



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

2014 Summary Report

Natural Resource Data Series NPS/KATM/NRDS—2015/747



ON THE COVER

The abandoned “cub-adult” munching on pineappleweed growing along the banks of the Brooks River (left); tall buttercup detected near the Brooks Falls trailhead for the first time this season (top right); and native fireweed in bloom in front of Fure’s Cabin in the Bay of Islands (bottom right).

Photo of bear and fireweed courtesy of Tori Anderson, photo of buttercup courtesy of Mike Fitz

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Abstract

The 2014 Katmai Exotic Plant Management Team marks the fifth season that the Alaska Exotic Plant Management Team protocol for surveying and controlling invasive plants was followed throughout the growing season. The majority of field work focused on manual and chemical treatment of known infestations at Brooks Camp, the Valley of Ten Thousand Smokes Road, Lake Camp, Fure's Cabin, Nonvianuk ranger cabin, and government property in King Salmon. The team applied Milestone VM herbicide to treat common dandelion (*Taraxacum officinale* ssp. *officinale*) at Fure's Cabin, Nonvianuk cabin, and Lake Camp. It was also used to treat fall dandelion (*Leontodon autumnalis*), sheep sorrel (*Rumex acetosella*), and pineappleweed (*Matricaria discoidea*) at Lake Camp, as these infestations were either too large to effectively control manually, in difficult areas to access, or did not respond well to manual treatment. Manual control has proven successful for moderately-sized infestations, such as the Brooks Camp cultural site. Katmai National Park and Preserve has a relatively narrow extent and limited severity of invasive plants compared to infestations in other parts of Alaska or the contiguous United States due to the park's remote location and continual efforts by several Exotic Plant Management Teams. Ongoing and future construction projects at Brooks Camp will disturb existing vegetation. Revegetation plans will be necessary to ensure that the newly-exposed areas are restored post-construction.

Acknowledgments

This season would not have been so successful if not for the help of employees from several different divisions. W. Rapp (Natural Resources), our supervisor through the end of August, introduced us to Alaska and the Park. She was always willing to answer any questions we had, even after leaving Katmai. T. Hamon (Natural Resources) became our supervisor after Whitney's departure, and he also made himself available to answer any questions on our end. Thanks also goes to those responsible for transporting us to more remote areas of the park: W. Artz (Law Enforcement), for trying to work us into backcountry flights; A. Gilliland (Law Enforcement), for flying us around the park; R. Peterson, K. Nicolato, M. Saxton (all Natural Resources), and R. Gonzales (Law Enforcement) for accompanying us on backcountry trips. We'd also like to thank C. Turner (Natural Resources), for providing us with additional opportunities to learn more about the scope of the Natural Resources work. Many of the Interpretive staff, especially M. Fitz, supported our cause this season by raising awareness with visitors and by keeping a vigilant eye out for invasive plants around the Park when we could not be there ourselves. C. Overbaugh and P. Frank at the regional office deserve special thanks for an informative orientation in May, their constant availability, assisting with our data analysis, and proofreading our report. Lastly, we'd like to thank the Student Conservation Association (SCA) for organizing and making possible such eye-opening internships. We are very grateful for the opportunity given to us this summer and hope to continue the conservation ideal espoused by the SCA wherever our lives take us!

Abbreviations

AKEPIC Alaska Exotic Plants Information Clearinghouse
AKNHP Alaska Natural Heritage Program
ALAG Alagnak Wild River
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
GPS Global Positioning System
KATM Katmai National Park & Preserve
NPS National Park Service
SAGA Southeast Alaska Guidance Association
SCA Student Conservation Association
TCC Tribal Civilian Corps
USGS US Geological Survey
VC Visitor Center
VRAA Valley Road Administrative Area
VTTS Valley of Ten Thousand Smokes

Invasive plants infringe upon far less ground in Alaska than in most other areas of the world. The problem is especially restricted in KATM by its remote location, a natural limitation to anthropogenic disturbance and transportation of plant material. The park also provides a natural barrier to invasive plant species with its circumboreal climate that prevents the establishment of many non-native plants. Despite logistical and climatic deterrents, KATM is still vulnerable to some invasive plant species. Lake Camp, an entry-way to the park, and Brooks Camp, famous for Brooks Falls and access to the Valley of Ten Thousand Smokes (VTTS), are developed sites with high visitation and the most extensive infestations within the park. Smaller infestations occur in some backcountry sites.

Invasive plant species threaten the native ecosystem because they have evolved in a different environment and are adapted to a separate set of resources. The competitive influences that normally deter their spread do not exist when they enter a new ecosystem, allowing them to outcompete the native vegetation. Invasive plants can reduce local biodiversity, alter ecosystems, contribute to habitat degradation, and compromise the genetic integrity of native plants through hybridization (Vitousek *et al.* 1997, D'Antonio *et al.* 2001). Additionally, milder temperatures and increased precipitation associated with climate change could potentially shift dispersal patterns of nonnative plants and facilitate their colonization of northern latitudes (Rupp and Loya 2009, Walther 2000). Given these potential threats, monitoring and control of invasive plants within the park should continue to preserve KATM's native ecosystem.

Invasive Plant Survey & Management History

In 2000, the US Geological Survey (USGS) was the first to collect Global Positioning System (GPS) data showing the extent of invasive plants infestations in KATM. The Exotic Plant Management Team (EPMT) in 2005 updated this data and synthesized it into three separate databases: the Alaska EPMT geodatabase; 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 (AKNHP); and the Alien Plant Control and Monitoring (APCAM), a nationwide NPS database for invasive plant data (Rapp 2009). In 2005, surveys were conducted at Brooks Camp, the VTTS road, Lake Camp, and along the outer coast at Hallo, Swikshak and Kaguyak Bays. The 2005 team manually treated high ranked species and small infestations (Bauder and Heys 2005). A single volunteer performed control work at Brooks Camp in 2006 and 2007, with the assistance of a Tribal Civilian Corps (TCC) crew in 2007 (Rapp 2009). From 2008 through 2013, Southeast Alaska Guidance Association (SAGA) crews visited for about a week each season to perform control work at Brooks Camp and Lake Camp.

2010 marks the first season that KATM had two Student Conservation Association (SCA) interns. The interns focused their invasive plant work on Brooks Camp, the VTTS road, Lake Camp, and King Salmon. Infestations were also controlled at Fure's Cabin and Nonvianuk ranger cabin, and Jojo Lake was surveyed with no invasive plants detected. New locations were surveyed in 2011: Funnel and Moraine Creeks and Crosswind Lake, all within the Katmai National Preserve; along the outer coast at Geographic Harbor, Takli and Little Takli Islands; and areas on Naknek Lake including the Bay of Islands, and Idavain and Margot Creeks. Common mouse-ear chickweed, common

chickweed, and European forget-me-not were found in the park for the first time in 2011. In 2012, the landing strips throughout KATM and ANIA were surveyed for the first time. The EPMT in 2013 was able to survey and treat new areas including ALAG and the Nonvianuk River and ranger cabin (Landry and Voznitza 2014).

The goal of the 2014 EPMT was to monitor and control known infestations while also expanding the EPMT's knowledge of invasive plants in the park by surveying in as many remote areas as possible. During the field season, manual control efforts continued at known disturbed areas including Brooks Camp, the VTTS road, Lake Camp, and government-administered property in King Salmon. Chemical control continued at Fure's Cabin, Nonvianuk River and ranger cabin, and Lake Camp. Kamishak River and Swikshak Lagoon were surveyed for the first time this season.

Prevention is the most effective way to limit the spread of invasive species within the park, making it a priority for the EPMT. The 2011 EPMT installed informational signs, boot brushes and conducted vehicle inspections. A revegetation manual to be used in future project planning to minimize species introductions was also created by the 2011 team. In 2012, the revegetation manual was completed and vehicle and heavy machinery inspections continued throughout construction projects. The 2013 EPMT updated existing boot brush signs and participated in many education and outreach events. The 2013 team hosted a booth at the Bristol Bay Borough's Fishtival, led a children's program at the visitor center, and participated in the high school science camp put on by the U.S. Fish and Wildlife Service (USFWS) (Landry and Voznitza 2014).

The 2014 EPMT continued preventative efforts by reaching out to adults at Fishtival, leading multiple children's programs at the King Salmon Visitor Center, and presenting segments on invasive species, GPS, and ecology at the USFWS Science and Cultural Camp. At Fishtival, the EPMT provided a game for people to distinguish between native and invasive plants to help inform the locals about each plant. The KSVC programs taught children about basic plant structure and the problems associated with invasive plants. During the science camp, the EPMT gave a presentation on invasive species, and then hosted a walk around the USFWS building to show them specific examples. The EPMT also helped out with the various nature walks associated with the science camp and briefly taught the students about basic GPS.

Methods

Fieldwork was conducted from May to October 2014 in KATM according to the 2014 Alaska EPMT Field Protocol (Million *et al.* 2014). The majority of fieldwork was conducted by Alex Lindsey and Victoria Anderson (SCA interns), with assistance from Whitney Rapp (KATM EPMT coordinator).

Fieldwork consisted of both treating previously known, high priority infestations and surveying other areas within the park. Areas surveyed or treated were mapped using a Trimble GeoExplorer Series GeoXT GPS unit equipped with a standardized Alaska EPMT data dictionary specific to KATM. High priority infestations were controlled manually or chemically. Manual control consisted of hand pulling for plants easily uprooted and digging for plants with more persistent roots. Most manual treatment occurred at Brooks Camp, the VRAA, Lake Brooks, and Lake Camp. Chemical control was conducted using the broad-leaf-specific herbicide Milestone VM, containing the active ingredient aminopyralid. Herbicide was applied by Whitney Rapp at Fure's Cabin, Nonvianuk, and Lake Camp, as she was the only EPMT member certified to do so.

Another goal of the season was to monitor and expand GPS data for remote visitor-use areas. Due to this year's efforts, formal and informal data was updated for Pfaff Mine, Margot Creek, Kamishak Bay and River, Swikshak Bay and Lagoon, and Moraine and Funnel Creek

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		
			Acres Surveyed	Species Acres Infested*	Acres Treated
2005	2	6/20-6/29	174.325 (37.507)	6.622 (0.012)	0.076
2007	< 1	intermittent	5.198	0.526	0.495
2008	< 1	intermittent	6.112	0.495	0.495
2009	< 1	intermittent	3.071	0.631	0.083
2010	2	5/3-9/30	105.959 (14.527)	14.417 (0.276)	7.464 (0.276)
2011	2	4/25-10/25	37.562 (1.497)	8.626 (1.497)	3.650 (0.143)
2012	2	5/20-9/28	95.867 (7.576)	11.953 (3.351)	3.262 (0.072)
2014	2	5/1-10/20	46.872 (0.949)	1.160 (0.073)	0.559 (0.042)

* Acres infested are calculated by acres mapped times the percent cover.

