser infestations include the eastern, northern and western edges of the maintenance yard. Common dandelion, sheep sorrel and narrowleaf hawksbeard were manually treated throughout the administrative area. Pineappleweed was neither inventoried nor treated because it would be a futile effort, especially due to the fact that pineappleweed thrives only in disturbed sites.

July: All previously mentioned species were again found throughout the maintenance yard and floatplane dock areas. Manual treatment was performed on common dandelion, sheep sorrel and narrowleaf hawksbeard within the maintenance yard. Future EPMT members should take under consideration that narrowleaf hawksbeard will be more easily identifiable during this month and should therefore wait to manually treat until this time. In addition to this plant, EPMT continued to treat shepherd's purse and common dandelion rosettes within and along the entrance of the maintenance yard. Common chickweed and shepherd's purse were treated along the marina building dock. Common chickweed has covered the majority of the gravel area and therefore manual treatment was a big effort. An unknown *Ranunculus* sp., or buttercup, was found adjacent to the marina building on the river bank. A sample was taken to be identified.

September: Manual control work was conducted at the floatplane dock; common dandelion, shepherd's purse, and for the first time, a species of chickweed were removed. The chickweed species could not be positively identified because the plants did not have inflorescence to distinguish it between common chickweed and common mouse-ear chickweed. However, it will most likely be identified as common mouse-ear chickweed due to its close proximity to another infestation of this

species at the marina building. The marina building and maintenance yard were also treated for the same species found in prior months. The common mouse-ear chickweed infestation at the marina building is expanding rapidly and does not respond well to manual treatment therefore it is recommended that future EPMT's investigate an alternative method of treatment especially for this particular area because it is difficult to pull the entire plant and its roots when growing in gravel. Covering the area with a thick or double layer of black plastic or a dark colored tarp during the hottest or sunniest parts of the field season will increase the temperature of the soil surface and smother the infestation. The Statewide Integrated Pest Management Program website on how to manage pests is a great resource for developing this method of control further (Stapleton *et al.* 2008).

FAA Housing & Other Areas of King Salmon & Naknek

FAA housing is home to many full-time federal government staff members of various agencies headquartered in King Salmon. This year's effort was primarily focused on manual control due to the amount of data already collected. The primary species that were found were fall dandelion, oxeye daisy (*Leucanthemum vulgare*), common dandelion, alsike clover (*Trifolium hybridum*) and narrowleaf hawksbeard. Oxeye daisies were removed from the frontyard of the second duplex house on the northern-side of Rainbow Ridge Road and the last home on the left side. Alsike clover and fall



Figure 20. King Salmon Air Force Base sign marking the entrance to the base. Common dandelion could be found a little further up the road.

dandelion were found on the corner of Rainbow Ridge Road and Ptarmigan Trail Road. Patches of common dandelion were found along the eastern-side of Ptarmigan Road and an extensive amount of fall dandelion were found on the western side, adjacent to the community center. Narrowleaf hawksbeard and smooth brome were also found in this area. Rosettes, however, are widespread and difficult to positively identify because the FAA housing complex is routinely mowed.

Surveys throughout King Salmon led to the rediscovery of bird vetch in full flower along the northern side of the Alaskan Peninsula Highway. The area was left to determine its stages of phenology for the Citizen

Science project titled Melibee's Project, which is to be discussed later. During the last couple weeks of July, seed pods were beginning to develop. These plants, however, proved infertile, only developing a couple seed pods before the plants were found either dying or dead in mid-August.

Common dandelion was noted at the entrance of the airport terminals, thus creating a vector from which people can not only transport invasive plant species from where they originated, but also spread invasive plant species that are already present within the King Salmon area. This species was also noted in the grasses across from the Lake and Rapids Camp access road on the Air Force Base property.

Alsike clover, red clover (*Trifolium pratense*) and smooth brome grasses were also noted on base close to recently disturbed construction areas. In previous years, Siberian peashrub (*Caragana*

arborescens) was also discovered growing along Jensen Road, which leads from Pen Air to the local police department. Several large shrubs were also found in planter beds outside of a dilapidated Air Force building and Eddie's restaurant. Siberian peashrub continues to persist on Air Force property against one of the northern most buildings. European mountain ash (*Sorbus aucuparia*) and European bird cherry (*Prunus padus*) trees were observed in landscapes in King Salmon and Naknek, and as of this season appear to be in good shape.

