



Invasive Species Management in Glacier Bay National Park and Preserve

2012 Summary Report

Natural Resource Data Series NPS/GLBA/NRDS—2013/428



ON THE COVER

Native wildflowers in bloom on a pristine beach meadow in Glacier Bay National Park and Preserve's glorious backcountry.

Photograph by: Shahed Dowlatshahi, SCA

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

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Contents

	Page
Figures.....	v
Acknowledgments.....	vi
Acronyms.....	vi
Introduction.....	1
Methods.....	5
Site Selection	6
Results.....	8
Overview.....	8
Bartlett Cove.....	8
Creeping Buttercup	9
Reed Canarygrass.....	10
Other Species	11
Glacier Bay Lodge	12
Depot.....	12
Maintenance Building Hillside	12
Backcountry.....	13
West Arm.....	13
East Arm	15
Strawberry Island.....	16
Dry Bay.....	18
Gustavus	19
Discussion.....	21
Bartlett Cove.....	21

Contents (continued)

	Page
Restoration	22
Backcountry	23
Gustavus	24
Dry Bay.....	25
Herbicide Application.....	25
Outreach & Education.....	27
Invasive Fauna	29
European Green Crab.....	29
Carpet Tunicate	30
Eurasian Collared Dove	30
Gypsy Moth	30
Other Species	30
Appendix A. Invasiveness ranks for non-native plant species known or suspected to occur in Alaska	33

Figures

	Page
Figure 1. The diverse plant communities of Glacier Bay National Park and Preserve.....	1
Figure 2. Glacier Bay National Park and Preserve in Alaska.	2
Figure 3. The Bartlett Cove Developed Area and the gateway community of Gustavus.	4
Figure 4. Invasive plant infestations are first mapped (left) and then dug up and bagged (right).	5
Figure 5. Phenology of priority invasive plants in Glacier Bay National Park and Preserve.....	7
Figure 8. Reed canarygrass infestation on a hillside adjacent to the maintenance building in the BCDA	11
Figure 9. Tall buttercup infestation manually treated by the VIS every year with no reduction in size.	11
Figure 10. Surveyed areas in red - West Arm 07/09/12-07/11/12 - Only common dandelions were found.	14
Figure 11. Surveyed areas in red - West Arm 08/05/12-08/07/12 - Only common dandelions were found.	15
Figure 12. Surveyed areas in red - East Arm 07/08/12-07/09/12 – Only common dandelions were found.	16
Figure 13. Perennial sowthistle infestation on Strawberry Island.	17
Figure 14. Oxeye daisy infestation by fish plant in Dry Bay reduced in area and density over time	18
Figure 15. The disturbed roadside area provides ideal conditions for invasive plant establishment.....	23
Figure 16. Surveys in Glacier Bay’s glorious backcountry	24
Figure 18. Reed canarygrass infestation before (left) and after (right) herbicide treatment.	26
Figure 17. <i>S. arvensis</i> on Strawberry Island before (left) after (right) herbicide treatment.	26
Figure 19. A group of children from Hoonah learned about invasive species in the park (left).	27
Figure 20. Fukui traps baited with herring-filled cans to attract crabs (left).	29

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Acronyms

ADF&G	Alaska Department of Fish and Game
AKDNR	Alaska Division of Natural Resources
BCDA	Bartlett Cove Developed Area
EPMT	Exotic Plant Management Team
GIS	Geographic Information System
GLBA	Glacier Bay National Park and Preserve
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
NPS	National Park Service
NRCS	Natural Resource Conservation Service
SAGA	Southeast Alaska Guidance Association
SCA	Student Conservation Association
UNESCO	United Nations Educational, Scientific and Cultural Organization

Introduction

Glacier Bay National Park and Preserve (GLBA) located west of the Alaska state capital, Juneau, comprises 3.28 million acres of Southeast Alaska (Figure 2). The park is part of the 25 million acre UNESCO World Heritage Site - one of the world's largest international protected areas - which also includes Wrangell-St. Elias National Park and Preserve, and Canada's Kluane and Tatshenshini-Alsek National Parks. GLBA is a unique mix of mountain ranges, ice fields, tidewater glaciers, fjords, and many different types of terrestrial landscapes. The diverse ecosystems of the park allow for an affluence of plant communities, nearly unrivaled in any one area of the globe (Figure 1). Glacier Bay's landscape includes lowland, old-growth forests, bogs and wetlands, and alpine tundra. The amount of shoreline within Glacier Bay also brings with it an abundance of tidally influenced ecosystems such as beach meadows, salt marshes, and estuaries. In addition, over the last 250 years rapid glacial recession has exposed many parts of the bay to bare rock. With such dynamic glacial activity and natural disturbances, GLBA exemplifies the many fluctuations and geologic formations that are possible in a natural ecosystem.



Figure 1. The diverse plant communities of Glacier Bay National Park and Preserve.

Invasive species are one of the greatest threats to the pristine glory of Alaska's national parks. These plants and animals, introduced by humans to an area outside of their native range, aggressively compete with native species, cost citizens and the U.S. government millions of dollars annually, and are implicated in the listing of almost half of all endangered species (Pimental et al., 2000). The introduction of invasive species is not strictly isolated to areas of substantial human impact and disturbance. Natural disturbances such as glacial recession are common in Glacier Bay and may also be ideal sites for invasive plants to establish. The vectors for invasive species introduction, such as backcountry camping and boating recreation, in combination with any type of natural or man-made disturbance, may lead to the establishment and spread of invasive species populations.

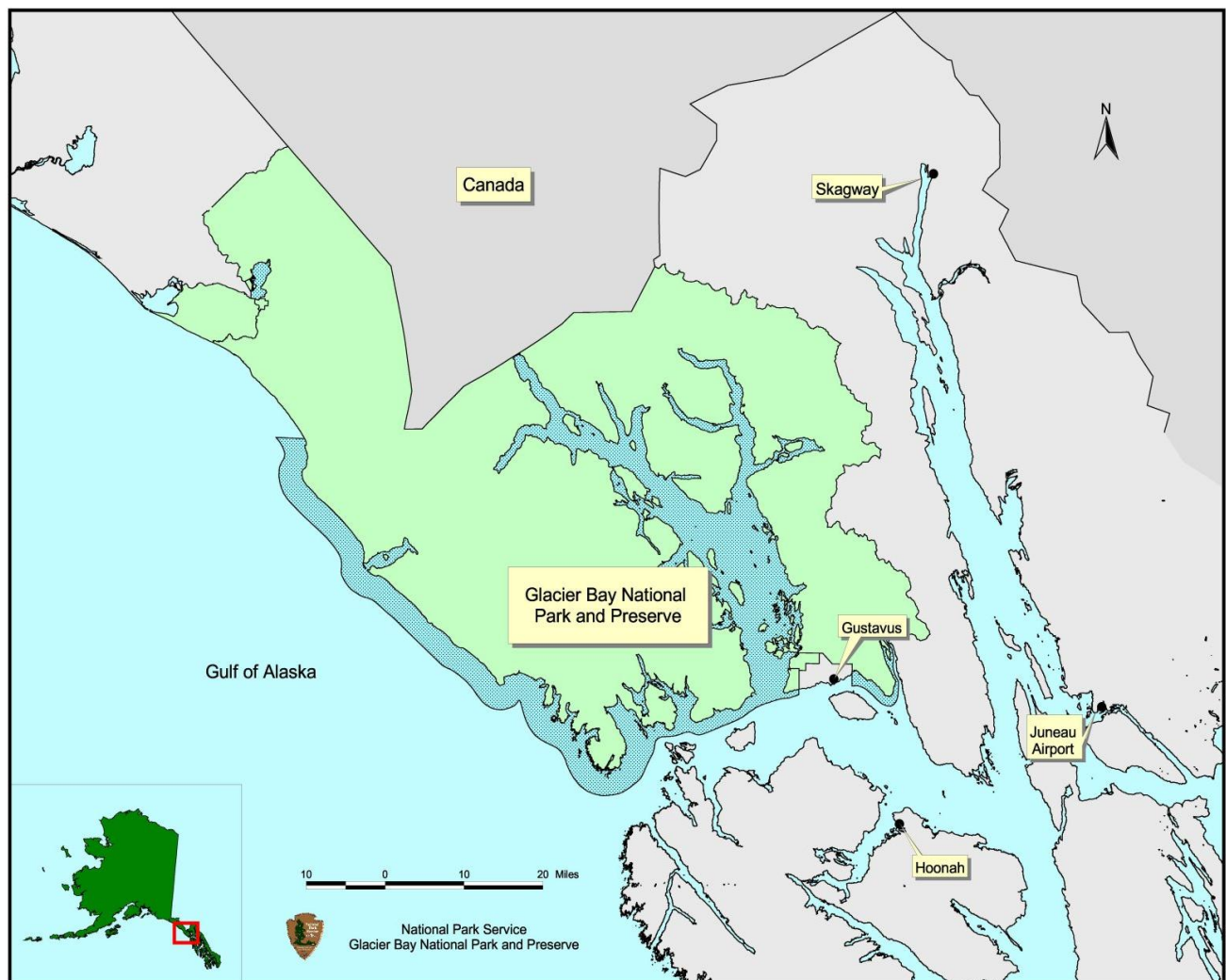


Figure 2. Glacier Bay National Park and Preserve in Alaska.

While Glacier Bay is susceptible to invasive plant establishment due to regular natural and unnatural disturbances, there are factors that prevent it from being a highly probable location for such invasions. The park is not a part of the state or federal road system, which may be the most important corridor for invasive plant colonization aside from intentional plantings of non-native species, and the vast majority of the park's visitors are cruise ship passengers who stay aboard the ships while inside the park. The heavy canopy cover of the Sitka spruce forests also prevents many invasive plants from establishing in GLBA; many acres of the park consist of the heavily shaded understory of such forests, under which the invasive plants found in the disturbed areas of the park cannot thrive.

However, Glacier Bay is not completely immune to the threats posed by invasive plants. While people from all around the world take pleasure in camping and kayaking in the backcountry of the park, they can also serve as vectors for exotic plants and animals. Ferry service to the gateway community of Gustavus began in 2010 and has increased in frequency over the past two years, bringing more and more vehicles from larger cities such as Juneau. These factors increase the probability of the introduction of invasive species to Gustavus and the developed front-country of the park, known as the Bartlett Cove Developed Area (BCDA). As a result, introduction of these species to wilderness backcountry locations is increasingly likely.

Since its establishment in 2005, the Alaska Exotic Plant Management Team (EPMT) in GLBA has been working to prevent the introduction and spread of invasive plant species and to monitor the presence of invasive animal species as well (Rapp, 2005). Before 2011, control efforts were limited to manual removal of invasive species, but since then the use of herbicides has been incorporated into the available options for control in limited and practical situations.

The national EPMT program in Alaska was initiated prior to the most threatening invasive species becoming established to an extent to which manual methods would be ineffective. Thus far, most of the invasive species found in GLBA have been in the BCDA an area within one mile of all Bartlett Cove facilities (Figure 3). Only the common dandelion (*Taraxacum officinale*) has successfully established in the park's backcountry. A focus in 2013 and in future years should be to increase surveys in the most isolated and recently deglaciated locations in the park and to focus control efforts in the BCDA on the most problematic species.



Figure 3. The Bartlett Cove Developed Area and the gateway community of Gustavus.

Methods

Field work for the 2012 season was conducted from late May to early September. The park's EPMT consisted of two Student Conservation Association (SCA) interns, Shahed Dowlatshahi (from May to November) and Patrick Mershon (from May to August). A Southeast Alaska Guidance Association (SAGA) volunteer crew, consisting of four crewmembers and two crew leaders, assisted in invasive plant removal for one week in July. Aside from two herbicide applications, all other invasive plant control was accomplished manually. The dug up plant material was put in mesh bags, weighed, dried, and burned in the park's incinerator (Figure 4). In backcountry areas where travel was difficult, removed plant material weights were estimated. Invasive plants removed from the community of Gustavus were taken to the city's waste management facility for burial.



Figure 4. Invasive plant infestations are first mapped (left) and then dug up and bagged (right).