2014 Highlights and Observations

- Backcountry trips to Kamishak, Swikshak Lagoon, Moraine, Pfaff Mine, and Margot Creek allowed the EPMT to collect more current data for other high-visitor use locations.
- This year marked the first time that the sheep sorrel at Lake Camp and common dandelions at Nonvianuk were sprayed completely. These areas could not be fully sprayed in 2013 because the EPMT did not have enough herbicide in Nonvianuk and construction equipment covered much of the sheep sorrel at Lake Camp. Nonvianuk will probably need to be sprayed again next season, as many of the common dandelions had already gone to seed by the time W. Rapp was able to spray.
- The EPMT found no infestations of bird vetch in the park this year.
- The team found and manually treated common plantains on the Windy Creek trail and Dumpling Mountain trail early in the season. These did not reappear later in the season.
- Ranger M. Fitz found tall buttercup (*ranunculus acris*) near the trailhead for the Brooks Falls Trail. W. Rapp was able to eliminate it on a visit to Brooks Camp.
- The revegetation work conducted by 2013's EPMT and SAGA crew around the VRAA appears successful, with the transplanting method demonstrating quicker results than the seeding method.

- The educational outreach events put on at the King Salmon Visitor Center, Fishtival, and during Science Camp Week were successful at increasing awareness of the EPMT's message.
- Three all-staff newsletters emailed throughout the season helped raise awareness of the EPMT's goals within several divisions.

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
<i>Capsella bursa-pastoris</i>	shepherd's purse	40	x	x	x	x	-	-	x	x	x	-	x
<i>Bromus inermis ssp. Inermis</i>	smooth brome	62	x	-	-	-	-	-	-	x	x	-	x
<i>Cerastium fontanum</i>	mouse ear chickweed	36	-	-	-	0	-	0	-	0	-	-	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>	pineappleweed	32	x	x	x	x	-	-	x	x	x	x	x
<i>Myosotis scorpioides</i>	European forget-me-not	54	-	-	-	-	0	-	-	-	-	-	-
<i>Plantago major</i>	common plantain	44	x	x	-	-	-	-	x	x	-	-	-
<i>Poa annua</i>	annual bluegrass	46	x	x	-	x	-	0	-	-	-	-	-
<i>Rumex acetosella</i>	common sheep sorrel	51	0	x	x	-	-	-	x	x	-	-	-
<i>Stellaria media</i>	common chickweed	42	-	-	x	-	-	-	-	-	-	-	-
<i>Taraxacum officinale ssp. officinale</i>	common dandelion	58	x	x	x	x	-	x	x	x	x	x	x
<i>Trifolium repens</i>	white clover	59	-	-	-	-	-	-	x	-	x	-	-
<i>Vicia cracca</i>	bird vetch	73	-	0	-	-	-	-	-	-	-	-	x

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

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
Detected only off NPS lands	<i>Alopecurus pratensis</i>	meadow foxtail	52	-	-	-	-	-	-	-	o	-	-	-
	<i>Caragana arborescens</i>	Siberian peashrub	74	-	-	-	-	-	-	x	-	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	-	x	-	-
	<i>Ranunculus acris</i>	tall buttercup	54	x	-	-	-	-	-	-	-	-	-	x
	<i>Ranunculus repens</i>	creeping buttercup	54	-	-	-	-	-	-	x	-	-	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	-	x
	<i>Tanacetum vulgare</i>	common tansy	60	-	-	-	-	-	-	-	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	-	-	-	-	-	-	o	-	-	-	x

x – Observed during current EPMT field season.

o – Observed during prior EPMT field season, but not this field season.

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

Brooks Camp

The Brooks Camp Developed Area (BCDA) is situated along the Brooks River and Naknek Lake and includes a minimal network of trails, infrastructure, and roads. As the epicenter of park activity and one of the few non-wilderness locations in the park, the BCDA poses the largest challenge for invasive plant management in Katmai. Boats and planes transport people from all over the world to Brooks Camp, a major entryway to the park and where most visitors spend their time in Katmai. Promises of salmon fishing and bear sightings bring in these world-travelers, many of whom have little knowledge of the danger invasive plants pose to Katmai's ecosystem.



Figure 2. A map of the BCDA.

Efforts at Brooks Camp this year focused on manually treating common dandelions, common plantains, and shepherd's purse. No chemical treatment was utilized in the BCDA so as not to attract unwanted attention from visitors. In June, all areas were mapped, even if they did not harbor any invasive plants. It is important to map all trails each year, even if no invasive plants currently exist, so that the EPMT can show how the vegetation progressed over the season. Whitney encouraged the team to not waste time treating pineappleweed or annual bluegrass, given their low invasiveness rankings and already expansive coverage. Though this year's crew did not treat the pineappleweed or annual bluegrass, these plants should have been mapped if they fell within the realm of an area which required mapping for another purpose.

BCDA Campground & Dumpling Mountain

As the only fully developed campground in the BCDA, this area is heavily used during the summer. The infestations at the campground are typically restricted to the interwoven trail system and at common areas, such as the picnic grounds, restrooms, firewood storage area, and the food and gear cache. The undisturbed and plentiful patches of vegetation which dominate the campground have rarely contained any invasive plants. This year was no different, as infestations of common dandelion, common plantain, and shepherd's purse occurred mostly along the trail system, at tent sites, and around common areas, with a few minor exceptions at the southern end of the campground. The four-mile trail up Dumpling Mountain, accessible at the north end of the campground, contained only a few infestations of common plantain and shepherd's purse. Next year's group should be sure to check for reoccurrences in July.

June: Many common dandelions and common plantains were identified along the trail system and by campsites. Due to an early phenology this year, many dandelions had already gone to seed and

eleven shepherd's purse were discovered despite it being fairly early in the season. These shepherd's purse were found between the firewood pile and the picnic area just adjacent on the north side of the pile. Invasive plants around occupied tent sites, and multiple afternoon visits were required to minimize disturbance to campers.

Given their quick progress in the BCDA during their June visit and an early phenology, the EPMT ventured up Dumpling Mountain in June. This adventure is typically recommended for a July or September visit, when bears

pose difficulties to inventory and control work in the heart of the BCDA. A couple common plantains were found along this popular hike leading from the campground to the radio repeater. One occurred only 59 meters from the campground. The second plantain appears to be the same one found in past years around the 900-foot elevation mark. Both patches were manually controlled with little effort.

July: Due to the extensive control work completed in the campground in June, only a couple hours were needed here in July. Dandelions, common plantain, and shepherd's purse were again the most abundant invasive plants in the campground at this time. Multiple trips were made to the campground since it was predominantly full during this peak season and the EPMT was not able to work around all the campsites during their first visit. Except for one campsite near the bathrooms which was occupied all week, all campsites were checked for invasive plants by the end of the EPMT's visit.

The EPMT inventoried Dumpling Mountain trail again this month and found only five small plantains near the very beginning of the trail. These invaders were removed by hand immediately. The patch at the 900 foot elevation mark was not found again.

August: With the campground completely empty during the majority of their August visit, the EPMT was able to control infestations in only a couple of visits. All infestations occurred on the edges of trails and campsites, and most were easily managed within 0.1 hours. There was one large patch of common plantains and common dandelions around a campsite in the center of the campground. The site took 1.25 hours to control.



Figure 3. Alex and Tori enjoy the company of interpretive ranger N. Collier on their hike up Dumpling.



Figure 4. The campground contains dense areas of native vegetation.

The EPMT thought they may have found two instances of *Stellaria media* in the campground. When returning to ID it, however, the rain caused the flowers to stay closed, and the EPMT was unable to make a positive ID. They plan to return in early September to try again.

Tori Anderson did a quick survey of Dumpling Mountain on her personal time. This scan revealed only one invasive species, a shepherd's purse located about 150 m from the fence gate at the north end of the campground. This specimen was later mapped and manually removed.

September: Yet again the campground was mostly empty during the EPMT's September visit, allowing for a thorough scouring for invasive plants. The team found thirteen common dandelions and one common plantain. This lower number was expected, as the team had been dutifully removing several invasive plants in the campground throughout the season. The team had time to only walk the beginning of the Dumpling Mountain Trail.

Employee Facilities

The employee facilities are located between the ranger station on the south end and the generator building to the north. In addition to housing facilities, this area includes the bathhouse/old maintenance building, incinerator building, gear cache, leach field, yurt, generator building, and the network of trails connecting these places. NPS employees mostly inhabit Park Avenue, while Lodge employees live in Tuckerville. Construction of new housing facilities is still in the initial phases on the opposite side of Brooks River adjacent to the new maintenance yard. This site remains of high priority for surveillance in the coming seasons, as fill importation poses significant risk for the transportation of invasive species.

June: Park Avenue remains mostly free of invasive species, except for the ubiquitous pineappleweed and annual bluegrass which this year's EPMT decided to leave untreated due to its low invasiveness ranking. Only one patch of seven common plantains was found around the cabins and tent frames. This patch was found at the northernmost cabin site, close to the generator building, and was easily controlled. Outside the generator building, the EPMT found minor patches of pineappleweed and plantains.

Tuckerville harbored few invasive plants in June – this year's EPMT spotted only one occurrence of dandelions within the electrical fence boundary. The EPMT found it difficult to identify a potential shepherd's purse, and so the team plans to revisit and identify this plant during their July visit. The road leading from the leach field to the lodge's storage and recreational building is mostly free of invasive plants (with a minimal exception of dandelions immediately outside Tuckerville's entrance) until its terminus at the storage building, where dandelions and plantain abound. This area was quickly mapped and controlled within an hour.

The leach field is located between the ranger cache and Tuckerville and had a large amount of pineappleweed around its edge. A large patch of pineappleweed existed immediately across the road running next to Leach Field. Due to pineappleweed's low priority, the EPMT left these infestations untreated to make best use of time.

The south end of the employee facilities proved largely invasive free. The EPMT found only one dandelion outside of the incinerator building, one plantain outside the ranger cache, and nothing other than pineappleweed outside the yurt and the bathhouse/old maintenance building.

The new NPS employee housing site remains free of invasive plants, both around the cul-de-sac road and around the only two structures erected at this point.

July: Once again, no invasive plants were found along Park Avenue. The generator building at the end of this road and the trail heading down to the beach from this building both hosted several invasive plants, including plantain, common dandelion, and shepherd's purse. The shepherd's purse at this site extended back into the native vegetation in spots and was most likely not completely eradicated. This is a spot to check regularly in the future.

Tuckerville contained many more invasive plants in July than it did in June. The EPMT found many dandelions and shepherd's purse, with most infestations occurring close to or slightly underneath



Figure 5. Tori weeding at Tuckerville.

cabins. While the EPMT was surprised to find these invasive plants given the lack of invasive plants here in June, these plants were still easily managed within a couple control hours. The storage and recreational building at the end of the road demonstrated a noticeable decrease in invasive plants in July as compared to June, though some maintenance was still necessary.

One shepherd's purse was found in the leach field, but otherwise remained mostly clear of invasive plants. The only other invasive found here is pineappleweed, and the EPMT spent no time treating it.