The teams record incidental observations throughout Bristol Bay Borough. New species included crown vetch (*Coronilla varia*), birdsfoot trefoil (*Lotus corniculatus*) and curly dock (*Rumex crispus*), which were found growing near the Ocean Beauty cannery in Naknek. Tall buttercup (*Ranunculus acris*) was also found in the area growing in small patches in South Naknek and at a hunting camp on the Naknek River. Creeping buttercup (*Ranunculus repens*) was observed in the grassy area near the river at the USFWS headquarters. Toadflax (*Linaria vulgaris*) has been observed in small patches in Naknek and King Salmon. Non-native grasses documented in the area include meadow foxtail (*Alopecurus pratensis*), smooth brome, common timothy (*Phleum pratense*), bluegrasses (*Poa spp.*) and foxtail barley (*Hordeum jubatum*) (if considered non-native). All of these species pose a long term threat to the area and have the potential of being spread to NPS land; however, EPMT resources continue to be primarily focused on lands managed by NPS.

Education & Outreach Events/Activities

Educating the public about the potential risks associated with the spread of invasive plants is an important responsibility of the EPMT and plays a vital role in gaining support and cooperation of community members. Boot brushes continue to be one method of making people aware of the presence of invasive plant species and also by allowing them to actively participate in the prevention of their spread. Due to King Salmon's high fluctuation of residents present throughout the year, invasive species have become more apparent over time and continue to be a growing risk to the park's various ecosystems. This is especially true at popular locations like Lake Camp, which is easily accessible to residents of King Salmon and Naknek, and is utilized as a direct portal to the interior areas of KATM.

Another means to expand awareness of invasive species is through simple methods such as invasive plant informational brochures and bulletins. These can be found and are maintained at the King Salmon, Brooks Camp and Three Forks visitor centers.



Figure 21. Education outreach event at the King Salmon Visitor Center.

In July, the Fishtival events prompted the EPMT to set up an informational “Wheel of Fortune” with prizes available to those who answered the given question correctly. The aim of EPMT participation is to make our team known to the community and to provide information about how to identify, report, and prevent the spread of invasive plants in the area or on their property. Informational coloring books and pressed invasive plant bookmarks were also handed out to both participants and winners of the game. This festival is a way to make our presence known and to also provide broad spectrum information about what EPMT does and how they can help out.

Also in July, the EPMT led an outreach event at the King Salmon Visitor Center. The goal of the educational session was to get local children interested in their natural environment, specifically wildflowers. Basic plant structure was the main focus of the session, which included a plant structure puzzle to build their own plant out of paper cutouts and coloring utensils. A round of wildflower “Bingo” was also played as a way to keep some kids occupied as the others finished up their flower creations. The experience was positive for both the kids and the EPMT, and is highly recommended for future outreach events.

Gypsy Moth & Other Invasive Species Projects

As part of a research study by the University of Fairbanks, the EPMT took part in the study titled, ‘Melibee’s Project’ or Citizen Scientist, which takes a look at how invasive species are affecting pollination rates of the native species of wildflowers. Species of interest include white sweetclover (*Melilotus alba*), lowbush cranberry (*Vaccinium vitis-idaea*), bog blueberry (*Vaccinium uliginosum*) and bird vetch. The plant species that we chose to observe were bird vetch, lowbush cranberry and blueberry, as there is no white sweetclover documented in the area. Data was collected every week or whenever possible if EPMT was conducting control work elsewhere, and uploaded to the Melibee’s Project website, <http://handsontheland.org/environmental-monitoring/melibee-project/>. Data collected in this area is highly valuable to the Melibee’s project because of King Salmon’s unique location in relation to where most other datasets are collected.