Data collection and management were conducted following the standardized 2012 Alaska EPMT Field Protocol (Million et al. 2012). Data were collected using a Trimble GeoXH 6000 Global Navigation Satellite System (GNSS) datalogger with TerraSync v.5.21 software, and differentially corrected and edited using GPS Pathfinder Office v.5.30 (Figure 4). Information such as site description, invasive species present, percentage of area covered by the species, and percent treated was standardized using the Alaska EPMT data dictionary referenced in the 2012 Field Protocol. Data were then uploaded to the Alaska regional folder for use in the geographical information system (GIS) database ESRI® ArcMap™ 10.0.

Accuracy in mapping invasive plant infestations has increased significantly in the last two years as a result of switching to the more sophisticated Trimble GeoExplorer® 6000 device. The addition of the Floodlight™ technology has improved the Trimble device's horizontal accuracy to the decimeter-level, whereas earlier device accuracies were at the single-meter level. For this reason, smaller areas previously mapped using line or point features with an estimated buffer area, can now be mapped using the polygon feature, making the maps more accurate and the data more comparable from year to year. The level of estimation that goes into determining buffer sizes can vary significantly from person to person, so by limiting the number of line and point features, estimation errors are reduced.

All EPMT data collected in GLBA since 2005 are accessible through NPS ThemeManager. These data can be transferred to the Trimble unit and utilized in navigating to previously surveyed or treated infestations. This is an immensely useful tool for finding the exact location of previously identified infestations and prioritizing survey and treatment areas. The data can be filtered to display all infestations mapped in a certain year or all infestations of a certain species across years, and in many other useful ways. For example, all 2012 maps can be uploaded to the Trimble unit and used in the field; or the data can be filtered to display all infestations of reed canarygrass (*Phalaris arundinacea*) ever found in the park. It is recommended that the utilization of each park's historical data be a part of the training in Anchorage for all EPMT members in the future.

Site Selection

Data was collected from sites previously surveyed and/or treated, as well as ones never previously surveyed by the EPMT program. Areas for control were selected based on the relative invasiveness of the species present, the potential for eradication, and whether the area had been recently or ever surveyed. The Alaska invasive species rankings (Carlson et al. 2008) were used to determine the invasiveness of exotic plants found in the park. The rankings, ranging from one to 100 (higher numbers being more invasive), provide insight into a species' relative noxiousness or threat to native plant communities (Appendix A). This number is determined by the sum of the ratings a plant receives in the following four categories: ecological impact, biological characteristics and dispersal ability, ecological amplitude and distribution, and feasibility of control. Areas were prioritized for treatment after taking into consideration the above factors plus the phenology of the invasive plants.

Invasive plants such as common timothy (*Phleum pratense*) and wood forget-me-not (*Myosotis sylvatica*) that bloom earlier in the season were the focus of treatment in early June, while tall buttercup (*Ranunculus acris*), creeping buttercup (*Ranunculus repens*), and oxeye daisy (*Leucanthemum vulgare*) were controlled in late June, and reed canarygrass and other late-blooming plants were treated in July and August. Future EPMT crew members can utilize the phenology chart for the park's main invasive species to prioritize the monitoring and treatment of these plants based on when they bloom and are thereby most easily detected (Figure 5).

Control work was focused on the Bartlett Cove area for much of the 2012 season. The EPMT crew also spent a week at Dry Bay in the Glacier Bay National Preserve for monitoring and control. Invasive plant surveys and manual treatment were additionally conducted in the backcountry areas of Glacier Bay.

Taxon	Common Name	Date of First Flower
<i>Viola tricolor</i>	Johnny jumpup	06/08
<i>Myosotis sylvatica</i>	Wood forget-me-not	06/10
<i>Phleum pratense</i>	Common timothy	06/10
<i>Ranunculus acris</i>	Tall buttercup	06/14
<i>Ranunculus repens</i>	Creeping buttercup	06/14
<i>Dactylis glomerata</i>	Orchardgrass	06/18
<i>Rumex acetosella</i>	Common sheep sorrel	06/24
<i>Leucanthemum vulgare</i>	Oxeye daisy	06/29
<i>Centaurea montana</i>	Perennial cornflower	06/29
<i>Symphytum officinale</i>	Common comfrey	07/01
<i>Phalaris arundinacea</i>	Reed canarygrass	07/01
<i>Matricaria discoidea</i>	Pineappleweed	07/02
<i>Geranium robertianum</i>	Herb Robert	07/04
<i>Capsella bursa-pastoris</i>	Shepherd's purse	07/04

Figure 5. Phenology of priority invasive plants in Glacier Bay National Park and Preserve.

Results

Overview

Overall, 74.5 acres of land were inventoried for the presence of invasive species this season. Manual treatment was performed on 27 canopy acres, with 2.1 acres being the actual area treated for invasive species, taking into account the percent cover of the infestation as well as the percentage of the area treated. More than 4000 pounds of wet plant material, dirt, and gravel were removed and subsequently buried or burned this season.

While hand-pulling common dandelion was done extensively in the past, efforts to control this species were ended in 2012. We have determined that common dandelion is widespread enough to be considered integrated into the natural communities in most areas of the park. They were hand-pulled only twice this season - once by the Visitor Information Station (VIS) in order to educate a group of children from Hoonah about invasive plant control, and a second time on an island in Hugh Miller Inlet where the population was small enough to warrant manual treatment with hopes of successful eradication.

Bartlett Cove

The BCDA is the main focus for invasive species control and monitoring in GLBA (Figure 6). In 2012, manual removal of previously identified infestations was continued with the aim of limiting their spread, reducing their size, or eradicating them. Some new populations were discovered, and some previously identified ones were found to have been eradicated, indicating that previous control efforts were effective. What follows is this season's work on notable species and disturbed areas in the BCDA.

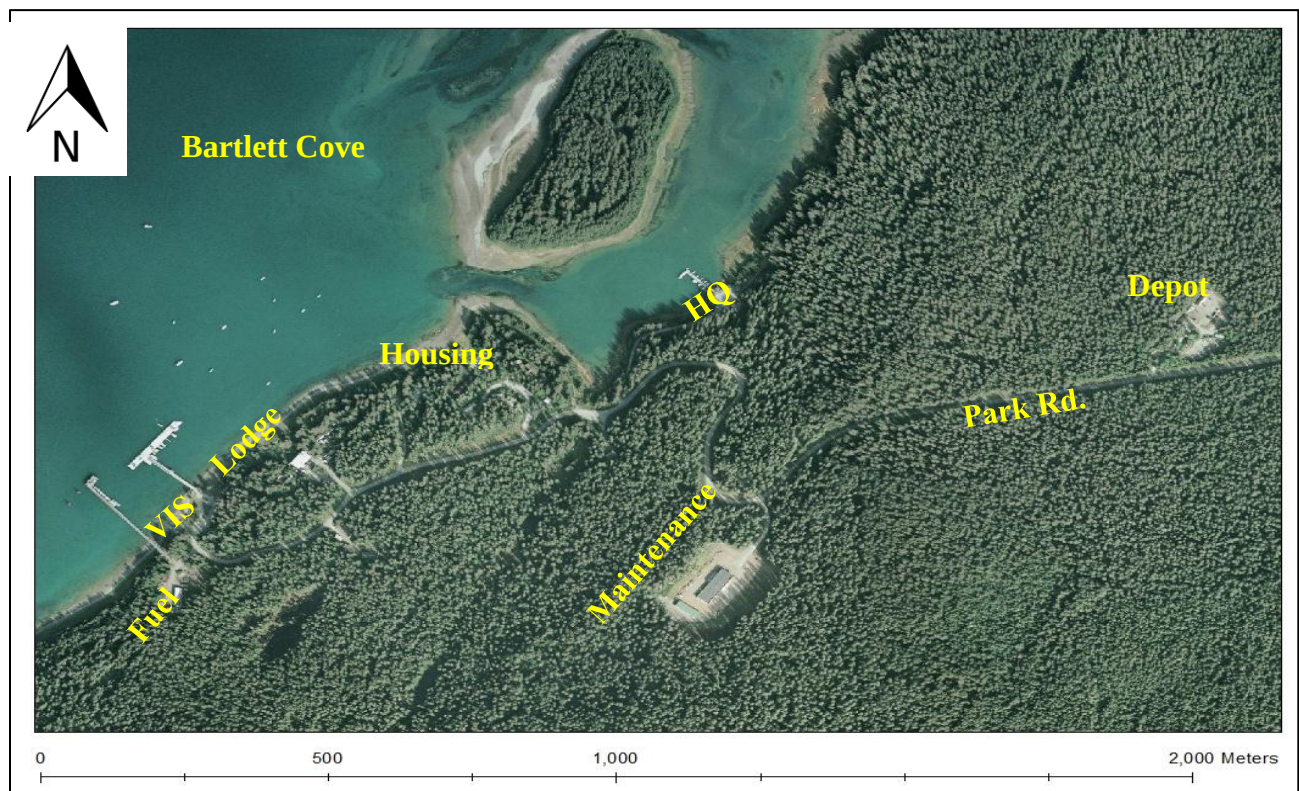


Figure 6. Bartlett Cove facilities referred to in report. Glacier Bay front-country invasive plant control and monitoring is focused on disturbed areas around these facilities and the park road.

The following invasive plants were found and manually treated within the BCDA this season: common timothy, tall buttercup, oxeye daisy, creeping buttercup, reed canarygrass, quackgrass (*Elymus repens*), orchardgrass (*Dactylis glomerata*), herb Robert (*Geranium robertianum*), perennial cornflower (*Centaurea montana*), pineappleweed (*Matricaria discoidea*), shepherd's purse, wood forget-me-not (*Myosotis sylvatica*), common comfrey (*Symphytum officinale*), and a single Himalayan blue poppy (*Meconopsis betonicifolia*) planted as an ornamental.

Creeping Buttercup

One of the most problematic invasive plants found in the park is creeping buttercup. This plant spreads by creeping rhizomes and can quickly displace native plant populations if not controlled and eradicated. Creeping buttercup control was a main focus of this season's EPMT. A significant amount of time was devoted to manually treating known creeping buttercup populations in Bartlett Cove.

There are five distinct areas where creeping buttercup is found in Bartlett Cove and with assistance from a volunteer SAGA crew a total of approximately 200 person-hours were spent on these infestations. The largest one is located on the lawn of permanent housing unit GBQ03 and from there it has spread and established smaller "satellite" infestations in the surrounding area (Figure 7). Besides the extensive treatment of this infestation, populations of creeping buttercup were controlled near the waste management facility (depot), water treatment plant, and the park roadside. Two new infestations of creeping buttercup were found this year, both along the park road close to the headquarters turn-off. Thus far manual treatments in GLBA have not been effective in controlling the spread or reducing the density of creeping buttercup.

Since these plants grow vegetatively from the smallest fragment of root or rhizome left in the ground, manual treatment requires digging deeply and removing a significant amount of dirt and gravel along with the plant material. Because using the park incinerator to burn large volumes of this material is not feasible, a dirt pile covered with a tarp was established next to the fuel station in order to cover the approximately 2000 pounds of dug up buttercup material. This structure will remain undisturbed for as long as possible in order to prevent new infestations from spreading from it, in the hope that the soil seedbank will gradually die out.

