



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

2012 Summary Report

Natural Resource Data Series NPS/KATM/NRDS—2013/429



ON THE COVER

SCA Intern Allison Connealy (left) and EPMT Biologist Whitney Rapp survey for invasive plant species at Aniakchak Cabin.
Photograph by: Claire Parker

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Abstract

The 2012 Katmai Alaska Exotic Plant Management Team followed the protocol for surveying and controlling invasive plants from June through September. A total of 13 non-native species exist in the park, with 20 more species present in Bristol Bay Borough. The majority of monitoring and manual control efforts occurred at Brooks Camp, Lake Camp, the Valley of Ten Thousand Smokes Road and at Fure's Cabin. Herbicide was applied for the second time in the park to control the common dandelion (*Taraxacum officinale ssp. officinale*) infestation at Fure's Cabin but was not used on the bird vetch (*Vicia cracca*) infestation along the Valley of Ten Thousand Smokes Road as it was in 2011 since plants were not yet detectable in June of 2012. This infestation seems to be under control and can be manually treated. Overall, continued manual treatment at heavily infested sites, such as the Brooks Camp cultural site, has significantly reduced the extent and density of infestations in these areas. Revisiting previously surveyed sites was a high priority this season as well as manually treating as many acres as possible. New infestations were found throughout Brooks Camp along the falls trail and the road to Lake Brooks. Invasive plant infestations in Katmai are largely under control and not as pervasive as they are in other parks in Alaska or the lower 48 due to the park's remote location and efforts by the EPMT to control current infestations and prevent new ones. Continued monitoring and control are important to manage current infestations and prevent new ones. Finally, ongoing and planned construction and relocation projects at Brooks Camp will disturb existing vegetation, exposing new areas to colonization by non-native plants. Development of revegetation plans will help to minimize disturbance and restore the landscape post-construction.

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Abbreviations

AKEPIC	Alaska Exotic Plant Information Clearinghouse
AKNHP	Alaska Natural Heritage Program
ANIA	Aniakchak National Monument & Preserve
APCAM	Alien Plant Control and Monitoring
BCDA	Brooks Camp Developed Area
EPMT	Exotic Plant Management Team
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
GPS	Global Positioning System
KATM	Katmai National Park & Preserve
NPS	National Park Service
PUC	Public Use Cabin
SCA	Student Conservation Association
SAGA	Southeast Alaska Guidance Association
TCC	Tribal Civilian Corps
VTTS	Valley of Ten Thousand Smokes

Introduction

Background

Katmai National Park and Preserve (KATM) lies at the base of the Alaskan Peninsula and covers 4.1 million acres of vast tundra fields, pristine waters and mountainous valleys, all accessible only by boat or plane (Figure 1). Much of the landscape is untouched except by natural successional forces, however, the wildlife and scenery draw thousands of visitors annually. This tourism poses a threat to Katmai's fragile ecological integrity because it facilitates the spread of exotic plant species into the park. Exotic, or nonnative plants are defined as any plant that occurs in a location as a result of human action. These plants can be invasive species, which are non-natives that establish and dominate habitats and can cause economic loss, environmental damage, or harm to human health (Schwörer et al. 2012).

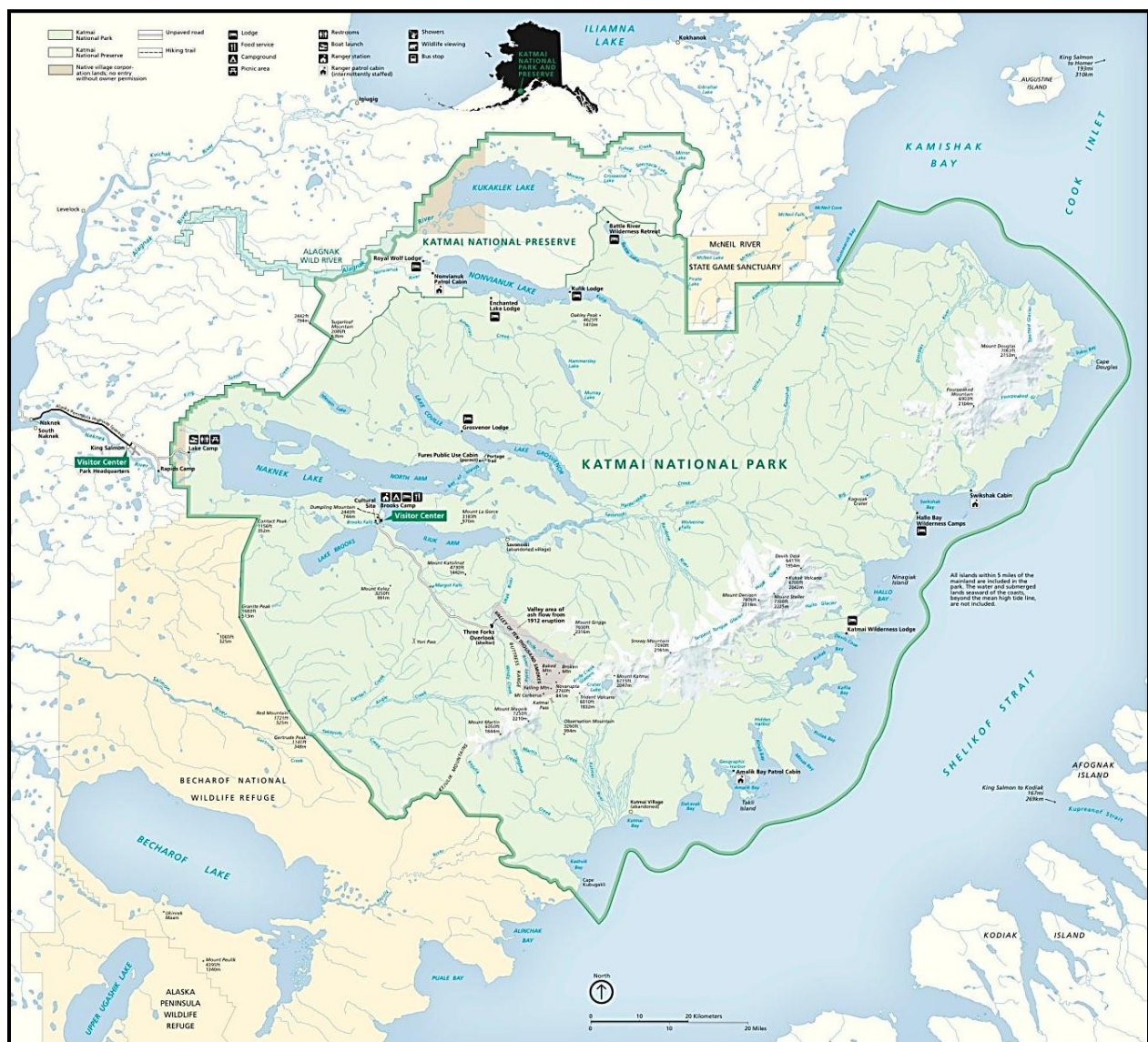


Figure 1. A map of Katmai National Park & Preserve.

The problem is not as extensive in Alaska as it is in most of the world (Schwörer et al., 2012) and the introduction of invasive plants is especially restricted in Katmai by its remote location, which limits anthropogenic disturbance and transport of plant material. The park's circumboreal climate helps as well, as it is intolerable to many non-native plants. However, Brooks Camp and Lake Camp are developed sites which receive the highest influx of visitors, and thus are particularly vulnerable to infestation and contain the most extensive infestations in the park, while smaller infestations have escaped to some backcountry sites.

Exotic plants threaten native ecosystems because they have evolved in a separate environment and are adapted to a distinct set of resources, so the competitive influences that normally limit their spread do not exist when they invade a new ecosystem. Their ability to outcompete native plants can reduce local biodiversity and contribute to habitat degradation and alteration of essential ecosystem functions, as well as compromise the genetic integrity of native plants through hybridization (Vitousek et al. 1997, D'Antonio et al. 2001). Furthermore, milder temperatures and increased precipitation, particularly in winters, associated with climate change (Rupp and Loya 2009) have the potential to shift dispersal patterns of non-native plants and facilitate their colonization of northern latitudes (Walther 2000). The economic impact can also be great. Nearly \$1.5 million went into control of invasive plants from 2007 to 2011 in the state of Alaska (Schwörer et al., 2012). Given these threats, continued monitoring and control of exotic plants within and around the park are essential to the preservation of Katmai's native ecosystems.

Invasive plant survey and 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 an EPMT in 2005 for synthesis into two regional databases: Alien Plant Control and Monitoring (APCAM), a nationwide NPS database for invasive plant data, and the Alaska Exotic Plants Information Clearinghouse (AKEPIC), a 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 (AKNHP) (Rapp 2008). Thorough surveys in 2005 were conducted at Lake Camp, Brooks Camp, the Valley of Ten Thousand Smokes 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 2008). 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.). 2010 was the first season that Katmai had staffing throughout the summer focused on invasive plant work., with a focus on Brooks Camp, the Valley of Ten Thousand Smokes (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, the two Student Conservation Association (SCA) interns surveyed new locations in Katmai National Preserve at Funnel and Moraine Creeks and Crosswind Lake, Geographic Harbor, Takli and Little Takli Islands, in 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*).

