



Invasive and Exotic Species Management for Glacier Bay National Park & Preserve

2010 Summary Report

Natural Resource Data Series NPS/GLBA/NRDS—2010/108



ON THE COVER

This patch of perennial sowthistle (*Sonchus arvensis*) found on Strawberry Island is scheduled for herbicide application in 2011.

Photograph by: Whitney Rapp

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David Decker

National Park Service
Glacier Bay National Park & Preserve
PO Box 140
Gustavus, AK 99826

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Abbreviations

| | |
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| APCAM | Alien Plant Control and Management Database |
| AKEPIC | Alaska Exotic Plant Information Clearinghouse |
| EPMT | Exotic Plant Management Team |
| GLBA | Glacier Bay National Park and Preserve |
| GPS | Global Positioning System |
| NPS | National Park Service |
| ORV | Off-road Vehicle |
| SAGA | Southeast Alaska Guidance Association |
| SCA | Student Conservation Association |
| VIS | Visitor Information Station |

Abstract

This report describes the work done by the Alaska Exotic Plant Management Team at Glacier Bay National Park and Preserve. This season, the Glacier Bay team was comprised of one seasonal biological-technician and one American Recovery and Reinvestment Act funded Student Conservation Association intern. Plant inventories were conducted in the Bartlett Cove developed area, as well as in Dry Bay and in four backcountry areas of Glacier Bay proper. Control work was conducted mostly in Bartlett Cove, and there were four Southeast Alaska Guidance Association crews that assisted with the treatments. 197.96 acres were surveyed this season and 2.8 acres were controlled using manual control methods. This season, 1041.22 kg (2295.49 lbs) wet weight of invasive plants were removed. These plants were dried to 490.30 kg (1078.60 lbs) of dried plant material then incinerated. One new species was found this season; a single field mustard (*Brassica rapa*) was detected and removed at the Bartlett Cove waste management facility. In addition, perennial rye grass (*Lolium perenne*) was detected again in the park for the first time since 2006.

Acknowledgments

The Glacier Bay Exotic Plant Management Team would like to thank everyone who helped us and point us towards suspected weeds throughout the season. We would especially like to thank the Southeast Alaska Guidance Association crew for all their hard work pulling weeds, Dean Waguespack for incinerating our weeds, James Sowerwine for his time spent with the Southeast Alaska Guidance Association crew, the Glacier Bay law enforcement staff for transporting us throughout the park, Jim Capra and Erin Shanley for pulling daisies in Dry Bay, Bonnie Million for her work on the data and support, and Lewis Sharman for his guidance throughout the summer. The Glacier Bay Exotic Plant Management Team would also like to give a special thank you to Student Conservation Association intern Rachel Workin for all of her dedication and hard work throughout the summer.

Introduction

Glacier Bay National Park and Preserve (GLBA) is a 3.3 million acre national park that hosts a variety of ecosystems. GLBA is part of a larger World Heritage Site that includes Wrangell-St. Elias National Park and Preserve, Kluane National Park, and Tatshenshini-Alsek Provincial Park in Canada. These four sites create one of the largest protected areas in the world.

Invasive species are a threat to virtually all the National Park Service (NPS) units in the country (Drees 2004). Despite its relative remoteness, GLBA is no exception. Invasive plant inventories have been taking place in GLBA since 2004 (Heys and McKee 2004). To date, there are 34 invasive plant species growing in GLBA and another 11 in the neighboring town of Gustavus (Rapp 2009). Most are growing in disturbed areas, including along roadsides, construction areas, trails, and abandoned homesteads.

GLBA is particularly vulnerable to invasion because there is an abundance of natural disturbances in the park that create areas that may be easily colonized by invasive plants. These disturbances include several retreating glaciers in the park that are continuously exposing new ground surfaces that have the potential to be colonized by invasive species and disrupt the natural process of succession.

While the potential for the establishment of invasive species is high, there are several factors that have prevented this from occurring. The first is that GLBA is an isolated park. GLBA and Gustavus are not on the Alaska road system, so everything must be brought in by either plane or boat. This is a benefit because it limits the number of vehicles that are entering the park from other areas of the state or country, thereby removing one of the major vectors (vehicle tires and undercarriages) for introduction of invasive species.

Another factor that is aiding in keeping invasive species out of GLBA is the fact that the vast majority of visitors to the park never actually set foot in the park. GLBA is unique in that the visitors (>90%) visit the park exclusively from the decks of cruise ships. This limits the frequency of accidental invasive species introductions by visitors. It also leaves only the escape of garden plants and the introduction of contaminated fill as the two main ways invasive species arrive in the park. Both these methods can be greatly reduced, if not eliminated, through effective education of the public and park employees.

Invasive species are a concern to managers because they have the potential to hybridize with native species (D'Antonio et. al 2001), out-compete native species for resources, change geophysical and geochemical processes (Ruesnik et. al 1995, Gordon 1998), and alter fish and wildlife habitat. The NPS Alaska Exotic Plant Management Team (EPMT) was created in 2003, and first inventoried GLBA in 2004. At that time they detected 15 invasive species in GLBA and Gustavus (Heys and McKee 2004). Today there are 45 confirmed invasive species in the area. An Alaska EPMT crew member was first stationed at GLBA in 2005. During the 2010 season there were two full-time crew members working exclusively on invasive species management and four Southeast Alaska Guidance Association (SAGA) crews that aided in the manual control of a variety of invasive species.

Beginning in 2011, the Alaska EPMT will be allowed to use herbicides to control select infestations of invasive species that have continuously resisted manual treatments and pose a great threat to the ecosystem. A total of ten acres will be allowed to be chemically treated each year on NPS lands throughout the state. The treatments will be done by a small number of certified individuals who will travel to all the sites that are scheduled for herbicide applications. GLBA has two infestations that are scheduled to be treated in the first year of the program: reed canarygrass (*Phalaris arundinacea*) on the hillside by the maintenance building and perennial sowthistle (*Sonchus arvensis*) on Strawberry Island.

Methods

2010 field work at GLBA was conducted from May to September. The GLBA EPMT consisted of NPS biological technician David Decker and Student Conservation Association (SCA) intern Rachel Workin. There were four weeks of assistance by SAGA crews. Data collection was conducted following the Alaska EPMT 2010 field protocol (Million and Rapp 2010). This included mapping areas where invasive species occurred, areas where no invasives were found, and areas that had been previously treated. Data was collected using a Trimble GeoXT 2003 global positioning system (GPS) data logger using TerraSync 4.10 software. Data was then differentially corrected and edited using GPS Pathfinder Office version 4.20. Finally, files were then sent to the NPS regional office for export to a geographic information system. The Alaska EPMT data dictionary collects sufficient information for the data to be used in two different databases (Million and Rapp 2010). These are the Alien Plant Control and Management Database (APCAM), which is the NPS database for invasive plant data, and the Alaska Exotic Plant Information Clearinghouse (AKEPIC), which is used for tracking invasive plant infestations throughout Alaska.

Manual control treatment methods included hand pulling or digging out plants. Vegetative material was placed into bags, weighed, and dried. Drying took place in the exhaust room above the park's diesel-powered electrical generators. After the vegetative material was sufficiently dry, it was again weighed and taken to the park incinerator for disposal.

Control areas were chosen by determining which species were the most threatening and the chance of success of treatments. These determinations were made using the Alaska Invasive Species rankings (Carlson et al. 2008). These rankings rate the relative threat a species poses to natural communities and gives them a value from one to one hundred, with higher numbered species being of the most concern. Small infestations of less-threatening species were treated because of the possibility of eradication from the park. The worst ranked species in the park were also treated to prevent them from spreading to uninfested areas of the park.

Results

Overview

This season, a total of 197.96 acres were surveyed in GLBA for invasive plant species, with 131.96 acres infested with invasive species. This amount includes areas that were mapped in Bartlett Cove, Dry Bay, the Beardslee Islands, Strawberry Island, Reid Inlet, and the East Arm. Also this season, 2.8 acres were treated by hand pulling. The treated areas were in Bartlett Cove and Dry Bay. The amount of invasive plants removed was 1041.22 kg (2295.49 lbs.) of wet plant material, which was dried to 490.30 kg (1078.60 lbs.), resulting in a reduction of 53 % water weight. The dry material was then incinerated.