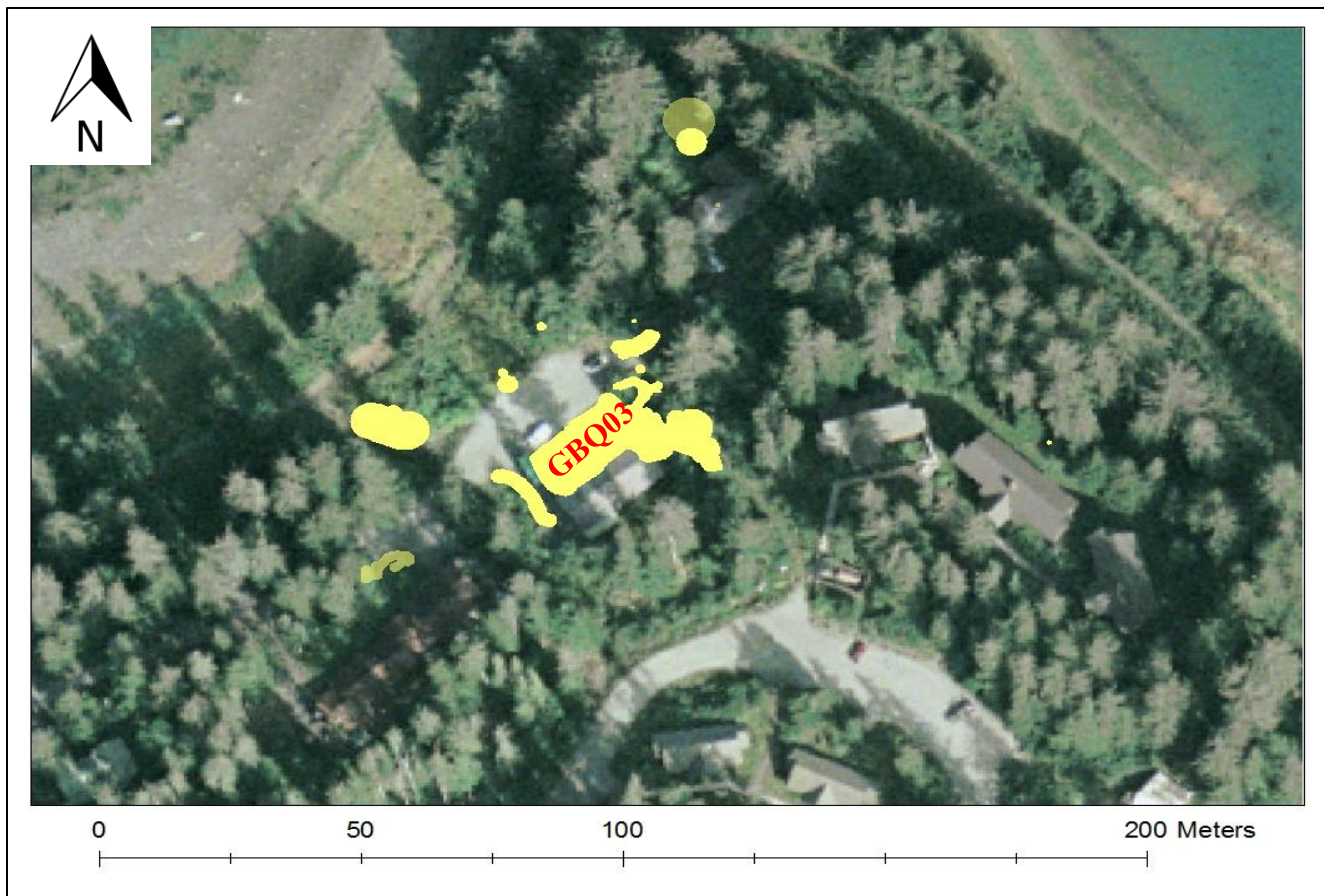


Figure 7. Creeping buttercup is spreading from the lawn of housing unit GBQ03 to surrounding areas.

Reed Canarygrass

The highest ranked invasive plant found in the park is reed canarygrass. Monitoring and treatment for this grass were continued in Bartlett Cove this season. Isolated and small new infestations, as well as previously documented ones were found and manually removed around BCDA facilities, notably by the VIS parking lot and inside the fenced area of the depot. In some instances small populations of the plant were found to have been eradicated from locations where they were present in previous years. This plant has not yet been found in the park's backcountry.

The major infestation of reed canarygrass in Bartlett Cove is found on a hillside adjacent to the maintenance building. The area was contaminated with reed canarygrass seed when contaminated fill was brought in following construction of the maintenance facility (Rapp 2007). The infestation was to be chemically treated last year, but the required time period of dry weather prior to application was not achieved during the scheduled time. This year 56% of the infested area was successfully treated with herbicide for the first time (Figure 8). Aquamaster®, with the active ingredient glyphosate, was applied at the rate of 4oz. per each gallon of spray, to individual plants on a sunny July 26th.

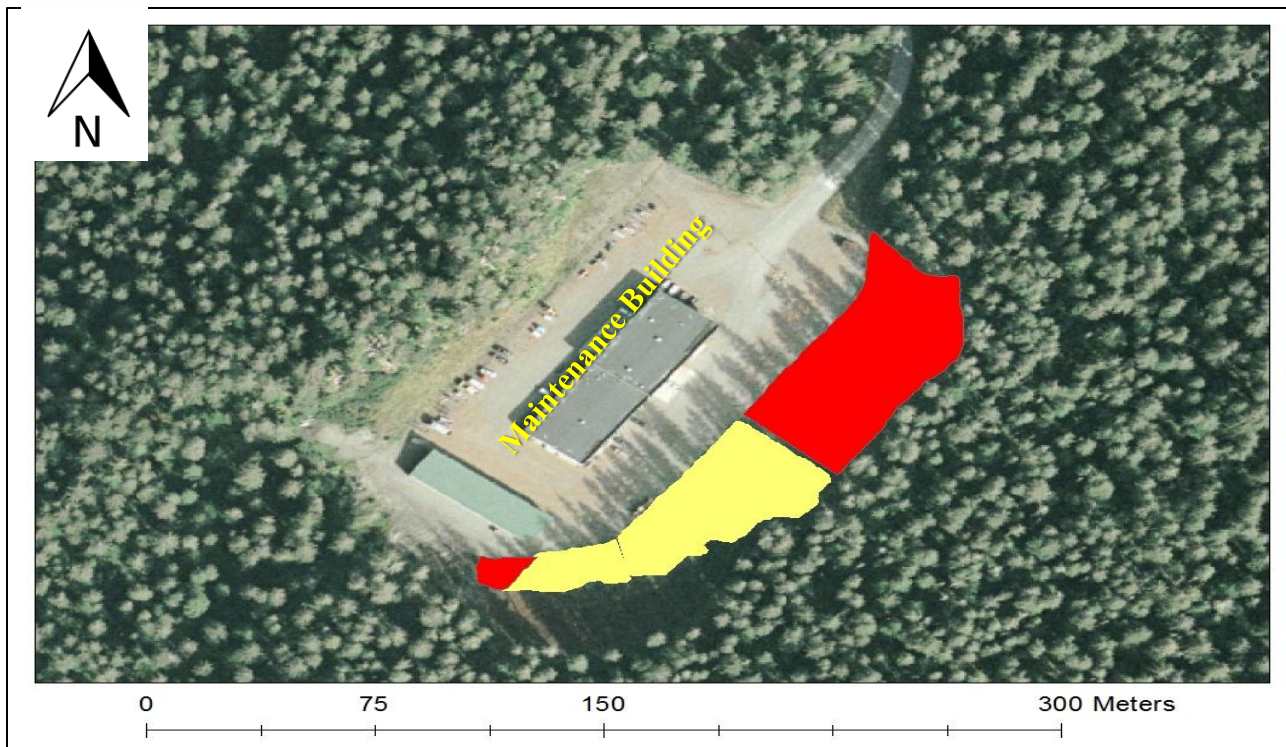


Figure 8. Reed canarygrass infestation on a hillside adjacent to the maintenance building in the BCDA
Red = Treated with herbicide in 2012 **Yellow** = Not treated in 2012

Other Species

The largest infestation of tall buttercup in Bartlett Cove is located near the VIS (Figure 9). This infestation has been treated for years with minimal success in decreasing area or density, and it was treated again this year by the EPMT and SAGA. This population is confined to a relatively isolated area and has not yet spread to surrounding areas. A small patch of tall buttercup was also found and manually treated close to the Glacier Bay Lodge.



Figure 9. Tall buttercup infestation manually treated by the VIS every year with no reduction in size.

Common timothy is one of the earliest blooming invasive plants in the park, and multiple small patches were manually treated in early June. Infestations were located in the Glacier Bay Lodge parking lot island, along the park roadside, and next to the fuel station. Common timothy should not be confused with the native alpine timothy (*Phleum alpinum*) which is also found in the area and has a much shorter panicle.

Oxeye daisy is an invasive plant abundant in Gustavus and found in smaller patches in Bartlett Cove. This season, a single oxeye daisy plant was found growing by the Bartlett River trailhead adjacent to the park road, and one was found by the flagpole close the VIS. Many previously mapped infestations of the plant were navigated to and not detected, including the population traditionally found by permanent housing. The manual treatment of this plant has controlled its spread in Bartlett Cove and effectively eradicated many small populations.

The only known population of herb Robert (*Geranium robertianum*) in the park was manually treated this year. The volunteer SAGA crew spent a few hours treating this species by the permanent housing area in Bartlett Cove.

Glacier Bay Lodge

The Glacier Bay Lodge parking lot area was visited often early in the season. Wood forget-me-not has been found growing in small numbers in the parking lot island over the years. It is possible that the area was seeded with the plant, or seeds could have come from planter boxes by the Lodge steps. A similar native species, alpine forget-me-not (*Eritrichium nanum*) is the state flower of Alaska. ‘Alaskan native wildflower seed’ mixes are common and could be potential source of this infestation. These mixes likely contain *M. sylvatica* seeds, due to it being a similar-looking species with the same common name as the native species and easier to cultivate. Common timothy and tall buttercup were also hand-pulled this year by the Glacier Bay Lodge parking lot.

Depot

The area surrounding the depot is host to a number of invasive plant species. Quackgrass is found growing in gravel inside the fenced area. Small patches of reed canarygrass were found, as well as common timothy, and shepherd’s purse. Common comfrey is found year after year in fill piles around the facility, its only location in the park. All of these species were dug up and burned in 2012. Pineappleweed is abundant in this area and not considered a priority, but some populations of the plant were treated, as time allowed. Creeping buttercup is the most important invasive plant in the depot area, and the SAGA crew spent approximately 50 person-hours hand pulling this infestation. Fill importation and dirt road disturbance by this area cause it to host a high number of invasive plants. Fortunately, none of these species are establishing beneath the adjacent forest canopy.

Maintenance Building Hillside

Besides the reed canarygrass infestation previously mentioned, the hillside adjacent to the maintenance facility has hosted a population of Johnny jumpup (*Viola tricolor*) for years. This plant blooms early in June and the showy flowers make it easily detectable. A single Johnny jumpup was found last year, while in 2010 the number was less than ten (Decker, 2010); plants were neither detected on the hillside nor anywhere else in the park this season. Manual treatments over the years seem to have been effective in eradicating this plant from the park. However both permanent housing (another location where the plant has been found) and the

maintenance hillside will be monitored in following years to ensure complete eradication. A number of perennial cornflower (*Centaurea montana*) plants that have been found on the maintenance hillside in past years were detected again this season. All plants were removed, weighed, and burned. This is the only infestation of perennial cornflower in the park, and control efforts should continue because of the high potential for complete eradication.

Backcountry

In 2012 the EPMT spent a significant amount of time surveying backcountry areas that had not been recently or ever surveyed, with the intent to ensure that all accessible areas of the park are investigated for the presence of invasive species over the years. Potential visitor use areas were targeted, and previous years' data were used to determine which sites had never been surveyed and which needed to be resurveyed. Due to the difficulty inherent in travelling to backcountry areas of Glacier Bay, only a small portion of the park is surveyed each year.

This year, areas surrounding the kayaker drop-off points in the East and West Arms were surveyed in July, and all beaches from Blue Mouse Cove to Ibach Point were surveyed in August. A small portion of Tarr Inlet was also surveyed in August. The perennial sowthistle infestation on Strawberry Island was treated with herbicide, and a small population of common dandelion was hand-pulled on an island in Hugh Miller Inlet.

Much of the past Glacier Bay backcountry monitoring and inventory data has failed to document the presence of invasive species. Generally, common dandelions are the only invasive plant present in the northern portion of the Bay. A population of oxeye daisy was found at Reid Inlet in 2006 and treated until 2008, but no plants have been observed in that location since, and the species is now considered eradicated from Reid Inlet. Besides common dandelions, no invasive plants were detected in backcountry surveys this season.

West Arm

Two trips were made to the West Arm for invasive plant surveys this season. The EPMT was dropped off and picked up by park vessels and utilized kayaks in order to navigate to survey sites on these trips.