Again, few invasive plants were found around the south end of employee facilities. Seven shepherd's purse and one common plantain were found by the ranger cache and four shepherd's purse were removed by the weather port. A few shepherd's purse were found along the trail to yurt and in the yurt yard itself.

A couple occurrences of shepherd's purse were found in the new employee housing by the maintenance yard. One patch was quite extensive, while the other occurrence contained only one stem.

August: Only a couple of invasive plants were found along Park Avenue. These plants were all found at the northern end of the road, near the generator building and included common plantain and shepherd's purse. The generator building itself hosted only a few common plantains and shepherd's purse. The patch of the shepherd's purse found in July infiltrating native vegetation at the North

corner of generator trail contained only one shepherd's purse this month, which was quickly removed.

The lodge's recreation and storage building hosted only a few common dandelions, fewer than previous months. Pineappleweed was omnipresent at this location, but not treated. The path leading from the recreational building to the northern end of Tuckerville contained several common dandelions which were easily removed.

Tuckerville itself contained noticeably fewer shepherd's purse than in July, and less invasive plants overall. Twenty-three common dandelions were found here, along with one small patch of shepherd's purse. This location took less than two total hours to control.

The leach field contained no invasive plants other than pineappleweed. The road to Tuckerville harbored only two common dandelions.

No invasive plants were found around the weather port, old maintenance building/bathhouse, or recreational gear cache. The EPMT found only two common dandelions by the incinerator building, along with a couple shepherd's purse found just within the incinerator gates.

At the new park housing next to the new maintenance building, a few shepherd's purse were found along the backside of the two new duplexes. As of mid-August, the duplexes each housed one park employee.

September: One shepherd's purse was found along Park Avenue, as well as three common plantains around the generator building.

The lodge's recreation and storage building again hosted several dandelions. Dandelions continued along the trail from the building to the side of Tuckerville. Tuckerville again contained a number of common dandelions which were manually removed.

Again, the leach field contained no invasive plants other than pineappleweed.

The EPMT found a few common plantains and shepherd's purse by the ranger cache and along the trail leading from the incinerator building to the ranger station.

No invasive plants were found by the two new duplexes near the maintenance building. The area had previously harbored invasive plants but had been filled in with more soil. Due to all the fill importation, the EPMT recommends future teams to keep an eye on this area, so as to catch problems before they become unmanageable.

Visitor Center Area

The Visitor Center (VC) area includes the VC, the adjacent food and gear cache and restrooms, picnic area, ranger station, and auditorium.

June: Very few notable invasive plants were found in this area in June. While pineappleweed is found almost everywhere in the park, its presence was most intrusive around the picnic area and auditorium. Nothing was done to control the pineappleweed given its low priority.

July: Again, few invasive plants were found in this area during the EPMT's July visit. The auditorium hosted one dandelion which was promptly removed. Other than that, only pineappleweed and annual bluegrass were present in this area.

August: Yet again, few invasive plants were found here. One small patch of shepherd's purse was found outside of the VC vault toilets.

September: The EPMT found that more shepherd's purse had grown back in the same area outside of the VC vault toilets. These stems were quickly removed.



Figure 6. These photos show the steadily diminishing density of dandelions at the cultural site.

Cultural Site

The cultural site exhibit includes an enclosed reconstructed pit house, known as a barabara, made in the style of native Alaskans from thousands of years ago. The trailhead to this site begins at the visitor center, winds behind the auditorium, and continues a short way into the woods, passing multiple housing pits along the way. The majority of infestations occur closer to the housing site, with the only invasive plants along the trail before that being annual bluegrass and pineappleweed,

both low priority invasive plants. At the cultural site, common dandelions posed a significant presence this year, but overall efforts were much less than in previous years. Revegetation efforts have proven successful, with native yarrow, largeleaf avens, and Jacob's ladder making a comeback to the area.

June: Four and a half control hours were spent at the cultural site during this visit, an hour longer than the EPMT crew spent here in June last year. The dandelions were mostly concentrated to the east, south, and west of the site, and along the trail immediately leading up to the site. Throughout the years, dandelions coverage has decreased substantially via manual control methods. This year's EPMT crew noted the amount of trampling necessary to extract all the dandelions. In future visits, this opportunity for invasive plants to spread should be minimized as much as possible.

July: The EPMT spent half a morning at this site in July eliminating dandelions that had not been completely eradicated during the June visit. The majority of these dandelions were found on the entrance side of the building and sporadically in the front yard.

August: The cultural site required minimal upkeep this month. The EPMT spent only two control hours at the location treating common dandelions. Infestations occurred again mostly along the trail, in the front yard, and farther back in the grasses near the entrance.

September: September's control work at the Cultural Site was again minimal, requiring only 1.7 hours of the EPMT's time. The EPMT treated common dandelion again along the trail, in the front yard, and to the west side of the entrance.

Brooks Lodge

Located along the mouth of the Brooks River and the Naknek beach, the Brooks Lodge area includes the Skytel, multiple cabins, the dining area and lounge, office building, trading post, fish freezing building, bathhouse, and multiple interconnecting trails. This area is the source of much visitor activity, and should be thoroughly examined upon every visit. Pineappleweed and annual bluegrass were present but not mapped. Shepherd's purse and common dandelion were also present.

June: Common dandelion was found sporadically throughout the Brooks lodge area but most heavily concentrated near the oxbow marsh overlook cabins. While shepherd's purse was generally identifiable by this point for most of BCDA, only one patch was found in front of Skytel and manually treated in about 20 minutes by one person. The dandelions in this area were controlled within 5.5 control hours.

July: During this month's visit, the EPMT once again found several sporadic dandelions around the lodge area, with a noticeable decrease in the amount by Skytel and the cabins. Shepherd's purse was abundant around and underneath cabins. This remains a high priority, as it is hard to ensure 100% eradication when trying to pull weeds lying underneath a cabin. This project took the lesser part of an afternoon.

August: The lodge hosted a fair number of invasive plants this month, and required a little less than 5 hours to control. The majority of infestations were common plantains, common dandelions, and

shepherd's purse. Again, Skytel and the two Oxbow cabins closest to it harbored the greatest number of infestations. The gravel parking area near the fish freezing building contained a significant amount of shepherd's purse.

September: The number of invasive plants at the lodge has steadily declined throughout the summer. In July, this area required 5.5 control hours, but it only required 4 hours this visit. The EPMT manually treated common dandelion and shepherd's purse, but left the pineappleweed standing due to its abundance and low priority. The parking lot by the fish freezing building harbored a small patch of young shepherd's purse.

Mouth of Brooks River

The mouth of the Brooks River includes the Closed Trail, Corner, Lower River Platform, Spit Road, Barge Landing, platform parking lot, Oxbow trails, and other nearby areas. Anglers, employees, and visitors interested in bear viewing frequent this area during the summer months. Pineappleweed and shepherd's purse dominate the invasive vegetation in this section, and pose the greatest risk along the Closed Trail and Spit Road, sections of which contain 50-75% cover. The Closed trail is an overgrown trail that leads to where the bridge previously connected to the developed side of the river. Spit Road connects the road under the platform to the barge landing, where the Qit'rwik was docked throughout most of the summer before the new Barge road was completed. The Closed Trail and Spit Roads had the most invasive plants in the area.



Figure 7. This sow and cubs walk down a freshly weeded Spit Road. The EPMT finished their morning work just in time for the bears' grand entrance!

June: Some shepherd's purse was found around at the Corner and on the beach below. More shepherd's purse could be found just to the right of the bridge on the BCDA side, then further down the closed trail at the very end, where shepherd's purse occupied 50-75% of the vegetation and required almost 11 control hours. Recent construction in this area without any revegetation efforts has allowed invasive plants to broadly colonize the area.

On the Platform side, 16 shepherd's purse stems were found just underneath the platform and 18 were found in the triangular area in between the platform and the mouth of the river. Shepherd's purse was abundant along the sides and straight down the middle of Spit Road, a source of significant construction activity during the height of summer. The EPMT spent 8 control hours in this area pulling extremely little shepherd's purse that had already gone to seed. They expect the area to contain still more shepherd's purse in July, since many plants were indistinguishable from the native rockcress at this point. At the terminus of Spit Road, one can find a few isolated incidences of shepherd's purse by the barge landing. The EPMT also inspected the future road leading to the barge landing and found no invasive plants.

The parking lot by the Platform harbored pineappleweed, but no higher priority invasive plants. Along the road leading out from the platform, the EPMT found and removed one dandelion and one shepherd's purse. Other than pineappleweed, this road is mostly invasive-free until the Brooks Falls Trailhead, except the open area between two meadows. Here, the EPMT found shepherd's purse along with a higher concentration of pineappleweed, most likely due to the increased sunlight available in this treeless segment of the road. This section remains of high priority and should be monitored in future visits.



Figure 8. The end of the Closed Trail was especially plagued by shepherd's purse, even in early June.

July: Due to high bear activity, relatively little work was accomplished in this area during July as compared with June. All areas were surveyed during breaks in bear activity. The EPMT found the sides and end of the closed trail and the sides of Spit Road to be overgrown with shepherd's purse. Some progress on this infestation was made on the closed trail one morning when bear activity was low. Spit Road and the Closed Trail promise to be a big project for August, when bear levels decrease again.

Some shepherd's purse was found underneath the Lower River Platform and in the triangular area in front of this platform by the bridge. It was removed with little effort.

Again, no invasive plants were found in the lower parking lot. Along the Valley Road to the falls, the EPMT found several isolated instances of shepherd's purse, which continued sporadically all the way to Brooks Lake.

The beach between the corner and Visitor's Center hosted a few patches of shepherd's purse. A line of them was found along and inside the lagoon and quickly removed.

August: The locations near the mouth of the Brooks River contained a small number of invasive plants. A few shepherd's purse and common plantain were found both at the corner and along the road from the lodge to the bridge. There were common plantain and shepherd's purse slightly off the road along Bear Trail. The EPMT found a line of shepherd's purse along Naknek beach near the lagoon. On the other side of the river, the EPMT found a few shepherd's purse in the triangular area in front of the Platform, and by the ramp access to the Platform.

The EPMT was alarmed to find that the shepherd's purse on the Closed Trail and Spit Road had spread dramatically. While the EPMT was able to remove some patches, a majority of the plants had already dropped their seeds, or were so dry that the EPMT could not prevent them dropping their seeds during removal. The shepherd's purse would have had to be eradicated during the July visit to prevent them from dropping their seeds. This was impractical due to high bear activity at the mouth of the river during that time. The EPMT recommends a second late-July visit in order to control these areas next year. As construction continues, the Spit road will remain a disturbed site, and will allow invasive plant growth. Until a restoration plan is in place, weeding this area would be futile. There are some plans to eliminate the road completely once construction finishes, in which case a containment plan will be necessary. The EPMT recommends that future interns stay informed on these construction plans and adjust their weeding as necessary. Because this year's EPMT had the time available, they did as much as possible given the circumstance to contain the infestation, though in future years, a different strategy may be necessary.