The objective of the 2012 EPMT was to monitor and control known infestations in the park and survey new areas. During the 2012 field season, all sites at Brooks Camp, the VTTS road, Lake Camp and Fure's Cabin were revisited and infestations were treated manually. Herbicide was applied to the common dandelion at Fure's Cabin. Multiple small, disjunct populations of common invasive species were discovered in previously uninfested spots at Brooks Camp and treated upon each encounter. Newly inventoried sites this year included the airstrips in Katmai and Aniakchak. Some of the tactics used to prevent further spread of invasive species into the park included informational signs, boot brushes and vehicle inspections. The 2012 EPMT completed a revegetation manual to be used in future project planning to minimize species introductions and effectively restore disturbed areas before they are colonized by invasive species. A consistent GPS database, along with early detection and rapid response tactics, provide Katmai the opportunity to strategically control current infestations and prevent their spread into backcountry locations before invasive plants become a more severe ecological threat.

Methods

Fieldwork in KATM was conducted from June to September, 2012, in accordance with the protocol developed by the Alaska Region Exotic Plant Management Team (Million & Rapp, 2011). Field work was conducted by Allison Connealy (SCA Intern), Claire Parker (SCA Intern), Tim Federal (EPMT Regional Contact) and Whitney Rapp (Katmai EPMT Coordinator). An eight-person AmeriCorps SAGA crew contributed their efforts for seven days in early June at Brooks Camp, providing 448 volunteer hours.

Areas in the park were surveyed for invasive species and all infestations were inventoried using a Trimble GeoExplorer 2008 Series GeoXT GPS unit equipped with a standardized EPMT data dictionary specific to KATM. Infestations of high priority species were controlled manually or chemically. Manual control consisted of hand pulling species that are easy to uproot, such as pineapple weed and sheep sorrel, and digging with a spade for plants with more difficult roots, such as dandelions and plantain. Most treatment was conducted in Brooks Camp and Lake Camp and focused on eradicating small infestations and containing larger ones. Chemical control was used for infestations that met the criteria detailed in the Alaska Region Invasive Plant Management Plan (NPS, 2010). This consisted of using Milestone VM herbicide which selectively targets broad-leafed weeds. Herbicide was applied by Tim Federal to common dandelions (*Taraxacum officinale* ssp. *officinale*) at Fure's Cabin in 2012.

Sites for control and monitoring were selected by evaluating which places in the park are most frequently visited. The Brooks Camp Developed Area (BCDA) has the highest visitation rate and most severe infestations and was a monthly focus for the EPMT throughout the season. The other major focus was Lake Camp, a peripherally-located access point from King Salmon into the park where many control hours were spent pulling sheep sorrel and digging fall dandelions.

Results

Overview

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

Year	# EPMT Personnel	Field Length	Invasive Plant GPS Data (NPS Lands/Non-NPS Lands)			Total Species Documented (NPS Lands/ Regionally)
			Species 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	95.69 (7.561)	11.781 (3.338)	3.127 (0.063)	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%.

2012 Highlights and Observations

- Participated in Naknek Fishtival (community event) with educational materials at a booth in the bazaar.
- Found only two individuals of bird vetch reoccurring along the VTTS road indicating that the previous year's treatment with herbicide was effective.
- Discovered individual clover growing in five-mile gravel pit on VTTS Road but was unable to identify species.
- Discovered one individual of pineapple weed spread to Three Forks visitor center on VTTS Road.
- Re-treated the common dandelion with Milestone herbicide at Fure's Cabin, marking the second season of use; scattered and sparse regrowth from 2011 treatment indicates that herbicide may be an effective treatment method for site.
- Surveyed many airplane landing strips within Katmai Park and Preserve and Aniakchak National Preserve with no invasives found—a positive sign of containment to previously known infested areas, and validation of early detection surveying methods to continually ensure the protection of backcountry areas from further infestation.
- In Bristol Bay Borough, documentation of new species *Alopecurus pratensis*, *Linaria vulgaris*, *Lotus corniculatus*, *Prunus padus*, *Ranunculus acris*, *Ranunculus repens*, *Securigera varia*, and *Trifolium pratense* were made this year.

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

Species			Invasiveness rank*	Within KA TM						Within Bristol Bay Borough				
	Scientific Name	Common Name		BCOA	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>Cerastium fontanum</i>	mouse ear chickweed	36	-	O	-	O	O	O	-	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	-	-	-	-	-	-
	<i>Taraxacum officinale</i> ssp. <i>officinale</i>	common dandelion	58	X	-	O	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	-	-	-	-	-	-	-	X	-	-	-
	<i>Bromus inermis</i> ssp. <i>inermis</i>	smooth brome	62	-	-	-	-	-	-	-	X	X	-	X
	<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 inodorum</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.

Brooks Camp

The Brooks Camp Developed Area (BCDA) is the network of roads, trails and lodging located at the mouth of Brooks River, along the shore of Naknek Lake. The facility attracts anglers and tourists from around the globe in the summer season for fishing, bear viewing and various outdoors activities. Due to the high rate of travel in and out of camp via boat and plane, the area is now the most heavily infested exotic plant area in Katmai National Park (KATM). Commonly observed invasive plant species reported in BCDA include common dandelion (*Taraxacum officinale*), common plantain (*Plantago major*), shepherd's purse (*Capsella bursa-pastoris*), annual bluegrass (*Poa annua*), and pineapple weed (*Matricaria discoidea*).



Figure 2. The Brooks Camp Developed Area.

A large portion of this year's efforts were focused on the manual removal of common dandelion and common plantain, being most prevalent, higher ranking, and most reasonably treatable species, given the extent and locations of their current growth. Initial inventories of the BCDA were conducted in early June before the arrival of an eight-person SAGA Americorps crew. The SAGA crew contributed seven work days towards invasive species control near the lower river platform and bridge, as well as performing various trail maintenance tasks near the end of their week. The SAGA AmeriCorps crew arrived on June 9th and worked from June 10th through June 16th, spending a majority of the time manually treating pineapple weed with the EPMT team. Due largely to the late-onset summer season in 2012, most of the other invasive species were too young to positively identify at that time. Therefore, to deal with the excessive number of work



Figure 3. SAGA crew gets out of the wind while manually treating pineapple weed.

hours available and keep crew morale high, the crew was given non-EPMT related tasks, such as trail maintenance on the Dumpling Mountain, Brooks Falls, Margot Falls, and Ukak Falls. Pulling pineapple weed all day--especially in the cold and wet conditions often occurring during a Brooks Camp summer--can become monotonous, and keeping a crew of young people engaged and productive presents a challenge when there are no other tasks with which to break up the day. Additionally, given current conditions, total eradication of pineapple weed is unrealistic; the low priority ranking of pineapple weed, its extensive, well-

established seedbank, and high density in many sites makes spending a large amount of time and effort performing manual treatment an inefficient use of time. Despite spending a few days working solely on pineapple weed, the crew of eight 18- to 24-year-olds worked with an impressive dedication and high work ethic and maintained a positive attitude; however, their time may have been better spent working in another park with more extensive infestations. Likewise, the EPMT's time was mostly consumed with finding tasks to keep SAGA busy rather than focusing on the project objective. If SAGA crews are arranged to return to Katmai in future seasons, it is strongly recommended to schedule a session in July or August, when shepherd's purse, common plantain, common dandelion, and other late-onset invasives are at a point in their phenology that they can be readily identified and treated. In the past, SAGA crews have been flown to King Salmon to work on the sheep sorrel infestation at Lake Camp, but this is an expensive alternative and drastically narrows options for diversity in tasks to complete or recreation.

BCDA Campground & Dumpling Mountain

The BCDA campground is located north of Brooks River and slightly west of Naknek Lake's beach. This high-traffic area is designated for tent camping and includes restrooms and picnic facilities. It is currently the only fully developed, enclosed campsite in KATM. Due to the high level of foot traffic, gear usage, and fill importation to maintain gravel trails, the campground paths and buildings are surrounded with dense infestations of common dandelion, common plantain, shepherd's purse, and annual bluegrass. However, these infestations appear contained to the disturbed areas, and have not spread to the patches of native vegetation. The hiking trail that leads up Dumpling Mountain extends four miles up to the summit, with its trailhead located along the north side of the campground.

June: The 2011 season found pineapple weed, common dandelion, annual bluegrass, and shepherd's purse present in this area starting in June, with common plantain not emerging until July. In 2012, all species including plantain were detected as early as June. Pineapple weed was mainly concentrated in patches around the fire pits but also grows along some of the footpaths. Instances of dandelion individuals or small patches occurred throughout grassy areas. Annual bluegrass lined most of the footpaths, gravel areas, and the entire Dumpling Mountain trail, and plantain appeared in patches near the fire pits as well as along the footpaths and scattered throughout gravel areas.

Shepherd's purse rosettes were noted in June, but due to difficulty in differentiating between the invasive and native mustard plants before they flower, it was decidedly too early during the initial June survey to manually pull rosettes or accurately inventory their growth. 96-100% of dandelion and plantain were manually treated by the EPMT team before SAGA's arrival due to their low concentration and relatively small area cover, and pineapple weed and annual bluegrass were inventoried.