One new invasive species was found within the park this season. A single field mustard plant was found at the depot, next to the park incinerator. Several machines operate in this area, one of which may have been the source, if it had been previously used outside the park and not properly cleaned. One collection was made this season for the park herbarium - a sample of common comfrey (*Symphytum officinale*) that was collected from the depot.

Bartlett Cove

In Bartlett Cove, the entirety of the main park road was monitored for invasive plants. There was a large concentration of invasive species occurring on the road. Species found were reed canarygrass, common timothy (*Phleum pratense*), common dandelion (*Taraxacum officinale ssp. officinale*), white clover (*Trifolium repens*), quackgrass (*Elymus repens*), creeping buttercup (*Ranunculus repens*), smooth brome (*Bromus inermis ssp. inermis*), orchard grass (*Dactylis glomerata*), perennial ryegrass (*Lolium perenne*), and oxeye daisy (*Leucanthemum vulgare*). All of these infestations, except white clover and common dandelion, were treated by hand pulling. The discovery of perennial rye grass was particularly discouraging because the species was thought to have been eradicated from the park. Prior to this season, it was last seen in 2006 (Rapp 2006).

The three marked trails in Bartlett Cove were also monitored this season. No invasive species were found on the Bartlett Lake Trail, or on the parts of the Bartlett River Trail and Forest Loop Trail that are in mature forests. The end of the Bartlett River Trail, where the trail is along the river, was infested with common dandelion and mouse-ear chickweed (*Cerastium fontanum*). The common dandelion infestation that was closest to the mature forest was treated by SAGA. This treatment was intended to lower the risk of spread to uninfested parts of the trail and to halt the spread along the coastline. The Forest Loop Trail had infestations of common dandelion and common plantain (*Plantago major*) where the trail runs along the beach. There was also a patch of reed canarygrass where the trail meets the park road. This infestation was treated by hand pulling. However, treatment was late in the season, and the species is expected to return based on previous results of hand pulling (Rapp 2009).

The beach trail and coastal areas were mapped halfway to Point Gustavus. The main species found were common dandelion, reed canarygrass, common plantain, common chickweed (*Stellaria media*), mouse-ear chickweed, creeping buttercup, and white clover. Of these species, the creeping buttercup was treated multiple times and the reed canarygrass was treated once. These two species occurred only along the section of the trail between the Visitor Information Station (VIS) and seasonal housing. Both species are expected to return next season in lower

densities due to extensive rhizomatous root systems and past results of hand pulling (Rapp 2009).

Areas adjacent to both permanent housing and seasonal housing were monitored this season and, for those locations, nothing new was discovered. There is an abundance of creeping buttercup at building GBQ 03. The flower beds at this residence are almost a monoculture, as is the lawn area. It is starting to spread to other areas of permanent housing as well as toward seasonal housing and toward the beach trail. The patches that are spreading to other areas were hand pulled to slow their progress, but seedlings are already starting to re-sprout, and the area will likely need continuous treatment to contain the infestation. Permanent housing is the only known infestation of herb robert (*Geranium robertianum*) in the park. It was first discovered in 2009 (Rapp 2009) and was treated again this season. The infestation is mostly between GBQ 04 and the small parking area next to it. The species of highest concern at seasonal housing was reed canarygrass, all of which was hand pulled this season.



Figure 1. One of this seasons SAGA crews manually controls quackgrass at the GLBA solid waste management facility.

The Bartlett Cover Waste Management Facility, referred to as “the depot” at GLBA is where the garbage from the park is processed and fill that is used for construction projects is stored. This season, the depot was again an area with a high number of invasive species. The two plants of common comfrey there were collected for the park herbarium. There was a patch of creeping buttercup near a gravel pile that was treated by SAGA. Quackgrass, which was most likely brought in by the pile of fill around which it is concentrated (Rapp 2009), was also targeted by the SAGA crews. Two other species found this season only at the depot were pineapple weed (*Matricaria discoidea*) and shepherd’s purse (*Capsella bursa-pastoris*). Both these species were treated by hand pulling as time allowed (Fig. 1).

One of the areas that have been treated for several years is the area adjacent to the VIS (Rapp 2009). Common dandelion was treated in the planted areas around the parking lot multiple times throughout the 2010 season. Also treated in this area were the common dandelion, common sheep sorrel (*Rumex acetosella*), and tall buttercup (*Ranunculus acris*) that grow between the fuel dock and the main dock. This work was conducted mainly by SAGA. The common sheep sorrel was treated multiple times throughout the season because this is the only place in the park it was located and it is an infestation that may possibly be eradicated if control efforts continue in future years.

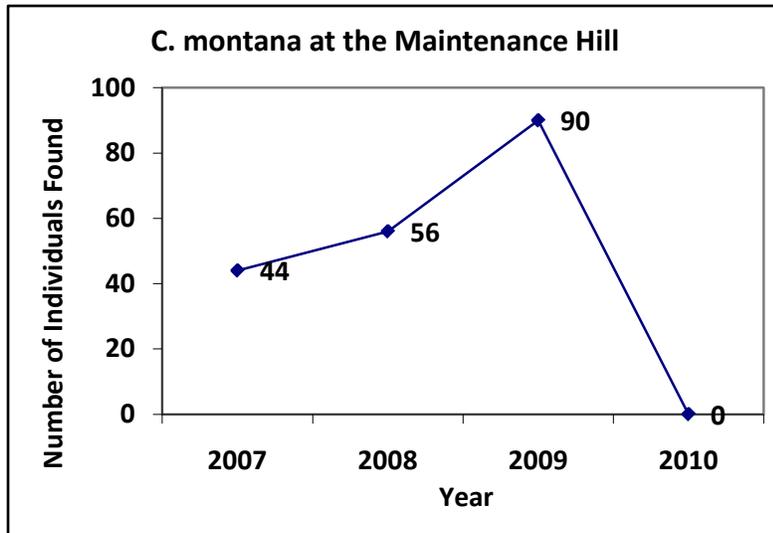


Figure 2. Manual treatment of perennial cornflower has occurred since 2007. No individuals were detected in 2010.

Another focus location that was surveyed in Bartlett Cove this season was the hillside adjacent to the maintenance building. This hillside has been infested with several species since it was re-vegetated subsequent to initial building construction (Rapp 2007). Along with species that are found in other areas of the park, the hillside also supports the only infestation of Johnny-jump-up (*Viola tricolor*) that was detected in the park this season. All individuals found on the hillside were pulled. Perennial cornflower (*Centaurea montana*), which had been found on the hillside since

2007 (Rapp 2007) was not located this season even though there were 90 individuals removed last season (Fig. 2). This plant is very conspicuous, so it is doubtful it was missed; it is likely that previous EPMT control efforts are proving to be successful. Perennial cornflower was, however, seen on private property in Gustavus, so monitoring for this species should continue. The other species of concern on the hillside is reed canarygrass. This is tentatively one of the species and areas that the Alaska EPMT has planned to treat with herbicide during the 2011 field season and, because of this, the area was carefully mapped several times over the course of the 2010 season

The area around the water towers was also surveyed several times this season due to the fact that it has supported a large infestation of oxeye daisy in previous years (Rapp 2009). This season, however, only a few individuals were found. There are several possible reasons for this: 1) continued manual treatments have started to exhaust the seed bank; 2) the corn gluten treatment that was applied in the spring of 2009 (Rapp 2009) prevented the seeds from germinating; 3) workers who installed a fence in the area this summer trampled or destroyed the seedlings so they could not mature. Gradual seed bank exhaustion seems like the best explanation as to why only a few individuals were observed this season since it is unlikely that corn gluten could have persisted in the soil for that length of time and it is equally unlikely that the vast majority of seedlings would be unable to survive the disturbance from construction.