During this month's visit, the EPMT mapped the trail systems off of Oxbow overlook. Most of the trails remained clear, even of pineappleweed, due to constant trampling and a boggy setting. However, at the end of the Oxbow Trail closest to the overlook, a patch of shepherd's purse and common plantain was found and removed.

September: Thanks to the dedication of several interpretive rangers, the EPMT found the Corner free of invasive plants. They did not find any invasive plants under the Platform or in the triangular area in front of the Platform; however, they were not given much time to check these areas given the high volume of bears in the mouth of the river during the EPMT's visit.



Figure 9. A sow and cubs walk on the lush carpet of pineappleweed on the Closed Trail.

A 50 meter, low-density stretch of shepherd's purse was again found along Naknek Lake beach's lagoon and removed with little effort.

The EPMT did not attempt to treat the closed trail or Spit Road this visit due to the same reasons mentioned in July's summary of the area. It would have been a poor use of resources to spend so much time treating a section which had already deposited so many seeds, and the density of brown bears made treatment risky.

With the new barge road complete, the EPMT inventoried it and found no invasive plants. Future teams should monitor this road to ensure it does not suffer the same fate as the old barge road, a fate difficult to escape given the high traffic volume this road receives.

Brooks Falls Trail & Platform

The EPMT made an effort this year to explore more around the Brooks Falls area. Similar to past years, pineappleweed was abundant underneath the platform, but left untreated due to its low invasiveness ranking and the infeasibility of accessing and controlling it. This year, the EPMT waded across to the other side of the falls with a bear technician to see if the bears had transported pineappleweed. Access within 100 yards of the fish ladder is restricted from June 15 – August 15, but they found abundant pineappleweed on the opposite side of the river, across from Riffles and down all the way until the bridge. This suggests that bears, not just anglers, act as vectors for pineappleweed. When access to the fish ladder reopens, the 2014 EPMT plans to inspect it thoroughly, again with the help of a bear tech or law enforcement.

June: While plenty of pineappleweed was noted underneath the platform and sporadically along the trail leading to the platform, no action was taken to control it due to its low invasiveness ranking. Efforts in this area instead centered on inventorying new areas, such as the angler's trail, and across the river from the platform. As noted above, pineappleweed was found across the river from the platform and along the water's edge up to the bridge. No action was taken to remove this pineappleweed. Its presence in this area where few humans travel suggests that bears are the main vectors.

July: The EPMT found no invasive plants along the Brooks Falls Trail during their July visit. Because of high bear activity, the land underneath the platforms was not surveyed at this time.

The parking lot for the Valley Bus and other lodge and park vehicles hosted a multitude of shepherd's purse. The EPMT spent 1.4 hours manually controlling this site.

August: The EPMT found two common dandelions, one shepherd's purse, and one common plantain along the Brooks Falls Trail this month. James Walton of the Southwest Alaskan Network (SWAN) Vegetation crew also brought to the EPMT's attention the *Phleum pretense* growing along the sides of the trail and provided the team with a specimen which Whitney later positively confirmed.

Unfortunately, this fact became known only a few hours prior to the EPMT's departure, so they were not able to see it for themselves.



Figure 10. This year did not bring as high numbers of bears to Brooks Camp as had visited in the past. The falls nevertheless provided ample entertainment.



Figure 11. Tall buttercup located near the Brooks Falls Trail. Photo taken by M. Fitz.

The EPMT hopes to make a quick visit in early September to see the extent of the infestation and control it.

Alex and Tori walked on the platform to the falls and were able to view the vegetation underneath. As expected, the pineappleweed was dense. There was also a dense growth of shepherd's purse growing alongside. Due to fish ladder regulations, the EPMT was not able to control it. Hopefully the bear activity will remain low when the EPMT visits again in early September to check on the *Phleum pratense*, and they will be able to remove it before it goes to seed.

Along the road near Brooks Falls trailhead, Mike Fitz located three possible tall buttercups in early August. Whitney Rapp visited the location and confirmed that they were tall buttercups (*Ranunculus acris*). She pressed a specimen, which the EPMT later mounted and sent to the park's herbarium for reference, and manually controlled the rest of the infestation.

The EPMT spent only 0.4 hours this month weeding the shepherd's purse in the lower parking lot where the Valley Bus is parked overnight. Only a few shepherd's purse were found along the road between the lower platform and the Lake Brooks housing.

September: The EPMT found only one common plantain along the falls trail this month. Underneath the platform, they could see the dense patches of pineappleweed and shepherd's purse, but bear activity prevented treatment. The EPMT recommends that future years' teams schedule a mid to late August visit to Brooks Camp, which would allow them to weed this area with no bears present. It did not appear in August that the shepherd's purse had gone to seed yet, so hopefully such a late visit would not be a problem.

The EPMT could not locate the *phleum pretense* that supposedly was "all along the Falls trail" (James Walton, SWAN vegetation crew). If James visits again next year, request his assistance with locating this invasive grass. It has not yet been located in the park, and only two instances have been found around Bristol Bay Borough, so every attempt should be made at discovering and eliminating it.

The lower parking lot again harbored a few shepherd's purse. The area still only took about 0.2 control hours, a number much lower than the 1.4 hours spent controlling it in July. No invasive plants, other than pineapple weed, were found along the road until just before BL3.

Lake Brooks Side

The Lake Brooks side is located at the head of the Brooks River. It includes park employee housing (BL 1, 2, and 3), and an old storage yard, a float plane access, and boat access in front of BL3. The headwaters are a popular fishing spot and draw many visitors. This area is becoming more heavily used as construction continues around the new maintenance area. Many maintenance workers live here and frequently bring small utility vehicles back and forth between their cabins and the new construction areas, both on the main road and a back road located behind BL 1. While currently harboring few invasive plants other than pineappleweed, this area is a high priority as construction continues and provides a favorable environment for invasive plants.

June: In June, the EPMT found some shepherd's purse in front of BL1, nothing by BL2, and another small patch of shepherd's purse on the southeast corner of BL3. A few patches of common plantain were found in the old abandoned storage yard by BL3, and were easily controlled. Otherwise, this area was fairly clear of invasive plants other than the ubiquitous pineappleweed, which was most present on the angler's trail in front of BL3 leading to the headwaters of the Brooks River.

July: During their July visit, the EPMT again found a small shepherd's purse infestation by the southeastern door of BL3. A few plants were also found underneath the recreational boats adjacent to the BL3 lawn. Some shepherd's purse and plantain were found by BL2 and BL1 and along the road connecting these cabins. The beach along the Lake Brooks side was partially surveyed with no invasive plants found to the point where they found signs of recent bear activity.

The road to BL1 dead-ends in an old sewage area where a narrower road connects the cabins to the new maintenance building. The EPMT found a small patch of shepherd's purse in this location and immediately removed it.

At the old storage yard next to BL3, the EPMT found a few more common plantain in flower, along with a line of shepherd's purse. A few shepherd's purse were removed from beside the storage cabin across from BL3. The outdoor picnic area between BL3 and BL1 and 2 harbored only a few shepherd's purse.

August: The areas by Lake Brooks harbored fewer invasive plants in August than in July. The occasional shepherd's purse and common plantain were found around the BL housing – particularly by the generator building, BL2, underneath the recreational boats, in the old storage yard, and by the picnic area.

September: The road leading to Lake Brooks was mostly clear of invasive plants, with the exception of three shepherd's purse along the road closest to BL3. BL3 was home to six shepherd's purse, while BL1 was only home to one stem. The patch of common plantains found in previous visits was again located outside the door of BL2. The picnic area hosted two shepherd's purse, while the yard between BL1 and the maintenance building was home to five shepherd's purse.

Mortuary Cove

Mortuary Cove, located just north of Brooks Camp, has been used since the 1990s as a mooring area for park boats. The site is preferred because it is more protected than the area surrounding the mouth of Brooks Camp and it has less interference with guests (Norris 1996). The trail to the cove can be accessed following the beach to a flagged path. The path is not frequently traveled, but should be monitored as it could be an access point for new invasive plants coming in on park boats.



Figure 12. Mortuary Cove is located in between these two outcroppings.

July: The EPMT located and inventoried the Mortuary Cove trail, finding the trail to be invasive free. The trail is not well defined and surrounded by tall grass, making navigation difficult at times.

The Valley of Ten Thousand Smokes

The Valley of Ten Thousand Smokes (VTTS) is a former river valley covered in volcanic ash by the 1912 eruption of Novarupta and most of the valley floor is still devoid of vegetation (Frank and Woods 2011). The VTTS road extends 23 miles from the BCDA allowing access to the valley and is a potential vector for invasive plants to spread into the backcountry (Mortensen et al. 2009). In 2005, the EPMT started surveying this road and overlooks by visually scanning from a slow moving vehicle. The surveys found infestations of shepherd's purse, pineappleweed, and annual bluegrass up to the first river crossing from the BCDA. It was also noted that the severity of infestation decreased as distance increased from the BCDA. Although these species have a low invasiveness ranking, containment measures should be taken due to the close proximity to a large naturally disturbed area.



Figure 13. The Valley on a clear June day.

Bird vetch, which is the highest ranking invasive plant found in the park, was discovered at mile marker 13.5 in 2009. Manual treatment was first used to try to eradicate, but was ineffective. In June 2011, Milestone herbicide (low impact broadleaf herbicide) was applied for the first time in KATM. The 2013 survey found no bird vetch at this location, showing the herbicide treatment effective. However, a new infestation of bird vetch was found on the Valley-side of the first river crossing and herbicide was applied in August 2013. An infestation of mouse-ear chickweed (*Cerastium fontanum*) growing interspersed with native *Cerastium* has also been found on the VTTS road.

Valley Road Administrative Area

The construction project on the Lake Brooks side is considered the Valley Road Administrative Area (VRAA) and will be the site of future employee housing. The road, utility corridors, two cabins and the VTTS road maintenance building have been completed. When construction began, no invasive species were found. In 2013,



Figure 14. Whitney and Alex survey the restoration work conducted next to the new maintenance building by the 2013 EPMT crew. The transplanted vegetation seemed to be faring well, in contrast to the seeded.

pineappleweed and shepherd's purse were discovered on the pathway between the two cabins. A restoration project started during the 2013 field season. It is located adjacent to the maintenance yard and progress should be observed to see if successful. The VRAA is important for future monitoring due to the activity that continually disturbs this area.

June: The EPMT found and treated one species of shepherd's purse around the maintenance yard fence. Pineappleweed was also present, but was not monitored or treated due to its low invasiveness ranking. A small patch of shepherd's purse was located, on the trail from the maintenance building towards Brooks Lake employee housing, and manually treated. Once again pineappleweed was also present. During this month, no invasive plants were found near the restoration project adjacent to the maintenance yard.