Figure 4. SCA intern Clair Parker maps common plantain on Dumpling Mountain trail.

July: One individual of common plantain (*Plantago major*) was found and pulled on Dumping Mountain Trail just before the first overlook and was removed. A return trip in late July found no further plantain individuals on the overlook. Over several trips, all of the plantain and dandelion found growing within the campground were retreated. Dandelions were often still in rosette form (lacking mature leaves or a flowering part) and often difficult to remove without losing taproots, which is not the ideal method of removal for this deep-rooting species. Shepherd's purse was successfully identified in flower and manually treated around the fire pits, picnic sheds, and gear cache building. Pineapple weed was present in nearly all the same areas as shepherd's purse, as well as along several footpaths, and was inventoried. Annual bluegrass was noted continually growing along most footpaths and around several tent sites, now in seed and often more dense, and was inventoried throughout the area.

August: The campground was retreated for pineapple weed, shepherd's purse, plantain, and common dandelion. All infestations were in previously known locations. The shepherd's purse plants in the campground are very short compared to those in other locations and intermingled with pineapple weed so it was more practical to treat both shepherd's purse and pineapple weed



Figure 5. The individual of plantain found on Dumping Mountain trail.

simultaneously than to try to leave the pineapple weed, as it is often not a priority to treat. The pineapple weed in some areas was also sparse enough with large enough plants that were easy to pull quickly and so manual treatment was an acceptable course of action.

September: The extensive infestation of annual bluegrass in the campground was inventoried lining the trails and campsites. Pineapple weed and shepherd's purse were retreated. Plantain and dandelions were not found in the areas that they had been infesting in previous months. Dumping Mountain was not resurveyed for plantain due to time restraints as camp was shutting down and travel opportunities between Brooks and King Salmon were slimming.

Employee Facilities

Most employee facilities in the BCDA are situated between the ranger station and the campground. Pineapple weed is sporadically dispersed along trail edges and in front of the bathhouse, incinerator, maintenance shop, gear caches, leach field and generators. Pineapple weed and annual bluegrass grow on the edges of "Park Avenue," the gravel trail where seasonal cabins and tent frames are located. These infestations have not spread into the native vegetation surrounding footpaths or the perimeters of employee housing structures. Informal control of pineapple weed has been carried out throughout the area by seasonal bear technician Imes Vaughn (Frank and Woods, 2011).

New employee facilities are being constructed across the bridge and this site will be particularly vulnerable to infestation because of the pioneering nature of many invasives after a disturbance and because of the high potential for fill materials and construction equipment to inadvertently

transport seed. This area should be closely monitored in coming seasons in order to mitigate further infestation by exotics.

June: Annual bluegrass was inventoried along edges of Park Avenue and the yurt and ranger station, as well as the bathrooms, recreation cache, incinerator buildings, generators, and the fenced in storage yards before the lodge employee housing known as Tuckerville. Pineapple weed was inventoried by the generators and fenced in storage yards. Plantain was found growing near the rec cache and incinerator and was manually treated. Plants were very young and small, consisting of only two leaves, identifiable by their parallel veins. Common dandelions were found sporadically throughout the area and were manually treated. Shepherd's purse was found in the area in prior years as early as June; however, they were not in a recognizable form as of June 2012. The rosettes are difficult to distinguish from a native mustard that grows in the same areas but has an earlier phenology and long, thin seedpods rather than the distinct heart-shaped seed pods. The EPMT spent a considerable amount of time trying to identify shepherd's purse from a rosette, but future teams should be advised to wait patiently for seed pods to be present as this is really the only way to make the positive identification. Finally, in June annual bluegrass was inventoried at 6-25% throughout Tuckerville.

July: Tuckerville had numerous common dandelions in patches throughout the lawn. They were manually treated in early July with some difficulty as the roots were entangled with tree roots. The infestations were retreated later in July and the plants were no longer flowering. Annual bluegrass in the area was going to seed, pineapple weed began flowering, and extensive infestations of plantain were re-emerging and treated in front of Park Avenue generators. Shepherd's purse was flowering, some with seed pods, and was found growing near the rec cache and maintenance shed. One individual of shepherd's purse was found and pulled at the fire hydrant by the auditorium. The white clover found near Park Ave generators last year was not detected as of July, 2012.

September: Annual bluegrass was inventoried growing densely along Park Avenue and in front of the generator. Pineapple weed was also found in front of the generator and was standing dead; it had dropped almost all of the flowering heads and consisted of shriveled brown stems. White clover was not detected in the 2012 season.

Cultural Site

The Brooks Camp cultural site exhibit is a reconstructed prehistoric house located a short walk from the visitor center. The south-facing lawn is maintained with occasional brush cutting and had a significant infestation of common dandelion, which has been decreasing in density through repeated manual treatments in recent years (Frank and Woods, 2011). Past seasons' efforts, particularly in dandelion control and native revegetation, appear to have been successful, as the previously infested lawn area only hosts scattered dandelion individuals which were easily treated by one EPMT member in 1.5 hours (initially in June). The area has been reseeded with native yarrow (*Achillea millefolium*), large-leaved avens (*Geum macrophyllum*), and Jacob's ladder (*Polemonium acutiflorum*) over the past two seasons, and these species are now growing readily along with native grasses. This site is still a high priority for frequent visitation and dandelion monitoring in order to maintain what progress has been made and to prevent reinfestation.



Figure 6. The three year progression of the vegetation around the cultural site.

June: Common dandelion was found and treated near the fish freezing building, lawns around trading post, lodge, and cabins. Annual bluegrass was inventoried around the edges of the lawns of the cabins, as was pineapple weed, which was especially concentrated around cabins 25, 26, and 27 with a large dense patch across from the cabins leading down to the trail to Brooks River. Small rosettes of what might have been shepherd's purse were detected around the fish freezing building and under some of the cabins along the main road, but a positive identification could not be made without the presence of seed pods as the rosettes of shepherd's purse are not

June: Annual bluegrass and pineapple weed was mapped along the entire trail to the cultural center and was not treated due to its extent and low priority. Individuals of common dandelion began appearing 25-30 yards before the lawn and were scattered throughout lawn and in the grass across road from building. Shepherd's purse was not yet detectable.

July: The EPMT retreated for dandelions in mid-July, finding and pulling 9 individual rosettes along the trail and edge of the lawn and a few more scattered in late July. Shepherd's purse was still not detected, but pineapple weed rosettes were lining the trail in increasingly thick infestations along the lawn.

September: The trail to the cultural center was heavily carpeted with annual bluegrass and was inventoried as 6-25 percent cover. There was one patch of dandelions that was retreated from July and a new patch behind the building. After late July, finding dandelions in the tall *Calamagrostis* is quite cumbersome so efforts in this area should be concentrated in earlier months.

Brooks Lodge

As a central hub of visitor activity within BCDA, the Brooks Lodge Restaurant, Trading Post, office, "Skytel," and surrounding cabins comprise a network of wooden buildings, lawns, and gravel paths between the Naknek Beach and Brooks River, near the river mouth and bridge crossing. This highly disturbed area hosts a plethora of annual bluegrass around most lawn and path edges. Aside from the ever-present grass, lawn mowing, trampling, and luggage cart traffic causes common dandelion, shepherd's

distinguishable from that of the native mustard lyrate rockcress (*Arabis lyrata*). No white clover (*Trifolium repens*) was found by the bathhouse as in the past two years.

July: Dandelions and plantain in lawns were retreated, and small patches of pineapple weed were inventoried as flowering. Shepherd's purse was positively identified in flowering patches near cabin 22. Extra care was taken to carefully determine the difference between shepherd's purse and the native mustard as they grow next to one another around the lodge cabins. It was also found around and under the trading post and office building, around lodge kitchen area, and edges of the cabins.

August: Further infestations of common dandelion were mapped and retreated in the same lawn areas as in previous months. The dandelions were in small rosettes and had to be searched for by scanning the lawns meticulously. There is a high likelihood that some were overlooked. Shepherd's purse was growing under and alongside most of the cabins in thick carpets. It was easily removed in large patches at a time. Extant pineapple weed infestations in previously inventoried areas were either in full flower or beginning to turn brown and die off.

September: Shepherd's purse was found and treated, having reoccurred around and underneath the cabins and dandelions were found in the same lawn areas as in previous months, especially around the fish freezing building.

Mouth of Brooks River

The mouth of the Brooks River receives a high volume of traffic from and visitors moving between main Brooks Camp and the Falls Platform.

Circulation also occurs with small vehicles driving equipment across the bridge and the river mouth—including the “corner,” the “point” on Naknek beach, “closed trail,” “spit road,” riverbanks, and areas below the lower platform. These areas host a variety of well-established invasives. The most notable are a dense mat of pineapple weed and shepherd's purse overtaking the closed trail. Early season pineapple weed was detected on this portion of gravel road, extending beyond the current bridge entrance and now closed to most traffic, and by late July both species were observed in full flower and inventoried at 6-25% vegetative cover. The closed trail was graded before camp opened, which regrettably removed all the establishing native vegetation and provided extensive disturbed ground for invasive plant establishment.



Figure 7. SAGA picks pineappleweed at the mouth of the Brooks River.