The Glacier Bay Lodge was also an area of high priority this season. In the past, this area has hosted a large number of invasive species that are found nowhere else in the park. It is assumed that these species escaped from the flower boxes that decorate the Lodge (Rapp 2009). This year the species that was most prevalent around the lodge and found nowhere else in the park is true forget-me-not (*Myosotis scorpioides*). Though it is most likely a garden escapee, it shows some very invasive tendencies. A small infestation was found growing under mature conifers that are in the area. This may be an indication that true forget-me-not has the ability to invade mature forests and not just disturbed areas. Also relocated at the lodge was white deadnettle (*Lamium album*). This species had been treated every season since 2005 (Rapp 2005). Only three stems

were found and treated this season, and it is possible the species may be eradicated in the near future.

Other infestations in the park included a few plants of oxeye daisy by the green shed near the administration buildings that were treated when discovered. The curly dock (*Rumex crispus*) that was found near the generator building in 2009 (Rapp 2009) was located again this year, along with a second plant nearby. Both were removed, however, due to the asphalt that they are growing out of it is difficult to remove the root system, leading to the conclusion that the plants will continue to persist without a concentrated effort to remove them. A small patch of creeping buttercup was found near the entrance to the water treatment building.

There are five major invasive species that are found essentially in the entirety of the Bartlett Cove area. These five species are common dandelion, white clover, common plantain, mouse-ear chickweed, and reed canarygrass. Of these species, reed canarygrass is the one that presents the biggest threat to the ecosystem of GLBA. It has begun to move out of the disturbed areas and into the undisturbed muskeg that is off the main park road near where it enters the park.

Dry Bay

The GLBA EPMT crew went to Dry Bay again this year for four days. The primary goal was to continue the manual treatment of oxeye daisy by the fish plant. Treatment of this infestation has been ongoing since 2005. Last season, 40 person hours were spent on the control of the area (Rapp 2009). This season, 7.4 person hours were spent by the EPMT on oxeye daisy in Dry Bay. This number is significantly lower than in years past because of the effective work done by the backcountry rangers that are stationed there. They informed us that they pulled around 2000 stems of oxeye daisy before we arrived. This was a great help and allowed us to thoroughly survey the Dry Bay airstrip in the limited time available, as well as to monitor several of the off-road vehicle (ORV) trails for bigleaf lupine (*Lupinus polyphyllus*).

Bigleaf lupine has been a species of considerable concern in the past at Dry Bay. Several of the ORV trails were mapped again this season, and it appears from this data and anecdotal reports from the rangers stationed there that bigleaf lupine is expanding its range. Although this species is not native to Alaska, it is native to the Pacific Northwest (Hultén 1968). While it is likely that this infestation originally escaped from a planting, it is possible that the species may be able to naturally expand to Alaska in the future with increasing temperatures due to climate change. Since bigleaf lupine is native to a geographic area relatively close to Southeast Alaska, it has a relatively high potential to arrive in the area naturally; therefore, no treatment efforts have been made.

The spatial extent of the invasive common dandelion versus the native horned dandelion (*Taraxacum officinale* ssp. *ceratophorum*) could not be determined this season because this trip to Dry Bay occurred after the plants had already gone to seed. Tentative identification might still have been possible based on leaf structure, but this method is less reliable due to the fact that the two species may be hybridizing (Rapp 2009). Informal observations were made, and it appeared that the invasive common dandelion was the dominant species in the highly disturbed areas near the Dry Bay airstrip, fish plant, and ORV trails.

Also found in Dry Bay were common plantain and mouse-ear chickweed. These two species were found mostly around the Dry Bay airstrip. Common plantain and mouse-ear chickweed, along with bigleaf lupine and oxeye daisy were also found at the ranger station. This is an area that should be monitored closely in the future due to the relatively high amount of people who come and go throughout the growing season. Researchers and maintenance workers who stay there all have the potential to introduce new invasive species via their equipment and clothing. The ranger station is also a place likely to be an area of early detection of other invasive species introduced to the Dry Bay area. The ranger station has a high level of ORV use. The park vehicles go to all areas of Dry Bay, then return, where seeds may get dislodged from vehicles. This could create a small, easily accessible area with a high diversity of invasive plants.

Beardslee Islands

A four-day trip to the Beardslee Islands was conducted this year to determine whether and at what rate common dandelion, the main invasive species found there, was expanding its range. After surveying the first few islands, it was determined that the surveys conducted prior to 2007 were preliminary only, and that the entirety of the area had not been surveyed. This determination was made because it is unlikely that the extent and densities of the infestations that were found in the majority of the areas surveyed could have reached the current size in three years. Since the previous data that was collected in the area was preliminary, and did not clearly indicate areas that were surveyed that did not have invasive species, the EPMT is unable to determine rate of expansion. Common chickweed and mouse-ear chickweed were also found in the Beardslees this season; neither species had been recorded previously.



Figure 3. EPMT members David Decker and Rachel Workin survey the coastline of one of the Beardslee Islands.

The data collected this year does not represent a full and thorough inventory of the area. It is a sample of what is most likely to be found along the majority of coastline (Fig. 3). It is theorized that wherever there is an area of vegetation between the upper extent of the American dunegrass (*Elymus mollis*) and the seaward extent of the alder (*Alnus sp.*), there is a high probability to find common dandelion. It commonly grows alongside native species that occupy this type of area, Nootka lupine (*Lupinus nootkatensis*) and arctic strawberry (*Rubus arcticus*), but common chickweed and mouse-ear chickweed are also frequent.

Along with surveying on the islands, the coastline of Hutchins Bay was also surveyed in selected areas. The findings were similar to those of the island surveys. There were high amounts of common dandelion in areas that had not been previously surveyed, and infestations that had been previously recorded were larger and had higher densities. This area also has the potential to contain invasive species that have yet to be found in the Beardslee Islands area because it is part of the mainland. This allows for exposure to a variety of seeds that have the ability to travel on animal fur, which could then easier lead to the introduction of new invasive species to the islands.

East Arm

The GLBA EPMT crew made a trip to Upper Muir Inlet this field season. All traversable coastlines were surveyed, including the area in front of Muir Glacier (Fig. 4), and no invasive plant species were found. Only coastal areas were surveyed because of time restrictions, and



Figure 4. SCA intern Rachel Workin records data at the face of Muir Glacier

since coastlines are the areas with the highest probability of invasion by invasive plants because of natural disturbances, lack of shrub cover, and animal and visitor usage. The area directly in front of Riggs Glacier was surveyed with the same result - no invasive species. The coastline south to McBride Inlet, McBride Inlet proper, and the area immediately south of McBride Inlet was surveyed and no invasive species were found. This is fortunate because there is a high probability that invasive seeds have made their way to these areas, yet have been unable to establish viable infestations like they have in the West Arm.

A separate trip to the lower East Arm was made later in the season. This trip yielded mixed results. The camper drop-off at Sebree Island is surprisingly free of invasive species. This was unexpected due to the high amount of use the area gets from people getting off the daily tour-boat at this location to access the backcountry. Common dandelion was found at the entrance to Adams Inlet, however. It is a relatively small infestation and could be controlled without consuming too much time. If it is determined that this infestation should be controlled, treatment efforts should target the early part of the season before plants go to seed.

Reid Inlet

A trip to Reid Inlet was made this season in order to continue the manual treatment of oxeye daisy on the east side of the mouth of the inlet. For the second consecutive season, no individuals were found at this location. The size of this infestation peaked in 2007 with 186 individuals, and in 2009 there were no individuals detected (Rapp 2009). This site serves as a model for how to treat other infestations in the park. It illustrates that patience and persistence are the two main keys to successful removal of invasive plants using manual treatment methods. This site should be revisited next season, and if no individuals are found, the infestation can be considered eradicated (Fig. 5).

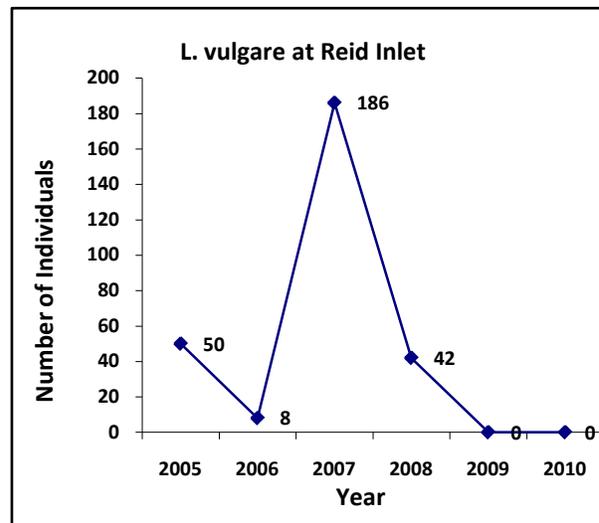


Figure 5. The number of oxeye daisy individuals observed and removed at Reid Inlet since 2005.