July: New infestations of shepherd's purse were located and treated in the maintenance yard. Shepherd's purse was found sporadically throughout the yard, with the densest patches behind the fuel storage containers and underneath the gas trailer. Another small patch was inventoried and controlled near the entrance of the duplex. The previous infestation of shepherd's purse on the trail between the maintenance yard and Brooks Lake employee housing was present and manually controlled. Pineappleweed was found in all areas mentioned above, but was not treated. The restoration project was still free of invasive plants, but shepherd's purse was found near the edge closest to the maintenance yard fence. This was promptly treated and should be continually monitored due to the lack of native vegetation growing here.

August: The EPMT located and manually controlled shepherd's purse along the edge of the fence, underneath the gas trailer, near the back of the maintenance building, and around rain water run off areas. Most of these infestations were present last month; however the patches were smaller and took less time to control. Previous infestation of shepherd's purse on the trail between the maintenance yard and Brooks Lake employee housing was not detected. Pineappleweed could still be found throughout, but left untreated. The restoration project had a few small infestations of shepherd's purse, located near maintenance runoff areas, which were mapped and treated. This is a primary concern since most of the restoration project is still bare from vegetation, making it a prime location for invasive plants to take over.

September: Previous infestations of shepherd's purse found around the maintenance building were once again present, but were smaller and took less time than previous months. Pineappleweed was found throughout the maintenance area and left untreated. The infestation of shepherd's purse on the trail between the maintenance yard and Brooks Lake employee housing was located again and promptly treated. Pineappleweed was found sporadically growing on parts of the trail, but was not treated. The restoration project was invasive free this month and some native vegetation is starting to spread. This project will be a continual battle to keep invasive free with most of it still bare from vegetation and being close to an area with invasive plants.

Squirrel Camp

Squirrel Camp is located on the VTTS road near the one-mile marker and has been used for temporary contractor housing since the early 1990's (Richard Sherman, KATM, pers. comm.). This

area is important to monitor due to the increased construction projects within BCDA and VRAA. Construction workers and equipment frequently travel between Squirrel Camp and construction sites providing a vector to transport invasive plants to newly disturbed areas. Previous years' surveys showed annual bluegrass, pineappleweed and shepherd's purse at this location.

June: Annual bluegrass and pineappleweed were found scattered around the edges of Squirrel Camp, but were not mapped. A new infestation of pineappleweed was inventoried near a newly disturbed area on VTTS road near the road leading to Squirrel Camp.

July: All previous infestations were present and were left untreated. No new infestations were located.

August: The EPMT found a new infestation of shepherd's purse in and around the fire pit, which was mapped and manually treated. Previous infestations of pineappleweed and annual bluegrass were still left untreated.

September: The infestation of shepherd's purse near the fire pit was located and treated with minimal time spent. However, within that same infestation common plantain was detected and manually controlled. Pineappleweed and annual bluegrass were still present and left untreated.

5-Mile Gravel Pit

Located at the five-mile marker on the VTTS road, the gravel pit is the source of fill material for Brooks Camp, VTTS road, and the VRAA construction sites. The materials here are frequently moved within the site, causing problems in locating previously infested areas. The EPMT made frequent visits and swept the entire area each visit. It is crucial to monitor the entire area due to the constantly changing locations of material. Previous years' EPMTs have found shepherd's purse, narrowleaf hawksbeard, and one individual plant of bird vetch in 2011.



Figure 15. Gravel pit with construction equipment.

June: After scanning the entire gravel pit, no infestations were found other than pineappleweed. This was left untreated due to its low invasiveness rank.

July: The EPMT identified shepherd's purse within the storage area and near the culverts. A small patch was also found near the bank of gravel directly ahead of the entrance of the gravel pit. All of the infestations were manually treated upon detection. One individual of narrowleaf hawksbeard was found within a patch of vegetation growing near the bank directly in front of the entrance, and controlled. The seed bank is almost exhausted, with only one individual found

this year.

August: Shepherd's purse was found and treated in the same locations as last month, but the infestations were smaller and sporadic. Whitney Rapp found and pulled three narrowleaf hawksbeard, upon her visit. Later in the month another individual narrowleaf hawksbeard was found and treated in same location. The rest of the gravel pit was scanned and no invasive plants were detected.

September: The EPMT searched the entire gravel pit and upon completion no invasive plants were found. Future EPMT members should continue to monitor the area due to the current construction projects.

Valley of Ten Thousand Smokes Road

On the VTTS road, mile marker 13.5 is the location of the previous infestation site of bird vetch. It was not located during the 2013 field season. However, the 2013 EPMT found a new infestation on the valley side of the first river crossing.

July: The EPMT used background files on the Trimble GPS to locate both sites of previous bird vetch infestations. No infestations were found and they were mapped as not detected. The two overlooks, Research Bay and Kettle Ponds, visited on valley tours were also surveyed with no invasive plants found.

August: Whitney Rapp surveyed locations and no infestations were found.

September: Mile marker 13.5 and the valley side of the first river crossing were surveyed by the EPMT for bird vetch and none was found. The Research Bay and Kettle Ponds overlooks were surveyed once again with no invasive plants located.

Ukak Falls, Margot Falls, & Windy Creek Trails

These trails are located off of the VTTS road. Previous surveys noted annual bluegrass in patches near the edges of the first section of the Ukak Falls trail and that the Margot Falls trail is invasive free. Annual bluegrass was found near the VTTS road in front of the bathrooms near the Margot Falls trail head. In 2005, common plantain was found and treated a few hundred yards down the Windy Creek trail (Bauder and Hayes 2005). This patch was also observed in 2011 and treated in 2012. The infestation was not found in 2013.

July: Margot Falls trail was surveyed and was free of invasive plants. However, patches of annual bluegrass were found around the



Figure 16. Margot Falls Trail remained free of invasive plants throughout the season.

bathroom at the trail head. The EPMT also found some annual bluegrass around the first section of the Ukak Falls trail; the rest of the trail was invasive free. These infestations were identified based on previous years' summary reports. The Windy Creek trail was surveyed and one infestation of common plantain was identified near the patch treated in 2012. This area was difficult to survey due to the dense patches of cow parsnip and should be revisited.

September: All the trails were surveyed once again and the previously located infestations were still present, with exception of the Windy Creek trail. With the absence of cow parsnip the Windy Creek trail was easier to survey, however no common plantain could be detected. Future EPMT should continue to monitor these trails as they provide a vector to the valley floor.

Naknek Lake

Fure's Cabin

Fure's Cabin is a restored public use cabin located in Naknek Lake's Bay of Islands. It is also an access point to Grosvenor Lake and the Savonoski Loop, following the Portage trail. The area is a popular camping and boating destination that receives numerous small groups throughout the year. The highest priority at Fure's Cabin is the treatment of the common dandelion in the grassy field around the cabin. Previous treatments of manual control provided a low success rate, resulting in the use of Milestone herbicide. Annual bluegrass is found along the trail leading to the cabin, and pineappleweed and shepherd's purse have been found near the fire pit. Very few invasive plants have been found along the Portage Trail.



Figure 17. In August, the fields surrounding Fure's cabin are aglow with native fireweed.

June: The common dandelion infestation still warrants the use of Milestone, which has been successful at reducing the size and time spent treating since 2011 (Whitney Rapp, KATM, pers. comm.). One half day was spent assisting Whitney Rapp locating common dandelions, removing flower and seed head, and chemically treating the infestation.

Annual bluegrass was also found along the path leading to the cabin and left untreated. Pineappleweed and shepherd's purse were located near the fire pit and manually treated. The Portage trail had no invasive plants and native dandelions were noted along the bank of Grosvenor Lake.

August: The EPMT briefly visited Fure's Cabin with the goals of monitoring the effectiveness of treatment and removing herbicide application signs. Common dandelions were found growing within the native grasses, but found in reduced numbers compared to June. These could be from new growth or plants previously missed. The Portage trail was also mapped for the park trails inventories. Using background files

on the GPS, the EPMT traveled to previous year's infestation of common mouse-ear chickweed and upon surveying no invasive plants were detected.

The Bay of Islands

The 2011 EPMT surveyed the edges of seven different islands within the Bay of Islands. No invasive plants were found during these surveys despite signs of human disturbances. These islands should continue to be monitored due to the proximity to departure areas with infestations such as Fure's Cabin, Lake Camp, and Brooks Camp.



Figure 18. The Bay of Islands viewed from the park's Cessna plane.

June: Two locations within the Bay of Islands were surveyed for the first time this season. The first was Burnt Island, which previously had been burned by a forest fire.

No invasive plants were found here, despite the vegetation change caused by significant natural disturbance. The other location was Double Beach, a common camping site. No invasive plants were found along the beach or trails leading to the camping site.

Idavain Creek & Margot Creek

Idavain Creek (west of the Bay of Islands) and Margot Creek (terminating in the Iliuk Arm) are popular fishing destinations on Naknek Lake. In 2011, the EPMT surveyed the bear/social trails, beach, large campsite, fire pit at the mouth, and the trail along the left side of Margot creek. No invasive plants were found here despite the constant use. The beach next to Idavain Creek had a pineappleweed infestation and was treated upon discovery; the 2012 EPMT found no reoccurrence.

August: While accompanying a patrol, Margot Creek was surveyed. Areas surveyed were the beach near the mouth of the creek, an island within the mouth, and the edges of the mouth. An individual of pineappleweed was found on the island within the mouth and was manually treated. No other invasive plants were detected within the surveyed areas. Not all used areas could be surveyed due to time constraints and bear activity.



Figure 19. Margot Creek is a popular fishing spot in August, when most of the bears have left Brooks Camp for better fishing elsewhere.

Lake Camp

Lake Camp is the only location in the park accessible by road from the Bristol Bay Borough. It provides a major access point for anglers, boaters, local residents, and NPS staff. This makes Lake Camp vulnerable to the introduction of invasive plants found in King Salmon and Naknek. It is also the location for the transport of construction vehicles and equipment to Brooks Camp, providing vectors for the introduction of new invasive plants.

Manual treatment was conducted in prior years to control shepherd's purse, sheep sorrel, pineappleweed, fall dandelion, and common dandelion. These were found on the edges of the upper and lower parking lots, picnic area lawns, around the



Figure 20. The first of several beautiful, hot, and buggy days spent spraying at Lake Camp.

bathroom, float docks, and the trails between the parking lots. This treatment was largely unsuccessful, resulting in the use of Milestone in 2013. After the first year of chemical treatment, the area had significantly less invasive plants compared to previous years.

June: No manual treatment was done during the month of June. Instead two half days were spent assisting Whitney Rapp locating and chemically treating plants at Lake Camp. The main species targeted was sheep sorrel, since Lake Camp is the only location within the park where it can be found. Fall dandelion, common dandelion and pineappleweed were also treated. Annual bluegrass was also found, but not monitored or treated.

July: One hour was spent chemically treating the area for the previously mentioned species. Common chickweed

was found for the first time at Lake Camp, along the edge of the upper parking lot and was manually controlled. Later in the month Lake Camp was visited to monitor chemical treatment. Upon surveying, treatment appeared to be effective as most areas treated were free of invasive plants. Some sheep sorrel and pineappleweed were located, but were not treated due to the ineffectiveness of manual treatment. Fall and common dandelions were also found and manually controlled upon detection, along with an individual of shepherd's purse. These could have been from new growth or previously missed plants.