June: Annual bluegrass was inventoried from the main road to “the corner”; on the footpaths between the corner and Naknek beach, and the corner to the point. It was also inventoried around the lower platform structure, and the main road leading to Brooks Falls Trail. Pineapple weed lined the main road to the corner; the footpaths between the corner and Naknek beach; the corner



Figure 8. A SAGA crewmember adjusts her bug net as she manually treats pineapple weed at the mouth of the Brooks River.

dandelions were detected. Shepherd's purse was found along the closed trail and spit road and inventoried as "flowering with seedpods present". The plants were tall and could be easily removed but were not treated due to the extent of the infestation; however, a group effort could be very effective at manually treating such an infestation. Late July would have been an opportune time to put a SAGA crew to use.

August: Shepherd's purse was selectively treated manually on the closed trail for those individuals with dry, brown seed pods ready to drop as this could be done easily by grabbing handfuls. This tactic was chosen in order to constrain the extent of the infestation while not spending an unreasonable amount of time working towards the impossibility of eradication with only one team member available. The shepherd's purse was interspersed with the thick infestation of pineapple weed, which was brown and dying, and much of it was pulled inadvertently along with the shepherd's purse. A smaller infestation of shepherd's purse next to the gate of the bridge near the lower platform was treated in its entirety as it was an isolated patch. The road from the bridge to the fork of the spit road and the Brooks Falls Trail was inventoried as containing pineapple weed in full flower and annual bluegrass in seed.

September: In September the bears congregate at the mouth of the river to feed on the spawned-out salmon. This makes surveying the area very difficult. The closed trail is particularly dangerous because there is no place for retreat if a bear were to corner a person at the end. Therefore, no

to the point, and densely infested the closed trail; the banks on either side of the bridge, around the lower platform structure, the spit road, and docking beach. One smaller infestation was present along the road before Brooks Falls Trail. What were believed to be shepherd's purse rosettes were noted on the closed trail and corner, but it was still too early to positively identify without seed pods present. Common dandelions were mapped and treated along the spit road.

July: Pineapple weed on the closed trail was in full flower and growing extremely densely, however, no more plantain or



Figure 9. Multiple bears at Brooks Falls in July make manual treatment of the area unwise.

opportunity arose in September to survey the area.

Brooks Falls Trail and Platform

The 2011 EPMT found multiple infestations along the gravel trail leading to Brooks Falls including scattered patches of pineapple weed, common dandelion, shepherd's purse and annual bluegrass. They also treated small infestations of plantain in front of the vault toilet at the falls trailhead (Frank and Woods, 2011). Their efforts were largely successful as many of these infestations were not detected in 2012.

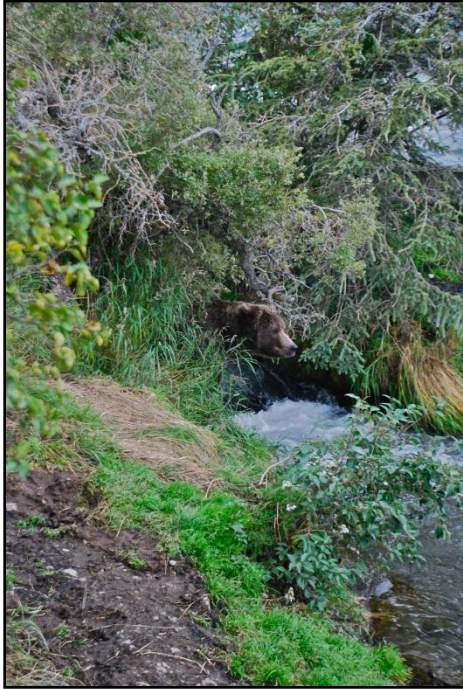


Figure 10. A bear in September heads to the falls across the bear trail lined with a thick infestation of annual bluegrass.

removed and, therefore, was selected for treatment. Pineapple weed has also infested the stream banks between the two platforms and covers the small island just downstream of the falls. In 2010 bears were witnessed eating the flowering heads of pineapple weed, and in 2011 the EPMT discovered pineapple weed growing out of bear feces (Frank and Woods, 2011). In 2012 the EPMT found shepherd's purse at the falls growing out of bear feces. Since the area surrounding the platforms is continually disturbed and bears further facilitate the dispersal of seeds, control

June: Annual bluegrass was inventoried along the entirety of the road. The area around the platform contained an extensive infestation of pineapple weed that was inventoried but no attempt was made at treatment as the tiny rosettes were a blanket across a large area. No other invasives were detectable in June.

July: No new infestations were found along the trail. An attempt was made at looking for new infestations by the falls from the platform; however, July is the busiest time of the year for tourists at Brooks. This year had a record number of visitors which made the wait to get to the platform over an hour long, which would have been a decidedly poor use of time. At all times during July there are typically numerous bears at the falls which makes inventory or treatment of the area impossible.

August: During a return visit in August, a single individual plantain plant was manually treated on the falls trail. Pineapple weed, annual bluegrass, and shepherd's purse grew in high density around the base of the falls platform. Shepherd's purse was the least extensive infestation and the most easily



Figure 11. A bear at the base of the Brooks Falls platform in September grazes on the dense infestation of annual bluegrass.

efforts at this site are generally ineffective.

September: In most years, the bears are not prevalent at the falls in September. However, this season was unique in that many large bears were consistently fishing at the falls. The lack of tourists causing a wait at the falls made it possible to make an assessment from the platform; however it would have been unwise to attempt to survey the area. A very thick blanket of annual bluegrass and dead pineapple weed could be seen from the platform and was being grazed on by a hyperphagic bear, and no shepherd's purse could be seen from the distance.

Lake Brooks side

Brooks Lake lies on the south side of Brooks River headwaters, approximately one mile (1.6 km) down a turnoff from the VTTS road. The lake is an access point for float planes, and in the vicinity lie NPS employee housing, a picnic area and maintenance yards. Surveys from previous seasons found the fenced-in storage yard at the very end of the road free of invasive plants, and a small infestation of pineapple weed and one plantain were removed from inside the electric fence around the mechanic's yard. There has also been ongoing treatment of shepherd's purse around the cabins in years past.

June: The 2012 EPMT found Lake Brooks side in a similar condition to years prior. The SAGA crew helped to remove pineapple weed along roads and footpaths of the cabins, and small rosettes of plantain were also treated.

July: In the month of July, treatment of plantain and pineapple weed was continued and suspected rosettes of shepherd's purse were noticed but not positively identified until late July at which time it was manually treated. Infestations of pineapple weed and plantain inside the electric fence around the mechanic's yard were relocated and treated.

August: A fairly large infestation of plantain was found on the road to Brooks side just before the first cabin. It appeared to be a new infestation and was treated and mapped. On arrival to the cabins at Brooks side, it was apparent that the areas that would have been treated had very recently been mowed and the stunted plants that were left were too mutilated to identify and treat.

September: The plantain found on the road just before Brooks side in August had not grown back in September. The pineapple weed behind the first cabin on the angler trail was inventoried as standing dead. Shepherd's purse and plantain were found next to the cabins and treated and annual bluegrass and pineapple weed were inventoried in the area.

Valley of Ten Thousand Smokes Road, Trails, and Pullouts

The Valley of Ten Thousand Smokes (VTTS) is a river valley filled with volcanic ash and pumice from the 1912 eruption of



Figure 12. The valley road in the fall.

Novarupta, the largest volcanic eruption of the twentieth century. 100 years later, most of the valley floor is still devoid of vegetation and is a popular tourist attraction for hikers and sightseers. The VTTS road, extending 23 miles from the BCDA through boreal forest and alpine tundra, is the only access point to the valley and represents a potential vector for invasive plants to spread into the backcountry. Since 2005, visual scans from a slow moving vehicle and surveys at vehicle pullouts have revealed pineapple weed, annual bluegrass and shepherd's purse at most pullouts, as well as along the entrance and fence at the sewage pit.

In 2009, bird vetch was discovered near mile marker 13.5, which is the highest ranked invasive plant in the park due to its ability to grow into dense thickets. It was manually treated in 2010, but the treatment was ineffective and there was high potential for it to spread along the VTTS road so a more aggressive approach was necessary. The NPS prepared an Alaska Region Invasive Plant Management Plan environmental assessment. The Finding of No Significant Impact (FONSI) allows the use of herbicides where physical control methods are ineffective, following a structured decision tree and mitigation measures to reduce any potential adverse impacts to park resources (NPS 2010). Milestone herbicide was applied in June 2011 for the first time in KATM to a 0.02 acre patch of bird vetch. The chemical treatment was effective for the rest of the year with a very small reoccurrence that was manually treated in July 2011. The VTTS road also had an infestation of mouse-ear chickweed (*Cerastium fontanum*, petal length about equal to sepal length) growing interspersed with native *Cerastium* (petals longer than sepals).