Reid Inlet was not completely devoid of invasive species. There were several small patches of common dandelion. This species has also been found in other parts of the West Arm (Heys and McKee 2004, Rapp 2009), so effective control may be difficult.

Strawberry Island

One trip was made to Strawberry Island this season, on August 18, 2010. Perennial sowthistle was mapped in great detail this season because of tentative plans by the Alaska EPMT to apply herbicide at this location next season. Strawberry Island is the only area in the park where this harmful invasive plant exists. The size of the infestation does not seem to be increasing, most likely due to the inability of the plant to reach maturity before winter (spread is primarily vegetative and slow). The site was visited late in the season and many of the plants had not yet bolted; it appeared that those that had started to flower had done so only recently.

Reed canarygrass was also found on the island. The infestations that were found were mapped, however the entire island was not surveyed because of the presence of a black bear. It is suspected that the reed canarygrass occurs at other locations on the island. Unlike many other invasive species in the park, reed canarygrass has demonstrated the ability to invade undisturbed areas. This is a great cause for concern about the infestations on Strawberry Island, because it is a possible seed source for reed canarygrass to spread farther into the park backcountry. The infestations of reed canarygrass on the island should be monitored closely; this is another species on the island that may be a candidate for herbicide application in the future.

Gustavus

The area around park housing in the town of Gustavus was visited once this season. A large infestation of common comfrey was found and treated. A small infestation of Canterbury bells (*Campanula medium*) was also discovered. This species had not been previously detected in this area and the infestation was treated. The area was not exhaustively surveyed and there are likely several more invasive species in the area.

No other areas in Gustavus were surveyed this season. The road system has been almost completely mapped (Rapp 2009), and residents in town are encouraged to contact the EPMT if they have questions about plant identifications or anything associated with invasive species. Although no formal surveying was done this season, the EPMT was asked to identify a plant thought to be spotted knapweed (*Centaurea stoebe*). The specimen in question turned out to be perennial cornflower, a species that the EPMT is familiar with because of infestations previously present on the maintenance hillside.

Discussion

Invasive Flora

Bartlett Cove

This season, the EPMTs focus was monitoring invasive plant species for the purpose of determining a long-term management plan that could be easily followed by future EPMT crews. The Bartlett Cove developed area was the main area of focus because it has shown in the past to host the highest number of invasive species (Rapp 2009, Rapp 2008, Rapp 2007, Rapp 2006, Rapp 2005). It is also the area where the most human activity occurs, and therefore has the highest probability of colonization by new invasive species. Within Bartlett Cove, major control efforts this season were focused on three separate areas, the VIS, the depot, and the main park road. Each area was chosen for different reasons, and the species controlled at each area were, for the most part, different.

At the VIS, the main species of concern was common dandelion. Control efforts have been ongoing around the flagpole and other vegetated patches in the parking lot since 2005 (Rapp 2005). It is also believed that this area was planted with native seeds at some point in the previous five years. The effort in treating these areas is extremely high, requiring multiple treatments per season. Common dandelion is ranked a 58 on the Alaska Invasive Species ranking scale (Carlson et al. 2008). This ranking is based on a one to one hundred scale, with the higher ranking species being the most damaging to ecosystems. A ranking of 58 indicates that common dandelion is not a species that does extensive harm to an ecosystem. Also, the park road is infested with common dandelion, so without controlling the entire park, the work done in a specific site for a species most likely will not have positive results because of the large seed source nearby. The work done at the VIS this season was done to prevent the seeds from possibly spreading to the backcountry, and as an outreach tool to talk to passing visitors about invasive species. It is recommended that in future seasons; EPMT crews should focus only on removing flower heads from the plants prior to them going to seed. This will accomplish both goals of preventing possible spread to the backcountry and outreach to visitors in a much less labor intensive and time consuming manner. It will also lower the amount of damage that is done to native species during the process of controlling invasive plants (damage can be done by trampling or accidental removal).

Another area of focus was the depot. This area is highly susceptible to the introduction of invasive species for three reasons. The first is that this is the area where fill for construction projects is stockpiled. If the fill originates from outside the park, there is a chance that it contains invasive plant seeds. An example of this is a large infestation of quackgrass growing from a pile of dirt that was placed at the depot years ago. A SAGA crew spent parts of three days there digging out a species that could have been prevented from entering the park by using clean fill. Another reason that the depot is a high priority is that there is a lot of machinery that goes through and is stored in that area. This is also another way that invasive species can be introduced. If the equipment is used in other areas and not properly cleaned, they may serve as vectors for invasive species to move into the area. The third reason that the depot is an area likely to have higher amounts of invasive species is that this is the area where the EPMT burns the plants that are pulled throughout the season. While every precaution is taken to prevent the spread of the invasive plants that are pulled, it is very possible that some seeds, especially those

that are wind dispersed, are able to escape the incinerator or the bags into which they have been collected.

Time was spent controlling five different species at the depot this season. These species included quackgrass, creeping buttercup, shepherd's purse, pineapple weed, and field mustard. In the future, EPMT crews should be able to effectively remove four out of the five of these species at the depot. Quackgrass is a difficult species to eradicate, but the SAGA crew this season spent extensive amounts of time digging them from the soil and sifting through the areas around the plants for root fragments that may re-sprout in future years. This amount of disturbance is acceptable at the depot because the soil in that area already lacks any other ground cover. Shepherd's purse and pineapple weed are two species that are easily pulled, and with consistent monitoring and control - a few times a season, for example - the seed bank in the area should become exhausted in the near future. There was only one plant of field mustard found and controlled at the depot, but it is likely that there are seeds in the soil that may germinate in the upcoming years. All individual plants should be treated before they go to seed to prevent this species from spreading to other parts of the park. Creeping buttercup is the only species treated at the depot this season that will likely persist for several seasons. This species has demonstrated its resilience to manual treatments in the past (Rapp 2009), so the effort required to eradicate this species will be significant. If the infestation of creeping buttercup at the depot is determined to be of high priority in future seasons, hand pulling should occur at least once a month for the first few seasons, or until there is a noticeable decrease in the size and density of the infestation. If plants are allowed to become too large, however, they will be able to resupply the root system with the energy needed to re-sprout after a treatment.



Figure 6. A SAGA crew controls reed canarygrass along the park road.

The third area of focus this season was the park road. This is an area that should be monitored every season because of its high level of use. All vehicles that come into the park travel the road, and the seeds that are collected on tires and undercarriages are deposited along the road. The main species that was controlled along the road this season was reed canarygrass. Reed canarygrass, ranked 83 (Carlson et al. 2008), was targeted because it is the highest ranked species in the park. SAGA crews were able to pull all the reed canarygrass that is along the sides of the road between the depot and the park entrance (Fig. 6). Along with removing reed canarygrass, all other identifiable invasive grasses were also removed from the road.

The park road was brushed this season, with some areas having the shrub layer that had grown in since the road was paved in 2002 being completely uprooted; in other areas the shrubs were cut to a few inches high, and in yet other areas the ground surface was “scalped” down to mineral soil. While it is understood that a certain distance from the pavement edge must be cleared for safety reasons and to protect the road surface from root damage, the extent of the clearing was back to the tree line along the entire corridor. This is a concern for the EPMT because one of the most effective methods used to control invasive species is to allow native vegetation that can out-compete them to establish and thrive. The shrub layer that was growing along the road was

beginning to have that effect. It is most likely that the shading from this layer was one of the main reasons that perennial ryegrass had not been seen in the park in several years. The area where it first reappeared was the area that was the first cleared this season. The point in the species' lifecycle when the infestation was first discovered suggests that the plants had begun to grow later in the season, which supports the theory that the shrub layer removed had been effectively suppressing its growth.