August: The EPMT continued to manually control fall dandelions. One individual of shepherd's purse was also present and treated. Common dandelions were not located after surveying the area.

September: Fall dandelions, sheep sorrel, and pineappleweed were located after scanning the area. The EPMT spent minimal time manually controlling the fall dandelions, since only 8 individuals were located. Sheep sorrel and pineappleweed were left untreated and no common dandelions could be found.

Grosvenor Lake & Savonoski Loop

Grosvenor Lake, Grosvenor Lodge, and the Savonoski Loop were surveyed for the first time in 2013. Detection was limited due to scanning the area mostly from paralleling the shoreline from kayaks. No invasive plants were located along the southwestern shore of Grosvenor Lake, however dandelions were found on the northwestern shore and on an isthmus of land separating a beaver pond from Grosvenor Lake. The species appeared to be non-native, but native species were also found around the lake. Dandelions appearing to be invasive also were detected in several areas along the shoreline between Coville and Grosvenor Lake. Grosvenor Lodge had many invasive plants amongst the surrounding buildings. These include common dandelion, annual bluegrass, shepherd's purse, and pineappleweed. The invasive plants were constrained to the disturbed and mowed areas, since the surrounding vegetation is dense grass. Lodge manager, Ray Irvin, and the staff have made efforts to manually control the dandelions over the years and supported the idea of collaborative efforts with future EPMT (Landry and Voznitza 2014).

The Savonoski Loop is a paddling route that starts from the Portage Trail (Fure's Cabin in the Bay of Islands to Grosvenor Lake) along Grosvenor Lake to the Savonoski River and back into the Iliuk Arm of Naknek Lake. No invasive plants were found along the survey, except for Bluff Camp. Bluff Camp, located at the beginning of Grosvenor River, had common mouse-ear chickweed and non-native dandelions. Both of them were interspersed with native vegetation making control efforts difficult.



Figure 21. The Savonoski River transports glacial runoff from the coast all the way to the Iliuk Arm of Naknek Lake.



Figure 22. American Creek in July. Photo courtesy of K. Nicolato.

American Creek

American Creek is a popular destination for rainbow trout fishing and white water rafting, along with wildlife viewing. It is also the location of historic trapping cabins used before Katmai National Monument expanded. These cabins once had established gardens while they were inhabited, which could have made it possible for the introduction and persistence of non-native plant species (Clemens and Norris 1999). Guides within the area have reported seeing dandelions, but it is not clear if they are native or invasive (Whitney Rapp, KATM, pers. comm.). As a result, it is a priority for the EPMT to visit the contemporary campsites and

historically used areas.

July: Whitney Rapp visited the area, while conducting visitor surveys, and found the area to be invasive free. Samples were taken of a rare birch tree and brought back for positive identification.

Katmai National Preserve & Alagnak Wild River

Nonvianuk Lake & Alagnak Wild River

The Alagnak Wild River (ALAG) is a separate park unit that is co-managed by KATM. The NPS manages most of the land around the river, but does not maintain any public facilities and there are many private inholdings making surveying the area complicated. To successfully survey the area requires camping or staying at a private lodge and getting permission to survey the private inholdings.

The 2011 EPMT visited the Nonvianuk ranger cabin and the trails near the mouth of the river, finding common dandelion and a small patch of common plantain. They also noted that the common dandelions were hybridizing with the native dandelion. This can be problematic, since hybrid species can have a higher fitness than the natives by having a more fertile population (Brock 2004). In 2013, Milestone was applied to the dandelions for the first time. Future EPMT teams should seek permission to survey and control invasive plants on campsites and the private inholdings, preventing the spread to other areas along Nonvianuk Lake and the Alagnak Wild River.



Figure 23. Alex and Tori work ahead of Whitney to pull the dandelions' seed heads before herbicide is sprayed.

June: Upon arrival, it was obvious where previous Milestone treatment of dandelions occurred, due to the greatly reduced percent cover compared to the untreated area. One half day was spent assisting Whitney Rapp chemically treat the common dandelion by removing flower and seed heads before spraying herbicide. Common plantain was not detected even after using the GPS to navigate to previous year's infestations. The beach and trail to a nearby campsite were inventoried and revealed no invasive plants, native dandelion was found along the beach. Trails to the old ranger cabin were also monitored and had no invasive plants on them.

Little Ku/Nanuktuk Creek

Little Ku is a small lake used for float plane landings for angler access to Nanuktuk Creek. The lake is surrounded by alpine tundra that comes up to the edge of the lake. In 2011, the EPMT surveyed along the edge of the lake and the surrounding area, with no invasive plants found. This site was not a priority for the 2014 field season, due to limited visitor use.

Moraine Creek, Funnel Creek, & Crosswind Lake

The mouth of Moraine Creek, located at the north eastern edge of Kukaklek Lake, is the last stop of many fishing and rafting trips. It is frequently used for a landing site for both float and wheeled planes picking up people from their trips. In 2011, the EPMT inventoried along Moraine Creek, Funnel Creek, and Crosswinds Lake finding only three small infestations of annual bluegrass. The first infestation was found at a trampled mud bank at the end of the portage trail from the pot hole where rafters stage their floats downriver. The second infestation was located on a well-worn float plane loading area approximately a half mile up from the mouth of Moraine Creek. The third infestation was found in a campsite, but did not extend beyond the disturbed area around the fire pit. All of these infestations were limited to locations of high disturbance, and should be revisited to monitor and controlled (Frank and Woods 2011).

October: While accompanying a trip for camera retrieval, the EPMT got to briefly survey the area. Earlier in the season NPS staff spotted, took photos, and samples of dandelions along the trail to the camera. The EPMT never verified these samples and upon surveying the area, no invasive plants were found.

Pfaff Mine

Pfaff Mine is located near the boundary line between the park and preserve and was prospecting site from 1964 to 1984. In 1984 the Bureau of Land Management declared the claim as null and void. Remnants of an airstrip and shelter remained on site, but all hazardous materials have been removed (ADEC 2013). In 2013, the landing strip and areas near the residence were inventoried by the EPMT. The tundra-dominated vegetation revealed no invasive plants.

August: The EPMT briefly surveyed Pfaff Mine while accompanying a weather station service trip. Surveys were cut short due to weather coming in; however most of the runway and path to the weather station were mapped with no invasive species found. The former mining roads on the adjacent hillside were not visited, but from a distance it looked like dense patches of alders were filling in the old roads.



Figure 24. The EPMT found no invasive plants at Swikshak, only native wildlife and a whole lot of marine debris.

Outer Coast

Katmai has a long history of anthropogenic uses including villages, canneries, farms, and mining operations especially along the coast. Identifying and surveying areas of former use and disturbance is a primary concern for the EPMT. These areas could contain older and more severe infestations that have gone undocumented. Current 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. From a 2005 KATM invasive plant report, pineappleweed was noted growing in Kaguyak Bay on a trail from the

beach to Hallo Bay Lodge, while no invasive plants were documented at Hallow or Swikshak Bays (Bauder and Heys 2005). In 2010, the EPMT was able to visit Katmai Bay and Amalik Bay where no invasive plants were located (Shepherd and Bartley 2010). The outer coast is one of the most logistically challenging places to reach in the park, since one needs optimum weather to reach it.

Geographic Harbor/Amilik Bay

Geographic Harbor is a popular bear viewing destination and a previous site of industrial activity. The 2011 EPMT surveyed the area and found no invasive species, likely due to heavy tidal influence and large alder thickets. Takli and Little Talki Islands are archeological sites, located in Amalik Bay, visited frequently by NPS staff. These islands were home to an ancient village, fox farm, and trapping cabin from the 1930's-1940's (Clemens and Norris 1999). Both islands are fairly dry and primarily consist of grasses, making them ideal sites for invasive plant establishment. As of 2011, no invasive plants were documented. Future surveys of the islands should locate the historic use sites to ensure that no invasive plants are present. The Amalik Bay cabin was also surveyed in 2011 and no invasive species were found.

Kaflia Bay

Before the 1912 eruption of Novarupta, Kaflia Bay was the site of a growing saltery and store. These operations attracted people from the surrounding areas within Katmai, steadily increasing its residential population, until Novarupta erupted. The eruption caused further development to be hindered (Clemens and Norris 1999). The site continues to have cultural significance and is visited by NPS staff and should be visited by the EPMT, since the area has never been surveyed.

Kamishak Bay and River

Kamishak Bay and River have had a long history of industrial and cultural use. Before Novarupta erupted, fur hunters established seasonal camps around the bay. Hunting guides continued to use the area until hunting became prohibited. During the 1920s, oil seeps were discovered on the shoreline of Kamishak Bay, leading to oil leases along the bay and to ten miles up the Kamishak River. However, no drilling occurred in the area and the leases were cancelled. In 1922, Kamishak Canning Company built a salmon cannery that was used for one season and not used again. From 1970-1973 clamming operations took place at Kamishak Bay, leading to the Alaska Department of Fish and Game building a cabin to monitor activities (Clemens and Norris 1999). Dating back to 1982 Kamishak Bay and River have been used by commercial operations for sport fishing (Norris 1992). Before this season Kamishak Bay and River have not been visited by any EPMT.

August: While accompanying a flight to drop off NPS employees for visitor surveys, the EPMT had a chance to survey the area for the first time. The area surveyed was from the river to the boat storage region. No invasive plants were located during the brief survey, in which no GPS data could be collected due to time restraints and having to help haul a boat to the river. Future EPMTs should try to survey more areas used by visitors around the river and bay.

Kukak & Kaguyak Bays

Kukak and Kaguyak Bays were surveyed in 2011 for the first time since 2005. The survey was done around two privately owned lodges, Katmai Lodge in Kukak Bay and Hallo Bay Bear Camp in

Kaguyak Bay. Both lodges provide coastal tourism for bear viewing and fishing, and could be a vector for invasive plants to gain access to more remote parts of the park. Survey work around Hallo Bay Bear Camp occurred from the coastal margin to the property boundary. Trails heading from the beach to the lodge revealed annual bluegrass, pineappleweed, and common plantain. In 2013, Roy Wood, Chief of Interpretation, documented common dandelion in the area, which the lodge has been manually controlling.

Around Katmai Wilderness Lodge the EPMT was able to survey the lodge property, along with its surrounding areas. They found annual bluegrass and common plantain in the pathways within camp and leading to the float plane land area. Common chickweed and common mouse-ear chickweed were found growing outside flower boxes around the lodge. The flower boxes contained ornamental species, including European forget-me-not (Frank and Woods 2011). In 2013, NPS staff took photos of possible invasive plants around the archeological sites in the Kukak Bay area. After analyzing the photo, no invasive plants were found (Landry and Voznitza 2014). Future EPMT should work with the lodges to control current infestations and to prevent the spread of planted species.