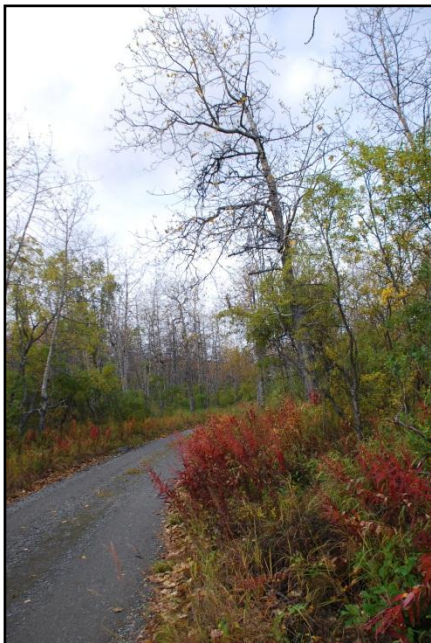


Figure 13. The site of the previous bird vetch infestation was invasive free in September.

VTTS Road

The road was surveyed from a slow-driving vehicle in the past but was not inventoried in such a way in the 2012 season. Annual bluegrass was noted at various stops, but it was not extending into native vegetation. It likely grows at varying density along entire length of road.

Mile 13.5

June: The EPMT used the background files on the Trimble to locate the site of bird vetch infestation from previous years. No returning plants were detected, so herbicide was not applied as planned.

July: Two small, non-flowering bird vetch plants were found and manually pulled at the site of infestation from previous years.

August: No reoccurring plants were found, indicating that using chemical treatment followed up with manual treatment was an effective method to control and eventually eradicate bird vetch.

September: Bird vetch was inventoried as not detected using the background file as a guide to determine the exact location of the previous infestation.



Figure 14. SCA intern Claire Parker mapping the bluegrass infestation at the bottom of the Ukak Falls Trail.

September: Annual bluegrass was growing in a slightly denser infestation than previous months but in the same locations and was manually treated. Treatment in the area may be superfluous as the infestation does not appear to be attenuating.

Margot Falls Trail

The Margot Falls trail was inventoried in the months of



Figure 16. Cow parsnip growing in June along the Windy Creek Trail obscuring plantain infestations at the edges of the trail.

June and September and was found to be invasive free. However, annual bluegrass was growing along the VTTS road in front of bathrooms near the trailhead. SAGA performed maintenance on the trail in June.

Ukak Falls Trail

June: Annual bluegrass was treated with SAGA along the first ½ mile from the trailhead, and in one patch past the fork to the confluence trail. This patch was relatively large and dense but still feasible to treat, especially with the help of SAGA.

July: The trail and patch at the fork were retreated for annual bluegrass but the infestations were far less extensive than in the month previous. The infestations were small enough to be efficiently treated by a team of two.

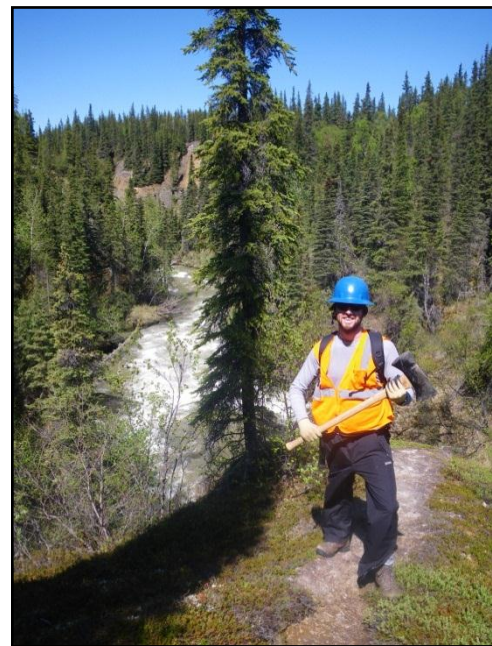


Figure 15. A SAGA crewmember trimming back overgrown vegetation on the Margot Falls Trail.

Windy Creek Trail and Baked Mountain Trail

June: The trip from Windy Creek Trail to the Baked Mountain huts is one of the most popular backpacking routes in the park and has a footpath from the heavy traffic. Since there is very little cover from native vegetation on the ash, this area is susceptible to invasion by exotics. The path was inventoried 12 miles from Windy Creek trailhead to Baked Mountain huts with no invasives found. The plantain patch found at the trailhead in 2011 was not yet detected in June

2012.

July: Annual bluegrass was noted but not mapped, extending from Windy Creek trailhead to the first stream crossing which is roughly 2 miles from the trailhead. Plantain was still undetected at the trailhead.

September: The Windy Creek trail had been overgrown with a dense population of cow parsnip for most of the season, but by September it had died and revealed the plantain that it had concealed for the past months. The plantain was yellowing and dying and, with the help of the background files on the GPS, 96-100 percent was treated.

Five-Mile Gravel Pit

The gravel pit is located at mile marker five. It is the source for fill material used on the VTTS road and throughout Brooks Camp and will be used for the ongoing Valley Road Administrative Area (VRAA) construction project. The materials at the pit are frequently moved around the area and from one season to the next the site looks very different. Searching for sites of past infestations is best accomplished by using the background files.

June: One individual *Trifolium* plant was found and removed. It was dried, dead and brown so it was hard to distinguish whether it was white, red (*Trifolium pratense*), or alsike clover (*Trifolium hybridum*) since the distinguishing features were obscured. 2012 was the first year that clover was found at the five-mile pit. Annual bluegrass and narrowleaf hawksbeard (*Crepis tectorum*) from last season were not yet detected; however, potential shepherd's purse rosettes inside the electric fence area were found and noted for positive identification once the seed pods were present. The native mustard also grows extensively in the pit, and care should be taken to avoid confusion of the two species. One common dandelion was treated. In 2011 a single individual of bird vetch was found and upon inspection guided by the GPS background files the area was marked as not detected as of June 2012.

July: The unidentified clover plant was rediscovered in late July not yet in flower. A photo was taken and the plant was left to flower for positive identification on a return visit. Shepherd's purse with flowers and seedpods was found and pulled inside the electric fence area. *Crepis* was found by using the GPS background files to see where it was mapped last year. It was near construction materials and promptly treated, pulling a few dozen flowering plants. The bird vetch was still not found where it was mapped last year.

September: The pit was visited in September with the hope of finding the patch of clover in flower for identification. Unfortunately, the materials in this area are constantly being shifted and the site of the clover infestation had a large concrete slab on top of it. In the following season the background file should be used to identify the location of this clover with positive identification of the species



Figure 17. The native mustard lyrate rock cress, with its distinct seed pods, growing in June at the five-mile pit.

most likely possible by August. It is suspected to be white clover from the size of the leaves in July. The area containing *Crepis* was also torn up and moved around and no plants were present. Bird vetch did not reoccur at the pit, which is exemplary of the effectiveness of early detection and treatment that result from careful monitoring.

Squirrel Camp

Squirrel Camp is at the one mile mark on the VTTS road and has been used for temporary contractor housing since the early 1990's (KATM, Richard Sherman, pers. comm.). It is an important site to monitor since its inhabitants regularly travel between the camp and newly disturbed construction sites. In the last season, infestations of pineapple weed and shepherd's purse were found.

June: Annual bluegrass was inventoried at the gate entrance and around the fire pit. Pineapple weed was also dispersed around the fire pit in low density so it was manually treated. Potential shepherd's purse rosettes were noted around the cabins but it was still too early to differentiate between the invasive and native mustard.

July: The pineapple weed infestation was still present but was largely thinned and was retreated. No positively identified shepherd's purse was found. It appeared that what we had thought might be invasive was, in fact, native. The annual bluegrass infestation had spread and was found in lines around the perimeter of the camp.

September: A large pile of rubble was covering the area in which pineapple weed was found in months prior; however, annual bluegrass was inventoried in a very dense strip in front of the cabins.

1.5 Mile Campground

About a mile and half down the VTTS road is an open area that can be used as an overflow campsite. For the 2012 season it was utilized for camping by the BBC film crew that was creating a documentary about the bears of Katmai. In a July survey, pineapple weed was flowering at the entrance along the VTTS road and 96-100% manually treated late in the month. The site should be revisited in later seasons to prevent its spread down the road or onto future campers' gear.

Bay of Islands and Research Bay Fure's Cabin

The highest priority at Fure's Cabin is continual, thorough treatment of the common dandelion infestation. Due to a low success rate in past seasons' efforts to manually control dandelions in the lawn and paths, application of Milestone (a low-impact broadleaf herbicide) has been deemed appropriate for the area and is in its second season of use. This chemical control effort



Figure 18. SCA intern Allison Connealy wearing a bug shirt and hip waders that were not adequate for the depth of water at Idavain Creek.

has thus far proven highly successful, as evidenced by the decreased growth of dandelions in the lawn and paths compared to the infestation's reported density in previous years. In an initial early June visit, common dandelion was still present in the lawn, but only as scattered individuals. Half of one workday was spent removing flowering heads in preparation for herbicide treatment and to prevent robust individuals from producing seed, and another half day was spent spot treating plants with Milestone. In addition to the dandelions found at this site in June, annual bluegrass was found on the footpaths. One individual pineapple weed with rosettes of shepherd's purse were found near the fire pit, and mouse-ear chickweed was found on the portage trail. Although the shepherd's purse was present in small rosettes, it was able to be identified by knowledge of the previous season's infestation.