One way that both these objectives can be accomplished is to cut the shrub layer at a few feet high. This will provide for the necessary visibility while allowing most of the native plants to continue to shade out the invasive species that are attempting to grow. For those plants threatening to disrupt the pavement edge, the EPMT recommends that these be properly identified as primarily the woody species only, and that they be aggressively controlled only as far back as the edge of the drainage ditch. Root disturbance from farther back than the ditch is highly unlikely.

Another concern is the brushing that was conducted on the maintenance hillside. Native vegetation that was purposely planted for restoration and erosion control (Rapp 2007, Rapp 2008) was removed for reasons not clearly understood. This is an area that no visitors use, nor does it pose any apparent safety hazards. With the expected herbicide treatment of this area in 2011, there will be very little vegetation left on the slope. The erosion mat that was placed there has already begun to disintegrate, which will leave very little to keep the hillside from eroding. Moreover, the ground surface is now and will be then highly vulnerable to invasion by invasive plants.

The above issues appear to be symptomatic of ineffective communication between resource management and maintenance. Sometimes there are conflicting objectives, and sometimes there are communication miscues. In both instances, improved communication is the key.

Reed canarygrass was the principle species of concern in the Bartlett Cove area this season. All flowering stems located were controlled in the developed Bartlett Cove area except on the hillside by the maintenance building' where it is scheduled for herbicide applications in 2011. Reed canarygrass is the highest-priority species of concern because it is successfully invading undisturbed areas in the park. Based on the amounts of reed canarygrass in the recently discovered areas, there are likely several more infestations than just those found this season. Reed canarygrass is a species that needs to be closely looked at by park management so that the best long-term strategic course of action can be determined. Unfortunately, the size of the infestations in the undisturbed areas is too large for manual treatment methods such as hand pulling. Moreover, they are in wetland/muskeg like areas that are more fragile than most other ecosystems and are not optimum areas for herbicide use.

Creeping buttercup, which is ranked 54, is another species of growing concern in Bartlett Cove. There are several infestations in the park. The major infestations are adjacent to the Glacier Bay Sea Kayak buildings, at the depot, on the park road, and around GBQ 03. The infestation by GBQ 03 is the worst of the four. The flower beds and lawn areas are nearly a monoculture of creeping buttercup. It is starting to spread to other areas of permanent housing, seasonal housing, and the beach trail. The creeping buttercup that was starting to move toward other areas was controlled this season by hand pulling. Seedlings are already starting to reemerge, however, and

some of the treatments created large areas of soil disturbances that may allow for the establishment of other invasive species. The creeping buttercup problem will persist until the primary seeds source is eradicated from GBQ 03. This will be a difficult task and must be coordinated with the residents of that housing unit. This is an area that will likely require methods other than hand pulling to be successful.

Creeping buttercup is considered a worse problem than common dandelion - even though it has a lower ranking - because it is showing signs that it may be able to form monocultures in undisturbed areas. While it currently occurs only near areas that have been disturbed, it is in some places growing beneath native vegetation and in areas that are not as disturbed as areas that support common dandelion. Creeping buttercup also tends to form dense continuous mats that prevent other vegetation from establishing. The amount of creeping buttercup is still controllable; leaving open the possibility that creeping buttercup can be eliminated from park, which is another reason why it is considered more of a priority than common dandelion.

Dry Bay

The GLBA EPMT's major concern in Dry Bay continues to be oxeye daisy. The amount of time needed to treat that infestation has steadily declined since 2007. While the number of hours it required to control the infestation this season is unknown, it did appear that the infestation is declining in size. It may be possible to develop a simple data sheet to give to the rangers in Dry Bay to record how much control effort they invest in the area. However, this may not be optimum because these rangers are going above and beyond their duties when they assist with invasive plant control and it would be unfair to create an expectation that this is one of their many required responsibilities. The oxeye daisy infestation is one which, with continued treatment, should be able to be eradicated by manual methods.

The other species of concern in Dry Bay is bigleaf lupine. While this species is currently considered non-native to Glacier Bay (Hultén 1968), and even has a ranking of 55 (Carlson et al. 2008), no treatment plans have been made. This is due to not only to the size of the infestation, but also to the possibility that this species may be able to reach Southeast Alaska naturally in the relative near future. Bigleaf lupine is native to the Pacific Northwest. With climate change, it is possible that the native range of bigleaf lupine may eventually expand into the area. Because of this, it has been determined that bigleaf lupine should not be considered a priority species for control.

Beardslee Islands

The survey in the Beardslee Islands this year did not have the intended results, which were to determine the rate of expansion of the invasive infestations. Nevertheless, it did provide valuable information for future seasons. It may be possible to use this season's data as a sample set to infer the conditions on the rest of the islands. Also, it can serve as the first season of data if it is determined that a detailed survey of the area is needed.

Common dandelion was the most prevalent species found, and was located in each of the areas visited. It grows in the areas between the upper extent of the American dunegrass and the lower extent of the alder. This habitat preference makes it possible to predict which areas of coastline will be most likely to contain common dandelion. Areas that did not have this type of habitat were found to not have any common dandelion. Using this baseline data as a guide it may be

possible to know the extent of the distribution of common dandelion in the Beardslees without having to survey the entirety of the coastline.

East Arm

This season's survey in the upper East Arm showed that there are still many natural places left in the park which do not have any invasive species. The results in Upper Muir Inlet were not as surprising as those at the mouth of McBride Inlet. McBride Inlet is a frequent stop for tour boats that travel in the park. Visitors go ashore around low tide to get close to icebergs that have become stranded (Fig. 7). With this relative high amount of use for a backcountry area, it is surprising that no invasive plants have been able to become established here.



Figure 7. Large pieces of ice are accessible at McBride Inlet, which draws many visitors to this area.

Lower in the East Arm is Adams Inlet. This is the inlet that is closest to the camper drop-off point on Sebree Island. The south side of the mouth of Adams Inlet is infested with common dandelion. It does not appear that the infestation has spread inland from the coastal area it inhabits, but the braided lower Dirt Glacier outwash may be susceptible to invasion. With common dandelion occurring in only a small number of areas in the rest of Adams Inlet (Rapp 2007) this is an area where controlling it would be beneficial. Common dandelion is a species that is common throughout Bartlett Cove and Gustavus. Control efforts in these areas do not have a high chance of success because of the abundant seed source that is never far away. Control efforts in more isolated areas, such as the mouth of Adams Inlet, have a much higher probability of success because the infestations are smaller and there is a much smaller chance that seeds from other infestations will reach the area. This is also a good candidate for control efforts because much of the East Arm is free of invasive species, and removing the closest seed sources is a good way for it to retain its pristine ecosystems.

The final place in the East Arm that was surveyed was the camper drop-off at Sebree Island. This area has a high potential to be invaded because this is the first “landfall” for most backcountry campers visiting the East Arm. There were, however, no invasive species found at or in the vicinity of the camper drop-off. This discovery, increases probability of success with respect to control efforts at the mouth of Adams Inlet and elsewhere in the East Arm.

Reid Inlet

This season, one visit was made to the site where control of oxeye daisy has been ongoing since 2005 (Rapp 2005). For the second consecutive year, no individuals were found. This result is encouraging because oxeye daisy control is occurring in other areas of the park and it shows that manual treatment by hand pulling is a successful way to eradicate it. A visit to Reid Inlet for oxeye daisy monitoring next season will be necessary to confirm that the infestation has been successfully eradicated. If no individuals are found in 2011, the infestation can be considered eradicated, and monitoring of the site can switch from an annual basis to every two or three years.

Common dandelion was found in Reid Inlet and has also been found in other places in the West Arm (Heys and McKee 2004, Rapp 2009). Control in the West Arm would be difficult because of the number of infestations. The best strategy for control would be to start at the northern most infestation, and work on control at that site for multiple seasons until the size and density begin to significantly decrease, and then work south toward Bartlett Cove over several years. This would be a labor-intensive and time-consuming effort and may represent an unsustainable use of resources.