Swikshak Bay & Lagoon

Swikshak Bay and Lagoon allows opportunity for invasive plants establishment due its previous use as a satellite location for clamming operations and fully functioning cannery. The remnants of the cannery were destroyed in 1972 by KATM personnel after deeming the buildings as hazardous, but abandoned vehicles and structures can still be found (Clemens and Norris 1999). The site continues to have archeological and cultural significance. Swikshak Bay was surveyed in 2005 with no invasive plants documented (Bauder and Heys 2005). Incidental trips by previous EPMT members have not documented any invasive plants. However, no EPMT members have surveyed the lagoon.

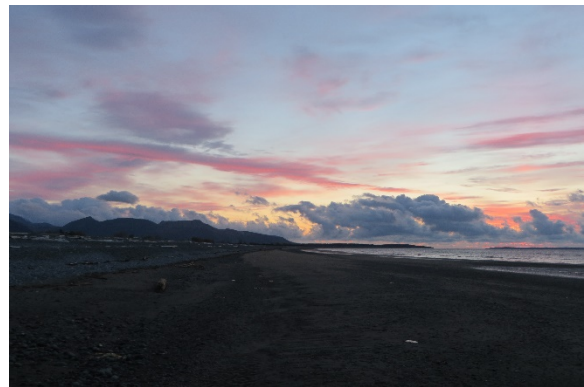


Figure 25. A Swikshak sunrise.



Figure 26. The sedge meadows of Swikshak provide nutrition for many bears in the spring.

September: While accompanying a trip to take down cameras and pickup marine debris, the EPMT surveyed Swikshak Bay and Lagoon finding it to be free of invasive plants. Areas surveyed and mapped included the trails from the cabin that go to the lagoon, beach, outhouse, and fire pit. The coast side of the lagoon was surveyed, but was not mapped. The beach was also surveyed, but could not be mapped due to aiding with marine debris cleanup. The beach surveyed started at the mouth of the lagoon, going towards and around the point, and continuing east along the beach for about a total of 5 miles.

Aniakchak National Monument & Preserve

Aniakchak National Monument and Preserve (ANIA), located on the Alaska Peninsula approximately 130 miles south of KATM, is a separate park unit that KATM manages. ANIA is a remote, undeveloped and infrequently visited NPS unit. Plant inventories performed by the AKNHP in 2004 and field work done in the preserve in 2009 both revealed no invasive species. Surveys performed in 2010, by the AKNHP, detected common dandelion growing along the Aniakchak River. The infestations were scattered along the river, growing in undisturbed areas. This is an uncommon pattern for dandelions in this region; however no EPMT has verified this infestation due to logistical challenges.

The 2012 EPMT surveyed landing strips at Lava Creek Cabin, Klutsch Cinder Strip, and Cinder River. All of the airstrips were free of invasive plants. They also surveyed around Packer's Cabin, located in Aniakchak Bay. No infestations were found, however, native dandelions were present. Specimens were taken to verify that they were native and not a hybrid species between native and non-native dandelions. A patch of nonnative chives were also found growing at Packer's Cabin. They are suspected to be remnants of past cultivation and are not considered to be invasive (Connealy and Parker 2013).



Figure 27. A map of Aniakchak National Monument & Preserve.

Bristol Bay Borough

The Bristol Bay Borough includes the towns of King Salmon, Naknek, and South Naknek. Most visitors to the area travel through the airport at King Salmon, making it an ideal vector for invasive plants and of special interest for EPMT projects.

NPS Administrated Property

NPS administrated property of concern to the EPMT includes headquarters, housing, and maintenance facilities.

May: Due to an early green-up this year, removing dandelions in early May would have been feasible for the 2014 EPMT. The team did not begin in earnest until late May, however, given the amount of trainings to attend and a lack of clarity as to which areas were most beneficial to treat. Some dandelions were removed by the new headquarters' parking lot, partly to practice using the Trimble unit.

June: The 2014 EPMT spent little time trying to control the abundant dandelions in the dorm quad, and focused their limited time on more isolated patches of dandelions around the area. More manageable plots of dandelions were removed from the quadplex yard, maintenance building, float plane dock area, road to the marina building, and small portions of the dorm quad.

July: In early July, *Crepis tectorum* was detected at the maintenance building for the first time this season. Multiple isolated stems were removed, along with a sizeable patch by the eastern gate. Dandelions were found in the maintenance yard, and along the road to the float plane dock and marina building. Additional dandelions, *Crepis tectorum*, and shepherd's purse were found at the float plane dock and marina building. Clover was abundant in the front lawn of the quadplex, though it was too early to identify which species. Later return trips to the maintenance yard and float plane dock were required to pull additional *Crepis tectorum*, shepherd's purse, and common dandelion that had sprouted.

The FAA housing had widespread exotic plants such as dandelions, sheep sorrel, *Crepis tectorum*, white clover, smooth brome, and oxeye daisy. Due to a lack of clarity over which property was acceptable to treat (multiple government agencies provide housing in this area, not just the Park Service), the EPMT waited to treat most of the infestations until it was possible to clarify this subject with Whitney Rapp. They ended up focusing their efforts on the blue-roofed community center, and the superintendent's yard and one unoccupied house. The community center had multiple fall dandelions and sheep sorrel. The EPMT treated the fall dandelions and left the sheep sorrel, as it has not responded well to manual treatment in the past. The community building required 1.7 hours to control. The unoccupied FAA house had several oxeye daisy, which took 0.5 hours to control. Finally, the superintendent's yard contained abundant oxeye daisy and common dandelion. Because common dandelion dominated the majority of the yard, the EPMT did not treat them, as the lack of vegetation would have been very noticeable. The oxeye daisy was treated in 6.3 hours and occurred to the front, side, and back of the house.

August: The EPMT continued control work at FAA housing in August, weeding more fall dandelions around the blue roofed community building in 1.1 hours.

Continued maintenance of the maintenance yard, marina building, and floatplane dock was conducted this month, revealing the same invasive species as last month.

The EPMT removed a patch of *Hieracium umbellatum* from near the refuge sign across from the airport.

September: The EPMT continued monitoring the maintenance yard, floatplane dock, and marina building throughout September. As expected, they found small numbers of common dandelion, *Crepis tectorum*, and shepherd's purse. A particular problem spot is the patch of common dandelions just to the right of the bridge down to the floatplane dock.

While assisting with USFWS science camp, the EPMT also had the opportunity to survey lower Pike's Ridge. No invasive plants were found along the trail off the road to Lake Camp.



Figure 28. Local high-schoolers helped us ensure that no invasive plants were on the lower Pike Ridge trail.

Other Bristol Bay Areas

This year's EPMT did not conduct any control work in King Salmon outside of NPS administered property. Alex and Tori were able to map the lower Pike Ridge hike while assisting with the FWS science camp, but this is the extent of other control work done in the area.

While not necessarily control work, the EPMT inspected the construction contractor's equipment in Naknek before it traveled to Brooks Camp on the barge. The contractors were easy to work with – most of their equipment passed inspection on the first visit, and the remainder passed a couple of days later on the second attempt. During these inspections, the EPMT ensured that no clumps of dirt which could harbor invasive seeds were sticking to any part of the equipment. It is especially important to check all nooks and crannies, especially the undercarriage of vehicles, since it is so hard to reach and is often overlooked by the cleaners. Wayne Carpenter, the lead contractor for the new Barge Road project, was aware of the destructive potential of invasive plants, and was pleasant to work with.



Figure 29. Tori and Alex teach local kids at the KSVC about the dangers of invasive plants.

Education and Outreach

Education remains central to the EPMT's focus, as years of EPMT work will be quickly erased if people are unaware of how exotic plants spread and their impacts on the local ecosystem. This year's EPMT made a point of reaching out to staff via newsletter updates alerting them to the presence of invasive plants in the park and asking for their help in tracking invasive plants down.

The EPMT also reached out to the local community in the Bristol Bay Borough. Through a children's series at the Visitor's Center, the 2014 EPMT raised the issue of invasive plants with kids and their parents in the hopes that individual households would rid their own yards of invasive plants and limit their spread. At the Bristol Bay Fishtival celebrating the end of the salmon season, the EPMT shared a booth with park staff where they played a Plant ID game. An adult demographic demonstrated their plant knowledge and the EPMT clarified for them which plants in the area were invasive or native. This provided an interesting mutual learning opportunity, as the EPMT was able to sense how residents felt about invasive plants in general. Most booth visitors were very receptive and demonstrated a desire to help out with the EPMT's mission.

Alex and Tori also helped out with the Fish & Wildlife Service's annual science camp. This camp brought a dozen high-school students from Bristol Bay Borough and beyond to King Salmon. Living in FAA housing for a week, these young adults received an introduction to a variety of scientific realms, including meteorology, wildlife tracking, ecology, botany, subsistence living, and chemistry. The EPMT chaperoned many events and participated in group hikes, where they were able to draw the student's attention to the native and invasive plants around them. They led sessions on invasive species and GPS use, explaining how the two concepts overlapped in their own work. Participating in this camp was a very refreshing experience for the team, as the students were very interested and

supportive. The EPMT was impressed with the exposure students had already had to GPS and how receptive they were to the prevention of invasive species.

Gypsy Moths and Other Invasive Species

Invasive pests have the potential to threaten biological diversity of the native populations in ways similar to many invasive plants. Introduced insects can displace native insects, spread aggressively, and cause economic harm. The gypsy moth defoliates hardwood trees, posing a significant threat to Alaska's forested ecosystems. The potential for introducing these exotic insects via shipping ports has brought about the implementation of an early detection and monitoring system for several species of gypsy moths. This year's team installed three different sticky traps containing a lure baited with the species' sex attractant pheromones. Traps were located behind the law enforcement cache at the NPS float plane dock, in a yard in FAA housing, and near the main shipping port in Naknek. The pheromones target the European gypsy moth



Figure 30. A gypsy moth trap is placed near the float plane dock in order to capture moths coming in from other areas of the park.

(*Lymantria dispar*) and the Asian gypsy moth (*Lymantria dispar ssp. Japonica*). Other moths, including non-target species, may also respond (Lance 2006). Initial installation occurred at the end of June, and data was collected at each site in June, July, August, September, and in late-September when the traps were taken down. No gypsy moths were detected during the 2014 field season. This monitoring program should continue in future seasons, due to its significant detection value and low time commitment.

Prevention and Restoration

Highly disturbed areas, including construction zones and highly trampled sections of park, are vulnerable to invasive plants. As a result, prevention and restoration are important techniques used by the EPMT to minimize new infestations. Preventing infestations is a more cost-effective means of management than controlling established infestations. This season, the EPMT inspected heavy machinery and vehicles destined for construction projects at Brooks Camp. Inspections took place at the contractor site in Naknek, which is the preferred site since it is not within the park boundaries and if equipment failed inspection it could be re-cleaned on site. KATM EPMT checked all joints, crevices, undercarriages, and chassis that could harbor dirt or plant material. Once the equipment passed inspection, it was marked with invasive plant flagging, clearing it for transport to Brooks Camp. As construction projects continue within the park, these inspections should remain a component of the EPMT.