As a way to determine the presence of other invasive species, gypsy moth (*Lymantria dispar asiatica*) data was also collected throughout the summer. Gypsy moths have yet to be documented in this area, but due to the large amount of cargo the King Salmon and Naknek areas receive throughout the year, there is a possibility that this species can invade. Gypsy moths have the capability of destroying and killing a large variety of native deciduous trees in the area and severely altering the environment’s natural function; therefore, this species is a high priority for both current and future EPMT crews to monitor. This year the EPMT was responsible for recording the presence of gypsy moths using traps setup in the woods alongside the park service dormitory, floatplane dock and adjacent to the Naknek public



Figure 22. One of the bog blueberry plants monitored for the Melibee's Project.

dock. These traps were checked monthly and yielded an absence of this invasive insect.

Prevention & Restoration

Restoration and prevention are two very important tools used in land management, especially when the main focus is to eliminate water erosion, stop the spread of invasive plants and/or to protect an existing plant community. Areas of high disturbance, such as construction zones and highly trafficked sections of the park, are extremely vulnerable to the establishment of invasive plants; therefore early mitigation of any damage done to the land is the best method to minimize the spread of invasive plants. Over the last few years, efforts in KATM have focused on manual control, as well as prevention of invasive plants by detailed inspection of all heavy equipment used during construction at BCDA. The heavy equipment was inspected by NPS staff before it made its way to Lake Camp, moved onto the barge and was transported to Brooks Camp. The goal of these detailed equipment screenings was to minimize the transport of seeds or other plant material to Brooks Camp where it could potentially get established in areas of high disturbance, such as construction zones. An example of a construction zone of interest at Brooks Camp is at the VRAA.

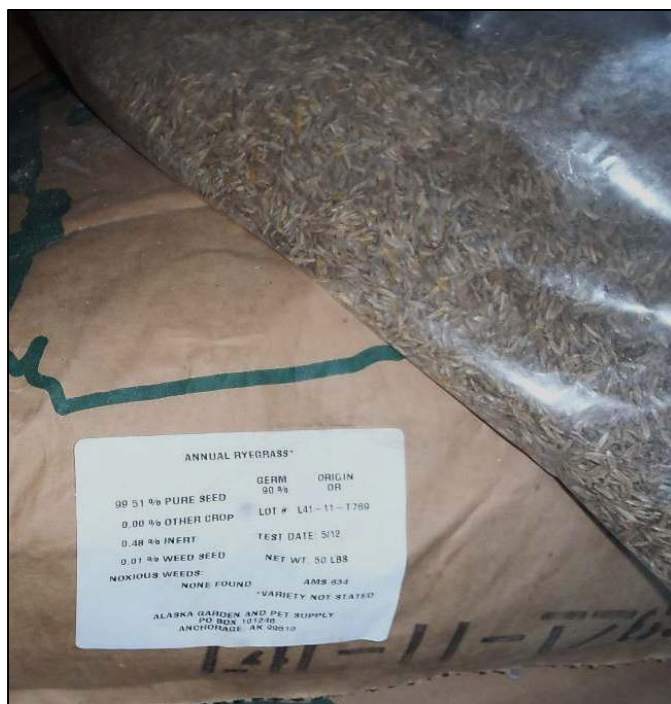


Figure 23. Annual ryegrass seeds and label used by contractor near the VRAA.

The contractor seeded some of the VRAA disturbed areas with annual ryegrass (*Lolium multiflorum*) certified by Alaska Mill & Feed in Anchorage with the intention of stabilizing the soil. The new seedlings found alongside the road leading to the maintenance building and near the new employee housing, did not appear in good condition. Grass seedlings were evident in many places, but most seem stunted. The most vigorous plants were usually in depressions, which likely provided adequate moisture and probably concentrated nutrients. If this type of grass is going to be used as a temporary revegetation solution, it would be important to make note that to guarantee the best results, seeds should be planted in areas with high water availability and good soil drainage. Addition of fertilizer would likely improve grass growth, but it would also benefit invasive species.