Strawberry Island

One visit was made to Strawberry Island this year to map the *S. arvensis* that is found on the island. Compared to previous season's data, the infestation appears to be either not expanding or expanding at a very slow rate. This area was mapped again this season because it is a tentative site for herbicide treatment next season. This site is a candidate for herbicide treatment because perennial sowthistle is ranked 73 (Carlson et al. 2008), which is the second-highest ranked species in the park. Another reason this site is a good candidate for an herbicide treatment is that it is the only known infestation of perennial sowthistle in the park. This means that if this infestation is eradicated, a highly invasive plant may have been completely removed from the park.

Reed canarygrass was also found on Strawberry Island. As previously stated, this is a species of great concern. The infestation on Strawberry Island should be considered one of the top control priorities of the EPMT. This infestation may have the potential to spread to other backcountry areas. Other islands are not too far away from Strawberry Island, and there are black bears and other wildlife on the island that may be able to transport seeds to other nearby areas. This infestation may be a better candidate for herbicide treatment than the one that is located on the maintenance hillside. Reasons for this include the relative isolation of the infestation (it is much less likely to be reseeded by nearby infestations), the accessibility this infestation has to other backcountry areas, and the fact that the known infestation is much smaller and more concentrated than the infestation on the maintenance hillside. In order for this to be an option, however, the entire island needs to be surveyed to ensure that there is not a much larger infestation on the interior of the island or on areas of coastline that have not yet been surveyed. If chemical control is not an option for the near future, EPMT crews should attempt to eradicate the infestation by manual treatment methods.

Gustavus

The only area surveyed this season in the community of Gustavus was at the GLBA property where the temporary housing units are located. Common comfrey was the main species of concern in this area. The infestation is growing, and while it was treated this season, it is highly likely that it will persist for several years. The reason for this is that the stems and roots break easily, allowing it to re-sprout. Treatment this season was made more difficult by the fact that gravel had been put down this season and the common comfrey was growing through the packed gravel. This limited treatment options to hand pulling because the packed stone made digging extremely difficult. For these reasons, it would be beneficial for future EPMT crews to visit the site every month during the growing season and remove all the above-ground growth and as much of the root crown as possible. This should be repeated in following seasons until the plants energy reserves can no longer support the constant need to re-grow the above-ground vegetative material.

Another reason why this area should be exhaustively surveyed next season is because there was work done on the property. It is possible that the gravel brought in was contaminated with invasive plants seeds and that equipment used may similarly have been contaminated. Also, the disturbances created could allow invasive species to establish in the area. These three factors increase the probability that new invasive species will be found there in the future.

Invasive fauna

Within Alaska, there is growing concern about invasive marine species invading. Species already present along the west coast of North America but not yet in Alaska include European green crab (*Carcinus maenas*) and Chinese mitten crab (*Eriocheir sinensis*). Invasive tunicate species have already been detected in Alaskan waters. Modeling has shown that coastal areas of the entire Gulf of Alaska have suitable habitat for green crabs. Glacier Bay's dynamic and productive marine ecosystem is at risk to invasions, so monitoring programs need to be in place to detect arriving species (Rapp 2009).

Tunicates

Surveys for several species of invasive marine tunicates were again preformed this season in June and September. A total of ten settlement plates are hanging from the Inner Dock, the Fuel Dock, and the Public Use Dock. They are inspected every three months, and are inspected for invasives, and new plates are deployed. In both surveys this season, no invasive tunicates were found. There has been a similar negative result each time the surveys have been conducted (Rapp 2009). Surveying for invasive tunicates should continue despite the consistent negative results because they can be extremely destructive to marine ecosystems and early detection may help prevent or slow their invasion. Invasive tunicates have been found in Sitka, and are thought to be in nearby Elfin Cove.

Carcinus maenas

Once again this season, surveys were conducted each month for European green crab (*Carcinus maenas*). Traps were deployed at Lagoon Island during the lowest low tide of each month (Fig. 8). Once again this season, no European green crabs were captured. Even though there have been negative results each season that surveys for European green crab have taken place (Rapp 2009), they should continue in following seasons to ensure that this marine invasive does arrive undetected to park.

Arion ater

The European black slug (*Arion ater*) was first detected in Gustavus in 2008 (Rapp 2008). It has become a nuisance species to residents, and some manual control of the slugs has begun. They have not yet been observed in GLBA. Future EPMT crews should learn to identify the slugs and train other members of the park staff in their identification.



Figure 8. The traps for *C. maenas* are placed on Lagoon Island during low tide.



Streptopelia decaocto

The Eurasian Collared-Dove (*Streptopelia decaocto*) (Fig. 9), is a recent invader to the area (Rapp 2007). This season there were several reports of the Eurasian collared-dove, including sightings in the area of the administration building, where they had not frequently been observed in the past. This is a species for which development of a monitoring and control program should be considered in the near future.

Figure 9. The Eurasian collared-dove was seen more frequently this season than in 2009, when this photo was taken by Nat Drumheller.

Outreach/Education

Once again this season, the GLBA EPMT created a booth for the Gustavus Fourth of July Festival. This season; the weed identification light up board was again used, and a game was developed that helped people learn to distinguish native plants from invasive plants. Temporary tattoos and Alaska native wildflowers buttons were given out as prizes. A display was made to illustrate how invasive seeds can be transported on the bottoms of shoes (Fig. 10).

Due to the time of the EPMT crew's arrival at the park, the training weeks for the interpretive and maintenance staffs were missed this season. These training periods are excellent opportunities for the EPMT to talk to other members of the park staff and make them aware of the problematic species that are found within the park and what they can do to help prevent the introduction of other invasive species or prevent the spread of those that are already here. It may be possible to develop a program that could be given to other members of the staff without the presence of an EPMT member if none have arrived in time for the usual training periods.



Figure 10. SCA intern Rachel Workin and NPS volunteer Joseph Whelan work the EPMT booth at the annual 4th of July Festival in Gustavus.

Recommendations for 2011

The main goals of the EPMT for upcoming seasons should be to continue to monitor Bartlett Cove for new invasive species, as well as to continue to inventory areas of the backcountry that have not yet been surveyed. Control work should focus on infestations of the invasive species that are the most likely to be successfully eradicated, as well as preventing the spread of species that pose the greatest threat to the park. Continued education and outreach programs for the staff and community should also be considered a high-priority for upcoming seasons.

In Bartlett Cove, oxeye daisy should continue to be controlled because of the possibility that it can be eradicated in the near future. Other species with low rankings that should continue to be treated for the same reason are common sheep sorrel, shepherd's purse, and pineapple weed. Also, all invasive grasses should be controlled where they threaten to spread into uninfested areas.

In 2011, it is recommended that the SAGA crews be scheduled for later in the season. GLBAs most threatening species, reed canarygrass can best be controlled later in the season, such as in late July or August. If crews are scheduled to come before the reed canarygrass is flowering and identifiable, it is recommended that creeping buttercup be treated. Crews that come before July may be too early to be effective. Only species that do not require a large crew for treatments are identifiable at this time, and control efforts by the EPMT are usually most efficient.

Control of common dandelion at the VIS should continue only as an outreach and backcountry spread prevention activity. Rather than attempting to completely remove the plant it is recommended that only the flowering heads be removed. This will save time and accomplish the same goal while avoiding the damage done to native plants that accompanies full control efforts.

A trip to Dry Bay should be made for oxeye daisy control. The time needed for control will depend on whether backcountry rangers are again aiding in the effort. Bigleaf lupine monitoring should not be a high priority, as the majority of trails in Dry Bay have already been mapped.

The oxeye daisy infestation at Reid Inlet should again be monitored to ensure that no individuals have returned. Other backcountry areas that may be surveyed are the East Arm south of McBride Inlet, including Wachusett Inlet and Adams Inlet. Any locations along the parks outer coast should be opportunistically inventoried, since little data for that area exists.

A roadside vegetation management plan for the park should be developed. If it is decided that control of invasive species along the park road is a priority, a restoration strategy combining efficient weed control with pavement protection and maintenance of sightlines should be formulated. If it is determined that the roadside is not a priority, the focus of the EPMT can shift to other areas of the park.

It is recommended that early detection programs for tunicates and European green crab continue. The tunicate surveys should be a higher priority because they have been recently found in Sitka and are thought to be in nearby Elfin Cove.