The Bay of Islands

The 2011 EPMT traveled to the Bay of Islands and found no invasive plants despite the clear signs of human activity from fishing and camping. In 2012 the site was not considered high priority and was not inventoried as it is logistically challenging to find someone to drive the boat to each island with sufficient time for mapping. However, law enforcement does patrol the area and there is potential to ride along on their patrols. Surveillance of this area is important as long distance transport of seeds via wind dispersal as well as steady visitation make The Bay of Islands a good candidate for continued monitoring, especially given the proximity to known infestations at Brooks Camp and Fure's Cabin.



Figure 20. A subadult bear pulls on the anchor rope of the boat containing the EPMT and makes mapping the area difficult.



Figure 19. SCA intern Claire Parker walks across a log to continue mapping the shoreline near Margot Creek.

Margot Creek

Margot Creek, not to be confused with Margot Falls in the BCDA, is another popular fishing site near the Bay of Islands that was inventoried with no invasives found in 2011. It was resurveyed in June of 2012 as it is a popular fishing site and it is still invasive free.

Idavain Creek

An attempt was made to survey the creek banks but only a small area was able to be inventoried due to heavy bear activity on the date of the visit. Less than ½ mile of shore line and creek banks were inventoried with no invasives found, but extensive surveying was impossible due to bear activity. If future visits are attempted, bear management should be consulted to choose a more appropriate time in the season for the venture, most likely in early June or

Late August. Chest waders should be worn to navigate the boggy river edges in this area.

Lake Camp

Lake Camp is located approximately 15 miles east of King Salmon, accessed via the Lake Camp/Rapids Camp Road. It is the only vehicular access point within the Katmai Park boundaries, and is also the most common docking point for boat traffic across Naknek Lake to Brooks Camp. This site is therefore a concentrated area for park employee traffic and Brooks Camp construction material transport and recreational angler visitors. Efforts in past seasons have utilized SAGA crew work hours to manually treat the moderately dense infestation of sheep sorrel, which extends around the edges of the upper and lower gravel parking lots, roads, and footpaths, around the bathroom facilities, throughout the picnic area lawn, and along the Naknek Lake shore around the float docks. Sheep sorrel has been found growing as far as $\frac{1}{4}$ mile up the Lake/Rapids Camp Road and into the nearest pullout before the parking lot; therefore, while remaining immediately contained to the parking and docking area, the infestation does appear to be capable of spreading further up the road—and has already been observed within King Salmon, suggesting an established cross-contamination between Lake Camp and the town.

June & July: Extensive manual treatment of sheep sorrel consisted of spending many afternoons picking small rosettes. Because sheep sorrel spreads through rhizomes, it was easily removed when the ground was a little bit wet with many plants on one root. It was often most desirable to work at lake camp on days that are cold, windy, and rainy as the white socks and mosquitos in the area swarm in such a way that makes work taxing even in full bug gear. Plants were often interspersed in grass and rocky areas around the edge of the parking lot. These areas were much more difficult to treat and remove the roots, especially without pulling up substantial amounts of native grasses that are helpful in stopping the spread of infestations into new areas. Care was taken to leave native flora and create as little disturbance in treatment as possible, especially when removing plants that were seeding. It appears that last year's attempts at manual treatment with the SAGA crew were largely ineffective based on the extent of regrowth this year. The parking lot, road, and dock areas were all still densely infested. This is of particular concern because of the potential for seed transfer with construction materials en route to Brooks Camp. Less than 50 fall dandelion individuals were found and pulled in the parking lot and picnic area with three plants by the docks. Pineapple weed was growing at low density in spots within the parking lot, along roads, and was inventoried.

August & September: As the sheep sorrel infestation was still very extensive and only one team member was left to conduct treatment, the focus moved away from trying to remove every rosette in an area. The EPMT tried mainly to remove those plants that were in seed. Treatments



Figure 21. Bugs swarm the vehicle at lake camp while the EPMT takes a mental health break to be out of the swarm for a moment.

of fall dandelions also continued as they began to flower and were growing quite densely in the picnic area and sporadically throughout the rest of the parking lot edges. A volunteer from Northwestern University was recruited in September to help with treatment at Lake Camp and made the treatment that day much more effective. Any volunteers that can be recruited to aid in treatment of this densely infested area should be utilized.

Katmai National Preserve

In August 2011 the EPMT travelled to the Katmai National Preserve to survey along Moraine and Funnell Creeks. These two waterways are known for their high bear densities and excellent fishing, and are therefore highly trafficked by anglers, bear viewers and hunters. Prior to last season, no surveys for exotic plants had been conducted in the preserve. 2011 sites included Little Ku, Moraine and Funnell Creeks, and Crosswinds Lake. Little Ku and Moraine Creek were surveyed in 2012 at the landing strips and no invasives were found. Funnell Creek and Crosswinds Lake were not revisited in 2012 but are good candidates for future surveys.

Nonvianuk Lake and Alagnak Wild River

The Alagnak Wild River is a separate park unit under the administrative supervision of KATM. The majority of land is owned by the NPS, but multiple private inholdings complicate survey efforts in this area. NPS backcountry law enforcement staff discovered an infestation of common dandelion on a private land holding at the confluence of the Alagnak and Nonvianuk rivers in early September 2011 (Luke Hayden, pers. comm. 2011). The infestation was photographed and a specimen was delivered to the EPMT. Backcountry rangers have also suggested that private land holdings on the north side of the Nonvianuk River contain an infestation of common dandelion. Due to logistic challenges, mapping and removal were not feasible this year. In 2010 and 2011 the EPMT briefly surveyed the Nonvianuk ranger cabin as well as the mouth of the Nonvianuk River and discovered common dandelion and a small patch of common plantain in the mown areas on the southern side of the head of Nonvianuk River. These infestations pose a threat of spreading further downstream on both the Nonvianuk and Alagnak Rivers. These infestations are small and could be eradicated with multiple treatments; therefore, return visits should be a priority in the coming years.

Outer Coast

The Katmai coast has a long history of anthropogenic use 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 been 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 report from 2005, pineapple weed was documented growing in Kaguyak Bay on a trail from the beach to Hallo Bay Lodge, while no exotic species were documented at Hallo or Swikshak Bays (Bauder and Heys, 2005). The 2010 EPMT briefly visited Katmai Bay and Amalik Bay and encountered no invasive species (Shepherd & Bartley, 2010). During the 2011 field season, trips to Geographic Harbor, Kukak Bay and Kaguyak Bay were successfully completed. The outer coast is one of the most logistically challenging places to reach in the park and efforts to survey at Hallo and Swikshak Bays in 2012 were thwarted by inclement weather.

Geographic Harbor, Takli and Little Takli Islands

Geographic Harbor, a popular bear viewing destination, was surveyed in 2011 with no invasive species found. It was not resurveyed in 2012 but is an option for future seasons. Takli and Little Takli Islands, which sit in Amalik Bay, were the home to an ancient village and a fox farm and trapping cabin from the early 1930's to 1940's (Clemens & Norris, 1999). This history of human use draws frequent visits by NPS archeologists. The islands are both fairly dry with vegetation composed primarily of grasses, making them ideal sites for the establishment of invasive plants. 2010 and 2011 surveys did not encounter any invasive species. 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 have detected no invasive species present.

Kukak and Kaguyak Bay

Surveys at both Kukak and Kaguyak Bays were performed in 2011 for the first time since 2005. The EPMT surveyed around two privately owned lodges, Katmai Wilderness Lodge in Kukak Bay and Hallo Bay Bear Camp in Kaguyak Bay while accompanying a cultural resource reconnaissance trip. Both lodges facilitate coastal tourism for bear viewing and fishing and pose a threat of translocating invasive species into the more remote areas of the park. Survey work near Hallo Bay Bear Camp occurred from the coastal margin to the property boundary with no access to the private lands. Annual bluegrass, pineapple weed and common plantain were discovered on the trails leading from the beach to the lodge. No other invasives were detected in surveys in the coastal dune.

Last year's EPMT surveyed the property of the Katmai Wilderness Lodge finding annual bluegrass, common plantain, common chickweed (*Stellaria media*) and common mouse-ear chickweed. 2011 was the first time those species had been found on the outer coast and this site should be revisited in future seasons to monitor these infestations (Frank and Woods, 2011).

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, making them potential sites of infestation. Twelve years ago, several lodges were surveyed and three invasive species, common plantain, common dandelion and pineapple weed, were present in disturbed areas around Grosvenor, Katmai, and Kulik Lodges (Densmore 2001). Common plantain was found at Katmai and Kulik Lodges, pineapple weed was found at Grosvenor and Katmai Lodges, and common dandelion was found at all three lodges. Given that these lodges are not often frequented by NPS staff, opportunities to survey these areas are limited.

In 2012, airstrip surveys 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. An airstrip not yet surveyed is the one near Pfaff Mine. EPMT staff should resurvey lodges, airstrips, and bases of commercial ventures in the future.



Figure 22. Whitney Rapp identifies native dandelions near Packer's Cabin in Aniackchak Bay.

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 both detected no exotic species. During surveys performed in 2010 by the AKNHP, common dandelion was discovered growing along the Aniackchak River (Shepherd and Bartley, 2010). Infestations were scattered along the river growing in undisturbed areas, which is an uncommon habitat for dandelions in this region.