07/09/12-07/11/12

Two days were spent surveying Charpentier and Hugh Miller Inlets and Sundew Cove in early July (Figure 10). Common dandelions were found on multiple Hugh Miller Inlet beaches but none were detected in Charpentier Inlet. An island in Hugh Miller Inlet was found to have a low density of common dandelions which were removed as time permitted. Several beaches around Sundew Cove were also surveyed, and nothing but common dandelion was found. Besides dandelions, no other invasive species were found on any of the sites surveyed on this trip.

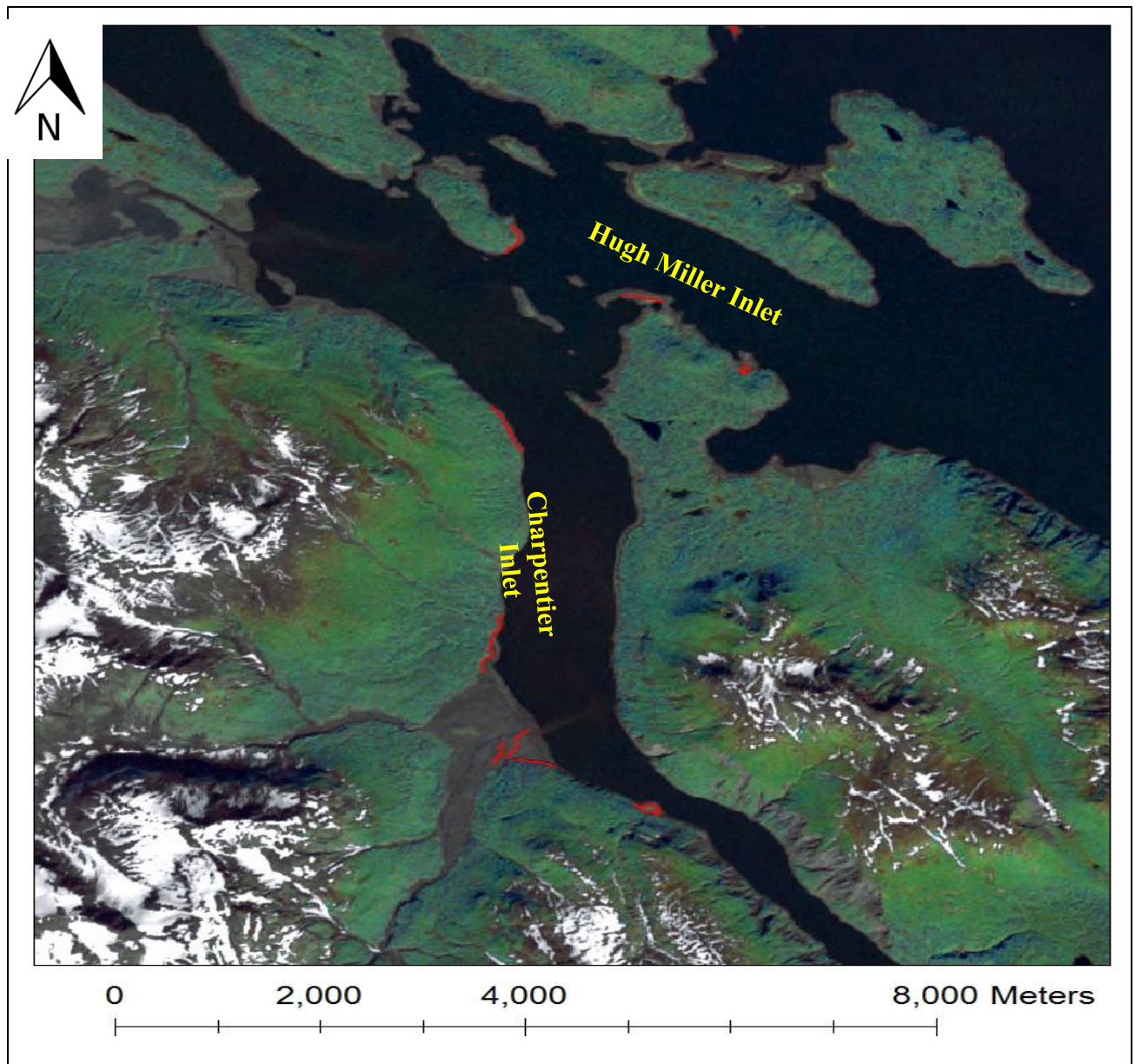


Figure 10. Surveyed areas in red - West Arm 07/09/12-07/11/12 - Only common dandelions were found.

08/05/12-08/07/12

In early August, two days were spent surveying beaches from Blue Mouse Cove up to Ibach Point (Figure 11). Once again, besides common dandelions no invasive plants were found on any of the beaches surveyed. Common dandelions were abundant on some beaches and non-existent on other, more rocky ones. A small portion of Tarr Inlet was also surveyed during this trip, and no invasive plants were found.

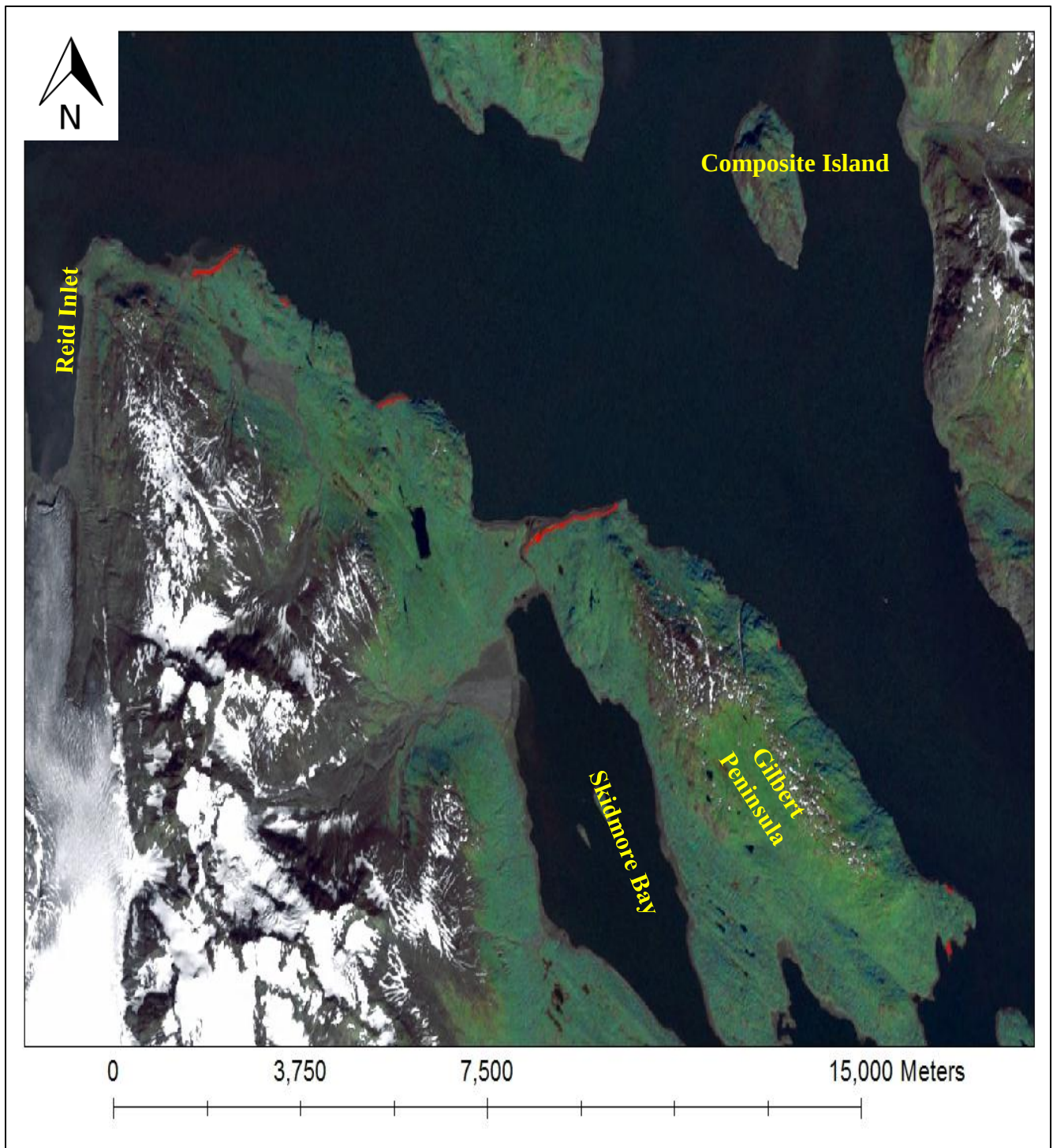


Figure 11. Surveyed areas in red - West Arm 08/05/12-08/07/12 - Only common dandelions were found.

East Arm

Mount Wright, Garforth Island, and Sebree Island were the sites surveyed in the lower East Arm this season (Figure 12). Vast expanses of previously unsurveyed land on Sebree Island were covered, and only common dandelions were found. Garforth Island also hosts only dandelions. The Mount Wright drop-off point proved free of any invasive species. No other invasive plants besides the common dandelions have ever been found in Glacier Bay's pristine East Arm.

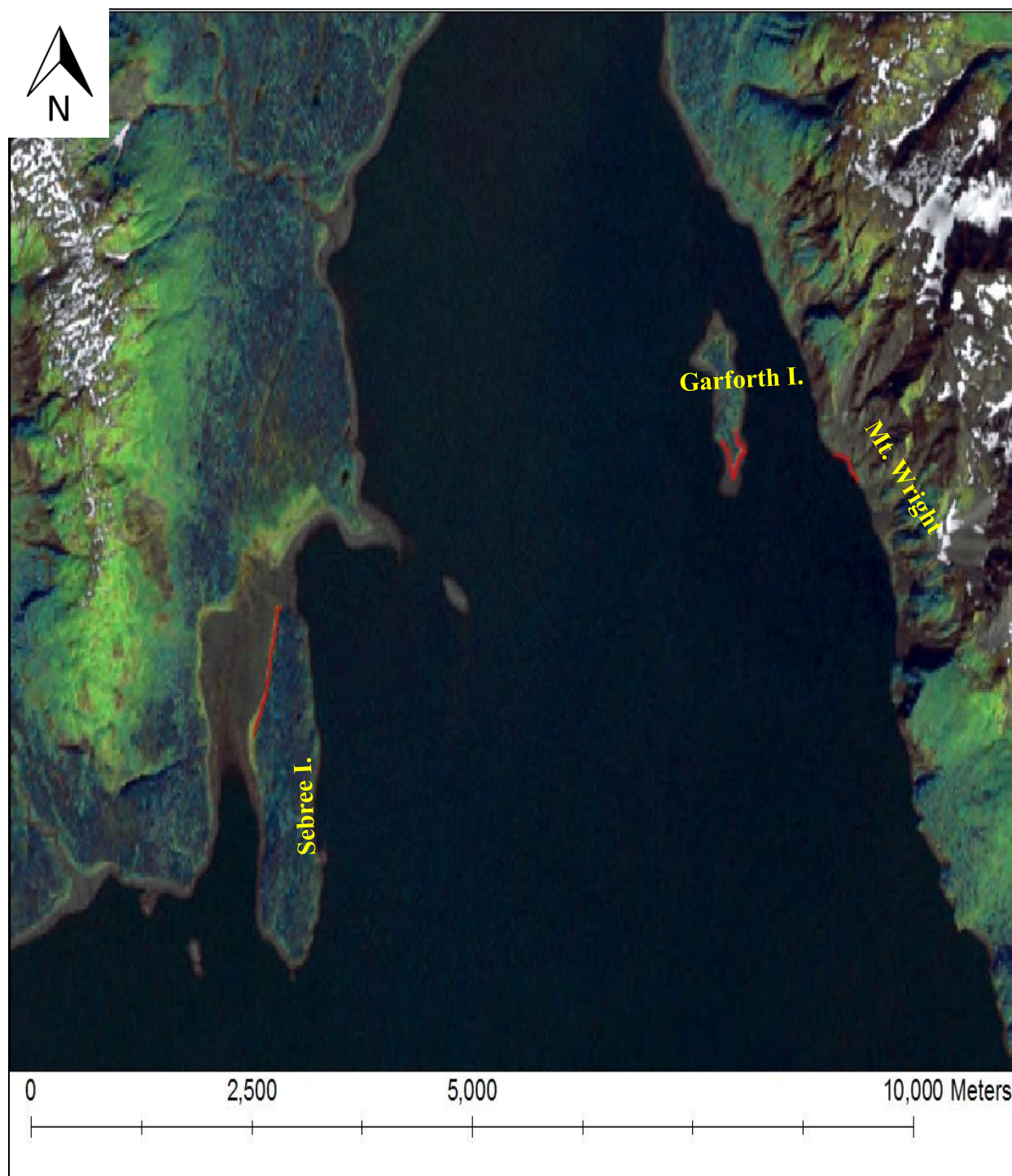


Figure 12. Surveyed areas in red - East Arm 07/08/12-07/09/12 – Only common dandelions were found.