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Appendix A - Flora Summary

The species listed are those located in and around GLBA. The numbers next to some of the species represents the ranking given to that species by the Alaska Natural Heritage Program. The rankings are based on a one to one hundred scale, with the most threatening species being given a higher rank (Carlson, et al. 2008).

***Achillea ptarmica* – Sneezeweed (46)**

This species has not been detected in the park, but has been planted as an ornamental in Gustavus (Rapp 2009).

***Aegopodium podagraria* – Bishop’s Goutweed**

This species has not been detected in the park, but has escaped plantings in Gustavus (Rapp 2009).

***Alchemilla mollis* – Lady’s Mantle**

This species has been planted at GBQ09A and should be treated if it is seen spreading into surrounding areas (Rapp 2009).

***Allium schoenoprasum* – Wild Chives**

This species grows in Dry Bay and is considered a native species (Hultén 1968); therefore, it is no longer a species of concern.

***Alopecurus pratensis* – Meadow Foxtail**

Several individuals of this species were removed throughout the park in 2007, 2008, and 2009 (Rapp 2009). This species was not a priority species this season and was monitored and removed when seen, but was not specifically targeted.

***Arctium minus* – Common Burdock**

A single individual of this species was found and removed by seasonal housing in 2006 (Rapp 2006), and has not been seen since (Rapp 2007, 2008, 2009). This species is being considered eradicated from the park.

***Brassica rapa* – Field Mustard**

This species was found in the park for the first time in the 2010 season. One individual was found at the depot, where it was removed. Monitoring for this species should continue in that area next season.

***Bromus inermis ssp. inermis* – Smooth Brome (62)**

This species was first detected and treated in Bartlett Cove in 2009 (Rapp 2009). There is a large infestation of this species along the roads of Gustavus. This season, the individual that was located along the park road last season was relocated and treated. Monitoring and treatments for this species in the park should continue.

***Campanula medium* – Canterbury Bells**

Several individuals were found and treated this season at the GLBA property in Gustavus. It had been previously removed from the maintenance hillside (Rapp 2008), and no individuals were seen in Bartlett Cove this season.

***Capsella bursa-pastoris* – Shepherd's Purse (40)**

This species has been found at the depot for several seasons. This season, all individuals found were removed. This species was treated, even though it is not a high-ranking species, because of the restricted size and location of the infestation, which appears within our capacity to successfully eradicate with future treatments.

***Centaurea montana* – Perennial Cornflower**

This species was observed in Gustavus this season. However, the infestation that had been located on the maintenance hillside was not relocated this season. While over 90 individuals were removed in 2009 (Rapp 2009), it is possible that the treatments of this species were successful and the infestation eradicated. Monitoring should continue for the next few seasons to confirm that this species is no longer in the Bartlett Cove.

***Cerastium fontanum* – Mouse-ear Chickweed (36)**

This species is located in most disturbed areas of Bartlett Cove. It is also abundant in Dry Bay, the Beardslee Islands, the Bartlett River, and several other backcountry areas (Rapp 2009). Since this species is abundant in several different areas in the park and it is a low-threat species, treatment of this species is not advisable due to the probability of continuous re-seeding from abundant nearby seed sources and the amount of time it would take to eradicate it from park.

***Cirsium arvense* – Canada Thistle (76)**

This species which is currently growing in Gustavus is a species of great concern to the park. It was reported on the park boundary this season (58°25'37.54'' N: 135°51'46.05''W), though it was not located by the EPMT. It is believed that this species will soon be in the park, and aggressive treatment should commence as soon as it is detected.

***Dactylis glomerata* – Orchardgrass (53)**

There were three small infestations of this species found and treated this season. One was located in the permanent housing area of Bartlett Cove, one along the park road, and one along a section of the park boundary. This species has been controlled since 2005 (Rapp 2005) with positive results, as the number of infestations is decreasing.

***Elymus repens* – Quackgrass (59)**

This species is found in several places in the park. It is most abundant at the depot, where a SAGA crew thoroughly removed it this season. All above and below ground evidence of the species was removed, so next season the infestation should be significantly smaller. Control for this species should also begin on the maintenance hillside, and the section of park boundary that is just south of the main entrance to the park. The infestation near the park entrance on the main road was also treated this season.

***Geranium robertianum* – Herb Robert**

This species is found growing around GBQ04 in the permanent housing area of Bartlett Cove. All individuals were manually treated this season, and treatments should continue in following seasons to ensure that the species does not spread. This species seems to flower in early August, with the plants going to seed in late August.

***Hieracium aurantiacum* – Orange Hawkweed (79)**

This species has not yet been located in GLBA; however, it is in Gustavus. This species is being treated in town with mixed results by property owners. If any individual is found in the park, it should be aggressively treated immediately.

***Hordeum jubatum* – Foxtail Barley (63)**

This species, previously considered invasive is located in several areas in the park, and is considered a native species (Hultén 1968). Monitoring of this species is no longer warranted and there should be no treatment efforts on this species.

***Hypochaeris radicata* – Hairy Cat's Ear**

This species has not been seen in the park since 2005, when a single individual was removed from the Bartlett River trailhead (Rapp 2005). This species is found in several locations in Gustavus. If this species is detected again careful steps should be taken correctly identifying it as it is in question whether this infestation was actually fall dandelion (*Leontodon autumnalis*).

***Lamium album* – White Deadnettle**

This species has been treated at the Glacier Bay Lodge since 2005 (Rapp 2005). There were only three individuals found in that area this season and all were treated. Monitoring and treatments should continue, as it may be possible to successfully eradicate this species from the park.

***Leucanthemum vulgare* – Oxeye Daisy (61)**

All individuals in Bartlett Cove were treated this season in the hopes that it will soon be eradicated from the area. The large infestation at the water towers has been reduced to a few individuals, and the remainder of the individuals removed from Bartlett Cove were not in large infestations, but scattered throughout the area.

For the second straight season, there were no individuals located at the mouth of Reid Inlet (Rapp 2009). The number of hours required for manually treating the infestation in Dry Bay has been decreasing since 2007, with that trend continuing this season.

***Linaria vulgaris* – Yellow Toadflax, Butter and Eggs (69)**

While this species has not yet been detected in the park it is present in Gustavus. This species should be continued to be monitored for, with all individuals found being treated immediately. This species should also be a focus of the outreach program, as it was most likely introduced as a garden plant.

***Lolium perenne* – Perennial Ryegrass (41)**

This species contains two subspecies that apparently were inadvertently included in the sterile grass seed mix intentionally sown for erosion control following the paving of the park road in 2002. Prior to this season, no individuals of either subspecies had been detected since 2006. Several individuals were detected and treated along the north side of the park road between the VIS and seasonal housing late in the season. Monitoring for this species should continue next season to determine whether the infestation returns along the entirety of its previous extent.

***Lupinus polyphyllus* – Bigleaf Lupine (55)**

This species is native to the Pacific Northwest, but is thought to be artificially introduced to Alaska (Hultén 1968). This species grows throughout Dry Bay, as well as in Gustavus, but has not yet been seen in Bartlett Cove. While it is classified as an invasive species, there is no treatment currently taking place for this species because it is thought that it may be able to naturally arrive in this area in the relative near future. Because of this, it may not be worthwhile to continue monitoring this species in the Dry Bay area due to its already extensive infestations. Monitoring in Bartlett Cove should continue, however, because if found it would represent a new species for the area. At the time of arrival in Bartlett Cove, it should be determined whether this species should be treated as a native whose range is expanding naturally, or an invasive that should be removed.

***Matricaria discoidea* – Pineapple Weed (32)**

This species was found only at the depot this season. It was treated, even though it is not a species of high concern, because the lone infestation in Bartlett Cove is isolated, and there is a good chance to eradicate this species from the park in the near future.

***Myosotis scorpioides* – Forget-me-not**

This species is found exclusively around the Glacier Bay Lodge. It is an escaped ornamental that is showing signs of becoming invasive. All individuals were removed this season and treatment should be continued in the following seasons. This species has shown the ability to grow under conifer tree cover, which is a concern because it indicates that it may be able to invade undisturbed areas. For this reason the species should be a high control priority for future EPMT crews.