A 2012 visit by the EPMT to ANIA surveyed landing strips at Lava Creek Cabin, Klutsch 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 Aniackchak 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 a 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

Bristol Bay Borough consists of King Salmon, Naknek, and South Naknek. The town of King Salmon is the main access point for visitors, vehicles, and equipment going into the park and is therefore the primary source for translocation of invasive species.

NPS Administrated Property

June: Dandelion rosettes were present and scattered throughout grassy areas by the float docks and were treated. Pineapple weed was growing in disturbed areas of the parking lot in small patches and was inventoried. *Crepis* was found in the marina area in years previous but was not yet detected in June of 2012. Shepherd's purse rosettes were suspected but too small for positive identification.



Figure 23. SCA intern Allison Connealy inventories native dandelions near Packer's Cabin in Aniackchak Bay.

July: Common dandelion was removed along the road leading to the docks and parking area with medium control effort. One person worked on this treatment over two afternoons with some difficulty due to the increasing height of the grass as the season continues obscuring visibility. Care was taken to remove the root with the rest of the plant and to leave as little disturbance as possible. Pineapple weed was growing in low density around the marina area, scattered throughout the gravel. A few individuals of common dandelion were found by the marina



Figure 24. Non-native chives growing at Packer's Cabin.

building, growing in patches along the road leading to the marina and lining vegetation around the weather service dome. *Crepis* was identifiable and removed around the weed storage hut and the gravel around the weather service dome. One individual plant of what was thought to be prostrate knotweed, an invasive, was growing in gravel by the weather service dome. Unfortunately, confirming whether it is a native variety would have required careful comparison of seeds using microscopy so positive identification was not possible. Sheep sorrel was also found growing with the *Crepis* in the gravel and was treated.

Around the employee housing and surrounding roads, annual bluegrass was lining some lawn areas. Pineapple weed was growing in a dense mat in the lawn behind the NPS dorm and scattered in the other yards as well. It began flowering in the first week of July and was standing dead by mid-September. Dandelions were lining the NPS dorm lawn along Park Service Road and were pulled where detected. These infestations were present throughout the season.

Other Bristol Bay Areas

The Federal Aviation Administration (FAA) housing area is home to many full time federal government staff as well as several large infestations of exotic plants. In September the EPMT visually surveyed for presence and expansion of invasive species documented in previous years. Significant infestations of alsike clover, narrowleaf hawksbeard, oxeye daisy, (*Leucanthemum vulgare*), and fall dandelion were observed growing along roadsides, with Ptarmigan Trail being the most heavily infested road.

Surveys around King Salmon, which extended to include the Air Force base, found significant infestations of common dandelion in the grassy areas along roadsides. Infestations of pineapple weed were found growing in the road margins and around most buildings. Bird vetch was growing along the Alaska Peninsula Highway towards Naknek just before Flatnose Henry Road along with alsike clover. Permission to treat the bird vetch is an arduous task but would be worthwhile considering the high priority of this weed. Infestations of alsike clover, white clover, and narrowleaf hawksbeard as well as pineapple weed and bluegrass infest the parking lots and paths in between the trailers and huts south of the NPS office.

The infestations of common tansy (*Tanacetum vulgare*) discovered in previous years along West Housing Road and behind the Johnson Drilling Company were not found in 2011; however, two plants were removed from West Housing Road this year. Common tansy had been treated in previous years through collaboration with Susan Savage of the U.S. Fish and Wildlife Service, and future EPMT should follow up on these infestations to ensure they do not return.

Incidental documentation of invasive plants continues throughout Bristol Bay Borough. This season new species documented in the area included crown vetch, birdsfoot trefoil, and curly dock growing near the Ocean Beauty cannery in Naknek. Tall buttercup was first observed in the area growing in small patches in South Naknek and at a hunting camp on the Naknek River. Creeping buttercup was observed in the grassy area near the river at the FWS headquarters. Non-native grasses documented in the area include meadow foxtail, smooth brome, common timothy, bluegrasses, and foxtail barley (if considered non-native). The ornamental species, particularly European bird cherry, European mountain-ash, and Siberian peashrub, planted on the Air Force Base and other areas are reproducing and pose a long term threat to the area.

Education and Outreach

Educating the public about the potential risks associated with the spread of invasive plants is an important responsibility of the EPMT in order to gain the support and cooperation of the community. This year, efforts from past years were continued, such as use of boot brushes at Lake Camp, Brooks Camp, and the office building. The use of boot brushes dislodges potential seed and plant material from shoes in order to prevent transport to new areas. This is especially important at Lake Camp because of the extent of infestations in King Salmon creating a high potential for transport of these infestations across the lake to the park. For the same reason, the 2012 EPMT continued inspecting construction equipment before it was transported to Brooks Camp with emphasis on communicating the purpose to the construction workers and contractors. The EPMT printed and restocked new general EPMT and species specific brochures at King Salmon Visitor Center and Brooks Camp throughout season. New brochure holders were installed at the NPS float dock in King Salmon, Brooks Camp visitor center and Three Forks visitor center.

Further efforts included Whitney Rapp's (NPS) community presentations at the FWS office and the school in May followed by a summer school presentation in June. An email was sent to the Park Service employees detailing the EPMT's mission and spreading the word about Invasive Plant Awareness Week. National Park Service had a booth at the Naknek Fishtival bazar and this year the EPMT presented live plant samples and pamphlets as well as activity books for children at the booth.

Gypsy Moths and Other Invasive Species

Invasive pests threaten biological diversity in a similar manner as invasive plants do. Introduced exotic insects can spread aggressively and displace native species, and have the potential to cause economic harm. The gypsy moth poses a significant hardwood defoliation threat to Alaska's forested ecosystems, and a detection and monitoring system for multiple species has been in place for several years. Recreational vehicle traffic is thought to be the primary mode of gypsy moth transport, but potential introductions via shipping ports are of increasing concern. The only species of gypsy moth currently detected in Alaska is the European gypsy moth (*Lymantria dispar*) and no known reproducing populations have been established (USFS Issue

Paper, June 2011). Despite this, Bristol Bay's maritime shipping port leaves it vulnerable to introductions. In July of 2012, gypsy moth egg masses were detected on a vessel in Ketchikan and the craft was ordered to leave Alaska for fumigation by the Customs and Border Patrol (Tammy Davis, pers. comm. 2012). In accordance with the EPMT's early detection and rapid response strategy, a gypsy moth trapping system has been incorporated into our monitoring efforts. The sticky traps contain a lure baited with synthetic versions of the species' sex attractant pheromones, which can also apply to Asian gypsy moths (*Lymantria dispar* ssp. *japonica*). Other exotic moth species may respond, including non-target species, although records are inconclusive (Lance 2006). Traps were installed in 4 locations: behind the law enforcement cache at the NPS float plane dock, in the yard between the NPS dorm and maintenance building, in Whitney Rapp's backyard, and near the main shipping port in Naknek. Initial installation occurred in June, and GPS data was collected at each site in June, July, August, and in September when the traps were disassembled. Various insects were captured in the traps, but no gypsy moths were present. Given the low time commitment required by this monitoring program and its significant detection value, it should continue in future seasons.

A notable insect defoliator present in Alaska is the geometrid moth. Multiple species exist, the most destructive being the Bruce spanworm (*Operophtera bruceata*) and the autumnal moth (*Epirrita autumnata*). They occur in various locations in South Central Alaska, and are working their way down the Kenai Peninsula. An outbreak can involve the defoliation of hundreds of trees and shrubs by the caterpillars over numerous years, ending with a crash in the caterpillar population. It typically takes several years of continuous defoliation to kill native deciduous trees and shrubs, especially if the ability to produce a second crop of leaves per season is maintained, although extreme weather conditions may have a greater impact on compromised trees (Rasy et. al. 2011). Geometrid moth caterpillars were observed in KATM in 2011 and have caused defoliation at Brooks Camp and in the Bay of Islands (KATM, Whitney Rapp, pers. comm.). It is unknown whether geometrid moths were accidentally brought to Alaska by humans, or how climate change will affect outbreaks. The damage to native vegetation precipitated by geometrid moths demonstrates the importance of monitoring for other defoliating pests like gypsy moths, whose presence could potentially exacerbate preexisting destruction.

Prevention and Restoration

Taking proactive measures to keep newly disturbed and undisturbed areas free of invasive plant introduction is a highly preferred plan of action in comparison with the manual treatment required once an infestation is thoroughly established. Therefore, focusing on the likely points of new establishment is the first and most necessary step towards early spread prevention. Since the Brooks Camp construction sites (located at various points along the VTTS Road on Brooks Lake side) receive the highest amount of construction vehicle and material traffic and are currently being developed for new employee facilities, prevention efforts necessitate thorough inspection of all heavy equipment that poses a threat of seed or soil transport, before it is moved from Lake Camp to Brooks Camp via barge. Equipment inspections took place during the 2012 season, primarily by having NPS staff go to the contractor yards. Facilitating the inspections at the contractor site is the preferable method, because it limits wasted time, energy, and fuel in transporting equipment that has a strong potential to initially fail inspection and will need to be re-cleaned. Previous seasons' inspections initially took place at Lake Camp, which both caused excessive travel and towing when equipment failed a check (as there is no water source or cleaning facility at Lake Camp). This system also presented the danger of further contaminating

the Lake Camp parking area and thus, transitively, other vehicles passing through. During inspection, EMPT staff thoroughly checked all joints and crevices that could harbor dirt or plant material, paying particular attention to undercarriages and chassis. It is recognized that machinery requires grease and some dirt is inevitable, so the purpose of the inspections should be made clear to operators as they often focus on making the machinery aesthetically clean rather than removing potential contaminants in unseen crevices. Invasive plant flagging tape was used to indicate approval. These inspections involve modest preliminary measures that potentially eliminate the need for years of future control efforts.