The 2013 EPMT executed a restoration project behind the newly constructed Brooks Camp maintenance building, which was essentially left bare post construction, to compare direct sowing of native seeds and transplanting native vegetation. The seeds used for revegetation of the disturbed site were collected during the first two weeks of August from two different locations, the Cultural Site

and Spit road. Due to the time of year it was not possible to collect two of the most desirable seeds used for revegetation, native yarrow and bluejoint reedgrass (*Calamagrostis canadensis*), as these seeds were still not fully matured. Due to their abundance, the EPMT crew collected a large number of largeleaf avens and meadow barley (*Hordeum bracyantherum*), and a very miniscule amount of stinging nettle (*Urtica dioica*) seeds as its population was significantly smaller compared to the other two species located at the Cultural site. At the end of Spit Road, a single species of grass was collected, American dune grass (*Leymus mollis*), as its seeds were mature and in high abundance. Only a sustainable amount of seeds were collected at both sites, ensuring that the population size of existing plants would not be compromised the following year. All seeds collected were cleaned by removing all unwanted plant material and stored in brown paper bags before they were sown behind the VRAA maintenance building. The EPMT and SAGA crew worked together in groups, the first group loosened up the soil with rakes, the second three person group placed seeds in rows and the last lightly covered the seeds with soil. It took six SAGA crew members and two members of the EPMT crew to sow all the seeds in approximately one and a half hours. The EPMT took four hours to collect and prepare seeds, then a crew of eight about 2.5 hours to sow 0.14419 acres with those seeds. If the same process were to be recreated, the EPMT would be able to sow approximately 0.02218 acres per hour with a crew.

The EPMT crew concurrently transplanted clumps of native vegetation dominated by grasses and moss. With help from the SAGA crew, the EPMT transplanted clumps from the trail designated as the future barge access road, as it will soon be a highly disturbed construction site. Even though a mitigation protocol was created for KATM that addresses the conservation of vegetation during construction, the choice was made to remove and transplant some plants prior to construction to increase their odds of survival. To increase efficiency, the EPMT utilized spades and wheelbarrows for removal and transportation to the main road, from which they were loaded onto a gator and brought to the VTTS maintenance building. This method required coordination with the maintenance staff; therefore, it is recommended that the future EPMT establish a dialogue prior to conducting a restoration project.



Figure 24. An excited Alex Voznitza poses with the last load of grasses to be transplanted for the 2013 revegetation project.

The following are some general rules used for transplanting:

- Plants should be transplanted on an overcast or rainy day, which will reduce the stress on the plants and minimize dessication.
- The hole for the transplant should be wider than the transplants itself.
- Effort should be made to loosen up the soil on all sides of the hole prior to planting.

- The transplant should be positioned at the same depth as the hole from which it was taken.
- Avoid exposing the roots to sunlight, as it can cause damage.
- Transplanting early or late in the season is preferable to mid-season when the plant is most active and more likely to desiccate or otherwise experience transplant shock.
- Lastly, the newly planted transplants need to be watered regularly for a few weeks following the transplant.

The transplant project occurred in August, which was less desirable than earlier or later in the season, but it was the time available for assistance from SAGA. There also isn't any outdoor water source to water the plants; therefore, during the first day of transplanting seven-gallon containers were filled up with water from inside the maintenance building and used to water the plants. There were sporadic showers throughout the second day; therefore, the plants were not watered by hand. In the future, a different method of watering should be investigated and discussed with the NPS maintenance staff. Over the course of 1.5 days, 115 transplants were removed from the Beaver Pond trail and planted at the revegetation site. The EPMT only acquired one gator for transportation efforts, requiring the SAGA crew and the EPMT to sometimes walk to and from the sites. At least 1.5 hours or 0.03327 acres that could have been treated were lost traveling between the Beaver Pond trail and the VTTS maintenance building. Subsequent visits to the site showed browning of the transplanted vegetation, but the real indication of success or failure will be in 2014.

Reseeding is a simple method for revegetation and has had success in mildly disturbed areas in the park. In October, the EPMT collected seeds from the campground and throughout Brooks Camp. *Calamagrostis canadensis* (blue-joint grass) and *Achillea millefolium* (yarrow) seeds were the primary seeds collected. They were dried and stratified by placing them in the headquarters freezer in preparation for next year's revegetation efforts. In coming years, efforts should continue to be made to collect and preserve seeds for future revegetation projects.