Strawberry Island

Perennial sowthistle (*Sonchus arvensis*) exists in high densities on the south side of the island. This is the site of a fox farm that existed from 1929 to 1938 (Kurtz 1995), and this large infestation is likely a remnant from that operation. A portion of the southwestern side of this population was successfully treated with herbicide for the first time in 2011. A preliminary trip

before this year's application determined that the area treated in 2011 had a much lower density of seedlings compared to the rest of the infestation. A late July herbicide application was designed to treat the entire perennial sowthistle infestation this season, and more than half of the infestation was successfully treated with Aquamaster®, including the area treated last year and a separate smaller infestation on the southeastern side (Figure 13). In total, 0.264 acres of the 0.458-acre infestation was treated this year. Aquamaster®, with the active ingredient glyphosate, was applied to individual plants at the rate of 4 oz. per each gallon of spray.

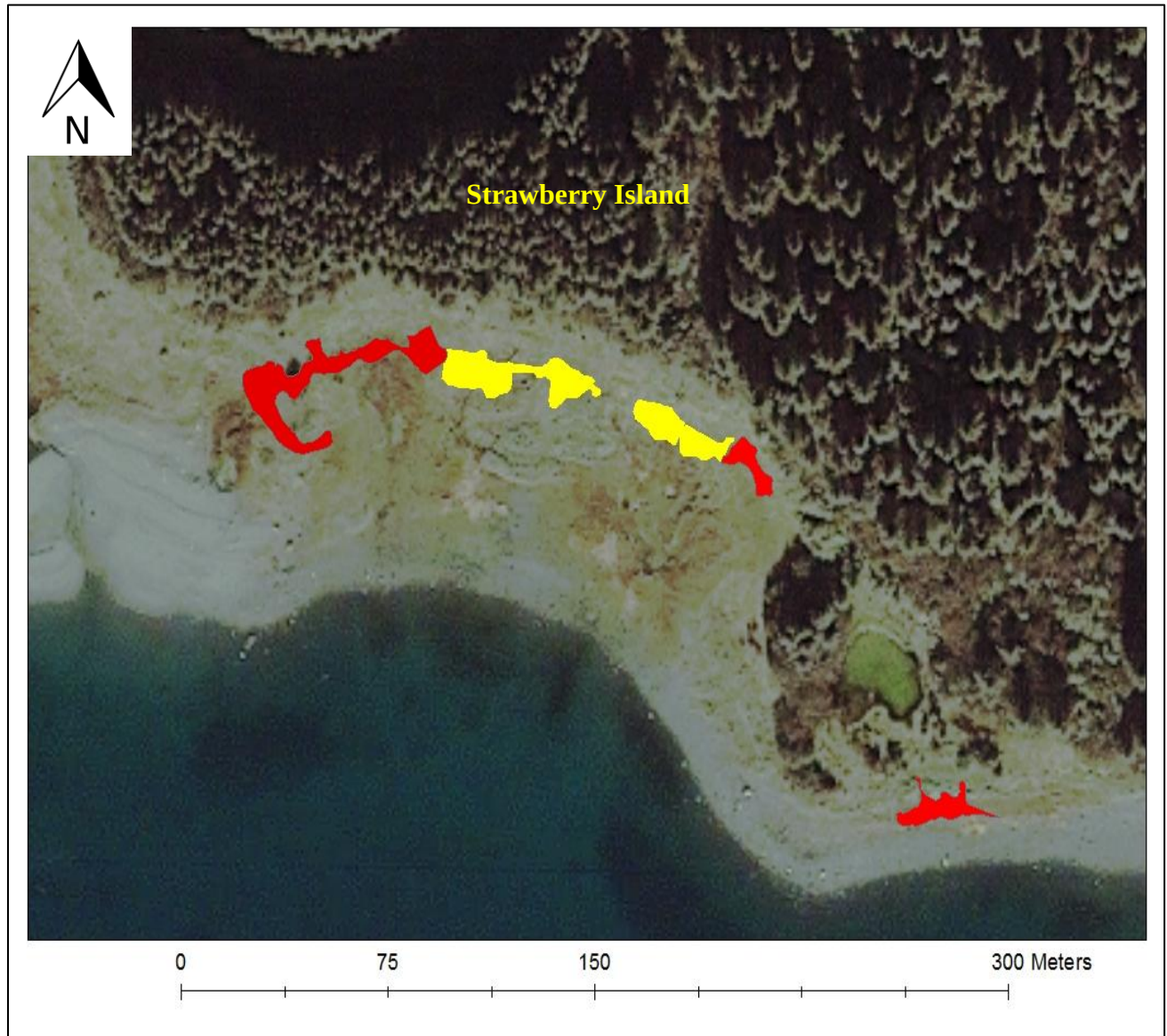


Figure 13. Perennial sowthistle infestation on Strawberry Island.

Red = Treated with herbicide in 2012 **Yellow** = Not treated in 2012

Dry Bay

The EPMT crew visited Dry Bay in Glacier Bay National Preserve in late July for one week of invasive plant control and survey. Oxeye daisy is present at two main areas in the preserve, and time was spent hand-pulling plants in both areas.

The fish plant by the airstrip has hosted a population of oxeye daisy for many years as a result of contaminated fill that was used in 2005 (Fisk 2011). With help from the law enforcement rangers stationed in the preserve, the area by the airstrip was 100% treated for oxeye daisy this season. Multiple isolated patches of oxeye daisy were found and mapped in this area. Some were not detected this season, indicating the success of previous treatments, and several new patches were discovered and treated. The size and density of this population has been drastically reduced since treatment by the EPMT began in 2005 (Figure 10).

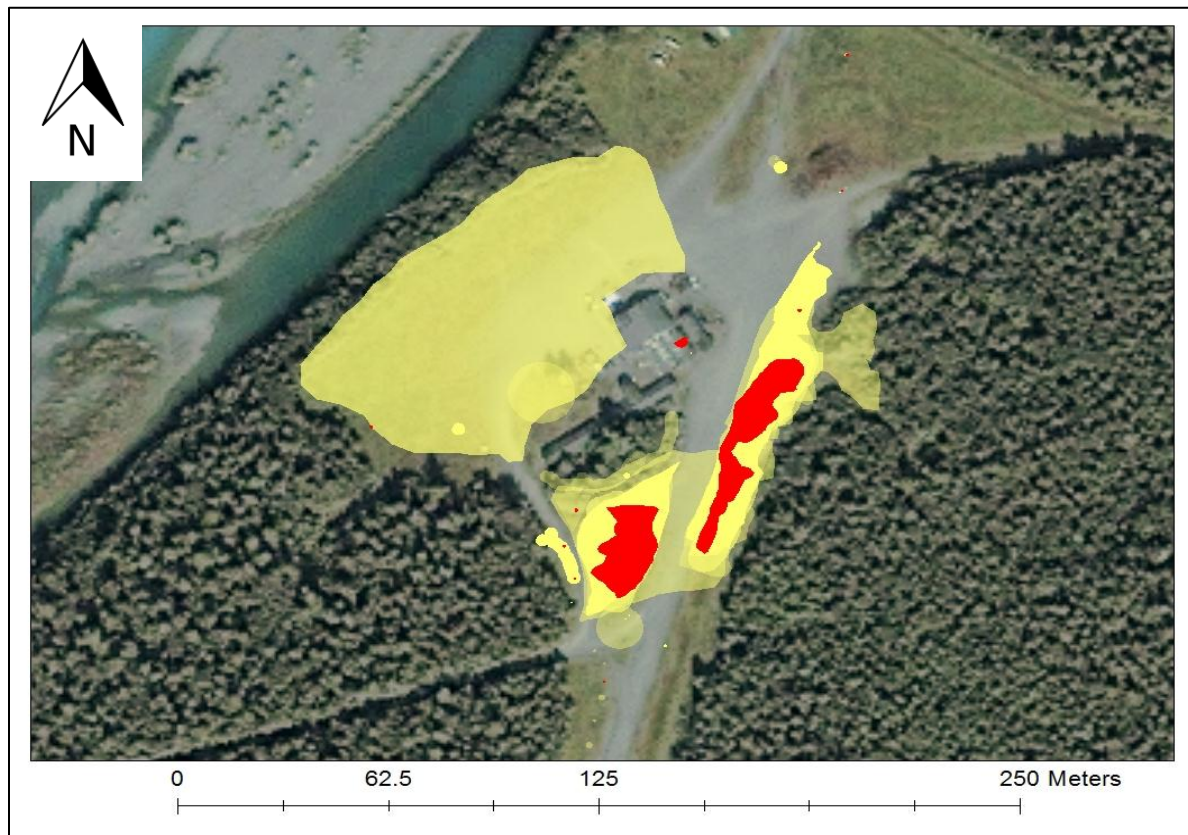


Figure 14. Oxeye daisy infestation by fish plant in Dry Bay reduced in area and density over time
Red = Infested area in 2012 **Yellow** = Infested area 2005-2011

A high density of oxeye daisies is found at the Hazen cabin near the Dog Salmon airstrip. This site has been treated for multiple years, and treatment was continued this year. The area was treated for flowering plants and seedlings, but complete seedling treatment was not possible due to time constraints and the high density of the seedlings.

In past years bigleaf lupine (*Lupinus polyphyllus*) has been extensively surveyed in the preserve. Surveys show that *L. polyphyllus* is quite common in the Dry Bay region outside the active floodplain of the Alsek River (Rapp 2009). Due to ambiguities surrounding the native range and

natural range expansion of this species (Hultén 1968), it was not prioritized for monitoring or control in 2012.

Gustavus

Gustavus is the gateway community to Glacier Bay National Park and an important factor in invasive species control within Bartlett Cove and Glacier Bay. Monitoring for invasive species in Gustavus has been conducted for many years and was continued in 2012. With the encroachment of species such as reed canarygrass and oxeye daisy in Gustavus, the focus in 2012 was on surveying the main road leading into the park.

A population of scentless false mayweed (*Tripleurospermum inodorum*) was found growing around the Gustavus School building and playground this season. After detecting the unusually fast spread of this plant it was identified as an invasive and all plants around the school were hand-pulled with the help of local volunteers. Approximately 500 pounds of the plant were burned at the park's waste management facility or disposed of at the city's waste management facility. This was the first time the plant was detected anywhere in Gustavus or the park. Scentless false mayweed was also observed growing around the natural food store in Gustavus but was not treated by the EPMT.

The volunteer SAGA crew spent one day treating common comfrey, perennial cornflower, common timothy, bigleaf lupine, and creeping buttercup around the park housing facilities in town. Species in Gustavus that are not present in the park include orange hawkweed (*Hieracium auranticum*), European mountain-ash (one sapling removed from the park in 2011), and bishop's goutweed (*Aegopodium podagraria*).

Discussion

Bartlett Cove

The Bartlett Cove Developed Area is highly impacted by human activity. Construction projects, brush cutting, lawn mowing, tourist use, and roadside clearing are some of the major disturbances that occur in Bartlett Cove. Many of these actions have a negative effect on native vegetation, and altering these natural areas increases opportunities for invasive species colonization and establishment. A goal of GLBA is to provide enjoyment to visitors who come to experience the pristine and untouched glory of the park, and at times balancing natural processes with visitor access can be a difficult task. Nevertheless, thoughtful planning can make it possible to manage an area for visitor enjoyment while retaining its natural character.