Restoration is another key element in preventing the establishment and spread of invasive plant species. Many human activities within the park, including anything from trampling to major construction, cause damage to native plant communities. When left unrestored, these disturbed areas become ideal for the invasion and establishment of exotic species. With new construction and renovation projects scheduled for KATM, it is crucial that restoration and revegetation be included within future project proposals so that disturbed areas can return to their natural state without hindrance by invasive species. Consequently, the 2011 and 2012 EPMT has created a citable document which outlines different disturbance scenarios and provides strategies for revegetation and restoration.

Reseeding is a simple method for revegetation and has had success in mildly disturbed areas in the park. Efforts to establish a seed bank for KATM were stalled by the cold summer and very poor overall seed production in this season and the last. In coming years, when feasible, efforts should be made to collect and preserve seeds for future revegetation projects.

Phenology

Varying phenology complicates control efforts and must be accounted for when planning field work. In June of both 2011 and 2012, many infestations at Brooks Camp described or mapped in previous years were not detected or were present in an immature and unidentifiable state and therefore could not be treated with the SAGA crew. On return trips to the BCDA in July and August these infestations had reemerged. The general phenological variability in the most prevalent species is as follows:

- 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.
- Pineapple weed 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 pineapple weed in June with rosettes of native yarrow, which can be distinguished by its darker color 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 (*Arabis lyrata*). When stem leaves are present, shepherd's purse can be

distinguished by its sessile and sagittate leaves, whereas lyrate rock cress leaves are stalked and only occasionally sessile. The seed pods of shepherd's purse are obvious heart-shaped silicles, while those of lyrate rock cress are long, thin siliques.

- Common plantain also displays a variable phenology. In graveled areas and waste places, such as the parking lot outside of BL-3 or the gravel pad near the generators, common plantain can be found in early June and will emerge in waves throughout the growing season. Areas with limited sunlight and heightened competition, such as trampled areas in the camp ground and along the Dumpling Mountain and Windy Creek trails, common plantain is very difficult to detect until late July or August.
- Narrowleaf hawksbeard has a late phenology and can be difficult to find before July, as the plant will only be a very small rosette that is nearly impossible to positively identify. Late July to August is the optimal time to survey for and treat narrowleaf hawksbeard before it goes to seed.
- Bird vetch will begin to come up in June but has not been observed in flower before August. This species 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.



Figure 25. SCA intern Claire Parker keeps the fire hot to dispose of this year's plant material.



Figure 26. The weather port that stored plant material from past years is ripped apart.

Disposal Methods

The disposal of plant material that accumulates during the field season has been a significant issue for the KATM EPMT over the past three years. Several disposal methods have been investigated including burning and heating the plant material to 300° Fahrenheit in order to sterilize the seeds, leaving behind only compostable biomass. This method is viable but is time consuming due to the slow heating process and the overwhelming amount of plant material.

The EPMT in past seasons have contacted the local dump to inquire about several methods of

disposal at their facilities, including burying at a depth of 15 feet, burning in an incinerator and burning in a wooden pallet fire, but officials from the dump provided very little cooperation and were unwilling to aid in any disposal measures. Therefore the EPMT again resorted to burning

the plant material. A specialty burn barrel with perforated metal sides to improve air intake was ordered and assembled. In 2011 the EPMT did not find the burn barrel to be efficient and used pallets, cardboard, and a voracious amount of fuel to burn the materials. This year cardboard was used exclusively and all plant material collected in the season was effectively disposed of via burning in the burn barrel. Cardboard was collected from NPS employees, the King Ko, and the A/C. The local businesses are very willing to help provide cardboard as it saves them a trip to the dump and it is free and abundant. To effectively burn plant material, the EPMT found that filling the burn barrel with cardboard and continually feeding it to keep it ablaze while slowly adding plant material to the top was the most effective means of disposal. If large clumps of plant material are added to the burn barrel and they fall to the bottom or the sides, they do not burn efficiently and unburned material will accumulate at the bottom of the barrel.



Figure 27. Plant material leftover from previous seasons.

The weather port that stored the bags of weeds from past season was torn into by bears and wind and the bags torn apart, leaving quite a mess. The 2012 EPMT moved the bags from the weather port to the shed behind the marina building to contain them and keep burn materials more dry. Because the roof of the shed has significant holes in it, care must be taken to keep materials under tarps or in dry corners. It should be noted that some bags from past seasons were nearly impossible for one person to carry from the weather port to the nearby shed because they had been combined and were incredibly heavy. Bags should not be filled to the point that they are not easily transportable.

The plant material which has accumulated over the past seasons has heavily decomposed, contains large amounts of residual soils and is often saturated; therefore, when it is put in contact with fire it does not fuel the fire but rather extinguishes it. The soil also tends to fall all the way through the barrel without being burned at all. Burning plants immediately or soon after removing them to prevent decomposition and water log is ideal and will keep the problem from amassing. The composted materials from the past needs to be disposed of and the following are some possible options.

- 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.

Recommendations for 2013 Field Season

- Schedule SAGA crew for later in season (July or August)
- Survey entire VTTS Road in vehicle or possibly from bicycles
- Burn weeds as soon as possible upon removal and research more effective plant matter disposal plan for the composted material from years past
- Seed collection in September for revegetation
- Coordinate lessons for school kids with KS Visitor Center
- Attention to new construction sites in Brooks Camp
- Encourage keeping an up-to-date schedule for the Palyaq and other NPS boats in order to facilitate more efficient logistics
- Positively identify clover at five mile pit
- Recruit volunteers to aid in treatment at Lake Camp
- Continue to monitor the VTTS road for bird vetch

Literature Cited

- Bauder, P. and J. Heys. 2005. Exotic plant survey of Katmai National Park and Preserve: Summer 2005 field season report. National Park Service, Unpublished Report, Anchorage, Alaska.
- Clemens, J. and F. Norris. 1999. Building in an ashen land – historic resource study of Katmai National Park and Preserve. National Park Service, Alaska Regional Office.
- D'Antonio, C., L.A. Meyerson, and J. Denslow. 2001. Exotic Species and Conservation: Research Needs. In: Soule, M.E. and G.H. Orians (Eds). Conservation Biology: Research Priorities for the Next Decade. Washington, DC: Island Press.
- Densmore, R.V., P.C. McKee, and C. Roland. 2001. Exotic plants in Alaskan National Park units. Unpublished report, Anchorage, Alaska.
- Frank, P. and A. Woods. 2011. Invasive species management for Katmai National Park & Preserve: 2011 Summary Report. Natural Resource Data Series NPS/KATM/NRDS/2011/222. National Park Service, Fort Collins, Colorado.
- Lance, Dave. 2006. Guidelines for Detection Trapping of Exotic Lymantriid and Lasiocampid Moths. USDA.
http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/AKEPMT/GypsyMoth/Shared%20Documents/GuidelinesForDetectionTrappingofGypsyMoths.pdf Accessed 9/28/11.
- Million, B. and W. Rapp. 2011. Alaska Exotic Plant Management Team 2011 Field Protocol. National Park Service, Alaska Regional Office.
- National Park Service. 2010. Finding of No Significant Impact, Alaska Region Invasive Plant Management Plan, February 2010. National Park Service, Alaska Regional Office.
- Rapp, W. 2008. Invasive species summary for the Southwest Alaska Inventory and Monitoring Network (SWAN). National Park Service Unpublished Report, Anchorage, Alaska.
- Rasy, M., Chumley, J., Lojewski, N. and J. Lundquist. 2011. Geometric moth defoliation and activity on the Kenai Peninsula and South Central Alaska. Integrated Pest Management Issues, University of Alaska-Fairbanks Cooperative Extension Service.
- Shepherd, C. and D. Bartley. 2010. Invasive and exotic species management for Katmai National Park & Preserve: 2010 summary report. Natural Resource Data Series NPS/KATM/NRDS—2010/107. National Park Service, Fort Collins, Colorado.
- Schwörer, T, Federer, R. and Ferren, H. 2012. Managing Invasive Species:How Much Do We Spend?. Online publication. Institute of Social and Economic Research, University of Alaska Anchorage. http://www.iser.uaa.alaska.edu/Publications/2012_07-InvasiveSpecies.pdf Accessed 1/10/2013.

US Forest Service. Issue paper, June 2011. Invasive Interceptions: Gypsy Moth and Invasive Moth Detection in Alaska. Alaska Region.

http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/AKEPMT/GypsyMoth/Shared%20Documents/GypsyMothDetectionTrappinginAK_2011final.pdf Accessed 9/28/11.

Appendix: Maps of Invasive Plant Distributions