Volunteers

An adult SAGA crew joined the EPMT this August at BCDA to remove large infestations of invasive plants. Based on previous recommendations, the SAGA crew arrived at Brooks Camp in the beginning of August instead of June as it had in previous years. The later arrival of the SAGA crew was helpful as many of the invasive plants were delayed in development this year, an example of which would be common plantain. KATM EPMT was able to remove a significant percentage of higher ranked infestations earlier in the season, but with the help of six SAGA crew members, the EPMT was able to pull extensive populations of lower ranked invasive plants as well. Out of a total of eleven work days that the SAGA crew was contracted to work, seven and a half days were spent on manual control of infestations, a single day was spent on touring the VTTS, and day and a half was dedicated to a revegetation project behind the VTTS maintenance building, as previously described.



Figure 26. The still energetic SAGA crew, after a long rainy day of manual treatment.

Recruiting other volunteers earlier in the season is a possibility that future EPMT crews should take under consideration. Perhaps offering accommodations at the campground or the yurt as well as free travel to and from Brooks Camp might be enough of an incentive for volunteers to dedicate some time during the season. Currently the Bear Management division has volunteers who have been helping out with bear monitoring for several years. They spend their weekends at Brooks Camp during the months of July and September and receive free stay and travel to and from Brooks as well as an opportunity to observe

KATM bears up close. Many members of the Bristol Bay Borough community and seasonal workers from King Salmon never have an opportunity to visit the park, and therefore, cannot relate to those who are fortunate enough to work in what was, for many of these community members, the home of their ancestors before the 1912 eruption. Providing the opportunity for these individuals to volunteer at the park may create a stronger bond between community members, KATM and NPS staff, thereby encouraging more community involvement with the park's various activities.

Disposal Methods

Prior to the 2013 field season, disposal of invasive plant materials was an enormous challenge for KATM EPMT. In previous years, EPMT investigated several methods that could possibly be used to kill viable seeds and plant material collected during the season. One of these methods included heating up an oven to 300° Fahrenheit to sterilize the seeds and burning the remaining plant material inside burn barrels that were made out of recycled oil drums. A fire was then built and fueled with cardboard, wooden pallets, and waste gas/diesel. The 2010-2 KATM EPMT staff also contacted the local dump to explore alternative disposable methods, such as burying plant material at depths of 15 feet, burning in the incinerator or burning in a wooden pallet fire, unfortunately the local dump officials were not cooperative to assuring the NPS that our invasive plant issues would not be spread to the dump and beyond.

This year the KATM's superintendent allowed for burning of all plant material collected throughout the season in the BC incinerator. The work load associated with the arduous process of burning the invasive plants was shifted onto the maintenance staff but this method was found to be more effective than any previous methods ever attempted as all plant material was completely burned inside the



Figure 25. Collecting invasive plants into our signature green bags is just one method to dispose of invasive plant species.

incinerator. The Brooks Camp incinerator does necessitate more diesel fuel to completely incinerate all of the plant material. In previous years when plant material was burned in metal drums, the EPMT had a difficult time keeping the fire burning and at the appropriate temperature needed to guarantee that all the plant material was disposed of correctly. Often remnants found at the bottom of the barrel were not burnt completely, thus creating another potential vector for spreading invasive plants. During the 2013 field season, the majority of the manual control work occurred at Brooks Camp, where all plants were immediately delivered to the incinerator room. All plants that were collected during manual control work near King Salmon were stored inside the marina building, and then later transported to Brooks Camp to be burned.

As noted in previous years, immediate disposal of plant material is recommended, as heavily decomposed plant material when added to fire does not fuel the fire but rather extinguishes it. If the decision to burn all collected plants in Brook Camp's incinerator room is reversed, KATM EPMT should either return to burning all plants inside burn barrels or consider alternative routes that were proposed by previous exotic plant management staff. The methods considered in previous years include the following:

- Purchasing a large container, such as a fish tote, that could be used to store plant material for several years until it decomposes fully and is no longer viable, at which point it can be disposed of at the dump.
- The plant material could be packaged and shipped to Anchorage or Seattle where it could be disposed of in a larger dump or incinerated. While expensive, it requires limited man hours and allows more time to focus on other work priorities.
- A wood fired stone or brick kiln could be constructed to heat and sterilize plant material. An insulated structure such as a kiln could heat much larger quantities of plant material than the kitchen oven which has previously been used. This method would be logistically complicated to achieve due to costs and the space requirements.