***Phalaris arundinacea* – Reed Canarygrass (83)**

This species is the highest ranked species found in the park. It is found in several places in Bartlett Cove including areas that have not been disturbed. Manual treatments of infestations in the Bartlett Cove area have been ongoing since 2005 with little success (Rapp 2009). This season the majority of treatment effort was focused on the removal of seeding plants from discrete infestations in hopes of reducing the spread of the species. This was done because of poor past results, as well as not wanting to create a large disturbance to the soil with a treatment that has been shown to be ineffective.

There is an infestation of this species on Strawberry Island which should be thoroughly mapped next season and recommended for herbicide treatment. The large infestations in the undisturbed areas off the main park road were not treated this season, and will most likely continue to spread. This is the most threatening species to GLBA, and a comprehensive management plan for its control should be developed by park managers.

***Phleum pratense* – Common Timothy (54)**

This is a common roadside species in Bartlett Cove. It is spreading into one of the areas already hosting a large infestation of reed canarygrass, but other than in that area it has not shown an ability to spread into undisturbed areas. Individuals were treated in areas where treatments for other species were taking place, but there were no efforts specifically aimed toward treatment of common timothy.

***Plantago major* – Common Plantain (44)**

This species is common throughout Bartlett Cove and Dry Bay. It is not considered a major threat and no treatments were conducted this season. There is no evidence that this species can invade undisturbed areas, and should not be considered a high-priority species for control.

***Poa annua* – Annual Bluegrass (46), *P. palustris* – Fowl Bluegrass, *P. pratensis* – Kentucky Bluegrass (52)**

These three species are grouped together because it is extremely difficult to distinguish them from the native bluegrasses without extensive training in grass identification. Because of this, it will be extremely difficult to identify a species in the field with sufficient confidence to treat it. None of these species were monitored or treated this season.

***Ranunculus acris* – Tall Buttercup (54)**

This species was treated by SAGA this season, with the majority of the treatments occurring in the area between public use dock and the fuel dock. All other infestations this season were treated when found.

***Ranunculus repens* – Creeping Buttercup (54)**

This is a species of growing concern in GLBA. Even though this species has the same ranking as tall buttercup, it displays a greater ability to spread, form monocultures, and is more resistant to manual treatments. The worst infestation of this species is at GBQ 03 in permanent housing. It is spreading from that location toward other residences, the beach trail, and the seasonal housing area. Other than the main infestation in the flowerbeds and lawn of GBQ 03, all infestations were treated this summer.

There were several different methods used to treat each infestation. The infestation at the kayak rental area was treated by SAGA, and the entire top layer of soil was removed in an effort to remove the majority of the root systems. The same treatment was performed on the path from permanent to seasonal housing; however, at that location a second treatment of removing seedlings was conducted to ensure all individuals were removed. The infestations that are spreading to other residences in permanent housing and toward the beach trail, as well as the infestations along the road and at the depot, were hand-pulled only, taking care to remove as much of the root system as possible. By performing these different treatments, it may be possible, in 2011, to determine the relative effectiveness of each treatment.

Another option in the manual treatment of *R. repens* is frequent and repeated treatment of infestations throughout the season. This will be a time-consuming effort, but may be the only option – barring chemical treatment - to eradicate the smaller infestations. A decision by park management needs to be made on what should be done with the large infestation at GBQ 03.

***Rosa rugosa* – Rugosa Rose or Sitka Rose**

This species is present at several locations in Gustavus. It has not yet been detected in GLBA.

***Rumex acetosella* – Sheep Sorrel (51)**

This species was found in only one location this season. However, it has been reported in other areas in Bartlett Cove in the past (Rapp 2009). It was located and treated between the public use and fuel docks. This is a species that likely can be successfully eradicated from the park with continued treatment efforts in future seasons. This species is small and can be difficult to locate, so it is not an optimum species for larger SAGA crews. Since the infestations are not large, control should be able to be done by the EPMT with possibly a few volunteers.

***Rumex crispus* – Curly Dock (48)**

This species was found and treated for the first time in 2009 (Rapp2009). It was found in the same location this season by the entrance to the fuel dock. There were two plants this season and both were removed. There is a high probability that these individuals survived the treatment because the asphalt hindered the attempts to dig them out. Monitoring and treatment of this species should continue. It is similar to the native western dock (*R. aquaticus*), so care in identification is needed.

***Sonchus arvensis* – Perennial Sowthistle (73)**

The second highest ranked species in the park, perennial sowthistle has been detected only on Strawberry Island. This species was mapped in great detail this season because it is tentatively scheduled to be treated with herbicide next season. There are reports of this species in Gustavus, so the park road should be monitored for it in the future. If an infestation does appear in Bartlett Cove, plants should not be allowed to go to seed.

***Sorbus aucuparia* – European Mountain Ash (59)**

This species has not been seen in GLBA since a seedling was removed from the depot in 2007 (Rapp 2007, Rapp 2008, Rapp 2009). Trees of this species have been planted in Gustavus, so monitoring in the park should continue.

***Stellaria media* – Common Chickweed (42)**

This species is present in several areas of GLBA. This is not a high-priority species, and while monitoring for this species occurred this season, there were no treatments conducted. This species occurs in the backcountry, Bartlett Cove, and Gustavus.

***Symphytum officinale* – Common Comfrey**

This species is growing at the depot in Bartlett Cove and at the GLBA property in Gustavus. This species has an extensive root system that breaks easily. For this reason, manual treatments are difficult. A possible strategy to combat this is to remove all above-ground growth once or twice a month for the length of the season every season until the root system is starved. While this may be time consuming, it will most likely be more successful than trying to dig out the whole plant once each season. Since it is easily identified by its hairy leaves, seedlings can even be treated. This method is thought to be more successful because individuals at the depot have been treated once annually (by hand pulling) since 2006, yet they have reappeared each year in good health.

***Tanacetum vulgare* – Common Tansy (57)**

This species has been planted as an ornamental in Gustavus, but has not yet been seen in the park.

***Taraxacum officinale ssp. officinale* – Common Dandelion (58)**

In the past this species was considered a priority in the park. This season, however, it was determined that the control and education efforts that have been invested in this species could better serve the park if they were targeted on other species. While isolated treatments were conducted, they were limited to discrete areas where a reasonable possibility of success existed. Control efforts for this species should be concentrated only in backcountry areas where small infestations exist. Fortunately, common dandelion usually does not successfully invade undisturbed areas.

In Dry Bay, where the native and invasive subspecies of *Taraxacum sp.* exist, there is still not much that can be done about the invasive form. The size of the infestations makes it not feasible to manually treat them. Also, differentiating the two species is most easily done while the species are in full flower. The point in the season at which this occurs, however, does not necessarily coincide with when oxeye daisy flowers, which is the main species of concern in Dry Bay. The result of this is that two trips would most likely be needed to accomplish both goals of *Taraxacum sp.* identification and removal of oxeye daisy. Only one trip this season was possible, and the control of oxeye daisy was the higher priority.

***Trifolium pratense* – Red Clover (53)**

This species is much more prevalent in Gustavus than GLBA. From 2005 to 2009, all plants in Bartlett Cove were removed without success as the infestations were found in the same areas each season (Rapp 2009). This season, no treatments were conducted, but monitoring did occur.

***Trifolium repens* – White Clover (59)**

This species is present throughout Bartlett Cove. It is a prevalent species in disturbed areas including along the park road and some of the trails. This species is extremely difficult to manually treat, and is too abundant to do so. It has not been found in the backcountry or any other undisturbed areas, so this species should not be a high priority.

***Triticum aestivum* – Common Wheat**

This sterile species was planted along the roadside after the park road was paved between 2002 and 2005 (Rapp 2009). Since 2007, no individuals have been seen in Bartlett Cove (Rapp 2007, 2008, 2009).

***Veronica serpyllifolia* – Thyme-leaf Speedwell**

There are both native and invasive variations of this species. Due to their similarity and only minute morphological differences, treatment should not begin until a reliable method of field differentiation is identified.

***Viola tricolor* – Johnny-Jump-Up**

This species was found on the maintenance hillside, and all individuals were treated. It should be possible to eradicate this species in the future if treatment continues.