Restoration is another technique used to prevent the establishment and spread of invasive plant species. Activities within the park such as trampling or construction can cause damage to native plant communities. If these disturbed areas are left unrestored, they become ideal locations for establishment of invasive plants. As construction continues within KATM, it is critical that the EPMT also continues restoration and revegetation efforts to return those disturbed areas to their natural state without the introduction of invasive species. To assist this effort, the 2011 and 2012 EPMT created a mitigation document outlining different disturbance scenarios and strategies to restore them. The 2013 EPMT took on the project of revegetating the area around the new maintenance building. They compared two methods of revegetation; direct sowing of native seeds and transplanting native vegetation. Upon survey work done this season, the transplanting of native vegetation seemed to be more successful at revegetating the area but should continue to be monitored for more clear results. The 2013 EPMT also created a KATM seed bank, mainly collecting seeds from blue-joint grass (*Calamagrostis canadensis*) and yarrow (*Achillea millefolium*), to be used in reseeding disturbed areas. This year seed collection was done during September at the campground and cultural site. Although these sites are a little farther away from restoration projects, they allowed the most successful seed collection. Seeds from blue-joint grass, yarrow, fireweed (*Epilobium angustifolium*), and large leaf avens (*Geum macrophyllum*) were collected and added to the KATM seed bank. Future EPMT members should continue to plan restoration of the construction sites after completion and continue to expand the KATM seed bank.

Disposal Methods

Disposal of invasive plants was an enormous challenge prior to the 2013 field season. Previous EPMT investigated using an oven heated up to 300° Fahrenheit to sterilize the seeds, but was

inefficient due to long heating period and limited space. Instead burn barrels fueled by cardboard, wooden pallets, and waste gas/diesel were used. Previous years have also contacted the local dump to explore alternative disposal methods including; burying plant material at least 15 feet underground, burning in the incinerator, or burning in wooden pallet fires. Regrettably, the local dump officials would not guarantee proper disposal (Frank and Woods 2011).

In 2013, the Brooks Camp incinerator was used to burn all of the plant material collected during the field season. The incinerator does require more fuel for complete consumption and is more effective than burn barrels. Previous EPMT have noted difficulties keeping the fire burning and at the correct temperature inside the burning barrels to make all of the plant material nonviable, creating another potential vector for the spread of invasive plants (Landry and Voznitza 2014). This year's EPMT continued to use the incinerator to dispose of all plant material. While at Brooks Camp, plant materials collected were immediately brought to the incinerator. Around King Salmon plant materials were stored in the shed behind the marina building and later brought to Brooks Camp. In August, the EPMT took on the task of disposing all previous years' plant materials that accumulated in the storage shed behind the marina building. All previous plant material collected was loaded and transported to the Brooks Camp incinerator for proper disposal. Immediate disposal of plant material is recommended since plant material stored in the shed tends to become waterlogged, making the bags heavy and difficult to burn.



Figure 31. The EPMT loaded a ton of weeds onto the Palayaq for transportation out to the Brooks Camp incinerator.

Using the incinerator continues to be the best option for disposal, but if incinerator becomes unavailable, the EPMT should return to burning all plants in burn barrels or consider an alternative option proposed by previous EPMT. These options include the following:

- Purchasing a large container, such as a fish tote, that could be used for long term storage. Allowing the plant material to fully decompose, this could then be transported to the dump.
- The plant material could be shipped to Anchorage or Seattle where it could be properly disposed of at a dump or incinerated. This option is expensive, but requires less man hours allowing more time for the staff to focus on other work tasks.
- Finding a dry location where plant material could be spread out on screen shelves to dry and removing residual dirt from the roots. This would increase the burning process significantly.

- Construction of a wood fired stone or brick kiln to heat and sterilize plant material. An insulated structure such as a kiln could heat larger quantities of plant material than the oven previously investigated. This method is logistically complicated due to its cost and space requirement, but could be efficient after construction.

Phenology

Phenology varies from year-to-year and micro-climate to micro-climate. An awareness of when plants bloom and go to seed relative to each other and how one micro-climate progresses relative to another, however, can help immensely when planning for field work. A flexible schedule and ready transportation help accommodate these varying plant cycles.

An early and continued warm spell on the Alaskan peninsula resulted in a slightly earlier phenology this year than in most past years. Brooks Camp phenology was about a week or more delayed from King Salmon phenology, most likely due to an abundance of shaded areas and a slightly cooler climate. Below is listed a general guide for when the most abundant invasive species in KATM bloom and go to seed:

- The earliest plants detectable in the Park are sheep sorrel and common dandelion. These plants generally remain until late September. This year, common dandelions were first found around the new Headquarters building in King Salmon before the SCA interns had even arrived on May 1. Sheep sorrel was found already flowering at Lake Camp on June 4.
- Pineappleweed was first found in flower on June 20 at Brooks Camp, though it is detectable by its unique leaves earlier. This year's EPMT did not spend much time trying to distinguish it from the native yarrow as they were not treating it. If needed, however, this difference is made obvious by the darker color and larger size of the yarrow earlier in the season.
- Shepherd's purse varies greatly in phenology from site to site. While many instances were detectable in sunnier spots at Brooks Camp during their June visit, positive identifications in shadier spots were impossible until July. Special care must be taken with this plant, as it bears close resemblance to a native rockcress, *Arabis lyrata*. The two often grow side-by-side, so a positive identification of all plants in an area is necessary before treating the area. This year's EPMT waited until seed pods had developed on plants before weeding. The native rockcress has long, sessile seedpods while the invasive shepherd's purse has



Figure 32. Note the heart-shaped seed pods on these shepherd's purse plants, something the native rockcress does not have.

small heart-shaped seedpods.

- Common plantain also has a varied phenology depending on site conditions. In areas with less competition, it was detected flowering by June 18 at Brooks Camp. However, in shadier areas with more native vegetation, it was not found until September. Without a flower, this species can be difficult to tell apart from native plants. However, the leaf features five very distinctive parallel veins, made obvious by tearing the leaf in half horizontally.
- *Crepis tectorum* is usually not found until later in the season. This year it was found in flower as early as July 2 in the King Salmon maintenance yard, and again at Brooks Camp only a few days later at the 5-mile gravel pit. This is a high-priority species to treat, so positive identification and removal before the plant goes to seed is important. Keeping a close eye on the maintenance yard throughout the summer will give one a reference point for when plants should be flowering and going to seed at Brooks Camp. Once in flower, this plant is distinguishable by its bright yellow flowers, long stalk, and sessile leaves.
- Bird vetch growth is detectable as early as June, but flowers have not been found at KATM until August. Early in the season, bird vetch may be confused with the native marsh pea. Bird vetch tends to have more and smaller leaves than the native marsh pea, typically has branched tendrils, and a smooth and round stem. Marsh pea, on the other hand, has only one terminal tendril and a winged stem.

Recommendations for 2015 Field Season

Suggested Schedule

May:

- Attend all applicable trainings geared toward interpretation staff, including Dunker and aviation training, bear training, informational talks, all-employee meeting, etc.
- Read relevant Job Hazard Analyses on herbicide spraying (JHA) and vehicle use policies.
- Read through past years' reports and determine the focal points for the upcoming season.
- Meet the Visitor Center staff and restock their collection of exotic plant brochures.
- Figure out how the park works – transportation, flight calendar, etc.
- Learn more about the plants of the park through reading in the library and by walking around NPS administrated property.
- Memorize the phenology of invasive plants in the area.
- Familiarize oneself with general park geography.
- Help out around office when possible in order to meet the staff.
- Attend AKEPMT training in Anchorage.
- Pull dandelions around NPS Administrated properties.
- Begin organizing educational outreach programs for the VC and Fishtival.

June:

- Begin field work.
 - Spray at Fure's Cabin before dandelions go to seed. Check the Portage Trail to Grosvenor to ensure nothing is creeping back on either end of the trail.
 - Spray sheep sorrel and dandelions at Lake Camp before they go to seed.
 - Pull early phenology plants at Brooks Camp. Focus on areas that will be inaccessible during the July influx of bears, such as the Falls Platform and the land around the mouth of the Brooks River. The Campground should also be closely inspected at this point, as the increasing amount of visitors as the season continues will render control methods impractical in July. Take care to distinguish the native lyrate rockcress from shepherd's purse before pulling. Depending on the length and harshness of the winter, control of shepherd's purse may or may not be feasible at this point.

- Spray at Nonvianuk and Grosvenor before dandelions go to seed.
 - Map all areas surveyed, even if no invasive plants are found.
- Hang gypsy moth traps.
- Begin data analysis and report writing immediately upon return to headquarters.
- Pick dates for education programs and develop a solid lesson plan.

July:

- Continue field work.
 - Hop on to backcountry expeditions when possible to map remote areas and ensure no invasive plants are spreading unbeknownst to us.
 - During July trip to BC, do not waste time controlling near the Falls and at the mouth of Brooks River, as bears create quite the obstacle this month. Instead, venture out on the Valley Road.
 - Learn protocol for driving the Excursion at BC. Sign out the vehicle in advance and participate in Valley Road Traffic radio check-ins.
 - Check gypsy moth traps.
- Correct and analyze data in between Brooks Camp visits.
- Write as much of the report as feasible whenever based out of headquarters.
- Participate in Fishtival. Coordinate with administration, as they usually have a booth at the bazaar as well.
- During downtime, take advantage of NPS's access to free ESRI GIS trainings:
<http://inpakroms03web/rgr/akgis/index.cfm?action=dsp&topic=training&item=esrivirtual>

August:

- Continue field work.
 - At Brooks Camp, focus weeding efforts on the mouth of the river, as this area most likely went uncontrolled in July, and will again be uncontrollable in September.
 - Ensure that neither bird vetch nor tall buttercup are growing in the aforementioned sites.
- In downtime, arrange education and outreach events through visitor center.

- Initiate contact with USFWS to help with their annual science camp in the beginning of September.
- Begin researching revegetation and seed collection methods.

September:

- Help Julia Pinnix at Fish & Wildlife with their annual Science Camp for high schoolers. Teach a section on invasive plants and GPS, and help out with all ecology and botany related sections.
- Finish control work at Brooks Camp and back in King Salmon. Send data into Regional Office, which will then provide the team with data for acreage table and any other useful numbers and figures.
- Accompany teams taking down camera equipment, as many cameras are in locations that need to be inventoried or monitored. Though treatment this late in the season is unlikely given that most plants have gone to seed for the season, knowing which locations harbor invasive plants will allow next year's crew to identify early-on the areas to be chemically treated and bring the proper amount of herbicide necessary to do the job.
- Complete the report and turn in to your King Salmon supervisor and the Regional Office, giving them ample time to proofread and return edits.

October:

- Take down gypsy moth traps.
- Deliver remaining King Salmon weeds to the Brooks Camp incinerator.
- Complete report.
- Participate in other Natural Resources pursuits as requested.
- If transportation is available, collect seeds at Brooks Camp, separate and dry them, then store them in the freezer at Headquarters.

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