The greatest challenge in preventing invasive plant establishment in Bartlett Cove is brush removal that causes physical disturbance of the ground surface. Exposing the understory to direct sunlight and digging up the top-soil layer together provide an ideal environment for invasive plants. Sites like the maintenance facility hillside, which is host to many invasive plants including the largest population of reed canarygrass in all of Alaska's national parks, is an example of how these actions can have a serious negative impact on native plant communities. Another example is the annual roadside clearing to keep roads clear of brush and debris. The same SAGA crew that helped the EPMT treat invasive plants assisted the maintenance department remove alder from the roadside. Alder thickets along the roadside very effectively reduces the chances of invasive plant establishment. A vegetation management plan should be devised so that clear objectives and protocols are in place for the management of roadside vegetation. Efforts should be made to balance safety and pavement protection needs with the desire to keep as much native vegetation intact as possible, and to prevent creating disturbed areas along the roadside. Doing so will help provide a natural setting for visitors to the park as well as limiting the chance of invasive plant establishment.

Creeping buttercup will need a developed and focused plan for its control in Bartlett Cove. This plant has an invasiveness rating of 54 and can easily spread if not controlled, yet the potential exists to eradicate it from the park; these factors make its control a high priority of the program. Keeping creeping buttercup out of the park's backcountry is also of considerable importance. This is a shade-tolerant species found growing in full sunlight, in gravel along the park road, and among a dense alder thicket by permanent housing. Bartlett Cove buttercup populations have reached a point in their spread where manual control may no longer be effective in reducing their size or density, and they seem to be spreading to undisturbed areas.

Based on current data from GLBA, manual control is recommended for small (1-2 m²) populations, and herbicide application for larger ones. In fact, herbicide application seems necessary at this point in order to eradicate the plant from Bartlett Cove. *R. repens* is one of the last herbaceous species to die back in the fall and the plants stay green into late October while the majority of the surrounding species die back; thus an herbicide treatment would likely be effective through September with little impact on native vegetation. While manual treatment should continue in order to contain the spread, chemical control should be seriously considered for the future management of this species.

Every year reed canarygrass is found in new locations in the BCDA due to the large seed-bank that exists in soils outside the park. However, the areas where it has reappeared have been

isolated and with regular manual treatments most of these small populations can be controlled and eventually eradicated. With a concerted effort, reed canarygrass can be contained and not allowed to spread into the park's backcountry.

The permanent housing unit GBQ04, which has the only population of herb Robert in the park, should be able to be made weed-free in the next few years with continuing manual treatments. The oxeye daisy population usually detected in this location was not found this year but should be monitored in future years to ensure eradication. It should be noted that many oxeye daisy infestations found in Bartlett Cove in previous years were navigated to and not found this year. The monitoring of all these sites should continue to ensure the populations have been completely eradicated.

The waste management facility in the BCDA is an area where significant disturbance of the ground layer occurs every season. As the source of stored fill material for the park and host to a number of invasive plants, annual surveys of the area are necessary. Invasive plants traditionally found in this area should continue to be controlled every season in hopes of eradication.

A few non-native species are abundant within the BCDA, including common dandelion, mouse-ear chickweed (*Cerastium fontanum*), white clover (*Trifolium repens*), and common plantain (*Plantago major*). These species are not considered a high priority for treatment due to their relative abundance and low degree of invasiveness (Carlson et al. 2008). After years of manual treatment in the BCDA, dandelion populations have expanded or remained the same and are no longer being treated. We recommend that time be spent on smaller populations of more harmful plants in Bartlett Cove as opposed to the more abundant (but less noxious) species mentioned above.

Restoration

Exotic plant management should focus not only on removal of invasive plant species, but also preventative actions that will significantly reduce the chances for invasive species establishment. A necessary component of invasive species management is a plan for revegetation following a construction project. Policies that protect natural vegetation will significantly reduce the potential for invasive plant population establishment in the park. A revegetation protocol that promotes the health of native plant communities should be developed for the BCDA. Such a protocol would address seed collection and planting techniques, seed storage, and how to monitor revegetated sites for native species establishment. Issues such as roadside clearing, vegetation alteration for construction projects, and management of vegetated areas around park buildings should also be addressed in this plan.

Current park actions have had a detrimental effect on native plant regeneration in many areas. Altering the park's current vegetation management strategies to take into account natural processes for revegetation, such as allowing for alder growth, will improve the ability of native species to reestablish in disturbed areas. The focus should be on the park road where open disturbed ground, combined with vehicle and pedestrian traffic transporting seeds into the park, provides ideal conditions for invasive species establishment (Figure 15).

Several sites were revegetated with native seeds following invasive plant removal this year. These sites were mapped and should be monitored for the growth of planted natives and the disappearance of the invasive species in the next few years. It is recommended that the EPMT

program develop a protocol for managing revegetation data similar to that for invasive plant infestations. This could be accomplished by utilizing a separate data dictionary to map areas where native seeds are planted, record what seeds were planted, and what invasive plants were removed. This would enable future EMPT members to monitor the success or failure of revegetation efforts.



Figure 15. The disturbed roadside area provides ideal conditions for invasive plant establishment.

Backcountry

Monitoring is a powerful tool for identifying invasive plant populations in their early stages. If identified early, problems can be addressed while cost-effective solutions are still available. An invasive plant is much easier to control at the initial stages of invasion, compared to eradicating it once it is well established at a site. EPMT staff should survey in detail any area in the backcountry that they travel to and make sure that there are no populations of the more dangerous invasive plants found in Bartlett Cove such as reed canarygrass and creeping buttercup. A methodical and slow approach should be taken while surveying beach meadows and stream sides. Early detection of small infestations is crucial in keeping Glacier Bay's backcountry free of invasive species.

Surveys for an invasive plant should be conducted if opportunities for effective management exist based on the results of the survey. Simply documenting the expansion or abundance of common dandelion in the bay while no real management solution is available is a futile effort and a waste of resources better invested on actively surveying for more harmful and less established invasive plants. Dandelions were observed growing along the beach meadows in almost all the backcountry areas surveyed this year. EPMT's backcountry trips in the future should focus on monitoring for invasive plants besides common dandelions. Effective manual

treatment is nearly impossible for these dense and long-established populations and should not be a priority. If the crew is actively looking for dandelions they are liable to miss other invasive plants potentially present in an area. Travel time can also be a limiting factor for invasive species work in the Glacier Bay backcountry, so adequate organization and planning are important to being effective.



Commonly used backcountry camping areas should be priority sites for monitoring. Considering the current populations of reed canarygrass in Gustavus, it is quite possible for the plant to spread to wilderness areas regularly used by backcountry visitors. Well thought-out strategies for monitoring should be employed to prevent an area from going unchecked for many years and visitor use surveys should be used for prioritization of monitoring locations. Isolated areas such as the park's outer coast receive very few visitors but they should be considered for monitoring every

Figure 16. Surveys in Glacier Bay's glorious backcountry

few years because invasive species establishment is still possible via seed and plant part transport by animals, wind, etc.

Overall, Glacier Bay wilderness areas appear essentially free of invasive plants besides common dandelions which are too numerous and widespread to effectively treat. Monitoring in future years should focus on covering more ground in order to ensure these backcountry areas stay free of invasive plants already occurring in the BCDA and Gustavus.

Gustavus

Many invasive plants are found in Gustavus that have not yet reached the park. The most important of these is orange hawkweed, and outreach efforts in the future will focus on eradicating this species from areas near the park boundary as well as along roadsides. False scentless mayweed was the only new invasive plant found in the area this season. It is crucial to monitor for the presence of this plant around the Gustavus School in upcoming years and make sure it is treated before flowering and seed production commence. This is an annual plant and even if the flower heads are removed the seeds will remain viable, so all plant material should be bagged and burned. It is essential that this population be treated every year in Gustavus.

Many non-native tree and shrub species are planted in Gustavus as ornamentals. Limiting the scope of their use by promoting the use of native species would reduce the chance that any of these non-native species with invasive qualities could become a threat to native plant

communities. Gustavus is a small community removed from the road system and thus has some ability to resist the establishment of highly invasive species. However, with the increase in ferry traffic it is likely that species present near the ferry terminal in Juneau, will show up in Gustavus.

Dry Bay

The GLBA EPMT manages invasive species in Glacier Bay National Preserve. Due to its isolation from the park's headquarters, only a single week-long visit was possible in 2012. Infestations of oxeye daisy in the Dry Bay area have been treated for several years. The population at the fish plant adjacent to the airstrip has been significantly reduced in size and density over time (Figure 14). Regular yearly treatments can be effective for a species such as oxeye daisy because it is an annual that reproduces only by seed. For hand-pulling treatments to be effective, yearly visits are necessary to keep the populations from spreading. Due to seedling density, the oxeye daisy population at the Hazen cabin site near the Dog Salmon airstrip is likely not going to be eradicated for many years. It is strongly recommended that EPMT members visit Dry Bay every year in late July or early August to control and monitor the oxeye daisy population by the airstrip and the cabin as there is a reasonable chance of eradicating the species from both sites with continued manual treatments.

Bigleaf lupine is abundant in the preserve and likely native to western North America. This species may naturally spread its range northward into Southeast Alaska. Because of its broad distribution and density, bigleaf lupine should no longer be treated in Dry Bay. Future decisions on its treatment will be made when it is discovered within the park boundary, which is likely since it is also commonly found in Gustavus

Herbicide Application

2012 marked the second year that chemicals were used to battle invasive plants in GLBA. Approximately 57% of the perennial sowthistle infestation on Strawberry Island and 56% of the reed canarygrass infestation on the maintenance hill in the BCDA were successfully treated in late July. Observational follow-up trips to both sites in September determined applications to have been highly successful in killing the targeted plants (Figures 17 and 18). However, even in the treated areas many plants still survive, as it is difficult to find and spray all individual plants. A task for 2013 will be to compare the perennial sowthistle area treated in both 2011 and 2012, to the area treated only in 2012, and the area not treated at all. This will provide a good sense of how effective the treatment has been over the course of two years. It is also recommended that up to four people be used to treat this infestation so that all the infested area can be treated in one day-trip. It is likely that treatment will need to continue for several years in order for this population to be completely eradicated. Perennial sowthistle has the ability to reproduce by root fragments (MN DNR 2011), requiring a multi-year focus on the area to guarantee eradication.

A comparison between areas treated and not treated should also be carried out next year for the reed canarygrass infestation to evaluate effectiveness. It is likely that multiple treatments in upcoming years will be necessary to completely eradicate reed canarygrass from the area. This is an important infestation to be controlled because of its size, and the fact that many park vehicles pass by this hillside and can potentially spread plant seeds to other areas of the park.



Figure 17. *S. arvensis* on Strawberry Island before (left) after (right) herbicide treatment.



Figure 18. Reed canarygrass infestation before (left) and after (right) herbicide treatment.



Figure 19. A group of children from Hoonah learned about invasive species in the park (left). EPMT staffed an educational booth at the 4th of July Festival in Gustavus (right).

Aquamaster™, a broad spectrum herbicide, was used to treat both infestations. Glyphosate, the active ingredient in this herbicide, has favorable environmental characteristics, such as degradation over relatively short times in soil, sediment, and natural waters, and tight binding to most soils and sediment, which reduces bioavailability soon after application. Both sites will be scheduled for treatment in 2013, with follow-up applications in subsequent years to ensure complete eradication. It is recommended that the interns and technicians in charge of the program next year acquire herbicide applicator certifications during the EPMT training in Anchorage. This will ensure that herbicide treatments are accomplished without depending on licensed applicators travelling to the park from the regional office, making it easier to schedule treatments based on weather.

Outreach & Education

In 2012 the EPMT staffed a booth at the Gustavus Fourth of July Festival to raise awareness of invasive species found in town and the park, the threat they pose to these pristine natural areas, and what people can do to help. A presentation was given for the public and park staff at the Glacier Bay Lodge regarding invasive species in Glacier Bay and Gustavus. This season's inventory and control activities were also described. Both of the above outreach activities were great ways for the EPMT team to reach the public, and they should be continued in the future.