Phenology

Plant phenology within KATM and Bristol Bay Borough significantly varies from site to site which may pose some difficulties when planning control efforts throughout the park. During the 2013 growing season, the EPMT observed that plant phenology in the park were significantly delayed compared to the plant phenology in King Salmon. This contrast was mostly observed at Brooks Camp.

Pineappleweed was hard to distinguish from the native yarrow when it first began emerging at Lake Camp during early June. Shepherd's purse was not manually treated during June and early July since the plants had yet to develop their seedpods, which are critical for distinguishing from the native rock cress. The unusually warm weather and numerous sunny days during the 2013 growing season significantly benefited the native plant community. This was especially noticeable on the way to the VTTS where almost sixty percent of the mountain side during the latter half of the season, was pink

from the native fireweed. Below, general phenological variability is listed for the most prevalent species in KATM:

- Sheep sorrel and common dandelion can be easily detected from late May through September. Common dandelion shows specific resilience to site specific variability. For example, common dandelion can be found in June at both the cultural site a highly disturbed area with a favorable south-facing slope and the camp ground a heavily shaded area with substantial competition from native plants. It was discovered during EPMT's initial trip to Fure's Cabin that some common dandelion had already begun going into seed in early June.
- Pineappleweed also has a fairly predictable phenology as it could be found as early as June in all locations. It is present in very small rosettes at this stage and is quite cumbersome to remove; however, easily identifiable. Care should be taken not to confuse the small rosettes of pineappleweed in June with rosettes of native yarrow, which can be distinguished by its darker color, smell, and typically larger size early in the season.
- Shepherd's purse is one of the more confounding species as its phenology can vary greatly from site to site. When young, it is very difficult to distinguish between shepherd's purse and the native rock cress. When stem leaves are present, shepherd's purse can be recognized by its sessile and sagittate leaves, whereas lyrate rock cress (*Arabis lyrata*) leaves are stalked and only occasionally sessile. The seed pods of shepherd's purse are obvious heart-shaped siliques, while those of lyrate rock cress are long, thin siliques.
- Common plantain displays site specific phenology variability. During June and early July, the EPMT saw more common plantain emerging at Brooks campground than on the Lake Brooks side of the BCDA, which contrasts what has been observed in previous years. At Lake Brooks the largest group of common plantains was found in early August and only a few plants were in flower, the remaining plants were still in the rosette stage.
- In previous years, narrowleaf hawksbeard has been observed to have late phenology and combined with its very small basal rosettes, can be very difficult to identify before July. During the 2013 growing season, narrowleaf hawksbeard was first discovered in flower on June 25th, in the King Salmon maintenance yard. The early flowering of the narrowleaf hawksbeard could have possibly been accredited to the extremely warm summer and numerous sunny days that KATM experienced in June and July.
- Bird vetch foliage began to emerge in June. Prior to this year it had not been observed in flower before August. A small patch of bird vetch found off the Alaska Peninsula Highway heading towards Naknek was already in flower during the first week of July. That same patch of bird vetch was already dying in mid-August while the bird vetch on the VTTS Road, found at about the same time of year, still had not fully developed mature seed pods. Bird vetch is distinguishable from other natives by its foliage and lack of winged stems. It looks very similar to the native marsh pea but a quick test of rolling the stem between the fingers reveals whether the stem is completely smooth and round, as is the case in bird vetch, or

winged as in marsh pea. The leaflets of bird vetch are also smaller and more numerous than those of marsh pea.

Suggested Schedule

It is highly recommended to work on the summary report continuously throughout the season so as to accurately reflect any work completed throughout the park.

April: Review all previous EPMT protocols, plant phenology charts and become familiar with the park's plant community, including both native and non-native plants.

May: KATM EPMT staff should attend all training sessions offered by the park, including mandatory bear training, dunker training, and all training offered to interpretation staff related to resources in the park. During downtime begin creating education outreach workbooks and programs that could be used at the King Salmon visitor center for the kids as well as develop an adult program that could be presented during evening programs at Brooks Camp.