Due to the species' relative ease of identification and recent discovery in town, false scentless mayweed should be a focus for outreach with Gustavus residents. Public awareness of this plant as well as other easily identified species such as orange hawkweed should be a priority of EPMT outreach and education events in town. Continuing to inform visitors and residents about the threats that are posed by invasive species that are likely to reach Gustavus in the coming years will be important in helping to detect infestations before they establish.

The interpretation staff at GLBA is a great conduit for information dissemination to the public. Efforts should be made to include invasive species education in the interpretive staff program by relaying information to rangers who are interacting with park visitors on a daily basis. Park maintenance staff should also be made aware of the potential problems that moving contaminated soil and disturbing native vegetation can cause with regard to invasive plants. In order to alleviate the pressure that is put on native plant communities, the cutting of alder thickets on the hills of the park road should be reconsidered. These actions have direct negative impacts on native plant communities and increase opportunities for invasive plant establishment.

An invasive species boot brush along with an educational sign is being designed for park visitor education. The brush and the sign will demonstrate how invasive plant seeds can be transported via boots and other gear while providing a useful tool for visitors to brush these potential invaders off of their footwear before entering the backcountry.



Figure 20. Fukui traps baited with herring-filled cans to attract crabs (left). Native helmet crab trapped, sexed, measured, and released (right).

Invasive Fauna

European Green Crab

The European green crab (*Carcinus maenas*) is one of the most deleterious invasive species in the world, with the potential to displace native crab species and threaten shellfish and shorebird populations (PWS RCAC 2004). The crabs have yet to be reported north of Vancouver Island, British Columbia, Canada (ADF&G 2012). In GLBA monitoring for the crab has been conducted since 2008 and was continued in 2012. This season three trapping sessions were carried out to detect the crab's presence - one in early June, one in early July, and one in October.

All three trappings took place on the north side of Lagoon Island. Eight Fukui crab traps were deployed one foot below the water on the lowest low tide of the month. Each trap was baited with two herring cut up into several pieces and placed in a ventilated plastic bait can. The traps were held in place by re-bar stakes and placed 20 to 30 meters apart. The GPS coordinates of each trap were recorded for reference in future years. The next day traps were retrieved and checked and the salinity and temperature of the water were recorded. Native helmet and Dungeness crabs were trapped, sexed, measured and released. No European green crabs were found in any of the traps this season, and none have been detected in previous years. Trappings will continue in order to monitor for the presence of the crab in future years.

Carpet Tunicate

Non-native tunicates, soft-bodied marine invertebrates commonly known as sea-squirts, attach to hard surfaces and have been found in Alaskan waters in recent years. The most threatening of these is *Didemnum vexillum*, first found in Sitka's Whiting Harbor in June 2010. Since its discovery in Alaska, eradication efforts have been pursued, and monitoring has increased. This invasive sea-squirt has the potential to seriously damage not only shoreline habitats but deeper offshore areas as well. Other potential invasive tunicate species being monitored for are *Botrylloides violaceus* and *Botryllus schosseri*. Monitoring is conducted by hanging ten PVC plates from three different docks in Bartlett Cove and checking them every three months to see if any of the invasive tunicates have attached to these hard surfaces. The plates were checked this season in early June, and re-deployed and checked again in September. No invasive tunicates were detected this season, and none have been detected previously in Glacier Bay. Currently, the plates are in the water and should be checked in three months. Monitoring has been ongoing in Glacier Bay by the EPMT program and should continue.

Eurasian Collared Dove

The Eurasian collared dove (*Streptopelia decaocto*) has been observed for several years in Gustavus, Bartlett Cove, and at Dry Bay in Glacier Bay National Preserve. Observational reporting to the EPMT began in 2011 and was continued this year. An email was sent to all park employees asking them to report all sightings of the bird at the park or in Gustavus. While standardized data from previous years are not available, anecdotal information and communications with park staff indicate that sightings have increased. No management plan has been determined to be necessary due to a lack of information pointing to any deleterious effect that the doves might have on native species. Reporting should continue to track the spread of this species in the area.

Gypsy Moth

Monitoring for gypsy moths (*Lymantria dispar*) by the EPMT began in 2011 and was continued in 2012. Gypsy moths use deciduous trees for food and can cause serious defoliation, threatening the health of the trees and species that depend upon them. Current populations have spread westward across the upper United States, reaching west of the Mississippi River. Moths have also been found along the coasts of Oregon and Washington (APHIS 2012). There are European and Asian subspecies of the *L. dispar*; the European subspecies is the most abundant in the U.S. The only sighting in Alaska has been of a single male Asian gypsy moth in Fairbanks in 2006 (ADF&G 2012). Three moth traps were deployed in early June in Gustavus - near the airport, at the garden store (Gustavus Gardens), and at the ferry terminal. These traps were checked three times this season and no invasive moths were found. The EPMT program should continue the gypsy moth monitoring program in subsequent years.

Other Species

Exotic species with no active monitoring in GLBA that have been detected or might be detected include: the European black slug (*Arion ater*), Atlantic salmon (*Salmo salar*), European starling (*Sturnus vulgaris*), barred owl (*Strix varia*) and brown-headed cowbird (*Molothus ater*). At this time no decisions have been made regarding monitoring activities to detect the presence of any these species.

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Appendix A. Invasiveness ranks for non-native plant species known or suspected to occur in Alaska

*Species of greatest concern in **yellow** based on invasiveness ranking and current known locations.

Unified Ecoregions of Alaska

USDA Code	Plant species (synonyms provided parenthetically)	Common name	Invasiveness ¹	Pacific Mar.	Int. Bor.	Arctic -Alp.
ACPT	<i>Achillea ptarmica</i>	sneezeweed	46	Yes	Yes	Yes
ACRE3	<i>Acroptilon repens</i> †	Russian knapweed	66	Yes	Yes	Yes
AEPO	<i>Aegopodium podagraria</i>	bishop's goutweed	57	Yes	Yes	Yes
ALMO12	<i>Alchemilla mollis</i> *	lady's mantle	56	Yes	Yes	Yes
ALMO4	<i>Alchemilla monticola</i> *	hairy lady's mantle	56	Yes	Yes	Yes
ALPE4	<i>Alliaria petiolata</i>	garlic mustard	70	Yes	—	—
ALGL2	<i>Alnus glutinosa</i> †	European alder	61	Yes	Yes	Yes
ALGE2	<i>Alopecurus geniculatus</i>	water foxtail	49	Yes	Yes	Yes
ALPR3	<i>Alopecurus pratensis</i>	meadow foxtail	52	Yes	Yes	Yes
AMRE	<i>Amaranthus retroflexus</i>	redroot pigweed	45	Yes	Yes	Yes
ANCO2	<i>Anthemis cotula</i>	mayweed chamomile	41	Yes	Yes	—
ARM12	<i>Arctium minus</i>	common burdock	49	Yes	Yes	Yes
BRSY	<i>Brachypodium sylvaticum</i> †	false slender brome	70	Yes	Yes	Yes
BRNA	<i>Brassica napus</i>	rapeseed mustard	47	Yes	Yes	Yes
BRRRA	<i>Brassica rapa</i>	birdsrape mustard	50	Yes	Yes	Yes
BRINI	<i>Bromus inermis</i> ssp. <i>inermis</i>	smooth brome	62	Yes	Yes	Yes
BRTE	<i>Bromus tectorum</i>	cheatgrass	78	Yes	Yes	Yes
CARA	<i>Campanula rapunculoides</i>	rampion bellflower	64	Yes	Yes	Yes
CABU2	<i>Capsella bursa-pastoris</i>	shepherd's purse	40	Yes	Yes	Yes
CAAR18	<i>Caragana arborescens</i>	Siberian peashrub	74	Yes	Yes	Yes
CAAC	<i>Carduus acanthoides</i> *†	plumeless thistle	61	Yes	Yes	Yes
CANU4	<i>Carduus nutans</i> *†	musk thistle	61	Yes	Yes	Yes
CAPY2	<i>Carduus pycnocephalus</i> *†	Italian thistle	61	Yes	Yes	Yes
CATE2	<i>Carduus tenuiflorus</i> *†	slender-flowered thistle	61	Yes	Yes	Yes
CEMO	<i>Centaurea montana</i>	perennial cornflower	46	Yes	Yes	Yes
CESO3	<i>Centaurea solstitialis</i> ***	yellow star-thistle				
CEST8	<i>Centaurea stoebe</i>	spotted knapweed	86	Yes	Yes	—
CEFOV2	<i>Cerastium fontanum</i> ssp. <i>vulgare</i> *	big chickweed	36	Yes	Yes	Yes
CEGL2	<i>Cerastium glomeratum</i> *	sticky chickweed	36	Yes	Yes	Yes
CHALA	<i>Chenopodium album</i>	lambsquarters	37	Yes	Yes	Yes
CIAR4	<i>Cirsium arvense</i>	Canada thistle	76	Yes	Yes	Yes
CIVU	<i>Cirsium vulgare</i>	bull thistle	61	Yes	Yes	Yes
COAR4	<i>Convolvulus arvensis</i>	field bindweed	56	Yes	Yes	Yes
COVA2	<i>Coronilla varia</i>	crownvetch	68	Yes	Yes	Yes
COC07	<i>Cotula coronopifolia</i>	common brassbuttons	42	Yes	—	—
CRTE3	<i>Crepis tectorum</i>	narrowleaf hawksbeard	56	Yes	Yes	Yes
CRVU2	<i>Crupina vulgaris</i> ***	common crupina				

USDA Code	Plant species (synonyms provided parenthetically)	Common name	Invasiveness ¹	Pacific Mar.	Int. Bor.	Arctic -Alp.
CYSC4	<i>Cytisus scoparius</i>	Scotch broom	69	Yes	—	—
DAGL	<i>Dactylis glomerata</i>	orchardgrass	53	Yes	Yes	Yes
DEEL	<i>Deschampsia elongata</i>	slender hairgrass	35	Yes	Yes	Yes
DESO2	<i>Descurainia sophia</i>	herb sophia	41	Yes	Yes	Yes
DIPU	<i>Digitalis purpurea</i>	purple foxglove	51	Yes	Yes	—
ELCA7	<i>Elodea canadensis</i>	Canadian waterweed	79	Yes	Yes	Yes
ELRE4	<i>Elymus repens</i>	quackgrass	59	Yes	Yes	Yes
ELSI	<i>Elymus sibiricus</i>	Siberian wildrye	53	Yes	Yes	Yes
EUES	<i>Euphorbia esula</i> †	leafy spurge	84	Yes	Yes	—
EUNE3	<i>Euphrasia nemorosa</i>	common eyebright	42	Yes	Yes	Yes
POBO10	<i>Fallopia ×bohemica</i> * (<i>Polygonum xbohemicum</i>)	Bohemian knotweed	87	Yes	Yes	—
FACO	<i>Fallopia convolvulus</i> (<i>Polygonum convolvulus</i>)	black bindweed	50	Yes	Yes	Yes
FAJA2	<i>Fallopia japonica</i> * (<i>Polygonum cuspidatum</i>)	Japanese knotweed	87	Yes	Yes	—
FASA3	<i>Fallopia sachalinensis</i> * (<i>Polygonum sachalinensis</i>)	giant knotweed	87	Yes	Yes	—
GABI3	<i>Galeopsis bifida</i> *	splitlip hempnettle	50	Yes	Yes	Yes
GATE2	<i>Galeopsis tetrahit</i> *	brittlestem hempnettle	50	Yes	Yes	Yes
GERO	<i>Geranium robertianum</i>	herb Robert	67	Yes	Yes	Yes
GLHE2	<i>Glechoma hederacea</i>	ground ivy	48	Yes	Yes	Yes
GYPA	<i>Gypsophila paniculata</i>	baby's-breath	57	Yes	Yes	Yes
HEHE	<i>Hedera helix</i>	English ivy	73	Yes	—	—
HEMA17	<i>Heracleum mantegazzianum</i> †	giant hogweed	81	Yes	Yes	Yes
HEMA3	<i>Hesperis matronalis</i>	dames rocket	41	Yes	Yes	—
HIAU	<i>Hieracium aurantiacum</i> *	orange hawkweed	79	Yes	Yes	Yes
HICA10	<i>Hieracium caespitosum</i> *	meadow hawkweed	79	Yes	Yes	Yes
HILA8	<i>Hieracium lachenalii</i>	common hawkweed	57	Yes	Yes	Yes
HIPIP	<i>Hieracium pilosella</i>	mouse-ear hawkweed	63	Yes	Yes	Yes
HUUM	<i>Hieracium umbellatum</i>	narrowleaf hawkweed	51	Yes	Yes	Yes
HOLA	<i>Holcus lanatus</i>	common velvetgrass	56	Yes	—	—
HOJU	<i>Hordeum jubatum</i>	foxtail barley	63	Yes	Yes	Yes
HOMUL	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	leporinum barley	60	—	Yes	—
HOVU	<i>Hordeum vulgare</i>	common barley	39	Yes	Yes	Yes
HYVE3	<i>Hydrilla verticillata</i> †	hydrilla	80	Yes	Yes	Yes
HYPE	<i>Hypericum perforatum</i>	common St. Johnswort	52	Yes	Yes	Yes
HYRA3	<i>Hypochaeris radicata</i>	hairy catsear	44	Yes	Yes	Yes
ILAQ80	<i>Ilex aquifolium</i>	English holly	67	Yes	—	—
IMGL	<i>Impatiens glandulifera</i>	ornamental jewelweed	82	Yes	Yes	—
IRPS	<i>Iris pseudacorus</i>	yellowflag iris	66	Yes	Yes	Yes
LAAL	<i>Lamium album</i>	white deadnettle	40	Yes	Yes	Yes
LASQ	<i>Lappula squarrosa</i>	European stickseed	44	Yes	Yes	Yes
LACO3	<i>Lapsana communis</i>	nipplewort	33	Yes	Yes	Yes