June: Begin manual control at BCDA of early phenology infestations, starting with the campground, cultural site, employee housing, and lodge cabins, as well as Brooks Lake and sections of VTTS. An orientation to travelling on the VTTS Road should be acquired as soon as possible, as this will be helpful throughout the season with control work and surveying pull-off locations on this road. Manually or chemically treat Fure's Cabin before dandelion infestation goes to seed, this will help reduce the number of new seedlings that may appear later in the season. Survey VTTS Road paying attention to sites where bird vetch has previously been discovered. If possible survey the entire road using bikes to determine if there are any new infestations of bird vetch that have not developed reproductive features. Manually treat invasive infestations at Lake Camp; focus on removing flowers of common dandelions, fall dandelions and shepherd's purse before any chemical control. Replace any damaged or faded boot brush signs if necessary. Inspect all vehicles for any seeds or other plant material before they are transported into the park. Inspect and remove any plant material on all tools used for ground disturbing maintenance work.

July: BCDA in July is heavily trafficked by bears; therefore, manual control work might not be the most efficient way to manage time especially during mid-July. Work delays should be expected due to bear management, never the less, treat as much area as possible. Surveying and treating other parts of the park, such as the outer coast, Nonvianuk cabin and the preserve might be a better alternative. Continue surveying VTTS Road, stopping at 5 mile gravel pit, Squirrel Camp, Margot Falls and the VTTS maintenance building. Continue manual treatment at Lake Camp if chemical treatment was not yet administered.

August: Bear populations within BCDA are significantly lower compared to July as most bears have moved to other parts of the park to feed. During the 2013 field season, the SAGA crew arrived at BCDA in August, which allowed for manual treatment of large infestations, like pineappleweed, found throughout the camp. This is one of the best times to bring in groups of volunteers to help with the manual treatment of invasive infestations and to help with the revegetation of areas that have

experienced a high amount of disturbance related to construction and/or foot traffic. Collect, clean, store and/or directly sow seeds into post construction areas to stabilize soil and to minimize the potential of new infestations on disturbed lands. If chemical treatment is not administered at Lake Camp, continue manual control of existing infestations.

September: If feasible, make another trip to BCDA to collect more seeds, focusing on native yarrow and bluejoint as they work best in any restoration project. Manually treat any remaining late phenology infestations, especially common plantain, near the Windy Creek trail and in the Brooks campground. Manually treat any remaining invasive infestations at Lake Camp, FAA housing and on other NPS land in King Salmon. Finish writing the first draft of the end of the season report. Correct and edit all remaining GPS data, mount and label all herbarium specimens and organize all pictures taken throughout the season. Deliver all remaining plant material to the incinerator building at BCDA to be burned.

October: Make any necessary edits to the end of the season report. Finalize and submit the report to the AK NPS Regional Office. Any heavy construction-related equipment that is being transported to BCDA should be inspected prior to leaving the contractors' property or Lake Camp. Deliver any remaining plants to the incinerator building at BCDA to be burned.

Recommendations for the 2014 Season

- Require that maintenance staff procure a means to clean their equipment and vehicle tires as frequently as necessary, particularly for equipment departing King Salmon for Brooks Camp.
- Establish a relationship with the Brooks Lodge workers and owner, in order to encourage more active participation on their behalf. When operating plans and/or contracts are re-written, ensure language that promotes invasive plant prevention and control is included.
- It is highly recommended that an adult crew return later in the season, in addition, an older crew required less management and motivation to stay on task throughout the week.
- Establish a relationship with the King Salmon Visitor Center staff to coordinate programs that educate and encourage the public and its' younger population to actively participate in the conservation programs that are offered.
- Establish a relationship with the USFWS early in the season to coordinate projects relevant to invasive plant management. The science camp offered to high school students in September would be a good opportunity to conduct such a project.
- Prioritize surveying cabins and other areas of concentrated human use in the parks over the past 100 years.
- Work with floatplane and angler CUAs to educate on aquatic invasive transport and reporting.

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