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LEAU2	<i>Leontodon autumnalis</i>	fall dandelion	51	Yes	Yes	Yes
LEDE	<i>Lepidium densiflorum</i>	common pepperweed	25	Yes	Yes	Yes
LELA2	<i>Lepidium latifolium</i> †	broadleaved pepperweed	71	—	Yes	Yes
LEVU	<i>Leucanthemum vulgare</i>	oxeye daisy	61	Yes	Yes	Yes
LIDA	<i>Linaria dalmatica</i>	Dalmatian toadflax	58	—	Yes	—
LIVU2	<i>Linaria vulgaris</i>	yellow toadflax	69	Yes	Yes	Yes
LOPEM2	<i>Lolium multiflorum</i>	Italian ryegrass	41	Yes	Yes	Yes
LOPEP	<i>Lolium perenne</i>	perennial ryegrass	52	Yes	Yes	Yes
LOTA	<i>Lonicera tatarica</i>	Tatarian honeysuckle	66	Yes	Yes	—
LOCO6	<i>Lotus corniculatus</i>	birdsfoot trefoil	65	Yes	Yes	Yes
LUPOP4	<i>Lupinus polyphyllus</i> **	bigleaf lupine	71	Yes	Yes	Yes
LYSA2	<i>Lythrum salicaria</i> *	purple loosestrife	84	—	Yes	—
LYVI3	<i>Lythrum virgatum</i> *	European wand loosestrife	84	—	Yes	—
MADI6	<i>Matricaria discoidea</i>	pineappleweed	32	Yes	Yes	Yes
MELU	<i>Medicago lupulina</i>	black medick	48	Yes	Yes	Yes
MESAF	<i>Medicago sativa</i> ssp. <i>falcata</i>	yellow alfalfa	64	Yes	Yes	Yes
MESAS	<i>Medicago sativa</i> ssp. <i>sativa</i>	alfalfa	59	Yes	Yes	Yes
MEAL12	<i>Melilotus alba</i>	white sweetclover	81	Yes	Yes	Yes
MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	69	Yes	Yes	Yes
MEPI	<i>Mentha ×piperita</i> *	peppermint	43	Yes	Yes	Yes
MESP3	<i>Mentha spicata</i> *	spearmint	43	Yes	Yes	Yes
MYMU	<i>Mycelis muralis</i>	wall lettuce	31	Yes	—	—
MYSC	<i>Myosotis scorpioides</i>	European forget-me-not	54	Yes	Yes	Yes
MYSP2	<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	90	Yes	Yes	Yes
NYODO	<i>Nymphaea odorata</i> ssp. <i>odorata</i>	American white waterlily	80	Yes	—	—
PANUA	<i>Papaver croceum</i>	Icelandic poppy	39	Yes	Yes	Yes
PELA22	<i>Persicaria lapathifolia</i> * (<i>Polygonum lapathifolium</i>)	curlytop knotweed	47	Yes	Yes	Yes
PEMA24	<i>Persicaria maculosa</i> * (<i>Polygonum persicaria</i>)	spotted ladythumb	47	Yes	Yes	Yes
POPO5	<i>Persicaria wallichii</i> (<i>Polygonum polystachyum</i>)	Himalayan knotweed	80	Yes	—	—
PHAR3	<i>Phalaris arundinacea</i>	reed canarygrass	83	Yes	Yes	Yes
PHPR3	<i>Phleum pratense</i>	timothy	54	Yes	Yes	Yes
PHAU7	<i>Phragmites australis</i>	common reed	83	Yes	Yes	Yes
PLMA2	<i>Plantago major</i>	common plantain	44	Yes	Yes	Yes
POAN	<i>Poa annua</i>	annual bluegrass	46	Yes	Yes	Yes
POCO	<i>Poa compressa</i>	Canada bluegrass	39	Yes	Yes	Yes
POPR	<i>Poa pratensis</i> ssp. <i>irrigata</i> *	spreading bluegrass	52	Yes	Yes	Yes
POPR	<i>Poa pratensis</i> ssp. <i>pratensis</i> *	Kentucky bluegrass	52	Yes	Yes	Yes
POTR2	<i>Poa trivialis</i> *	rough bluegrass	52	Yes	Yes	Yes
POAV	<i>Polygonum aviculare</i>	prostrate knotweed	45	Yes	Yes	Yes
PORE5	<i>Potentilla recta</i> †	sulfur cinquefoil	57	Yes	Yes	—
PRPA5	<i>Prunus padus</i>	European bird cherry	74	Yes	Yes	—
PRVI	<i>Prunus virginiana</i>	chokecherry	74	Yes	Yes	Yes
RAAC3	<i>Ranunculus acris</i> *	tall buttercup	54	Yes	Yes	Yes

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RARE3	<i>Ranunculus repens</i> *	creeping buttercup	54	Yes	Yes	Yes
RORU	<i>Rosa rugosa</i>	rugosa rose	72	Yes	Yes	Yes
RUDI2	<i>Rubus discolor</i>	Himalayan blackberry	77	Yes	—	—
RUAC3	<i>Rumex acetosella</i>	common sheep sorrel	51	Yes	Yes	Yes
RUCR	<i>Rumex crispus</i> *	curly dock	48	Yes	Yes	Yes
RULO2	<i>Rumex longifolius</i> *	dooryard dock	48	Yes	Yes	Yes
RUOB	<i>Rumex obtusifolius</i> *	bitter dock	48	Yes	Yes	Yes
SAPR	<i>Sagina procumbens</i>	birdseye pearlwort	39	Yes	Yes	Yes
SAOF4	<i>Saponaria officinalis</i>	bouncingbet	34	Yes	Yes	—
SCPH	<i>Schedonorus arundinaceus</i>	tall fescue	63	Yes	Yes	Yes
SEJA	<i>Senecio jacobaea</i>	tansy ragwort	63	Yes	Yes	Yes
SESY	<i>Senecio sylvaticus</i>	woodland ragwort	41	Yes	Yes	Yes
SEVU	<i>Senecio vulgaris</i>	common groundsel	36	Yes	Yes	Yes
LYCH3	<i>Silene chalcidonica</i>	Maltese cross	42	Yes	Yes	Yes
SIDI4	<i>Silene dioica</i> *	red catchfly	42	Yes	Yes	Yes
SILA21	<i>Silene latifolia</i> *	white cockle	42	Yes	Yes	Yes
SINO	<i>Silene noctiflora</i> *	nightflowering silene	42	Yes	Yes	Yes
SIVU	<i>Silene vulgaris</i> *	bladder campion	42	Yes	Yes	Yes
SOAR2	<i>Sonchus arvensis</i>	perennial sowthistle	73	Yes	Yes	—
SOAS	<i>Sonchus asper</i>	spiny sowthistle	46	Yes	Yes	Yes
SOOL	<i>Sonchus oleraceus</i>	annual sowthistle	46	Yes	Yes	Yes
SOAR	<i>Sorbus aucuparia</i>	European mountain ash	59	Yes	—	—
SPAL	<i>Spartina alterniflora</i> *†	smooth cordgrass	86	Yes	—	—
SPAN5	<i>Spartina anglica</i> *†	common cordgrass	86	Yes	—	—
SPDE2	<i>Spartina densiflora</i> *†	denseflower cordgrass	86	Yes	—	—
SPPA	<i>Spartina patens</i> *†	saltmeadow cordgrass	86	Yes	—	—
SPAR	<i>Spergula arvensis</i>	corn spurry	32	Yes	Yes	Yes
SPRU	<i>Spergularia rubra</i>	red sandspurry	34	Yes	Yes	Yes
STME2	<i>Stellaria media</i> (non-seabird sites)	common chickweed	42	Yes	Yes	Yes
STME2	<i>Stellaria media</i> (seabird colonies)	common chickweed	54	Yes	Yes	Yes
SYOF	<i>Symphytum officinale</i>	common comfrey	48	Yes	Yes	Yes
TAVU	<i>Tanacetum vulgare</i>	common tansy	60	Yes	Yes	Yes
TAOFO	<i>Taraxacum officinale</i> ssp. <i>officinale</i>	common dandelion	58	Yes	Yes	Yes
THAR5	<i>Thlaspi arvense</i>	field pennycress	42	Yes	Yes	Yes
TRDU	<i>Tragopogon dubius</i>	yellow salsify	50	Yes	Yes	—
TRDU2	<i>Trifolium dubium</i>	suckling clover	50	Yes	Yes	Yes
TRHY	<i>Trifolium hybridum</i>	alsike clover	57	Yes	Yes	Yes
TRPR2	<i>Trifolium pratense</i>	red clover	53	Yes	Yes	Yes
TRRE3	<i>Trifolium repens</i>	white clover	59	Yes	Yes	Yes
TRIN11	<i>Tripleurospermum inodorum</i> (<i>T. perforatum</i>)	scentless chamomile	48	Yes	Yes	Yes
VETH	<i>Verbascum thapsus</i>	common mullein	52	Yes	Yes	—
VESES	<i>Veronica serpyllifolia</i> ssp. <i>serpyllifolia</i>	thymeleaf speedwell	36	Yes	Yes	Yes

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VICRC	<i>Vicia cracca</i>	bird vetch	73	Yes	Yes	Yes
VIVI	<i>Vicia villosa</i>	winter vetch	53	Yes	Yes	—
VITR	<i>Viola tricolor</i>	johnny jumpup	34	Yes	Yes	Yes
ZOJA2	<i>Zostera japonica</i> †	dwarf eelgrass	53	Yes	Yes	—

Table modified from Nawrocki et al. 2011. Invasiveness ranking system of 50 non-native plants for Alaska. Report prepared for Alaska Association of Conservation Districts. 38 pp.

† Species not known from Alaska (per AKEPIC and ALA Herbarium databases as of February 2011)

* Congeneric species ranked together

** the native status of *Hordeum jubatum* and *Lupinus polyphyllus* is debated

****Centaurea solstitialis* and *Crupina vulgaris* were rejected from consideration in the climate screening phase

Yes = present or high probability of establishing in the ecoregion

– = absent and low probability of establishment

¹ Invasiveness Scores (Carlson et al. 2008):

>80 = Extremely Invasive

70-79 = Highly Invasive

60-69 = Moderately Invasive

50-59 = Modestly Invasive

40-49 = Weakly Invasive

< 40 = Very Weakly Invasive